Vols. 1 and 2

Piano Tone Building

PROCEEDINGS OF THE
PIANO TECHNICIANS
CONFERENCE
CHICAGO
1916, 1917, 1918
NEW YORK
1919

Acoustic Department
American Steel & Wire Co.

HAROLD B. LEE LIBRARY
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH

INDEX

C PAGE

Composition of Tone (Oct. 19, 1916) 16
Composition of Tone (Jan. 16, 1918) 150
Conferences by Dates:
October 5, 1916 10
October 19, 1916 16
November 2, 1916 22
November 16, 1916 27
December 7, 1916 37
December 21, 1916 42
January 3, 1917 50
January 17, 1917 55
February 7, 1917 59
February 21, 1917 69
March 7, 1917 88
March 21, 1917 93
April 18, 1917 101
May 2, 1917 109
May 16, 1917 115
October 3, 1917 117
October 17, 1917 122
November 7, 1917 130
November 21, 1917 138
December 17, 1917 144
January 16, 1918 150
February 6, 1918 156
February 20, 1918 160
March 20, 1918 170
April 3, 1918 175
April 17, 1918 183
May 1, 1918 192
May 15, 1918 198

D

Dinner and General Discussion 115
Dinner and General Review 198

E

Effects of Hammer Felts and Tension 22
Engineering Problems in Piano Construction 50

F

Felt Resiliency 160

H PAGE

Hammers, from the Sheep to the Piano 27
Height of Keyboard, Hammer Felts 37

M

Members of Chicago Piano Technician Conferences 5–8
Mining Music 167
Mysteries of Glue 93

P

Peculiarities of Wound Strings 42
Piano Technicians Meet in Chicago 9
Problems of the Piano Action Maker 88

Q

Qualities and Uses of Wood 59

R

Resiliency of Piano Hammers 192

S

Sounding Boards, Oct. 3, 1917 117
Sounding Boards, Oct. 17, 1917 122
Salesmen and Technicians Meet 138
Small Grand Construction 183
Substitute Woods 130

T

The Meeting of the Hammer and the Wire . 101
Treatment of Piano After Leaving the Factory 109
Trade-in Pianos 144
The Hammer and the Wire 156
The Effect of Hammer and Wire Resiliency upon Tone Quality 170
The Finished Piano and the Tuner 175

V

Varnish 55

W

What Tone are We Striving for and Why? .. 10
Wood and the Piano Builders' Art 69

1. R. H. Waud. 2. W. Davis. 3. W. B. White. 4. S. W. Widney. 5. H. H. Arnold. 6. E. J. Fishbaugh. 7. F. E. Morton. 8. C. H. Jackson. 9. T. A. Johanson. 10. E. E. Beach. 11. C. C. Chickering. 12. E. B. Bartlett 13. C. M. Stanley 14. C. A. Brown. 15. C. H. J. Thorby.

ML
652
.P63
P62x

Piano Tone Building

PROCEEDINGS OF THE
PIANO TECHNICIANS'
CONFERENCE
CHICAGO
1916
1917
1918

Acoustic Department
American Steel & Wire
Company

HAROLD B. LEE LIBRARY
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH

PREFACE

THIS book is made up from the stenographic report of Technicians' Conferences held under the auspices of the American Steel & Wire Company in their Assembly Room at 208 S. La Salle Street, Chicago from September 16, 1916, to May 15, 1918, inclusive.

These reports have been edited by the Chairman as agreed upon by the original participants at their first meeting. The discussions at times becoming intimate, the names of individuals, firms and products figuring largely in comment and criticism, anticipation of censorship was deemed essential to free expression.

The interdependence of all contributing in any measure to the building of pianos was assumed from the beginning, and the entire proceedings were characterized by a desire to substitute understanding for belief —scientific construction for traditional assemblage.

F. BAACKES,
Vice Pres't and Gen'l Sales Agent

Members of Chicago Piano Technician Conferences

A

ABENDSCHEIN, G. F., Staib-Abendschein Co., New York.
AIMIN, C. L., Mgr. Piano Dept. Butler Bros., Co.
ALBRECHT, FRED J., 2650 W. 23rd St., Chicago.
ALBRIGHT, FRANK, Wm. L., Marshall Veneer Chicago.
ALLEN, E. H., Pres. Boston Piano Supply Co., Norwood, Mass.
ANDERS, O., Lyon & Healy, Chicago.
ANDERSON, C. E., Steger & Sons Piano Mfg. Co., Chicago.
ANDERSON, Geo. A., American Felt Co., Chicago.
ARMSTRONG, ELMON, Cote Piano Manufacturing Co., Fall River, Mass.
ARNOLD, H. H., Bush & Gerts Piano Co., Chicago.
ASH, W. E., Amphion Piano Co., Syracuse, New York.

B

BAACKES, F., Vice Pres't, Am. Steel & Wire Co.
BARTH, L. L., Vice-President, The Edward Hines Lumber Co., Chicago.
BARTLETT, E. B., W. W. Kimball Co., Chicago.
BATES, G. C., The Widney Company, Chicago.
BEACH, E. E., Hamilton Piano Co., Chicago Heights, Ill.
BECHT, E. G. J., Lyon & Healy, Chicago.
BEHRENDT, A., Williams Piano & Organ Co., Chicago.
BENNETT, H. D., Williams Piano & Organ Co., Chicago.
BENNING, F., Steger & Sons Piano Mfg. Co.
BERGER, E., Steger & Sons Piano Mfg. Co.
BILLINGS, F. C., Bransfield-Billings Co., Milwaukee, Wis.
BLACK, T. A., The Cable Company, Chicago.
BLESS, A., Gulbransen-Dickinson Co., Chicago.
BOE, N., Lyon & Healy, Chicago.
BOEHM, Paul, Adam Schaaf, Chicago.
BOLENS, A. D., Bush & Gerts Piano Co., Chicago.
BOTHE, M. C., The Widney Company, Chicago.
BOWERS, JAMES F., Lyon & Healy, Chicago.
BROWN, C. ARTHUR, Chemical Engineer, American Steel & Wire Company, Chicago.
BROWNELL, G. R., Lyon & Healy, Chicago.
BRYANT, W. H., Mgr. Chicago Office, The Felters Co.
BUCHANAN, R. H., Mgr. New York Office, The Felters Company.
BURBACH, H. J., Steger & Sons Piano Mfg. Co.
BURKHARDT, W. Z., American Felt Co., Chicago.
BURNS, J. C., Steger & Sons Piano Mfg. Co.
BUTTELL, G., Steger & Sons, Piano Mfg. Co.
BYRNE, Chas. E., Steger & Sons Piano Mfg. Co.

C

CAMMACK, H. D., W. W. Kimball Company, Chicago.
CASPAR, BERNARD, Lyon & Healy, Chicago.
CASPERSEN, EDWARD, The Hobart M. Cable Co., La Porte, Indiana.
CHAPLEAU, O., Lyon & Healy, Chicago.
CHEEK, T. F., Auto Pneumatic Action Co., New York.
CHICKERING, C. C., Chickering Brothers, Chicago.
CHILDS, J. G., American Felt Company, Chicago.
CLUTE, C. H., Adam Schaaf, Chicago.
COLE, C. F., American Felt Company, Chicago.
COLLINS, W. H., Lyon & Healy, Chicago.
CONVERSE, F.E., W. W. Kimball Co., Chicago.
CORDES, WILMER, American Steel & Wire Company, Chicago.
COURBOIN, CHARLES M., Belgian Organist.
CRIPPEN, H. L., Steger & Sons Piano Mfg. Co., Chicago.

D

DAVIS, R. E., J. P. Seeburg Piano Co., Chicago.
DAVIS, WILLIAM, W. W. Kimball Company, Chicago.
DEAN, A. C., American Steel & Wire Company, Chicago.
DEMES, G. B., W. W. Kimball Company, Chicago.
DEUTSCHMANN, CHARLES, Lyon & Healy, Chicago.
DEWEY, H. S., The Edward Hines Lumber Company, Chicago.
DINSER, L., Cincinnati, Ohio.
DONAHUE, E. W., American Steel & Wire Company, Chicago.
DOTY, B. H., Bush & Gerts Piano Co., Chicago.
DOYLE, H., The Hobart M. Cable Company, La Porte, Ind.

E

EASTMAN, E. M., Smith, Barnes & Strohber, North Milwaukee, Wis.
EVENHOUSE, E. M., Lyon & Healy, Chicago.

F

FIBEL, FRED, The Cable Company, Chicago.
FISHBAUGH, E. J., The Hobart M. Cable Co., La Porte, Indiana.
FISHER, R., The Hobart M. Cable Co., La Porte, Indiana.
FORMAN, A. R., American Steel & Wire Company, Chicago.

FRANC, C. A., Uncheckable Varnish Co., Chicago.
FREBORG, D. W., Price & Teeple Piano Co., Chicago.

G

GARVEY, R. J., U. S. Glue Co., Milwaukee, Wis.
GEARMAN, H. J., Adam Schaaf, Chicago.
GERE, ALBERT H., Steger & Sons Piano Mfg. Co.
GERLICH, J. E., J. P. Seeburg Piano Co., Chicago.
GERTS, JOHN H., Bush & Gerts Piano Co., Chicago.
GROH, JOHN, The John Church Co., Chicago.
GUILLAUME, E. M., Mgr. Felt Department, James H. Rhodes & Company, Chicago.
GULBRANSEN, C. R., Gulbransen-Dickinson Co., Chicago.
GUNTHER, E., Steger & Sons Piano Mfg. Co.

H

HUMPHRYS, E. S., Am. Steel & Wire Co.
HALL, SAM A., Blackwell Panhandle Sales Office, Chicago.
HALSTEAD, H. D., Felt Department, James H. Rhodes & Co., Chicago.
HAMEL, FRANK, Monmouth, Ill.
HAYES, LAMBERT, Steger & Sons Piano Mfg. Co.
HAYWOOD, M., Holton, Kansas.
HEATON, W. C., Brambach Piano Co., Chicago.
HEHR, WILLIAM, Price & Teeple Piano Co., Chicago.
HEMINGTON, DR. FRANCIS, Oak Park, Ill.
HESS, A. J., American Steel & Wire Company, Chicago.
HINMAN, R. R., Steger & Sons Piano Mfg. Co.
HOHMAN, S. B., Lincoln, Nebraska.
HORTON, J. H., E. F. Wilks, Sydney, Australia.
HORTON, DR. HORACE E., Ag'l Commr., Am. Steel & Wire Co.
HOWARD, F. O., American Steel & Wire Company, Worcester, Mass.
HUSTON, PHILIP W., The Edward Hines Lumber Co., Chicago.

J

JACKSON, C. H., Jackson Piano Co., Milwaukee, Wis.
JACOBSON, J. H., Orton Bros, Butte, Mont.
JARROW, H., American Felt Co., Chicago.
JENKINS, WM. S., The John Church Company., Chicago.
JENNINGS, JAMES E., Packard Piano Co., Fort Wayne, Ind.
JOBSON, FRANK, The Hobart M. Cable Co., La Porte, Indiana.
JOHANSON, THURE A., The Cable Company, St. Charles, Illinois.
JOHNSON, E. C., Schaaf Piano String Co., Chicago.
JOHNSON, M. A.. The John Church Co., Chicago.
JOHNSTON, GEO. C., Lyon & Healy, Chicago.
JONES, B. O., Bush & Gerts Piano Co., Chicago.

K

KAUMEYER, H. G., James H. Rhodes & Co., Chicago.
KEIL, A. D., Adam Schaaf, Chicago.
KELLER, M., W. W. Kimball Co., Chicago.
KELLEY, R. D., American Steel & Wire Company, Chicago.
KERR, FRANK, Hamilton Piano Co., Cincinnati, Ohio.
KIMBALL, V. W., W. W. Kimball Company, Chicago.
KINDER, H. G., The Widney Co., Chicago.
KIRK, W. I., Lyon & Healy, Chicago.
KLEPAC, JOS., American Steel & Wire Company, Chicago.
KNAGGE, JOS., Hamilton Piano Co., Chicago Heights, Ill.
KNIGHT C. S., JR., American Steel & Wire Company, Chicago.
KOLLBAUN, E. L., The John Church Co., Chicago.
KRAUSE, A., Steger & Sons Piano Mfg. Co.
KREITER, C., Kreiter Manufacturing Co., Milwaukee, Wis.

L

LANEY, E. C., Adam Schaaf, Chicago.
LAPHAM, E. H., Grosvenor & Lapham, Chicago.
LAUFER, E. W. D., Associate Agricultural Commissioner, American Steel & Wire Company, Chicago.
LINDEN, C. F., W. W. Kimball Company, Chicago.
LINDER, A., The John Church Co., Chicago.
LINDHAMMER, J., Williams Piano & Organ Co., Chicago.
LINDSAY, R. W., Pratt & Lambert, Chicago.
LINGENBERG, R. W., The Cable Co., Chicago.
LINN, W. S., Western Sales Manager, American Felt Co., Chicago.
LISK, GEORGE, The Widney Company, Chicago.
LORENZ, T. V., The Cable Company, Chicago.
LUFKIN, GEORGE, W. W. Kimball Company, Chicago.
LUND, F. T., P. A. Starck Piano Co., Chicago.
LUND, W. A. Chicago Branch, Kohler Industries, Brambach Piano Co.
LUNERBERG, A., W. W. Kimball Company, Chicago.

M

MERRIMAN, D. A., Ass't Gen'l Sales Agent, Am. Steel & Wire Co.
MACY, B. F., American Steel & Wire Company, Chicago.
MARTIN, J., Steger & Sons Piano Mfg. Co.
MAURER, G., W. W. Kimball Co., Chicago.
MAURITZ, JOHN, The Hobart M. Cable Co., La Porte, Indiana.
MCCLELLAN, W. F., Lyon & Healy, Chicago.
MCDERMOTT, G. A., Gulbransen-Dickinson Co., Chicago.
MCDONALD, A. P., The Widney Company, Chicago.

McDonald, D. A., Lyon & Healy, Chicago.
McGinnis, D. J., Vose & Sons, Chicago.
McKeever, Edw., Lyon & Healy, Chicago.
McMurdo, A. M., American Steel & Wire Company, Chicago.
Mehlhop, F. W., Mgr. Glue Department, Swift & Co., Chicago.
Meister, Wm. D., Adam Schaaf, Chicago.
Michaels, F. R., The Widney Company, Chicago.
Milner, Frank, T., W. W. Kimball Co., Chicago.
Minnet, A., Steger & Sons Piano Mfg. Co.
Moffatt, F. S., W. W. Kimball Co., Chicago.
Moore, Francis, The Cable Company, Chicago.
Moremus, H. B., Vice-President & Secretary, The Hobart M. Cable Co., La Porte, Indiana.
Morris, G. B., Assistant Sales Manager, Armour Glue Works, Chicago.
Murray, C. F., Charles W. House & Sons, Chicago.

N

Nelson, A. W., Supt. & Mgr. of the Middleville Plant of the Felters Co.
Nelson, Oscar, J. P. Seeburg Piano Co., Chicago.

O

Ostrander, E. B., Meyer & Weber, Chicago.

P

Paesel, F. C., Choralcelo Company.
Pagenta, Dan, Steger & Sons Piano Mfg. Co.
Peck, Frank, The Hobart M. Cable Co., La Porte, Indiana.
Peters, G. J., Gulbransen-Dickinson Co., Chicago.
Peterson, L., The Widney Company, Chicago.
Peterson, L. W., Gulbransen-Dickinson Company, Chicago.
Petit, G., The Cable Company, Chicago.
Pfeiffer, A. E., Production Engineer, Industrial Service & Equipment Co., Boston, Mass.
Pierce, N., The Widney Company, Chicago.
Platte, C. E., Standard Felt Co., Chicago.
Pound, Geo. W., General Counsel, Music Industries Chamber of Commerce, New York.
Powell, T. M., Secretary, Cable-Nelson Piano Co., South Haven, Mich.
Pratt, D., American Steel & Wire Company.

R

Rummel, Geo. F., Ass't Gen'l Sales Agent, Am. Steel & Wire Co..
Rauworth, E. S., Cable-Nelson Piano Co., South Haven, Michigan.
Reckow, Paul, W. W. Kimball Co., Chicago.
Reed, J. F., Paragon Foundries, Oregon, Illinois.
Richardson, B. B., Lyon & Healy, Chicago.
Rippberger, E. J., Steger & Sons Piano Mfg. Co.
Root, E. E., Lyon & Healy, Chicago.
Rose, E. H., (Prince Lei Lain) Hawaii.
Rossiter, L. B., Chicago Mat Board Company, Chicago.
Rush, E. J., Lyon & Healy, Chicago.
Ruth, Geo. A., Charles Pfriemer.

S

Salich, E., E. S. Salich & Co. Consulting Engineers, Chicago.
Schaaf, Walter A., Adam Schaaf, Chicago.
Scheel, C. F., Western Electric Co., Chicago.
Schenk, Albert, R. Wurlitzer Company, Chicago.
Schubert, Paul, Lyon & Healy, Chicago.
Schulten, G. B., J. P. Seeburg Piano Co., Chicago.
Schulz, Otto, M. Schulz Co., Chicago.
Schumacher, F., W. W. Kimball Co., Chicago.
Schurz, E. W., Treas. The Hobart M. Cable Co., La Porte, Indiana.
Scott, R. L., Lyon & Healy, Chicago.
Semerad, John, Lyon & Healy, Chicago.
Seeburg, J. P., The Widney Co., Chicago.
Seeburg, W. M., The Widney Co., Chicago.
Shanley, J. H., Pratt & Lambert, Chicago.
Sill, J. V., W. W. Kimball Co., Chicago.
Slaughter, R. A., Baldwin Piano Co., Chicago.
Sleeper, J. E., Bransfield-Billings Co., Milwaukee, Wis.
Smith, L. E., Julius Bauer & Co., Chicago.
Sodolski, E. J., Standard Felt Co., Chicago.
Sperry, R. W. E., Packard Piano Co., Fort Wayne, Indiana.
Stanley, Charles M., P. A. Starck Piano Co., Chicago.
Steger, F. I., Steger & Sons Piano Mfg. Co., Chicago.
Stehlik, J. W., P. A. Starck Piano Co., Chicago.
Stein, F., Steger & Sons Piano Mfg. Co.
Stewart, H. A., Price & Teeple Piano Co., Chicago.
Strauch, A. T., Strauch Brothers, New York.
Strudeman, A. A., American Steel & Wire Company, Chicago.
Stryker, E. L., W. W. Kimball Co., Chicago.

T

Taylor, H. T., Swift & Co., Chicago.
Taylor, S. D., Sales Manager, Perkins Glue Co., South Bend, Indiana.
Thode, G., M. Schulze Co., Chicago.
Thomas, C. M., The Widney Co., Chicago.
Thomas, J. F., Pratt & Lambert, Chicago.
Thorby, C. H. J., Straube Piano Co., Hammond, Indiana.
Triggs, Harold M., (Pianist), Chicago.
Turner, G. D., Superior Foundries Co., Cleveland, Ohio.
Twitchell, H. N., Steger & Sons Piano Mfg. Co.

V

Valentine, W. C., Chicago Branch Manager, U. S. Glue Co., Milwaukee, Wis.

VETH, A., Mason & Hamlin Co., Chicago.
VILIM, VINCENT, Pres. & Gen. Mgr. Import Felt Co., New York, N. Y.
VOLKMAN, O. J., Steger & Sons Piano Mfg. Co., Chicago.
VOSS, J. L., Lyon & Healy, Chicago.

W

WAHLBURG, Theo. N., The Cable Company, Chicago.
WARD, JOHN, The Hobart M. Cable Co., La Porte, Ind.
WAUD, ROBERT H., Lyon & Healy, Chicago.
WEBER, T. F., Meyer & Weber, Chicago.
WEIDLING, FRED, Smith, Barnes & Strohber Co., Chicago.
WESSEL, S. M., Chicago.
WHELAN, EUGENE, W. W. Kimball Co., Chicago.
WHELAN, L. L., Armour & Co., Chicago.
WHITE, WILLIAM BRAID, Chicago.
WICKFELDER, E. F., Lyon & Healy, Chicago.
WIDNEY, S. W., The Widney Co., Chicago.
WILD, JULIUS, The Hobart M. Cable Co., La Porte, Ind.
WILLIAMS, CARL, Williams Piano & Organ Co., Chicago.
WITT, F., Steger & Sons Piano Mfg. Co.

Y

YOUNG, L. S., American Steel & Wire Company, Chicago.

"Music Trades" Sept. 16, 1916

Piano Technicians Meet in Chicago

Frank E. Morton of American Steel & Wire Company, Assembles Factory Superintendents and Technical Department Heads

CHICAGO, ILL., Sept. 11.— A conference of superintendents and technical directors of piano manufactories was held in the conference room of the American Steel & Wire Company Wednesday evening of last week. The meeting, both in attendance and interest evinced, met the best anticipations of Frank E. Morton, acoustic engineer of the company, who worked out the plan. After a substantial dinner Mr. Morton explained the object of the conference.

It was, he said, to arrange for individual and collaborative study, research and experiment, and he offered a meeting place for conferences of the kind. Everyone present took part in the discussion of the plan, and it was unanimously agreed that it was for the betterment of the piano industry, and all pledged co-operation and support. Mr. Morton was chosen permanent chairman with power to act, and he was asked to outline subjects for future conferences, assigning subjects to members.

It was agreed to meet the first and third Thursdays of each month in the conference room of the American Steel & Wire Company, at 1140 Continental and Commercial Bank Building.

At the next meeting the subject will be "Piano Tone," the question to be answered being "What quality of tone are we striving to produce, and why?" The subject was assigned to C. H. Jackson of the Edmund Gram Piano Co., Milwaukee, and he was requested to prepare a paper giving the viewpoint of the manufacturer.

To add to the interest of the meeting Mr. Morton promised to have present a pianist of national repute who will give to those assembled the viewpoint of the artist performer, demonstrating these views upon the piano. It is hoped that this conference will go a long way toward reconciling the viewpoint of the manufacturer and artist.

It was agreed that the entire proceedings of each conference, including papers, discussions, quizzes, etc., be stenographically recorded, edited by the chairman, and that copies be furnished those present, the trade press and such non-residents as may express a live interest, and that these non-residents be invited to participate in future conferences to the extent of their interest by the contribution of papers, comments and suggestions with the privilege of personal attendance at their convenience.

It was also agreed that no information relative to the proceedings should be given out by anyone other than the chairman.

It was also agreed that the technical department heads in the manufactories represented be invited by their respective superintendents to attend whenever the subject under discussion had a direct bearing upon their line of work.

Tone regulators will be present at the meeting on Oct. 5.

The entire evening was characterized by unanimity of purpose and method.

A rising vote of thanks was tendered Mr. Morton and the officials of the American Steel & Wire Company.

Those present at the initial meeting were Thure Johanson, The Cable Company; E. B. Bartlett, W. W. Kimball Co.; William Davis, W. W. Kimball Co.; Fred Weidling, Smith, Barnes & Strohber Co.; H. H. Arnold, Bush & Gerts Piano Co.; William Braid White; Mr. E. E. Beach, Hamilton Piano Co.; Mr. C. H. J. Thorby, Straube Piano Co.; Robert H. Waud, Lyon & Healy; C. H. Jackson, Edmund Gram Piano Co.; E. J. Fishbaugh, Hobart M. Cable Co.; E. M. Eastman, Smith, Barnes & Strohber; Conrad Kreiter, Kreiter Manufacturing Co., and C. Arthur Brown, chief engineer, Water Purification Department, American Steel & Wire Company.

Letters were received from the following expressing regret that they were unable to attend and manifesting interest in future conferences: W. B. Price, Price & Teeple Piano Co.; Will M. Bauer, Julius Bauer & Co.; A. F. Larson, Marquette Piano Co., and G. Miller, Lester Piano Co.

Verbal messages were received from the following: Paul B. Klugh, The Cable Company; George Steger, Steger Piano Co.; Mr. Starke, Rudolph Wurlitzer Co.; Carl Williams, Williams Piano & Organ Co.; George Lufkin, Kimball Piano Co.; Mr. Consoer, Smith, Barnes & Strohber Co.

What Tone Are We Striving for and Why?

October 5, 1916

C. H. Jackson:

"The condition of the human mind is one of endless change and variety; hence the great diversity of opinion as to what constitutes quality of tone. Thanks to the progressive spirit and endeavor, we are not looking to the past alone for an inspiration. We hold a reverend admiration for the beliefs and contributions of the early pioneers in our calling, who, in accordance with their perceptions and opportunities, attained their standards of excellence. Fortunately for us, however, ambition has ever urged man to seek out channels of endeavor through which he might improve upon that which has been attained by past effort. Thus day by day the work of enlightenment continues.

"As time unfolds its wonderful possibilities to us, the manufacturer of that most expressive of musical instruments — the piano — is confronted by the problem of determining how best to meet the demands of the diversified ideas of the ultimate consumer.

"It is not a question of catering to the characteristic tonal idea, conceived by the individual preferring one specific tone quality, but the production of a composite tone possessing all the elements requisite for appeasing and fulfilling the demands of the human family.

"Consider, for instance, the varying demands in a single home. There are as many appetites to be satisfied here as there are members of the family.

"There is father, who shows a preference for the fundamental, positive and commanding tones; mother, whose mind naturally turns to the soft, sweet tones of the old family square; sister, who revels in symphony recitals and desires constant tonal reminders of the orchestral effects; while brother, with his cabaret tendencies, is delighted with the brassiness and crash of his effervescent vaudeville 'classic.'

"So here we stand as caterers to a diverse and varying taste — one dish only to tickle the palate of all. We have pleased some of the family all the time, we have perhaps pleased all of the family some of the time, but our problem is to please all of the family all the time.

"Personally, I am striving for a composite, universal tone — not merely a tone that you or I deem the most desirable, but one that will satisfy the demands of all those who purchase, and, in purchasing, furnish the means for further progress. To my mind, this is the solution of this problem; a method of procedure to which all of us may consent without sacrificing any past favored tone quality and without injury to our professional dignity.

"In this universal and composite tone we offer the elements of symphonic quality; just enough of the violin and the 'cello; the proper proportion of the contra-bass for a foundation of our tonal structure; sufficient smoothing and filling properties of the wood winds, pointed with the brilliancy of the trumpet and French horns — the whole constituting a perfect blend.

"All the primary colors combine to produce a pure white, and in this composition no specific color is lost and none dominates. This white, when viewed by one through blue glasses, has a decided blue tint; through green glasses, a green tint, etc. It becomes, therefore, the privilege of the manufacturer of pianos to furnish the all inclusive, composite tone and permit the artist to draw therefrom such characteristic partials as may satisfy his demands."

Frank E. Morton, acoustic engineer of the American Steel and Wire Company and chairman of the meeting, then asked for criticism, questions and suggestions.

William Braid White: "Is it not true that in approaching any question like this we are compelled to approach it from one very narrowly limited road? Is it not true that just as soon as we go in the direction of cutting down—if I may put it so—softening up the percussion effect, to the same extent, we lose in all the other qualities? The more we try to sostenuto that tone and the more we try to make it beautiful, the more we are getting away from the piano-forte, and I would

like to ask how we propose to initiate any discussion of this kind unless we start from that point of view?"

C. H. Jackson: "You are going beyond the point. I have been discussing the tone merely from the point of view as we know it today. Whether we are some day going to do it some other way than by percussion lies with these gatherings. I have endeavored to give my opinion—to give what constitutes a good tone and not the method of bringing it out."

F. E. Morton: "Perhaps it might be well for me to state that we are discussing an idea to-night, and it was my suggestion that we discuss the question in the abstract, instead of the concrete; the methods of construction; the materials used and like subjects will follow. In other words, what particular quality do we expect to get from the piano which we consider a good piano, after we have made it a satisfactory one to ourselves? That is an idea. I see Mr. White's trend, and there is a limitation. I think Mr. Jackson is working on the assumption that the combined brains of this august body will be sufficient to remove any limitations which now may exist. Other questions, please."

Thure A. Johanson: "I understand our chairman asked us to discuss 'What Tone Are We Striving After?' More than a half century ago two of our noted manufacturers of pianos took up the tonal question. One worked on the European idea of tone; the other wanted to make the piano an American instrument. He wanted the beautiful tone of the European instrument, but he wanted to better it by making a big tone in keeping with this country, for use on the concert stage. We have singers—singers with beautiful voices—but we also have great big singers with just as fine voices that carry well. They will fill an auditorium, where the smaller voice will only be at its best in a small room.

"Will the American public be satisfied with the small voice or the big voice with the big carrying power? The second manufacturer wanted a tone correspondingly big. The first worked for the beautiful, fine tone and the second wanted the big, carrying tone we have to-day in their piano and I believe that is what we are all now striving for.

Seventy-five per cent to ninety per cent of the manufacturers in the country are striving after big, pleasing, carrying tone. We can put it in the small room and it will sound beautiful and also in the big concert hall that the grand opera singer can fill. It seems to me that is what we should discuss. Find out how we can improve and come up to the best in the country."

E. B. Bartlett: "The piano has to fill such a multiplicity of requirements that we have a more difficult problem than the maker of any other instrument. With the organ we get the various tone qualities by means of different stops. Certain upper partials are emphasized and brought out. In the flutes we eliminate some of the upper partials, leaving that hollow, s mooth, sweet tone that is so greatly admired. In the reeds, we have a great variety, but in the Diapason we find all the elements that are present in these others, and Mr. Jackson's illustration of the white light embodying all the primary colors, was a very good one. The Diapason properly voiced embodies all the qualities found in the other stops. In the piano, the multiplicity of uses we have to combine in the one instrument is our difficulty. Years ago, a small piano was brought out. When it first appeared, it was noticeably nasal in quality. Alterations were made and the peculiar nasal quality disappeared. If I were to interpret the paper read, I would say that Mr. Jackson prefers the Diapason quality in the piano, and I agree with him."

C. H. Jackson: "That is exactly what I meant, Mr. Bartlett. On the other hand, the representative of a certain factory at one time told me they were basing the tone of their piano on that of the 'cello. If we are all lovers of the 'cello, well and good, but it is wrong for the manufacturer to attempt to insist upon the acceptance of any one characteristic of tone by his public."

R. H. Waud: "We have all heard plenty of pianos that sound very nice when played softly, but when one tries to bring out a full tone there is nothing left. Lots of our pianos are that way when forced. When the player demands power he can't get through with it. There is no bottom. A singing quality of tone is preferable to volume. When you strike a note you should have the tone without striving for it. You should have something you can remember, not something you have gone through and find there is a bottom or there isn't a bottom."

F. E. Morton: "Will you tell us exactly what you mean by singing quality of tone? I would like your definition."

R. H. Waud: "The singing quality of tone is one you can caress, can play something nice and sweet; and when you get to where sister plays, it will be a little stronger; brother, of course, likes the crash-bang, but the whole family likes the singing quality of tone that you can do anything with, and can't 'go through.' We are not trying to get the bass drum. There are lots of pianos that do that. Some of our friends in South America like to get the castenets and the mandolin. I don't believe the majority want that sort of stuff, and I don't believe any of us are striving to turn out instruments with mandolin attachments. We are merely catering to that trade asking for it. It is only dollars, and we want our dollars. We have two kinds of pianos—the grand, which is driving up and the upright, driving back. We should take into consideration the two kinds of pianos. Everybody is striving for the smaller grand. It seems to me that the piano that can stand up against the wall and can drive the tone into the wall and still come back to the people is the right kind of piano. There are reasons for it—must be reasons. We want to determine why."

E. E. Beach: "My ideas are very similar to Mr. Waud's and Mr. Jackson's—the tone which could be called a spontaneous tone, well sustained."

Thure Johanson: "The instrument we are trying to come nearest to is the human voice. In discussing quality of tone, we speak of the singing tone, and we also have the carrying tone. There are many kinds of voices. A singer who knows how to project the finest pianissimo will be heard to the end of the hall. Singing fortissimo he will fill the hall and pretty nearly lift the roof, and that is what we are striving for,—a piano that will carry when played pianissimo."

John H. Gerts: "I have spent, you might say, all my life working on pianos and looking over work, etc. When we speak here of the tone we are striving for, my idea is to get a greater tone, —first getting the false notes out of the piano. We should try to eliminate them first, then, of course, it is with each concern to draw up a good scale so that something will come out. I think it would be well to discuss how we first can get the false notes out of the piano."

Wm. Braid White: "I have just been amusing myself during the last ten minutes or so by observing the different definitions which various ones have made and their attempts to state what they mean by ideal tone,—the singing tone, the human voice, the Diapason, sweet and carrying, clear, etc. Each one has given a different definition and I might say if there were fifty, there would be fifty definitions. If we get a sustained tone, would not the rest follow? Are we not working for a tone which shall take us away from the limitations of the percussion instrument, bringing us nearer the quality we can't describe, which we know as the sostenuto? It seems to me that there is some working toward a definite end in that service."

E. J. Fishbaugh: "I have greatly benefited by what I have heard, and some new light on the subject has been given me. The kind of tone as I see it that we want, is the quality of tone that in pianissimo is the same general character of tone that we get at double forte. We want carrying power that will sustain the original quality of that tone."

F. E. Morton: "Madame Sturkow-Ryder has consented to give us the artist's side and I can assure you an interesting address."

Madame Sturkow-Ryder: "I really feel timid in addressing you all, and I am not going to try to enter your side of the argument, but only tell you what we artists think and feel when we have a piano under our hands. You may say, 'What do we care what the artist thinks—we sell our pianos to householders and to music lovers, only a very small percentage to artists,' but about nine-tenths of your patrons come to us and ask if we like a certain piano. They say, 'What do you think of it? I wish you would play on the piano we have chosen and tell us if it is good' or, 'We have to get a piano for Jennie, what piano do you think is the best,' so you see we are worth pleasing.

"In fact, the good artist is your greatest aid, for the most important thing to him is a fine performance, so when he finds a piano with a squeaky pedal, he tries to cover it by using the pedal rarely and quickly; if the bass predominates, he subdues his left hand; if the tone is weak, he helps out with the pedals; if the tone is shallow and noisy, he uses the soft pedal and makes the softest pianissimo possible, and so on, so you can see how valuable it is to have the artist on your side.

"Now about the tone. With the artist the tone is largely a matter of feeling. I should say that the great important feature of tone was to have it '*vital*,' '*alive*,' a tone that sparkles, that has an

after-clap, a tone, loud or soft, as long as you can hear it,—that is *alive*. I believe that a tone should have body, meat and vitality, for the things of real art are vital, living things. When it is not vital, it is dead, cold, second-hand, emotionless.

"Pounding on a note does not make it vital—it is the energy behind it that keeps it alive, like this—(illustrates). The quickness with which you think, makes it vital.

"As a general rule, artists don't hear much of the tone at a concert, but they feel it. It is very much like a person speaking, the sound of the tone goes away from him, is thrown out toward the audience and this is especially true when they are playing with the orchestra, for the sound of the instruments is in his ears and he hardly hears himself at all.

"Then there is clarity of tone. That is very desirable. I hardly know anything more disconcerting than a 'muddy' tone, a thick, flannel-mouthed, mushy tone—one simply can't make it sparkle.

"And here is where I want to say a word to the man who comes around and pricks up the felt in order to soften the tone—is he here?—for I have had him on my mind for a long time. He often does more harm to the tone than good. Please tell him to go carefully.

"Of course the action of a piano has a good deal to do with tone production. If it is very stiff, it is hard to play with fluency, and also hard to play compositions that require quick repetitions. I had to abandon a little 'etude' at a good many concerts last winter because the piano wouldn't take the repetition. Then a thick tone seems to the artist as if the action were heavy, because he has to work to get brilliancy, and a too-light action makes the piano feel shallow. The soft pedal is also frequently hard to move and when it does move the tone is often of an entirely different quality, so it has to be used with care—and the middle pedal sometimes works very slowly, and sometimes 'sticks,' prolonging a note to an awful length.

"Again, if the keys are too sharp, the edges I mean, it is sometimes a cause of discomfort to the artist, for a blow on a sharp key is quite a shock and a torn finger nail will spoil a good many delicate passages, to say nothing of the state of mind of the artist.

"All these things harass the player, so that he cannot think undividedly about the tone or the performance, and that is why they are so important.

"I am now going to play you two modern compositions by Rhene-Baton, as they show two distinct and different kinds of tone. The first is the pounding of the surf on the rocks and the turning of the tide, requiring a heavy, sonorous tone, a great deal of pedal and big crescendos; the second is the 'Spinning Girls of Carantec,' representing a group of women in the old Breton market with their work, chattering and gossiping. This requires a scintillating tone of extreme clarity and lightness and great fluency of technique."

F. E. Morton: "Assuming from Mr. Jackson's paper these tone characteristics are to be found in the ideal tone, and from Mr. Bartlett's likening it to the organ pipes, is it within the province of the artist to bring out any one distinct characteristic tone as a partial from this composite? Has the artist a selective power?"

Madame Sturkow-Ryder: "I should hate to feel that I wasn't master of the instrument and couldn't do exactly what I wanted with it. I would be a very poor artist to think I couldn't do that."

Wm. Braid White: "To what extent are we to regard the piano as mere plastic material?"

Madame Sturkow-Ryder: "I should say that the piano that had no character was like a person who had no character. I should only want to work with a piano that has character. We don't want you to strive for a character of tone that will be unfit for many uses. I doubt whether you could afford to specialize on any particular style of tone."

Wm. Braid White: "Does the artist really regard it as the artist's duty to create a quality or merely to color an existing quality?"

Madame Sturkow-Ryder: "It would be beyond any artist's ability to create quality. What an artist does is to make the best of all conditions, which means trying to give the most beautiful performance possible on whatever instrument is furnished. Does this cover?"

Wm. Braid White: "I would like to go even further. We are in the position of distressed mariners, looking for help. Madame Ryder can help us. Are we to give the artist something to color or something to create?"

Madame Sturkow-Ryder: "Go as far as you can. We cannot create the instrument, we may only use."

Thure Johanson: "Couldn't artists help by telling us what color of tone we should have in an instrument? Should we strive for a certain color of tone in a piano? It is impossible to photograph a tone. If that were possible we could start from a known point with the hope of arriving at something definite. Madame Sturkow-Ryder spoke of 'vitality' and 'meat' in the piano, but we would like to know what color of tone is the best. Mr. Jackson spoke about the 'cello. It is one of the most beautiful tones, but should we go after that quality?"

Madame Sturkow-Ryder: "While the 'cello is beautiful, it is limited in the scope of its quality. The quality most to be desired is that of the mezzo soprano, if you are selecting an example. The mezzo soprano is the only voice that does not lose in the high register and does not thicken in the low register. I am extremely partial to the contralto voice, but the contralto voice is limited like the 'cello. The ideal tone is the mezzo soprano. It has the widest range and does not sacrifice roundness of tone to pitch. The soprano is a wonderful tone for carrying; fineness, and for the confectionery of music, but it is not a satisfying tone. For the many uses the piano has to fill, the ideal quality of tone to be followed as nearly as possible is that of the mezzo soprano."

R. H. Waud: "Madame Ryder has spoken several times this evening regarding the mechanical uses of the pedal. We want to find out how far we should go in the mechanical work. In using the soft pedal to get effects, there are two ways of doing it. Which, from an artist's view, is the better one; shifting the keyboard and striking two strings or one string, or the one moving the hammer rail up with that 'gone' feeling?"

MadameSturkow-Ryder: "I should say the movement of the hammers to the two strings s satisfactory enough if the wire strikes the right place on the hammer, but that doesn't very often happen. Generally it gives a different quality of tone which is most disconcerting. For evenness of tone, an upright piano gives the most satisfaction in the change to the soft pedal."

Thure Johanson: "The way the grand actions are made you can never get a beautiful touch on account of the lost motion. If we could make this, the artist would rather use it. Madame Ryder spoke about squeaky pedals and rounding of sharps and many other defects. We are criminal when it comes to making a piano for the artist. We feel that it is perfect when it leaves the factory. There are many conditions which tend to put the piano out of order. We do not hear as much of the conditions of the pianos after they have been used by an artist, and it is a pleasure to meet an artist and hear of them, and it would be better to meet them more often. We should be more in touch with the artist and learn the defects in the piano. We don't figure that the pianos get out of order, but they do. When Madame Ryder meets our officers and officers of other concerns, she should tell them also."

Madame Sturkow-Ryder: "Don't think I am always fault-finding. While it is true that you should hear some of the faults, so also should you hear of the enjoyment derived from playing on your pianos. I often play on pianos that are beautiful."

Wm. Braid White: "In listening to Madame Ryder's playing, the second Breton piece for instance, I was particularly conscious of the atmosphere, and I was particularly interested in the manipulation of the pedals. Madame Ryder used the damper pedal. I would like to know whether on the whole she believes that the tone sustaining pedal is justified? Should an artist do without the tone sustainer?"

Madame Sturkow-Ryder: "Personally, I can see no reason why an artist can't get along without the sostenuto pedal. I tried to show you what could be done with the hand without using the sostenuto. I struck one note of a chord with greater energy. The tone of it ran into the next chord and formed without the use of the sostenuto pedal. There are certain effects which require the middle pedal, but they are not common and deal only with an artist's performance, not with the layman. We often avoid the soft pedal. I should rather say that the change of quality in the soft pedal is to be deplored. I am saying this without a great amount of thought on the subject. It is not so noticeable in an upright as in a grand—this change to a soft pedal tone. But why do you have your pedals so stiff? What you should have is a transformer. (Laughter.) Something else has annoyed me. Is there any reason why piano benches should all be of different heights?"

R. H. Waud: "I don't believe the difference is in the height. A grand piano bench is 19 inches from the floor to the top, and an upright bench is 20½ inches."

Mme. Sturkow-Ryder: "There is always so much unnecessary delay in getting a bench to fit the piano. There is a point where it is dramatically splendid to make people wait for you, and there is the very finest line between that and the effect of coming in too late—anything that retards a performance is to be deplored.

Thure Johanson: "Grand piano keyboards could be of uniform height; uprights also. On account of the architecture they vary. We make the piano 3 feet 11 inches to 4 feet 10 inches in height. The architecture of a piano could easily be changed to give a keyboard of uniform height."

Mme. Sturkow-Ryder: "All who pay $2.00 for a ticket to a concert are prospective buyers. What they hear on the stage impresses them. They are much more impressed there than by what they hear in a store. When anything goes wrong at a recital, the audience thinks there is something the matter with the piano. You should help us to help you. I try to do the best I can for the piano and for the audience."

R. H. Waud: "While we do not round the black keys for American trade, we are obliged to do so for the export trade."

C. H. Jackson: "I was very glad to hear Madame Ryder say that the pounding era is over. At one time I had charge of concert grands which were used for concert purposes. I have often heard people, after the concert, say, 'Did you hear that terrible piano?' The fact of the matter was that through this pounding, it did sound terrible to those people."

Mme. Sturkow-Ryder: "From very great artists we forgive moments of almost anything, but these artists are rare."

Wm. Braid White: "Should we not be interpreting you correctly if we said the one particular thought you want us to carry away, as illustrating what piano tone should be, is that modern music demands a constant change of color and all that we mean when we use the word 'atmosphere'?"

Mme. Sturkow-Ryder: "I want the materials at hand to create atmosphere. Atmosphere is the effect not the cause. You have therefore an instrument capable of producing effects, both that which we call atmosphere and the effects of classic music — body in the tone; meat."

E. B. Bartlett: "Would it be fair to ask the artist to do away with the soft pedal on the grand?"

Mme. Sturkow-Ryder: "That would limit concert work too much. There are some things that require the soft pedal."

E. B. Bartlett: "The advantages, then, out-weigh the disadvantages?"

Mme. Sturkow-Ryder: "Make the soft pedal as pliable as possible. The heaviness is not as objectionable as the position of the hammers on the wire."

F. E. Morton: "Mr. Johanson stated if we could get a photograph of a piano tone we would then be able to use that as a starting point and argue from that point. While we can't say truthfully that we have a photograph of piano tone, we have photographs of a reproduction of forms of vibration by Prof. Dayton C. Miller. Dr. Sabine also has succeeded in producing upon a photographic plate an impression which amounts to a photograph of the condensed portion of a sound wave. I think we should try to secure Dr. Muckey to present the Manometric Flame for our instruction. Very little has gone direct from the laboratory to the work bench. That is the reason why we reach out after the solution of problems only to find they are common knowledge to the acoustician. They have been solved only in the laboratory. They are still theories which have not been applied. We can analyze tone. We can build up tone and know positively that when this combination makes a certain quality of tone and that when one or more partials is taken away or amplified we have another quality, we have a basis from which we may go back to the factory and attack our problem. If we can recognize and define a certain tone quality in a piano and understand its composition, we will certainly be in a better position to reproduce that tone. Please give me credit for knowledge sufficient to keep me from assuming that any one thing is responsible for the tone of a piano. There are so many things, that I don't look for the working out of more than one or two subjects this winter. What is the function of the sounding board, for instance? We may learn how it is functioning; the response that the board is giving to the wire through the bridge; the relationship of the bridge to the sounding board; the relationship of the wire to the hammer.

"We will take for our next subject 'Tone Composition.' Of what is the piano tone composed; what are the partials and what is their relative intensity?"

It was suggested that Mr. Morton write this paper.

H. H. Arnold: "In regard to the different heights from the keyboard to the floor, I would suggest that we take measurements, bring them here at our next meeting and compare them."

Mme. Sturkow-Ryder was given a rising vote of thanks for her kindly co-operation with the manufacturers.

A vote of thanks was tendered Lyon & Healy for their courtesy in furnishing the piano for the evening. This instrument was a Steinway grand which was sent over by Manager William H. Collins of the piano department.

Composition of Tone

October 19, 1916

Mr. Morton stated that the co-operation of the trade press was evidenced by their treatment of the report of the last meeting and recommended that the music trade avail itself more generally of the services and privileges offered by the trade press.

After the results of observations of the height of grand keyboards were taken up, a general discussion followed upon the issue:

"Shall the architecture govern the height of keyboard, or shall the height of keyboard govern the style of architecture?"

A committee, consisting of Messrs. Waud, Chickering and Bartlett, was appointed to investigate further and report at the next meeting.

F. E. Morton: "It has been generally conceded by all theoreticians, and very largely by the practical men of the trade that the ideal tone is indefinable. No one person can say: 'This is an ideal tone.' We may say: 'This is a good 'cello tone; cornet tone; bassoon tone,' and I am under the impression that this is reasonable.

"There is in the mind of each musician an ideal tone for which he is striving, but to say to the public generally that this is an ideal tone — not a characteristic ideal tone — would be unreasonable. The acoustician can analyze a given tone, but the acoustician cannot synthesize and say: 'This tone is ideal.'

"The question arises: 'Is there such a thing as a characteristic piano tone — an ideal piano tone?'

"We will start with the understanding that tone is composite. That statement is true in a general way, but we have a tone not decomposable, for instance, that of the tuning fork and the flute in its lower middle register. They are simple tones produced by simple, or pendular vibrations. One of the simplest methods of illustrating or symbolizing the form of vibration is accomplished with a rope. In a measure, this visualizes the abstract. (Illustrated.) This is the form of a vibrating wire, and we may think of the appearance of a sound wave as being the same. Really it isn't, but I find it advisable to avoid the wave theory in preliminary discussions.

"This rope is vibrating in one segment only (illustrating) producing the fundamental or first partial. (Fig. 1.) We will assume that it vibrates at the rate of 64 per second, giving the pitch of C_1.

Fig. 1

"It is now vibrating in two segments, each segment at a rate of 128. (Fig. 2.) This produces the second partial C_2.

Fig. 2

"Here is a vibration in three segments or a rate of 192, (Fig. 3), producing G_2, which is the third partial.

Fig. 3

"You now observe a vibration in four segments or a rate of 256, giving C_3, the fourth partial.

"And now by increasing the tension, we get a vibration in five segments or a rate of 320, giving E_3. Six segments give G_3 with 384 vibrations, and seven segments, 448, giving Bb_3 as nearly as we may designate the key by our equal tempered scale.

"We need interest ourselves very little, and that negatively, in partials above the seventh, for they speak in hard metallic tones as the sound of bells and bars. These are overtones which your tone regulators are engaged in eliminating.

"After examining pianos very generally in this country, I have found only three makers striving for a tone involving the use of odd numbered higher partials. These three are now changing their scales, thus evidencing doubt of the correctness of their original plan.

"It may be interesting to know the value of an added partial. What is its function? Later, we will correlate with construction, going into the specific treatment of sounding board, plate, hammer, scale, proportions, etc. But first let me assure you that you cannot produce a partial tone from the sounding board that is not formed in the string.

"I have here a flute pipe which produces a simple tone. Here is C_2. We add one partial — the octave. You will observe the composite effect is brilliancy. I now add the third partial G_3 and you will note that the composite effect is life, virility, vitality — that something which in vocal work is called timbre. Here is the fourth partial C_4, which gives point or added brilliancy to the tone, relieving in a measure the heavy dullness effected by the third partial.

"The fifth partial qualifies the third and relieves the sharpness of the fourth. This fifth partial is E_4.

"We can more easily bear in mind a tone quality when we associate it with some particular instrument. Quality is absolutely dependent upon the relative intensity of the component partials, and you will note that by damping any one of these pipes, a change of tone quality is effected.

"The tone of this first pipe does not carry well. It is a simple tone — smooth, quieting but tiresome. We don't want to hear too much of it. The tuning fork has the same quality, becoming dull at lower pitches and at higher pitches a lack of seasoning — as it were. An old saying illustrates this: 'The only thing worse than a flute concerto is a concert of flutes.'

"The piano is supposed to be a universal instrument containing those tones found characteristic in all other instruments. We may therefore deduce that a simple tone is not a desirable piano tone. Let me call your attention to the tone of the flute and tuning fork. The qualities are identical and yet we can readily distinguish the difference. These tones are distinguishable through accompanying sounds. Helmholtz shows that the tone produced by blowing across a bottle is identical with that of the tuning fork. A certain organist objected to the tone of a flute stop because of the hissing, initial sound upon which the voicer had bestowed great care. The organist evidently was not a flutist. In analyzing tone, we must first strip it of its outer coverings — noises incident to its production.

"Given a series of partials to and including the seventh, allot 50 per cent intensity to the first partial, the balance in sequentially decreasing intensity and we have the mezzo soprano quality. This quality was referred to at our previous meeting as a pleasing tone, its quality uninfluenced to a marked degree by increased volume, and I think we safely may thus classify the piano tone.

"That tone carries well, but we must bear in mind that pitch is a factor in carrying power. The same quality carries farther at a higher pitch. The higher notes of your piano carry farther than the lower notes. This should be taken into consideration in tone regulating.

"By striking a piano wire in the middle, you will get a hollow sound, a tone in which the odd numbered higher partials predominate. This narrow stopped pipe produces a similar tone. Moving the hammer line toward the center gives this hollow quality, therefore, this quality indicates that the hammer line is too far toward the center. The same quality may be produced by stringing

with wire of too small gauge. If a larger number of odd numbered higher partials is added, the tone is nasal. Note the tone of this Salicional pipe. It is pungent. You can approach this nasal quality by moving the hammer line toward the agraffe.

"We frequently refer to a given tone as 'thin.' What we really mean is that the fundamental or first partial is lacking in intensity. This effect may be produced by high tension.

"The shape and elasticity of the hammer affects the relative intensity of partials, and therefore is a potent factor in tone production. Helmholtz gives the following sequence for wire struck by a hammer touching the string for three-sevenths of the periodic time of the prime tone: 100, 99.7, 8.9, 2.3, 1.2, 0.01, 0.

"For a string struck by a perfect hard hammer: 100, 324.7, 504.9, 504.9, 324.7, 100. and 0. from which we may determine that the intensity of higher partials is directly as the hardness of the hammer and inversely as the length of time the hammer remains upon the wire.

"And now before taking up the striking point and its effect, I want you to hear the tone of a stretched wire actuated electrically. (Illustrated.)

"The magnet interruptions are the same as the rate of vibration of the wire. Now please note that the fundamental or first partial is relatively weak and that the second and fourth partials are very strong. A tone sustained as this tone is permits prolonged study, and a fuller realization of its composition. This a pleasing tone — not a satisfying tone owing to the weakness of the first partial. We may define good tone as one in which the first partial dominates by a relative intensity of at least 50 per cent, and a poor tone as one in which the first partial is weak.

"The striking point of the hammer upon the wire is a matter of great interest to the trade now and with good reason, for, in a great measure, regardless of other contributing factors and within the range prescribed by other factors, the position of the striking point determines tone quality. The first attempt to locate a definite striking point was made in 1788 by John Broadwood, assisted by Signor Cavallo. As a result of their experiments, one-ninth of the vibrating length of the string was adopted as the striking point, considerable latitude being allowed in the extreme treble. In 1844 Carl Kuetzing proposed one-eighth. Since that time the distance has been shortened upon occasion to produce a greater volume. With the type of hammer now in use the one-eighth point influences materially the seventh and ninth nodes, thus destroying, to some extent, the odd numbered partials.

"If a distance of less than one-eighth is used, the softer hammer is required to get the same quality of tone. The tone regulator in picking up the felt, is, in effect, restraining the hand of the player, for insofar as the function of the wire is concerned the hard blow with a soft hammer is equivalent to a soft blow with a hard hammer. The harder the hammer and the harder the blow, the greater number of higher partials developed. Thus the picking up of felts actually changes the quality of tone as well as the volume.

"Tension is a vital factor. The effect of increased tension is identical with that of hardening and a hard wire vibrates segmentally, as a steel bar, with predominating odd numbered higher partials. The higher the tension the greater number of higher partials. A decrease from high tension increases the intensity of the fundamental and a point may be reached where a simple tone will result. Assuming as the ideal piano tone that in which the first partial has a proportionate intensity of 50 per cent, the other 50 per cent being distributed in sequentially decreasing intensity over the next six partials, the proper tension becomes an important factor. This degree of tension is variable as the composition and practice in wire making changes. Tests with Perfected wire have shown conclusively that this point lies between 160 and 165 lbs. and also shows that at this tension the wire becomes more responsive, with use.

"As tone quality is effected by tension, uniformity of quality depends upon uniform tension. Not being a revolutionist the immediate adoption of equal tension is not advocated as this would involve radical changes in the agraffe line or sweep, and without a change in sweep an equal tension only could be effected by the use of wire having a different gauge for each note. The gauges now in common use vary only .001 of an inch between half numbers and in our practice we consider .0002 of an inch allowable variation a maximum.

"I want to call your attention to the vibrating lengths on each side of the bar break, the tension varying from 30 to 60 lbs., the higher tension being above the break. You readily can determine the difference in quality before the tone regulator evens it up.

"As scale loading or the distribution of gauges is dependent upon sounding board ribbing, any change in the distribution must be followed by a change in position and weight of ribs.

"Assuming that your loading is correct, the method of securing a uniform tension is as follows:

"From the logarithm of the longer wire length subtract the logarithm of the shorter wire length and divide by the number of semi-tones intervening. The quotient is the logarithm of the semi-tone proportion. To the logarithm of the shortest wire length add the logarithm of the semi-tone proportion. The result is the logarithm of the string length next longer. Continue in like manner throughout the entire scale.

"In case the longest plain wire does not permit the required tension, simply adopt the given length in computing from No. 18 gauge."

C. C. Chickering: "A thicker wire then gives a higher tension?"

F. E. Morton: "Yes. The general practice in loading is good. It does not vary much. Some use four of No. 13, some six, but these variations are generally taken care of in the sounding board ribbing. You will secure much better results by using half numbers. If your longest plain wire will permit the required tension and if half numbers are used to and including 17½, the variation is not over four pounds each way, while it is much greater if whole numbers are used.

"The uniform tension scale has been demonstrated in a factory where the cost system is given great consideration. The results in eighteen months showed material saving of time in tone regulating, one less factory tuning, less time for full tuning and a more salable instrument. One scale showed this result: An increase in cost of wire 26c; an increase in cost of hammers 85c per set; increased cost of presser bar 75c; decrease in total production cost 32c per piano.

"The next factor for consideration is the sounding board. The ideal sounding board responds alike to all pitches and is sensitive to all degrees of vibrational intensity. This precludes the use of any material having a specific resonance; that is to say, responding more promptly or with greater intensity to one rate of vibration than to another. A sounding board of Rock Maple is undesirable because it has a definite pitch. If you were to suspend a Rock Maple sounding board and tap it, it would vibrate with a given audible pitch. That board would respond with greater vibrational intensity to its own pitch than to any other given pitch. A piano with a hard wood sounding board has a brilliant tone in one key only. That key is the keynote of the sounding board. The board responds readily to its own keynote and less readily to multiples of its own rate of vibration. Outside of its pitch number and multiples thereof the tone is dead and has no carrying power. A sounding board of Teak or Cedar does not respond readily to any pitch and this is characteristic of any wood of its type. Spruce marks the dividing line between the elastic and inelastic.

"The area of the sounding board is not a vital factor save in such instruments as are intended for use in a very large audience room or out of doors. This statement may seem iconoclastic but its truth has been demonstrated. We have here a small grand piano 4 feet 8 inches in length. Its sounding board is not much larger than that of a bass guitar, yet please note its volume. (Demonstrated upon Brambach grand piano.) This volume, clearness and brilliancy of tone is obtained not through area of sounding board but by the rigidity of its retention. You will observe that no soft linings are in evidence. I hold in my hand a thin strip of wood. I pull back the upper end and release it. It gives about two vibrations and then stops. The hand which holds the strip in place at its lower end is elastic. I now place one end of this strip in a vice, snap the upper end and it vibrates for several seconds. Be certain that no elastic material contacts your sounding board for it will act as a shock absorber while you are really desirous of shock reflection."

C. C. Chickering: "How do you approach the thin tones of the scale? This is very practical and nearly every piano maker has more or less trouble with this section."

F. E. Morton: "There is a section usually beginning with the fifth octave, commonly known as the 'weak spot' in most pianos. If you will follow a line from the point on the bridge where those wires cross, along the grain of the sounding board you will find that it passes under or very close to the bass bridge. If you will try out one of those pianos before putting on the bass strings you will find the weak section very much improved. Strike a key in the weak section. Your prime object is to make the sounding board 'dance.' The part of the board responding to the sixth octave on the piano lies close to the bass bridge and a heavy bearing upon the bass bridge

prohibits the dancing movement of the sounding board. I find that the tension of the bass strings, particularly at the break is abnormally high on the majority of pianos manufactured. The average tension in the extreme treble is 160 lbs. The average tension of plain wire at the break on a 6 foot 6 inch scale loaded with No. 20 wire is 138 lbs. On a 4 foot 4 inch scale about 125 lbs. The first bass string from the break on the majority of pianos has a tension of 185 to 235 lbs. Aside from the change in quality at the break because of this abrupt tension transition an extra heavy load is placed upon the sounding board at a point where the greatest responsiveness is required. One remedy, radical to be sure, is the extension of the 26 note bass scale to 29 for a 4 foot 6 inch and to 31 for the 4 foot 4 inch. The tension on wound strings should not be over 10 lbs. greater than that upon the plain wire and a much better result may be obtained on all bass scales regardless of size of case, by holding the maximum tension to 170 lbs. The practice of the string maker is excellent. His graduations in gauges of core and covering wire are correct. You have given him scales in which the first string from the break has too great length for the required pitch at a reasonable tension. If the string maker uses a core wire too small, sufficient energy cannot be conducted by this wire through the bridge to actuate the sounding board to the required amplitude and he is limited in his use of covering wire of smaller gauges by the need of durability, hence his only recourse lies in the use of a larger gauge core wire, the breaking weight of which increases more rapidly than the rate of vibration on increasing pitch. The result is broken strings, buzzing strings, ringing strings, returned to the string maker for replacement. The tension requirement on such bass string wire is such as only may be made by ignoring acoustic value. Some time ago I visited a bass string maker's shop. I found him in his experiment room surrounded by a pile of broken strings. He said he had been trying to get the proper core and covering wire for a new scale that had been given him. I computed relative length, weight, pitch and tension and found that the first string from the break had been given too great a length, and suggested that he send it back requesting a moving of the bass bridge and consequent shortening of the string. He said: 'If I did that the manufacturer would say: "I will send this scale to some string maker who can make these strings as I want them."'

"So do not expect the string maker to correct your bass scales. And do not be afraid of bringing the treble end of the bass bridge farther toward the center of your sounding board. The decrease in tension will tend to eliminate the break. The tone quality of your wound doubles will be materially improved and you will save the time of your tone regulator, for remember, the tone regulator takes as a standard the weakest point in your scale and brings the balance of the scale to that standard. Some string makers today are using music steel spring wire Nos. 17 and 18, which has no acoustic value for your bass strings because of the high tension requirement. The breaking weight of the wire should never be considered. If it were, you could draw those first bass strings up to 300 lbs. tension and have no trouble with them thereafter. The *all important factor is the elastic limit of the wire*, and if the wire has a breaking weight of 350 lbs. its elastic limit is not over 210 lbs. Once this wire is drawn to or beyond its elastic limit, it ceases to be music wire. Please remember this when drafting your scales."

C. C. Chickering: "This is very interesting and important and as a feature of our piano construction should be given prominence in the music trade papers, particularly your statement that our average piano is given too great tension in the bass."

Wm. Braid White: "Don't you think it is our duty to help the string maker as much as we can in making up his bass string loading? The formulae give length, weight, pitch and tension. From any three of the factors we can get the fourth. In the bass scale, it seems that if we decide upon the tension, it would be a very simple matter to apply the formulae reversed."

F. E. Morton: "It is practical. I have worked out lengths and gauges for several piano makers which have gone to the string makers with very satisfactory results. Recently three scales were forwarded to me with the statement that the string maker could not meet the demands of the draughtsman. I found the tension of the first wound strings from the break respectively 188½ lbs., 208 lbs. and 235½ lbs. No. 18 core wire was used and we will assume that the breaking weight of that wire is 360 lbs., which would be fair. The impression obtained that those strings could be pulled up to 350 lbs. with safety, but as the elastic limit was only 216 lbs. the wire stretched when that point was reached. In the case of the first one with a tension of 188½ lbs. at International pitch, the chipper and first tuner drew that string at least one semi-tone above International pitch, possibly more. This carried it very close to the elastic limit. In the case of the other two,

they were carried beyond the elastic limit by the chipper and first tuner and the core wire was dead as soon as the elastic limit was reached."

C. C. Chickering: "The question of changing the scale in the bass is not serious. The moving of the bass bridge on the sounding board is absolutely simple."

F. E. Morton: "If your hammer line is correctly placed in your present scale it will be absolutely wrong after the bridge is moved. If your hammer line is set at one-eighth, for every inch you move your bass bridge you must move your sweep one-eighth of an inch, therefore the changing of the scale involves changing the plate pattern, which is usually considered quite serious by the piano manufacturer. The points noted all affect the relative intensity of the partials. They are all vital factors in tone building. False or wild notes in the treble usually are found near the bar break or in the middle of the upper section. They may be caused by too heavy loading or from high tension because of inaccurate lengths. The lack of responsiveness of the bridge may be indicated. If your board is particularly rigid at that point, you are in effect vibrating your wire, bridge and sounding board as one. Cutting the bridge under the bar is bad practice. Raising the bar at that point is entirely feasible. It is a crime to cut the bridge."

C. C. Chickering: "If the manufacturer will put a rib under that point it will help."

F. E. Morton: "This has been done on some pianos. Here is one in which a small block is secured to the board under this point but there was no occasion for cutting the bar in the first place. A little engineering work on plate construction would save the time of the mechanic and clear up the break at the bar."

C. C. Chickering: "I find that the plate maker wants to get as near a straight line of resistance as he can. We have to fight him to get away from that."

F. E. Morton: "Still it can be done and has been done. The piano manufacturer should interest the engineer in his problem. Plate making is tending every day further in the direction of truss construction and there is not an engineer on general structural steel work, particularly bridge work, who could not give valuable assistance in the designing of plates. They meet problems every day compared with which this problem is elementary, and I trust before the winter is over we will be able to have at least one first class engineer on structural work address us on this subject."

F. Weidling: "You referred to the area of the sounding board and spoke of its carrying qualities. A note from a concert grand carries a great distance."

F. E. Morton: "The loss of energy is directly as the square of the distance, and the concert grand is subject to the same law as is the upright. If at 10 feet we have an energy of 100, at 20 feet we will have an energy of 25. This, however, is in the open and does not take account of reflection and reverberation. Therefore, the matter of carrying a volume need hardly be considered in a house piano. If your sounding board is established with absolute rigidity at all points, you have a board of maximum efficiency. Area cuts very little figure. Concert grand pianos, the sounding boards of which are split on both sides of the bridge leaving a working sounding board one foot wide only, have been used for considerable periods of time without the split being discerned through any change in tone, and this in halls not less than 35x75 feet."

C. C. Chickering: "Does that law of energy loss hold regardless of tone quality? Would the tone from an inferior instrument be heard as distinctly as a piano having a correct distribution of partials?"

F. E. Morton: "The law affects both pianos alike. The energy loss is always in proportion to the amount of energy put forth. Energy is lost on a poor piano between the stroke on the key and the vibration of the sounding board. Assuming that a 10-ounce blow is struck upon a key having a three-ounce touch, the vibration of the board with seven ounces energy would indicate absolute efficiency."

Wm. Braid White: "When you were speaking of the composition of tone you were a bit hard upon our friend the seventh partial. Helmholtz showed that the seventh partial is a very strong concomitant of the tone of the violin, and according to Dr. Miller's phonodeik, the human voice has a strong seventh partial. It has been established by experiment that when a string is struck upon a node the partial of that node will be eliminated. If the hammers were so pointed, speaking generally, that they would not have such a tendency to slop over on the seventh, it would have a better chance."

F. E. Morton: "The reason for the suppression of the seventh is that when it is developed

the ninth follows. The develop ·ent t any odd numbered partial makes audible the sequentially odd numbered higher partials."

C. C. Chickering: "Your argument in regard to tone production if accepted will seem to do away with tone regulating."

F. E. Morton: "If the tone is made uniform by attention to such points as have been indicated, a permanence of tone is assured. There is not a man here who would not be glad to know that the piano he is turning out today will be referred to ten years hence as: 'I would not take anything for my piano. It has the same sweet tone now that it had ten years ago.'

"There is no possibility of permanence resulting from tone regulating. The artist's scope is limited by the spongy top hammers, and remember, the tone regulator must use the poorest and weakest note on your scale as a standard. After several years' observation and experience I can freely say I have found no one factor greater than uniform tension. To be sure the treatment of the sounding board is important. The bellying of a board to a crown is unnecessary. Bellying in line with the bridge is much better and much more conducive to permanence."

C. C. Chickering: "Maybe I am wrong, but I am of the opinion that a crowned board is little insurance against the danger of a board splitting."

F. E. Morton: "If your crown is in line with your bridge, it is in line with the grain. I mean simply to crown your board in one way, not to approach the hemispherical."

Wm. Braid White: "The average tension is on the whole too high, and I would like to ask whether it would not be advisable for this conference to make a careful study of whether certain definite advantages could not be had by bringing about a gradual declension of our tension levels."

F. E. Morton: "This must go hand-in-hand with changes in the sounding board thickness and ribbing. I recall a case within the last year of a piano, the average tension of which was 200 lbs. The bass down as far as lengths would permit ran from 235 lbs. and after full discussion it was decided to adopt a lower tension. We compromised on 170 lbs. This was as much of the dog's tail as they were willing to cut off at one time. Later, I was asked to check up the piano. It was tonally dead all through. They were using the same sounding board, the same crown, the same ribbing that had been used with the higher tension. Of course it was dead. It takes a definite amount of energy to make the board vibrate, and it must be conducted by a given mass of wire. If the tension is lowered, the sounding board must be made more responsive. There must be less ribbing, less bearing, but the rigidity with which that board is retained at the outside becomes an all important point and the effect of any elastic material is quickly perceived. In a low tension scale, you have a 'thoroughbred' to deal with and every little blemish shows up very much plainer than it does in a 'plug' higher tension scale. Between 160 and 165 lbs. is a rational tension and you may well work toward that end in the development of the sounding board, and particularly in the manner of retaining that sounding board in its position."

After a discussion of specific instruments, the meeting was adjourned.

Effects of Hammer Felts and Tension

November 2, 1916

Topics for future deliberation were agreed upon.

The committee on the height of grand piano keyboards reported progress and requested the secretary to communicate with grand piano makers not represented, requesting data covering height of white keys from the floor; the distance from the front of the pedal to a perpendicular line drawn from the front of the keybed to the floor, and the height of piano benches.

F. E. Morton: "The proceedings of our last meeting are submitted for your criticism and comment, the principal points being the effect upon tone quality of hammer line, elasticity of hammer felt, elapsed time of hammer and wire contact and the ratio of length, weight, pitch and tension."

Wm. Braid White: "Don't you think we established certain conclusions regarding the safety limits of loading? It seems to me it is our duty to stress particularly for the attention of others the simple fact that we are engaged in developing an idea which is perfectly practical, which these

discussions are showing can be done, and that there is no longer the slightest excuse to 'fumble' that subject,— an even tension scale. There is nothing theoretical in it. We have established the fact and can go farther. These discussions should be considered the classic on that subject."

F. E. Morton: "Is it the purpose of this Conference to establish or act arbitrarily, or to study? This is a question to be decided. Personally, it has never been my intention to dictate or assume any imperialistic attitude in these matters, but I am strong for this one thing — the opinions and experience of all shall indicate a condition, that from this condition we may progress. For instance, I have been engaged for some time in a study of the sounding board. I have only this week succeeded in establishing one point, and that one point will furnish but a single constant for a big equation. If we can establish a certain number of constants our problems will more easily be solved."

E. B. Bartlett: "You have stated the matter according to my conception. The good we get from this individually is what we can absorb and carry home, not in attempting to formulate any set rules. I think the farther we keep away from anything that smacks of arbitrary rulings, the more we can accomplish. We should leave to the individual the adoption of any points appealing to him as helpful."

Wm. Braid White: "We have put ourselves in position of being in possession of certain constants, certain mathematical and mechanical facts. We have the opportunity of setting forth in a manner which has never been possible before, which never may be possible again, the existence of these things and their importance. What greater function can we have than establishing these things and establishing them in the most definite manner so that these discussions can stand as the classic on the subject?"

F. E. Morton: We seem to be agreed save in the manner of application. Any further suggestions?"

C. H. Jackson: "There is a question by Mr. Chickering reported in the last minutes: 'How do you approach the thin tones of the scale?' A year or so ago, I put the same question to Mr. Morton. I told him at the time that I thought the string lengths were all right, and he answered me very much as he has Mr. Chickering. He said: 'Look at your bass strings and let me see how you have them loaded.' We found that they were loaded up very heavily. I reduced the tension and the result was good, and I haven't had any complaint on that particular part of the piano and can now devote my attention to other things."

Wm. Braid White: "About a year and a half ago, a western manufacturer desired to improve his product. He permitted me to make him a new set of gauges for his scale. Using the American Steel & Wire Company's formula and wire, and taking his scale as it stood, we adopted a tension of 155 pounds in the treble and 170 in the bass simply by computing the weights according to the formulae. We strung up a few pianos with this new loading, and upon measuring found we came within about five pounds of the desired tension throughout. The result was that at a negligible cost, the manufacturer found his piano greatly improved, tuned better, the tone regulating reduced, and the tone was considerably more even and measurably improved."

E. B. Bartlett: "My experience has been largely theoretical. I got this even tension bug many years ago. It had occurred to me that the peculiarities of different pianos were due to difference in tension and possibly they would stand in tune better if the tension were equal. I laid out some string lengths by a formula I deduced from books I had read and made one piano. The wound section may have been a little high. The perusal of the minutes of the last meeting verifies a theory I formed from this piano. I overlooked one very important point. I gave the strings a little more bearing and didn't thin up the sounding board. It stood in tune wonderfully well. Later, based on that experience I made another piano at a tension of 196 pounds all through. We retained that for purposes of observation for a year and a half or two years. It was fairly satisfactory except for the hammer line. I am not sure yet what was wrong with it. The 196-pound tension piano has some bad spots in it which I think due to the improper location of the hammer line. This piano stood for nearly two years without being tuned. It wasn't absolutely smooth, but there was no spot in the scale that was way down or way up — none of those changes that would come from a scale that had a very uneven tension. I have been hoping I could get from these meetings a formula for the hammer line that would remedy this trouble. I believe Mr. Davis has carried out these ideas in some of our styles with very good results."

F. E. Morton: "Plate founders inform me that a plate of which they had the pattern frequently is taken as a basis in making a new scale. A few changes are made which will not necessitate a new pattern and the sweep of that plate is accepted. This makes the hammer line subservient to the sweep. This has been related by several plate founders as a very common experience, and leads me to think that the objection of the manufacturer to a change in his sweep line is based upon something more than the expense involved."

E. B. Bartlett: "In my computations on equal tension scales using the half sizes of wire, I found it impossible with a scientific hammer line to use a sweep for the upper bridge and we didn't attempt to do it. I think it quite likely that I was figuring too closely. In the second piano we did make the sweep of the upper bridge and maybe that is one of the errors. A different size wire would be required for each note to keep the sweep uniform and scientifically accurate at the same time, and that isn't feasible."

F. E. Morton: "The compromise which I have suggested of establishing a semitone proportion between gauge changes permits the sweep. This has been demonstrated by actual experiment. The one constant first established is the hammer line. One method of taking care of the treble is to establish ⅛ from the longest plain wire to the bar break; and from the bar break to the shortest wire a semitone proportion to 1/20. The same quality of tone is not desired in the last octave as obtains in the middle register. The piano would be unsaleable."

Wm. Braid White: "The first time I undertook to make a scale drawing I began by establishing an octave proportion of length. Knowing the ratio of tension to pitch and length and knowing the ratio of all factors to each other, I deduced a given proportion of length for the octave and from that obtained the semi-tone proportion. I undertook to lay out the hammer line as follows: Taking a point nearly 1/7 for the greater part of the bass, ⅛ for the entire middle section and then from about No. 26 or thereabout from the treble, going up to 1/9, 1/10, 1/12, as closely as I could measure, which landed me at about 1/20. Theoretically I was getting nineteen partials. I found in the first place that theoretical determination of the hammer line made a beautiful sweep. In adjusting the tension of the strings, I found little difficulty, and, using Perfected wire came very close to the required tension of 160 pounds."

F. E. Morton: "In the method of adjusting weights to lengths already determined, did the result show the common practice of loading to be nearly correct?"

Wm. Braid White: "Yes, except, of course, when approaching the break, which took a rather larger wire."

F. E. Morton: "Owing to the nature of steel regardless of tension, length and weight, the stiffness of the wire is a factor. Use a No. 21 or No. 22 wire at the break and you will find a rod or bar tonal effect. Because of the stiffness, it is impracticable at such a length; it will vibrate segmentally rather than fundamentally. The overtones are very much in evidence because of the nature of the steel itself, and you are absolutely obliged to take that into consideration, otherwise we could have a fairly uniform tension through to the wound strings regardless of length. Take a little grand of today, with plain wire length of between 38″ and 39″ at the break and it is so short that a No. 20 wire is impracticable on the last two notes before the break. No. 20 wire at that length becomes a bar in its tonal effect and you find overtones galore — in fact, the overtones in some cases are almost dominant."

Wm. Braid White: "On this particular scale the mathematical requirement was for No. 22 wire. We did try a No. 22 wire and found it impossible for that very reason. It was impossible to get a clear tone. It had no recognizable fundamental."

E. B. Bartlett: "Have you tried the effect of using a covered string there in order to maintain the tension?"

F. E. Morton: "It is impossible after the plate is formed. If you start on that basis in the first place — bringing the agraffe line in and the bridge closer so as to give a shorter string, the effect is not at all bad. It has been done in several cases with success. I have advocated a greater number of wound strings in the bass. I don't know of any reason why we should be limited to 28 notes in the bass, or any particular reason why, if we add wound strings, we should carry them over to the treble section. I have kept in very close touch with the development of one grand and have carried the bass section quite a little farther. We must have 48⅛ inches length on B, (key 27), in order to acquire a tension of 160 pounds with a No. 20 wire, so it is really quite a com-

promise, cutting down to 38, 39, 40, as we do in the small uprights and grands. I think we should have more data in our reports on hammer line experience. General data is limited and seems to have resulted rather from precedent than experiment."

E. B. Bartlett: "The hammer of necessity covers quite a space on the string, and the farther down the scale the more it covers. This is one of the difficulties I have experienced in getting a mathematical basis for it."

F. E. Morton: "Mr. White has stated that it was established before his time that the node is eliminated at the striking point. For instance, if the hammer strikes at a point ⅛ of the length of the string, the node of the eighth is destroyed. Helmholtz's experiments, however, were conducted with very small German silver wire and a considerable length was given in order that the effect might be observed, and the hammer used was a metal hammer — generally of brass. Theoretically, the node is abolished at the striking point, but practically segmental vibration is observed with a lesser degree of intensity. The point of greatest interest to us, however, is the effect of any change in the hammer line, as we must effect a change of quality in the extreme treble by this means."

E. B. Bartlett: "Suppose you start with one-eighth at the break, assuming you have 28 wound strings, and by equal steps reduce that ratio until you get to the highest string in the treble at say one-sixteenth the length of the string. Is it practicable?"

F. E. Morton: "There is a uniformity deemed essential through the middle of the piano and a given hammer line proportion will give that. We do, generally, maintain the same proportion for the hammer line through the center of the piano. For that reason I doubt if a graduated change would effect the purpose. We want the same quality of tone until we come to the point where uniformity of tone is sacrificed for brilliancy. We can agree that common practice of the hammer line is generally good and satisfactory, but that it is uniform is another proposition which we don't accept so readily. In a great many magnificent pianos some weak spots remain. What degree of uniformity we desire in the piano is still an open question and is a matter for discussion and research as well."

E. B. Bartlett: "You didn't change immediately from ⅛ to 1/9 between 58 and 59?"

F. E. Morton: "No. There may be a different point in each piano, but at the bar break or a trifle below we may safely begin to graduate. A curve plotted shows a straight line from that point to the break, and a geometrical progression to the extreme treble."

E. B. Bartlett: "I think the ideal scale is one that can be put down on paper and if all patterns were lost another just like it could be made."

C. C. Chickering: "You might be interested in Mr. Frank Chickering's experience. After working over the problem for many years he came to the conclusion that he could get the kind of tone he thought came nearest pleasing the average ear by striking the lower section of the piano at the eighth. The old German way was the seventh; the French idea was to strike shorter, and he got something between. About the thirtieth note from the treble he struck on the ninth, then from the ninth to the extreme treble graduated again. I have measured a good many pianos of different makes and have come to the conclusion that Mr. Chickering wasn't far from right in striking a perfect average."

Wm. Braid White: "Mr. Morton mentioned we had been guided more by precedent than anything else, and whenever we think of hammer lines we are compelled to think of the hammer itself. The hammer hasn't any striking point at all. If we have a good hammer we do once or twice strike that point. I wonder whether we could perhaps undertake, or suggest the undertaking of some research with a view to discovering what would happen if an attempt were really made to produce a hammer that came closer to striking where it is supposed to strike."

F. E. Morton: "We are getting just such hammers for experimental purposes and hope to get results. As I mentioned the other night, the length of time the hammer contacts the wire is an important matter. If a hammer strikes say for instance the eighth node, it rests on adjacent nodes just as long as it contacts the wire and those partials are damped by the hammer."

C. H. Jackson: "While we are reducing the tension on our strings, I think we ought to prevail upon the hammer makers to increase the tension of the felt on the moldings."

R. H. Waud: "Don't you think in some cases the action has something to do with the length of time the hammer stays on the string? In using the same actions you will find some of

them will work and some will not. You can keep on pressing the key and there is a point on some of them where the hammer will stop."

T. A. Johanson: "We all know the importance of the hammer. It is an important factor in producing tone. There are so many things that make a poor hammer. Quite a number of our hammer makers are not using the right kind of felt. They are trying to make a hammer hard by compression. It should be hardened in carding. I have no desire to dictate what hammer you should use. That is up to you. My idea is that the hammer should strike the string at a perfect line. If the hammer should be bored a little less than ⅜, or more, it might strike a down or up blow. Hammer makers are very careless in their boring. When the hammer strikes a blow that will fly off, it doesn't produce the result desired. We should help the hammer makers. We should have sufficient felt on top so that when the head of the hammer goes into the press it will not cup at one side and make the hammer lopsided. It is necessary to have the head shaped to perfection. If we could get together and visit a factory where the hammers are made it would be an excellent thing. We should aim at a big hammer. This will produce the best tone.

"The resistance of the hammer should be about the same as the strings."

H. H. Arnold: "A hammer maker in New York told me why the so-called German felt was superior to the American felt. Here, the wool is treated in large vats and a large amount of chemicals and especially alkalis are used for the purpose of bleaching, making the wool white. The idea that the hammer must be white is not carried out in the imported. They come in a pale yellow color on account of the natural oils being left in. Here, the life of the wool is killed by the alkalis and chemicals, resulting in short fibers. On further talking with this hammer maker, he stated that labor in this country was dearer than in Germany and that we couldn't afford to use the same process. There, the wool is placed in the sun to bleach instead of using alkalis and chemicals. If the method was changed here, just as good felt could be made. We can make American felt out of American wool just as well as the German people can make felt from American wool."

C. Arthur Brown: "I think you have reached the kernel of the whole thing. It was my privilege and pleasure a number of years ago to be brought into contact with the problem of how to purify water for use in the textile industries. I was connected with the first industry in this country to make a success of that work, and it was only after some eight or ten very able chemists had exhausted every resource that they learned that this company was able to purify water in such a way that it could be used in any one of the textile industries with satisfaction and success. Water plays a very large part in wool or any other fabric. You can kill any kind of fiber with an improper chemical treatment.

"This is one of the things in which Mr. Morton has interested me. As it happens, we have a large amount of data accumulated a number of years ago that will prove valuable in this connection. The methods of scouring, bleaching, washing and curing wool or any other fiber plays a vital part in the life of the resultant fiber. It is merely a question of putting that of which we have all the data into effect, and it may be well to state that like most operations, when you do it right, you do it more economically than when you do it wrong. We can do with American methods an equal quality of work and use less labor than is being used in Germany. They are making some mistakes. Their felt is not as good as can be produced. If you want the most resilient fibre in the world you must go to a Navajo Indian for it. They don't use any chemicals and it is the best in the world."

C. C. Chickering: "We formerly used a German felt on our hammers. We noticed a very decided change in the results in the upper register when we changed to domestic. We complained and changed from one concern to another. Then the first concern which had been supplying us asked for the privilege of sending some more hammers which we found very much better. They explained that they had changed their presses and moldings, and I gathered that the few experimental hammers which gave us better results had been given a higher pressure. They had loosened up the lower sections and left the pressure on the upper octave or two for a considerable length of time. The resultant hammer was a decided improvement—an improvement over the hammers we received from Germany. I might say, however, that they have left the pressure too far down in the scale to suit us. We are going to suggest that they take the pressure off a little earlier on six or eight notes which were made so hard that we got a rather thin tone on the scale.

"The point is very noticeable where the pressure ceases. There is almost a break in the scale of the hammers due to this treatment."

F. E. Morton: "Has anyone any experience with 'reinforced' hammers?"

C. H. Jackson: "I think the reinforcement is really good. It helps to retain the original shape of the hammer."

C. C. Chickering: "The tendency in recent years has been to make the hammer as light as possible, even to filing the shanks down."

F. E. Morton: "In 1887 or 1888 I made experiments with hammers submitted and devised an apparatus afterward called a 'kicker' for testing purposes. By this means, five years' wear was given the hammer in about three weeks' time. The wire was given the high tension then in use in the larger pianos, and some felt was actually cut as with a knife after one or two weeks' use. Other felt packed instead to the end of the test. An examination showed that in the hammers which did not cut the fibre showed a decided tendency to lay parallel with the wire, while the felt that was cut through showed more of a cross fibre. The fibre quality was about the same in both cases."

Mr. Morton then stated that certain experiments were being made with the idea of determining the extreme range of possibilities in sound board construction and placement. Anticipating a scarcity of clear spruce in the future, experiments have been made with steel and other alloys as well as with laminated woods. He said:

"Spruce is used because it has no specific resonance. A good spruce board does not respond to the pitch corresponding with its mass more than to any other pitch. It marks the dividing line between wood which acts as a shock absorber and that containing such an amount of resin as to give resonance to its own specific pitch. A laminated board will be practicable only when a glue is found having a rate of vibration synchronous with that of the wood itself. Under present practice, crowning leaves the fibre in a state of tension on one side and compression on the other side. Any mineral or animal substance, however, used in this process will eventuate in disintegration as the mineral rate of vibration is lower than the vegetable rate, while the animal rate is higher than that of the vegetable."

E. B. Bartlett: "How about shellac?"

F. E. Morton: "The process of extracting resin lowers its vibration rate. If the vibration rate of resin were higher, the cohesion of shellac would be sufficient for the purpose."

T. A. Johanson: "I do not think the laminated board ever may be made practicable, as climatic changes naturally will affect the three or five layers differently. I believe we will be able to get spruce for the next hundred years."

The policy governing the future of the conventions was then discussed at length.

F. E. Morton: "We can popularize honesty in the piano industry by means of these discussions. Honesty will be popularized not by advertising but by publicity."

C. C. Chickering: "What is the difference between advertising and publicity?"

F. E. Morton: "Advertising is the exploitation of a thing; publicity the exploitation of an idea."

F. E. Morton then demonstrated by means of apparatus the rhythmic movement of the sounding board, the projection of this movement upon a black screen being magnified 80,000 times.

Hammers, from the Sheep to the Piano

November 16, 1916

Chairman F. E. Morton: "When the hammer strikes the piano wire, the interests of the wire maker and the felt maker become mutual. In fact, the interests of every trade contributing to the completed instrument becomes involved. For about a year and a half I have been investigating felt and its relation to the piano. So far, it has been a matter of diagnosis. I have no big ideas to put forth, nothing to startle the trade but, realizing that diagnosis is 99 per cent and treatment 1 per cent, I am still engaged in diagnosis, and the assistance of the trade will be very grateful. Assuming that your attitude is practically the same, I have secured from the officials of The Felt-

ers Company of Boston an expression of their desire to co-operate with the trade for the improvement of the products of both. Assuming the expression was given in good faith, I have asked them to have representatives here capable of presenting the felt makers' side. They responded. Gentlemen, I don't want to seem for a moment to dictate the method by which this matter shall be handled, but I want to present this viewpoint to you. Between the sheep and the completed hammer there lies the felt maker and the hammer maker. I would like to know, and assume that you would like to know, the province of each and the responsibilities of each. If the felt is properly made and is abused in any way by the hammer maker, the effect upon you is just the same. All we reasonably may expect is to find out just what that status is. Certain it is if we can define the position of the felt maker, and our own, we have by a very simple process of deduction the position of the hammer maker, or if we succeed in defining the position of the hammer maker and our own, we will have defined the position of the felt maker. If we allow the felt maker to define his position; the hammer maker his position, we are in a position easily to define our own. In any event, I can see nothing but profit to all concerned whichever way it is handled."

Mr. Morton then introduced R. H. Buchanan, manager of the New York office; A. W. Nelson, superintendent and manager of the Middleville plant, and W. H. Bryant, manager of the Chicago office, who expressed their willingness to co-operate with the trade in any manner which might be deemed advisable following the evening's collaboration.

C. C. Chickering: "Would it be interesting to us all here tonight to have any one of these gentlemen tell us exactly what process the wool goes through from the time it is sheared to the time it is ready for the piano manufacturer? It might help to bring forward some nice questions."

H. H. Arnold: "I would like to ask whether there is any great difference in the quality of the wool, whether that wool is raised in one locality or another. For instance, whether it is raised in the southwest or northwest; on the Pacific Coast or the central or eastern states where farmers keep a few sheep and take better care of them; whether that has any influence on the finished felt?"

R. H. Buchanan: "Climate and blood are important. There are certain wools that have better felting qualities than others. Some imported wools are better for certain purposes than domestic, and it is the business of the felt maker to obtain a proper blending of wools. We must select in the first place. Every precaution is taken in preparing before putting them in work. After they are selected and graded we have certain blends which we work up in sections of sheets. Some wools felt harder and are more elastic and these are used for the treble. We couldn't use the same class of wool for the treble and bass."

C. C. Chickering: "Where do you get the wool for the bass end of the hammers?"

R. H. Buchanan: "This is left to the manufacturer and depends on the grade required. We make two grades of felt."

C. C. Chickering: "Starting with the best grade, where does the wool come from?"

R. H. Buchanan: "We use an imported wool in our best grades. The wool from Australia is good. Different wools come from different parts of Australia. It is a matter of selecting the proper wool."

R. H. Waud: "How do you grade your wool? According to quality, length, color or what?"

R. H. Buchanan: "It is a matter of blending. Length of fibre has something to do with it."

C. C. Chickering: "Is the second grade of wool coarser?"

R. H. Buchanan: "Yes. A little coarser."

C. C. Chickering: "After you have gotten through the lower end of your process, what do you do for the central?"

R. H. Buchanan: "As I said before, it is all a matter simply of blending the wool. We begin to make the felt from the bass and build on and on until we get to the treble."

C. C. Chickering: "Do you necessarily use a different growth of wool for the center and treble, and is it selected from different parts of the animal?"

R. H. Buchanan: "Yes, but no parts of the animal are recognized by the felt maker. This is the function of the wool sorter."

C. C. Chickering: "Do our fulling processes differ in any respect from the European?"

R. H. Buchanan: "Not so far as I know."

C. C. Chickering: "I have been told that we cut our felt in several pieces and then full them together, whereas abroad they step it up."

R. H. Buchanan: "We don't step it up."

Wm. Braid White: "Couldn't we get these gentlemen to tell us definitely the various steps, one by one, in the process?"

E. B. Bartlett: "I don't feel quite sure that I have all the information I could absorb on the question of wools. Someone told me years ago that in making hammer felt, particular wools of radically different character were required. Some crinkly that would easily tangle and hold together; others straight. The crinkly wool couldn't be worked alone; the straight wool couldn't be worked alone, so wools were selected with those qualities as well as length and strength of fibre. I think it would be interesting to know a little more about that."

R. H. Buchanan: "That is the selection and blending of wools I spoke of."

E. B. Bartlett: "If a grade or blend of wool does not run uniformly, to what extent is the personal equation applied?"

R. H. Buchanan: "We haven't any definite point to work from. We want to reach a definite result. That is what we are here for tonight. We buy wools according to grade, using every care possible in the preparation of those wools before they are put in work. It is a matter of the buyer's judgment entirely whether this wool is of the same blood and length of fibre."

E. B. Bartlett: "The proper proportion would be a matter of judgment based on an examination of the particular wool you are working with?"

R. H. Buchanan: "We have gone so far that we know what to use of each particular grade to get a result in a certain section of this felt."

F. E. Morton: "So far, only one point has been developed—whether or not the wool is crinkly. Are there any other points relating to the fibre of the wool; the diameter of the fibre? Does the fact that the wool was sheared from a dead sheep influence the condition of the fibre?"

A. W. Nelson: "Yes! Very largely."

F. E. Morton: "The dead wool won't felt! Does the period of time elapsing between the washing and shearing of the sheep affect the product?"

A. W. Nelson: "No. I don't believe so."

W. H. Bryant: "Most of these points you are bringing up are left to the personal equation and judgment. They are not germane to the purpose. What we want to find out is: From the sheep to the hammer, what can we do to construct a hammer felt that will give the desired result? We want to find what the desired standpoint is so we can handle the matter. We want to start from a clean base and a new start and work this proposition out to the end."

F. E. Morton: "I believe it is the desire of each man here to be placed in a position to co-operate in this work, but the limitations of each must be defined. If it is necessary to inaugurate a publicity campaign to educate the farmers of this country in the care of their sheep, we want to know what we require from that farmer. When we know this we will do our share. It seems to me we can't ask and answer too many questions to define our position. I believe we can bring out here, gentlemen, information that will give each of us a handle on the proposition so each may carry his share of the load. I know it is fully understood that every question and every answer is given in good faith. At just what point do the functions of each begin?"

H. H. Arnold: "When a man finds he has something—something he has made which is not exactly perfect—he has to go to the root of it to solve the difficulty. After the felt is made, the piano man doesn't care how it is made. We would like to know, because we would like to know what to avoid if we can. What we are interested in is a piece of felt that when it is made into a hammer will stay made. The hammer has to have a certain amount of life, a resiliency that will come back. After it has been striking the string for a long time it ought to show as little as possible sign of wear. The indenture should not be there at all, or as light as possible. Then the wool fibre should, in my opinion, be of such grade and material, and treated in such a manner that the contact of the hammer striking the string will not cut the fibre. That is where our trouble lies. First the indenture cutting in, and afterward the breaking of the fibre. Let us get to the point: Why do some hammers cut in more readily than others and become brittle? A good hammer after it is used for a long time should pick up, be loosened and brought back to a certain degree to its original state."

E. B. Bartlett: "I think you have stated the requisite qualities of a good hammer as well as it can be done. I don't quite see how we could follow that plan unless we could first find a felt that was ideal in character, adopt it as a standard and ask the man from whom we buy the felt to conform to that standard. It seems to me all we can undertake is to define the results we want in general terms, and let the men who have handled the same in a practical way explain the difficulties they meet."

William Braid White: "The first defect observed by the outside tuner is loss of shape, which may be due to a breaking or packing of the fibre. Hammers from two to four years old have broken down. Then there is the other kind which pack hard, but at the same time flatten out. Sometimes it is impossible to remedy the defects of a hammer of that sort, because there is no practical method of re-shaping. The process of ironing is beyond the capacity of the average man outside."

C. M. Stanley: "Years ago we picked the hammer into a cushion. We never went far under the surface to produce silent qualities. Old tone regulators of Baltimore, New York and Boston in my time picked the surface of the hammer and very seldom went to the second or third layer. A felt man then told me that the length and certain other characteristics of the hair made the hammer resilient and wear for years and capable of being brought back approximately to the original value. I defy any man today to use a set of needles on the ordinary hammer and produce that cushion in the way they produced it twenty years ago. I want to know what characteristic has vanished from the present hammer."

R. H. Buchanan: "I hardly know how to answer that. Methods have changed a great deal since then. I have watched tone regulating a great deal and believe the shape of the hammer is lost by over tone regulating. You are bound to do some damage if you use four or five needles."

E. J. Fishbaugh: "Is it possible to make a set of hammers that will require very little tone regulation?"

R. H. Buchanan: "It is our aim to make felt to graduate as uniformly as possible."

C. M. Stanley: "Years ago it was considered necessary to cap fifteen or sixteen hammers in the extreme treble with buckskin. We did that because we couldn't pick the hammer. There was nothing there to pick. We have been told that the pressures can be brought to bear on the felt that will produce certain characteristics of tone, but I believe it is impossible to produce a uniform hammer. It is not in the pressure. It is in the quality of felt that we must look for the solution of the problem."

W. H. Bryant: "We believe that it is possible to construct such sets of hammers from felt of the proper consistency."

R. W. E. Sperry: "I can't see how the hammer maker can do that. I believe the greatest trouble is with ourselves. Each has a different standard."

C. C. Chickering: "Don't you think that comes back to the question of the scale? One scale requires a hard hammer; another a softer."

F. E. Morton: "Several makers may be after the same effect by different procedure. By collaboration we may determine a single effective method. We have that in the steel business to the nth degree. One mill will make as many special steels as there are fabricators of the same product, and until these men collaborated, those conditions obtained. After collaborating, we find a uniform practice may be established by the fabricator to his own advantage and ours, reducing his cost and ours. This can be accomplished in the manufacture of pianos and player pianos as a result of these conferences."

E. B. Bartlett: "Isn't it true that we must look to the feltmaker for the durability and resiliency of the felt he supplies? Then, isn't it likely that we must have an understanding with our hammer maker to use the proper amount of pressure in forming those hammers to suit the scale, and if we want to get away from this excessive needling, isn't it necessary to devise our scale to make it unnecessary? The ideal piano would need no regulating."

William Davis: "A good set of hammers don't require much picking. When examined through a glass a first-class hammer shows a very fine fibre, uniform all through. The poorer hammers have coarse fibre. With the latter we get a very poor quality of tone."

F. E. Morton: "Does the hardness or softness of the felt enter into that, or will the hammer be good or bad according to the diameter of the fibre? Given then the finer fibre and it wouldn't matter as to the pressure."

William Davis: "Yes! The hammer that calls for excessive picking is full of heavy, coarse fibre."

C. Arthur Brown: "Is the short fibred hammer better?"

William Davis: "Long fibred is the best."

T. A. Johanson: "As the hammer maker builds up the hammer with very little felt in the middle section, it is hard to do much with it. You must have your weight in the middle section, and I believe most of the manufacturers want a hammer heavier in the middle section."

William Braid White: "We might venture to tell our felt hammer making friends that the matter of tone regulation has been perhaps somewhat misunderstood in the past, and we should say boldly that the object of tone regulating is now understood to be nothing but that of correcting the necessary and unavoidable mechanical deficiencies of the scale. Tone regulating is no longer to be considered as a matter of coloring your tone."

E. E. Beach: "Two sheets of felt made up with identically the same pressure will produce entirely different results when you come to tone regulating. One set of hammers may require an immense amount of needling, while the other set will be elastic and will respond readily to the efforts of the tone regulator and will not require any great effort to reach the tone he is after. The trouble lies in the felt. I have not been able to determine the reason."

R. H. Buchanan: "It would seem that of two sheets of felt weighing within an ounce or two of each other the amount of pressure the hammer coverer put on each will determine which one will require more needling than the other. You must start at a definite point and have a definite rule all the way through."

R. H. Waud: "My experience has been that given certain scales, the hammer maker could turn out hammers that would exactly suit the scale and need very little tone regulating. I have done it and gone through the whole business. Anyone making his own hammers from a fairly uniform felt should have no trouble in making them, if the sheet is good. See that the felt is not bumpy and reject all sheets that are not right. Those sheets that have hills and holes will require lots of tone regulating. The hammer makers' problem is to make hammers to suit all of us, but those making their own hammers should have little trouble. The tone regulating should not consume more than fifteen minutes."

C. M. Stanley: "It is the longevity of the hammer we are after. What we want to find out is what quality makes a good hammer—whether it is one mesh of felt or another, one grade or another; one kind of sheep under different conditions producing better wool than another. As far as making a hammer that will effectually smooth out the difficulties—grades of ironing, hard and soft needle, the bellying of the sounding board, etc. it is an impossibility. The tone regulating takes care of all this and it becomes a question of the durability of the hammer and bringing it back after use."

F. E. Morton: "We can stick to the felters' side of the hammer to advantage if we can only get on parallel lines. The shape of the hammer, the weight and all those points involved in the making of a hammer we know to be the functions of the hammer maker. He may tell us he can't do so and so unless he is given such and such felt, in which case the position of the felt maker is designated, and that is what we want to know. I would like a little more complete data. Any such experience as Mr. Davis has given is worth a great deal. Those who have tested and tried out hammers could give us valuable data to work upon that also would be of value to the hammer and felt makers."

C. C. Chickering: "The people who made our hammers began sending us felt which was unsatisfactory in the treble. We complained and they used a little harder pulling in the upper section, and arrived at what we wanted by leaving the presses on full over night, but loosening up the presses at the lower end. Where the tone breaks off we have to do a little more needling to make the scale even. It makes a harder hammer and seems to be a permanent hardness. It is possible they may have collaborated with the felt maker and produced a little harder hammer in the upper part. As near as I could gather it was done in the hammer department."

E. B. Bartlett: "Our retail department complained that the hammers were coming too soft. After they had taken steps to remedy the difficulty I was asked to come out to the factory with some of the retail force and the gentleman upon whose judgment we depended was very much pleased with the result. On making inquiries afterward, I found they were using identically the same felt, but leaving it in the presses longer and under heavy pressure. It brightened up wonder-

fully and so far as I know didn't increase the labor of the tone regulator. It was the same fundamentally, but treated differently in the presses when the hammers were made. We probably should look to the felt makers for the durability and resiliency which they have explained is due to the character and quality of wool, and I wondered at the same time whether the pressing process wouldn't have something to do with that; whether in our zeal for time saving on this side of the water we didn't rush this through with chemicals that left the felt brittle."

A. W. Nelson: "There are no chemicals used in the manufacture of our felt except soap and water. The finer the wool the better hammer you will get every time."

E. B. Bartlett: "Is there anything in the process of making felt by which you can determine the direction of the fibres in the finished hammer,—whether it shall be parallel with the string or across it? Which is the preferred position?"

R. H. Buchanan: "When they are parallel with the string. It doesn't cut the fibres then. The fibres are first carded and laid parallel. When they begin to harden and full, they crawl in, interlock and bind the mass together."

F. E. Morton: "The carding processes would be interesting to hear."

A. W. Nelson: "The fibres are constantly being worked so as to lay them parallel. The wool goes on the card picked, and is fed in there and the fibres of the web are parallel as they get to the finisher end of the card. We use all care in selecting the wool. We get it as clean as we can—free from specks. One of our great troubles comes from marking the sheep in the West. They put on a big brush of tar and the sorter is supposed to cut it off, but the specks show up all the way through. We have girls picking these specks from the wool. Then the wool is combed and from there run into a carder. We start at the bass of a sheet end and use a combination of wools which give most resiliency. Then it is run down on what we call a roller hardener. It is an endless apron running over brass rollers. The rollers are perforated for steam. Then a narrow web is run down. It widens out and builds a proper taper. If we want a full taper it is fed so that we get more wool in the treble and less in the bass, or a perfectly straight taper can be run. Some faults would come because the sheet has not been properly hardened. It is absolutely necessary that they be hardened together. You would get a soft spot in there if it wasn't hardened that couldn't be eliminated after it leaves the hardener. It is necessary that both sides be even. It takes about an hour and a half to run down a 12-pound sheet. This is taken from the hardener and cut into six sheets. It is then taken into the fulling room and washed very carefully and any oil or grease is washed out. Then it is put under these hammers and pounded from every different angle. It is rolled one way. A sheet will be about 60″ wide where it changes to 36″, and will be 50″ long where it will finish 39″. It is fulled in that operation. The whole operation is like a poor washerwoman with good underwear. We handle it with soap and pound it at all angles, so all portions are treated alike. Then we shrink it in the extreme treble portion to make that as hard as we can. We leave the bass where we think the customer wants it as nearly as we can find out. We make the treble as hard as we can and yet leave it elastic so there is a certain amount of stretch left in it."

F. E. Morton: "What characteristic in felt determines the elastic limit?"

W. H. Bryant: "The life of the wool that has been preserved through all these operations."

F. E. Morton: "Has the hammer maker any safeguard which will prevent him getting beyond the elastic limit?"

R. H. Buchanan: "I don't believe he has any positive safeguard."

F. E. Morton: "This results either in a loss of stock or poor hammer."

R. H. Buchanan: "Yes!"

J. Gerts: "I would like to ask these gentlemen what they think of reinforcing hammers?"

F. E. Morton: "That subject is coming up at another time. We are treating with the direction and control of energy and the object is to conduct the energy from the end of the key to the sounding board as effectively and efficiently as possible. That can be and will be worked out as an engineering problem. The resistance at the point of the hammer can be computed as accurately as any other problem in force and resistance. The shaping of the felt before it is put on the hammer is a question that does come up to the felt maker. As to elasticity, it was suggested at the last meeting that the resilience of the felt should be the same as that of the wire. There can be a proportion established. It is purely an engineering proposition."

William Braid White: "We have established, I think, the matter of pressure. The time the

hammers are left in the press is of importance to the tone quality. Couldn't we arrive at some definite data which the hammer maker could use for giving whatever results are desired, and if some experiments were made by the manufacturers and hammer makers, many advances could be made toward real knowledge of the subject and we then could accomplish something by working together."

F. E. Morton: "I agree with that fully. In the manufacture of steel—in annealing work, for instance—we used to be dependent upon the judgment, good or bad, of a man whose business it was to determine the temperature from the effects observed, and the whole process of annealing for a space of hours was up to the judgment of that one man. The factor of domestic troubles, indigestion, etc., which naturally warps a man's judgment was not recorded. We had the same problem that you have with the hammer maker. Today we have pyrometers which register the temperature, and if we want to know the condition of rods or wire, we have a record showing variations of a single degree, and no one can say, 'I thought it was all right,' or 'I did the best I could.' That part of the human element has been taken care of by scientific methods. There is room for a great deal of that sort of thing in hammer making. I think we may possibly find room for a great deal of that in the felt making process and we will try to find it and supply the need. The greatest engineers in the world combined can solve that problem. It is unnecessary to leave human equation in your business. It has been said that if one man could make the entire piano he would eventually reach a point where he could make a first class and uniform piano. The logic is clear, but we pass it from one operation to another and the piano becomes a composite of the efforts of numbers of men. The check on the human element is inadequate."

R. H. Buchanan: "Here is some felt which we make for people who manufacture their own hammers for their own use. That sheet is about 13½ lbs. These few hammers I have here were made from that sheet of felt. Here are three hammers from a sheet of felt that weighed 11 lbs. that is spoken of as a straight taper. This sheet of felt is what we called a full taper. A straight taper has a straight line on both sides."

F. E. Morton: "Is that felt drawn too tight? Is it up to its elastic limit?"

R. H. Buchanan: "The bass of the straight taper felt is the best hammer of the two."

E. B. Bartlett: "I understood you to say the larger was made from 11-lb., and the smaller from 13½. Is the difference of size due to the compression of the molds?"

R. H. Buchanan: "Yes."

R. W. E. Sperry: "Is there any special reason why the straight taper is used in preference to the full taper? Is there any price reason?"

R. H. Buchanan: "The full taper costs a little more money but contains more felt. Here are hammers from another set made by the same man. He thought he needed an extremely hard sheet of felt to make a hard hammer. These hammers were made from an extremely hard sheet of felt. The other one was made from a comparatively soft sheet."

C. C. Chickering: "How about the wieght?"

R. H. Buchanan: "The weight is the same within a couple of ounces to the sheet. We try to keep the sheet within four ounces. The harder the sheets the thinner and smaller for a given weight. One couldn't possibly felt the wools in the bass of that felt as firmly as is necessary in the treble."

Wm. Davis: "The hammer that has a mixture of coarse fibres will not wear as well as that with the uniform fibre."

W. H. Bryant: "That brings up the question of the blood of the stock."

H. H. Arnold: "Doesn't it come back to the question that two sheets of felt made exactly alike under the same pressure, uniform in every respect, given to two different hammer makers to make hammers, one will make a hard hammer from one sheet and one will turn out a uniform and soft hammer? If the manufacturer will instruct the hammer maker as to the degree of hardness necessary in certain parts of the sheet, can they make those hammers always uniform from the felt that is furnished them?"

R. H. Buchanan: "They should be able to make them fairly uniform. A man depends very largely on his sense of touch in screwing down a hammer press. He uses the very best form he can, I presume."

Wm. Braid White: "Have you any way or can a way be devised for measuring pressures?"

R. H. Buchanan: "I believe a way might be found."

Wm. Braid White: "Couldn't that obtain by collaboration between the piano manufacturers and you?"

R. H. Buchanan: "If you would co-operate with the hammer coverer and the hammer coverer with us it could be done."

R. W. E. Sperry: "I think Mr. Alfred Dolge a number of years ago worked on that principle in his hammer covering machines. He used a hydraulic pressure in three divisions and could regulate each division of the set from each unit. That was working on the idea you mention."

Wm. Braid White: "We should get down to an engineering aspect of things and proceed to find out where we are. When we have once found out what our faults are and can put them down on paper we can remedy them."

R. H. Buchanan: "We would be glad to have any of you who are interested in the manufacture of felt visit our mill, and we extend to you the courtesy and freedom of the mill. We will explain anything and will be glad of any suggestions you might make that would improve our product."

R. H. Waud: "Can you tell us what is in the wool that when you put a needle through, it feels like grit?"

R. H. Buchanan: "I have heard that. It is pretty hard to explain what that is. It is hard to convince some people that there is not sand in it."

W. H. Bryant: "It may be properties of the water that causes the condition."

R. H. Waud: "Why is our American felt so much whiter than the imported felt?"

R. H. Buchanan: "It is due to the finish as much as anything else. We are fast getting away from finishing felt. It was the custom of the manufacturers here to 'pounce' felt, meaning sanding. In other words, a finished sheet of felt has a few wrinkles and doesn't work very well and we avoid that as much as possible in the manufacture. The users of felt have complained of the wrinkles and we have pounced it—taken off the rough surface—and it seemed to whiten it."

R. H. Waud: "Doesn't some of the sand get into the felt?"

R. H. Buchanan: "No. It is finer than the finest talcum powder."

Wm. Davis: "What makes the imported felt finer than our American?"

R. H. Buchanan: "There can't be any finer wool bought than we buy and use in this country."

F. E. Morton: "Is it not true that foreign felt makers buy wool in America?"

R. H. Buchanan: "I am not positive."

Wm. Braid White: "It is quite certain they buy it from Australia?"

R. H. Buchanan: "Some is bought there."

C. Arthur Brown: "Do you know, Mr. Davis, whether the foreign fibre is finer than the American? Have you photo micrometered it?"

Wm. Davis: "You can readily distinguish from the feel."

C. Arthur Brown: "This might be due rather to the physical quality of the fibre than the absolute diameter."

Wm. Davis: "On looking through a glass one can see it is more uniform."

C. Arthur Brown: "A micrometer would give absolute diameter."

C. M. Stanley: "I have always been under the impression, Mr. Brown, that the wool coming from a single sheep is much finer in one part than another. What part of the sheep does the finer come from?"

C. Arthur Brown: "I couldn't say definitely myself."

C. M. Stanley: "I have been told that the finest wool comes from the forepart of the body."

C. Arthur Brown: "Logically, it should be so."

F. E. Morton: "Would it be a commercial proposition if determined?"

R. H. Buchanan: "Yes."

C. M. Stanley: "Old felt makers have told me that felt buyers could tell the different grades of wool by thrusting a hand in a bag containing it."

C. Arthur Brown: "That is true from all I can learn. I have learned that experienced wool buyers tell by the feel of the wool. I understand also that they can tell very quickly and accurately by that method whether the wool is from a live or dead animal."

T. A. Johanson: "Hasn't the shearing of the wool something to do with it—shearing in the spring or fall?"

C. Arthur Brown: "I would assume so. The question of the time of cutting would certainly have an effect upon the wool itself. It does on every other animal."

R. H. Waud: "I have been told that the sun bleached wool is better than the chemical."

C. Arthur Brown: "Any chemically bleached wool that is treated with a sulphur or chlorine or any active chemical bleach should, from the chemist's viewpoint, be less resilient and approach more nearly that of the dead fibre than would be the case when acted upon by the sun. The properties of ozone would very closely approach that of sun bleaching and offers a chance for experimentation that might be well worth while."

C. M. Stanley: "Twenty-five years ago, Mr. Dolge brought some hammers to be tested out. These hammers were tried and the result convinced me that the resiliency was in the sun bleached wool."

C. Arthur Brown: "The method of cleansing the wool and the quality of water that is used after cleansing would play a very important part in the life of the fibre. If you use a strong alkali on a wool or any other fibre, whether it be vegetable or animal in its nature, there is a certain action of the alkali that will injure the fibre. If that be followed with a wash of water that contains quantities of lime and magnesia there is an action that will injuriously affect the fibre itself. The French and English will not use anything other than very soft water. It has not received sufficient attention in American practice."

R. H. Buchanan: "We do not use chemicals in bleaching. After the hardening process we hang the sheets of felt out under a shed to let the air penetrate as long as we can—a week or ten days, longer if possible. After that we full it with soap made especially for that purpose."

Wm. Braid White: "The point is apparently established that if we are to make a distinction between the domestic and European, we have to go by some difference in the actual felting itself, and therefore there is no reason why the process here should not be as good as it is anywhere else."

C. Arthur Brown: "It is ordinary experience that there is no nation in the world that can do anything better than the American if he puts his gray matter in it."

Wm. Braid White: "We have been dealing almost entirely in the past with tradition. There is nothing fundamental about the foreign method that cannot easily be assimilated here."

R. H. Buchanan: "One of you mentioned having been told that a manufacturer made his felt by laying it up in layers. I have talked several times to a party who has been in several German mills and that is their method—it is not ours. Tests we have made for durability of German felt against domestic in a piano factory proved the domestic outwore the German felt. We believe that this is due to the fact that when a great mass of felt is worked—the thickness of the bass cut off in lengths and stepped—it is difficult to get adherence. They take the great mass and try to harden it together by wetting it and they put it between two large hardeners. They harden that together. We maintain they couldn't possibly get it together so that it will stay or have the same lasting quality as we do by making our sheet on the endless apron where it clings and knits better than if a great mass is taken and pressed. I made the tests and found that at the beginning their felt stood up with ours, but that afterward their felt cut through in jumps while ours was more even. The fibres were not all the same way as was ours, or as all American manufacturers. Our machinery is superior."

F. E. Morton: "So far as has been brought to your attention from your sales department, Mr. Bartlett, is there any sales value in a white hammer felt over the yellow?"

E. B. Bartlett: "I don't think so."

R. W. E. Sperry: "There are a few people who imagine the yellow tinted felt is imported. There seems to be a magic halo about the word 'imported.'"

F. E. Morton: "I would like to get an expression of opinion in regard to felt color. Is there any real advantage in a white felt over a yellow one?"

E. B. Bartlett: "I have something to do with the sales department in our house and my impression would be that it would depend altogether on how the change, if it were radical enough to be noticeable, was explained to the sales force. If we could tell them intelligently—give them a logical reason—it would be all right."

F. E. Morton: "I want to say that I think the result of this talk will possibly be greater than we imagine now from the interest that has arisen on both sides. The American Steel & Wire Co.

has a department of water purification and that department has been at the service of municipalities in the United States for several years with Mr. Brown as chief engineer. The health and welfare of the community is of tremendous importance to people depending upon increased racial activity for their increase in business. That means piano makers as well as steel makers. We have in the Steel Corporation a department to look after the welfare of employes, which service has been more or less extended to cities of the United States. The welfare of a city not only means the health of its people but provision for their needs industrially. The laundries must have the right sort of water, the mills must be given water that is usable as the progress of the community tends very strongly toward increasing activity and the demand for new things. A great deal of data has been collected which would apply directly to any industry and there are very few industries which are not dependent upon the water supply. It would be safe to say that data collected in research work applying to laundries for instance would apply to felt making. We also have data affecting soap making and experts in that line under Mr. Brown. We will co-operate with the felt makers, the farmers, the hammer makers and the piano makers, but there must be a central point. Collaboration only is effective when focalized. The central point in this case will be the Water Purification Department. I don't believe there is a single man in the business who wouldn't be very glad to be able to say: 'We make the best felt in America that can be made in the world and we are in the way of continuous progress.' It is certain that there is a sufficient amount of gray matter engaged in the arts and industries from the farmer to the artist to carry this to successful fruition. Collaboration would bring about immense results. The result of this collaboration would probably be our answer to the question: 'Is the American felt suitable in every respect for making a hammer for the American piano having an American tone?' And it is the solution of that problem that is engaging us. We are going to do this anyway. We would like you to help us. We want all the help we can get. I ask for your assistance and co-operation. Your experience with hammers is valuable. I assure you that insofar as the American Steel & Wire Company is concerned they are going into this matter to win. We have only one capital crime here and that is failure to make good. I ask you personally and collectively for any assistance, and no matter how trivial it is to you, your experiences are worth a whole lot. There are matters we have taken up in these meetings such as tension,—high, low, uniform and varying. Those are the wires that these hammers are going up against. When one string is pulled to 200 lbs. and another to 120, this marks the difference in the work of the hammer. We will have to bring the piano up to a point where it may be fit to receive a good thoroughbred hammer. Let us not standardize, but individualize on reasonable, rational lines and forget there is such a thing as 'talking points.' We know of course, that the condition of a hammer which strikes a wire drawn up to too high a tension or too small a gauge isn't in effect the same as one striking a lower tension or a larger gauge of wire, so we will have to take that into consideration, but at the same time we should not expend our effort in producing a hammer to do unnecessary work—work which is inconsistent with its proper functioning. Take into consideration all that lies back of that hammer and we will take up at a later meeting the things that lie ahead of it, such as shape, form, hammer line, the relation of the hammer and its proper function to the sounding board through the wire. We have engineers on pretty nearly every line that one could mention and through collaboration we can find a way of doing things. As Mr. Brown stated to me some time ago in discussing this matter, give me a sample of water that you want and I will produce it. There is no limitation to the production of synthetic water. We have been told frequently that the cause of certain characteristics in felt is due to the water used and I have been told in Germany that the Americans never could make good felt because they didn't have the water. We know better than that now. This is purely a commercial proposition and I hope the time will come when we will stop selling wool from this country for a few cents a pound and buying it back for a few dollars a pound."

Wm. Braid White: "May I ask you whether it will not be possible in the near future to have a structural engineer here in order that we may talk to him and take some steps forward to point out that piano construction is a stress problem? We can learn an immense amount."

F. E. Morton: "I am preparing for that now, but I want to work out the experimental stages before presenting them to you. They are complex enough after we have tested them out. I am having experimental scales drawn, patterns made, etc., and will give you the result at the proper time. The methods of plate construction will be demonstrated, but the experimental results will be determined before presenting them."

Height of Keyboard. Hammer Felts

December 7, 1916

The Committee on Height of Keyboard rendered the following report:

"The committee appointed at the meeting of October 19, 1916, to investigate and report on the question, *Shall the architecture govern the height of grand keyboards, or shall the height of keyboard govern the architecture?* beg to submit the following:

"The convenience of the artist should be the first consideration, and study of the height of keyboards of several pianos frequently heard in concert and recital leads to the inference that whether through accident or design, similar dimensions are used in many of the well known pianos.

"It appears that the height of the white keys is, in most of the cases considered, twenty-eight (28) inches. Some slight variation from 28 inches may be accounted for by different methods in measuring or lack of care in taking measurements, or even slight variations between individual instruments, so that any manufacturer adopting 28 inches as standard height for white keys in grand pianos cannot be far wrong. The horizontal distance between a perpendicular line dropped from the front end of the white keys to the front end of the pedals will naturally vary somewhat because of the varying length of keys in grand pianos of different sizes. A maximum distance of 10 inches in concert grands is probably about right; in small sizes seven and one-half inches is more usual."

E. B. Bartlett: "We have tried to boil down the result of our investigation. Of course, we have no legislative powers and we have even hesitated to put it in the form of a recommendation, but those who desire to conform to what appears to be the standard among pianos most largely used for concert purposes should have no difficulty in doing so."

The report of the committee was accepted with the thanks of the members to the committee.

F. E. Morton: "In our collaboration and collective research we have taken up the manufacture of felt. The point at which we are aiming must be kept in view, which is to place the responsibility for conditions. It is fair to say that with the interest shown here the responsibility will be placed with or without the assistance of those involved, from the sheep to the finished hammer. This involves the hammer maker and those who put it in the piano and fit it for use. We may go farther than that and invite such persons as may determine what happens to the hammer after leaving the factory,—the tuner and the repairman. Tonight we consider the man who receives the felt from the felter and fabricates it for your use. In looking for a man with a wide experience to present this side to us, it seemed right and in keeping with the purpose that we ask one using all makes of felt—domestic and imported. He should be able to define his position and responsibilities much better than one who only uses one make of felt. The Import Felt Company of New York uses the felts of a number of makers. In domestic felt they use Standard, Felters, American and Crane. In imported, Weickert and Dittersdorfer's felt, and through their interest in your welfare, which is identical with their own, Mr. Vincent Vilim, president and general manager of that company, is here to answer such questions as we may see fit to ask."

Vincent Vilim: "I appreciate the opportunity to be here tonight at the invitation of Mr. Morton. I have been making piano hammers for twenty-six years. I like the business and want to continue for the next fifty—if that is possible. I have used all makes of felts and I find they differ greatly in quality. I have all kinds of tapers here—the American, straight and German; also all kinds of felts and hammers finished and unfinished, down to the hammer molds. We want to find out where your trouble lies. I came here for your interest as well as mine, and for that purpose I have everything here to show you. First we take the hammer moldings and count off as much as we need in the sets. We then tighten them up in the clamps. Then we glue on the under felt. (Illustrates.) It is then forced down into a small mold. It remains in the mold for an hour and then is finished up. When it comes out of the under felt mold it looks the same as a top felt and is tapered the same. It is then ready for top felt glueing. Here is a piece of straight taper felt. Only a few manufacturers run the under felt all the way through."

F. E. Morton: "What is the function of the under felt?"

V. Vilim: "It is only for appearance. It only serves to build the hammer up."

H. H. Arnold: "Does an inferior grade of under felt have any bearing at all upon the hammer?"

V. Vilim: "Not so far as I know. We can make a 12-pound hammer out of a 13-pound felt. (Illustrates.) It is forced into the mold; then it is glued. We put on just enough glue to hold."

C. Arthur Brown: "What quality of glue do you use?"

V. Vilim: "It depends on the temperature of the work room. A cold room demands a high grade glue. We keep our work room at 85 degrees the year round. We have steam heat in our department in June."

C. Arthur Brown: "Does the quality of the glue affect the hammer?"

V. Vilim: "It depends rather upon the way it is used."

Wm. Braid White: "If you used no under felt, would you have less difficulty in gluing?"

V. Vilim: "It would save labor. No under felt trimming would be required, but it would be hard to convince piano manufacturers. They want an under felt because of its appearance. We would rather make single coat hammers."

H. H. Arnold: "What would be the relative difference in expense?"

V. Vilim: "About 30c more per set."

H. H. Arnold: "There would be a difference of $4.50 on one sheet, not allowing for the under felt and the labor. From your experience do you believe we would get better results?"

V. Vilim: "That question is up to the piano manufacturer and the tone regulator."

E. B. Bartlett: "Suppose you wanted to make a set of hammers of that same size without the under felt, you would naturally use a thicker piece of felt. When you come to strain it over the molding, wouldn't you put a much greater stress on the face of the hammer because of the additional thickness of the felt, and wouldn't it be apt to tear apart more and be less durable than a thinner top felt?"

C. Arthur Brown: "That is true, but a change in the method might effect a difference in the stress."

E. B. Bartlett: "A method could be devised."

Wm. Braid White: "If that were true, it would be better to have three layers than one."

C. Arthur Brown: "If you were to carry that to an absurdity, an infinitesimal number of layers of felt would give you an absolutely non-resilient hammer."

E. B. Bartlett: "In the old days they used to cap hammers with leather in order to give a brightness. When you are down half the thickness of this top felt you are about through, anyway, and it is immaterial whether it strikes a joint or not, it seems to me. There might be an objection to a second glue joint because of its effect on the elasticity. This under felt is so far from the striking point it would be negligible."

F. E. Morton: "Do you recognize an elastic limit in felt?"

V. Vilim: "I do. There is a limit to everything. The tone regulator can spoil a good hammer. I believe a good many tone regulators ought first to try their hammers. They usually pick it without trying it and some are over picked. I find in many cases hammers picked to death."

Wm. Braid White: "In reference to top and under felt—as the felt has to be stretched and tensioned, is not the amount of stretching so far in advance of all the other tensions that the extra thickness would be negligible in practice?"

V. Vilim: "When we get a piece of felt with a hard base or full taper we construct special molds to get the right tension on all hammers. We are carrying twelve special molds to meet customers' requirements."

C. H. Jackson: "You will notice that on all of these samples of hammers that one side of the felt has not been properly glued on to the front of the moldings. While this may seem a trivial matter at first thought, I can say that upon investigation I have found this to be the cause of weak spots in the treble, times without number. I have never had to remove any of the hammers in the lower sections for this reason, because it would not be noticeable unless they were much looser than the samples here. However, I have found that where there is the least bit of defective gluing in the treble hammers, it causes 'punk' or 'mushy' tones. I first made this discovery about five years ago, and I have checked it up very closely ever since and know what I am talking about. The hammers are from three different makers, so you can see that the trouble is not confined to any one hammer shop. I am not making the claim that this is the cause of all weak trebles, but, however, when a weak spot shows up in a part of the treble that is ordinarily good, invariably it will be found that the hammers are causing the trouble. At times I have

removed as many as eight and ten hammers that were in the same condition as these samples, and upon putting in new hammers the trouble was righted."

V. Vilim: "One man glues one side and one the other. The glue is applied to the felt only, never to the molding. The trouble was experienced because the man who glued on one side did not apply the glue all the way up to the under felt."

F. E. Morton: "By what means is the felt forced into the mold?"

V. Vilim: "We begin at the treble and press down by hand toward the bass, and when we get the bass down to a certain depth, we work back toward the treble. After it is down in the mold we put our iron side cauls on and screw them up. If a hard treble is required it is screwed hard. The workman practically regulates the tone of the hammer by the degree of pressure. He judges this by human touch—experience."

F. E. Morton: "Assuming that felt could be made and delivered to you with its resilience and elastic limit known throughout the sheet, would a machine or apparatus to measure your pressure on the side cauls be valuable? Would it replace the human equation?"

V. Vilim: "Yes, it would."

C. Arthur Brown: "Assuming that the felt is not uniform but possessed of variable elastic limit and resiliency, would a machine which would take cognizance of these conditions and bring the felt to any desired pressure at any point eliminate the human touch?"

V. Vilim: "I don't believe it could be done; there is too much life in the felt."

H. H. Arnold: "If the felt in this case came to the hammer maker registering the amount of resistance, wouldn't that eliminate all the human equation?"

V. Vilim: "I don't think it would. We have tried many plans. Some felts need more pressure than others. Every piece has a different life."

F. E. Morton: "Is that life apparent to the feel of the man at the screw?"

V. Vilim: "The man who works the press knows when it requires more or less. He can tell by the way the felt comes down and up. Some sections don't come up even when taken from the same piece."

F. E. Morton: "All the factors in these equations are variables. We have not struck a single constant yet."

C. Arthur Brown: "I would like to ask whether I understood Mr. Vilim clearly in stating that two pieces of felt cut from the same sheet will vary materially?"

V. Vilim: "Yes."

C. Arthur Brown: "This shows a lack of homogeneity in the felt itself as it comes to you. Is this correct?"

V. Vilim: "Yes."

H. H. Arnold: "Then no two sets of hammers would come out exactly alike unless by accident, but an experienced hammer maker can make them nearly alike."

V. Vilim: "Yes."

C. Arthur Brown: "This question of the human element—as I understand it, cutting from the same sheet, you get non-homogeneous felts. That requires, according to your statement, the individuality of the workman to make that non-homogeneous felt into two homogeneous sets of hammers. Doesn't that come back to the application of pressure required to compensate the non-homogeneity of the felts?"

V. Vilim: "I don't know how I should answer that question. We depend upon our men more than upon the felt. I cut every piece of felt that goes into the hammers we make. When I get a piece that requires more pressure, I mark it for my man in this section. He goes according to my specifications."

C. Arthur Brown: "You rely then upon the human intelligence to bring the non-homogeneous felt to a homogeneous set of hammers?"

V. Vilim: "Yes."

C. Arthur Brown: "Assuming that human element was not used but the machine or mold took cognizance of every idiosyncrasy of the section of felt it was pressing and brought them to a uniform or predetermined pressure, would not that be more perfect than the human element could possibly introduce?"

V. Vilim: "That is to be found out. I would be very much interested in such a machine."

H. H. Arnold: "Is a soft felt better than a hard felt for a soft hammer?"

V. Vilim: "Yes. We can make a soft hammer out of a hard piece of felt by lessening the pressure after it is forced into the mold. For a soft hammer we ease up on the screw."

H. H. Arnold: "This comes back to a mechanical basis. If your machine were properly set, you could regulate it."

V. Vilim: "The trouble would develop with a piece of felt having a German taper. When this molding is put on, the ends of the sheet are free. It is low in bass and treble and heavy in the middle."

H. H. Arnold: "The machine would mechanically care for an even pressure."

V. Vilim: "We would have to spend a great deal of money for machinery that would overcome this trouble."

H. H. Arnold: "The question is, how much better would the hammers be?"

F. E. Morton: "Is the foreign taper also known as the full taper?"

V. Vilim: "Yes. It is heavy and has a very small bass. This sheet would make a 16 lb. hammer but only a 13 lb. bass."

Wm. Braid White: "Suppose you have a sheet of soft felt, can you make a set of hammers permanently hard?"

V. Vilim: "No. If the felt is too soft it cannot be done. It cannot be done by pressure unless it is treated. We would rather send it back to the maker than treat it."

F. E. Morton: "By what means does the manufacturer get his specifications to you? Does he give you a set of hammers to duplicate?"

V. Vilim: "Yes. We examine them, note the characteristics and duplicate them as nearly as possible. We try to better them."

F. E. Morton: "Can you tell what the piano manufacturer wants by the hammers that are submitted to you? Can you tell where the points of improvement should lie?"

V. Vilim: "We try to guess at it. It is the only thing we can do."

F. E. Morton: "Mr. Widney, how do you determine what sort of hammers the manufacturer wants—by samples he submits to you or by having him try certain hammers. Do you take into consideration any characteristics of the pianos for which they are intended?"

S. W. Widney: "No. Usually he gives an order for a sample set or more. When he gets a set that satisfies him he orders them duplicated. He rarely gives other technical directions."

V. Vilim: "When the right set of hammers has been submitted by the customer I examine the set thoroughly and I know just what is required. I know what I must use, whether a heavy or straight taper, and a soft or hard felt."

C. Arthur Brown: "It depends then altogether upon your ability to judge from a physical inspection what that hammer really is. You have no physical tests?"

V. Vilim: "No."

H. H. Arnold: "If I were to order a set of hammers and give instructions that I wanted them soft in the bass, medium hard toward the center, and running toward hard in the high treble, that would be your only guide?"

V. Vilim: "Yes. I suggest to all piano manufacturers that they use a different boring for the different weight hammers. A 14 lb. hammer should have a different striking distance than a 12 lb. hammer. The boring should vary one-sixteenth to one-eighth inch. The piano manufacturer gets different striking distances and wonders where the trouble lies. Some use the same boring on hammers of different weights. A 14 lb. hammer should have a boring of 2½ inches in the treble where a 9 lb. hammer should have 2¼ inches. This can be shown on some hammers I have here. In the extreme treble it does not vary so much."

F. E. Morton: "Is your process up to the point of over felting identical on all hammers?"

V. Vilim: "Yes. After the top sheet is glued on and taken out of the press, it goes to the hammer trimmer. He evens up all the defects of the felt. If it is a little bit one-sided he gives it the proper shape. It then goes to the sandpaper man. He uses sandpaper from coarse down to 0000. Some makers use coarse sandpaper only and dress it up with hot cauls. When the hammer is cut the felt pulls out on the bottom side. We place it in a cold press which puts it back in place."

C. Arthur Brown: "What is the maximum temperature to which that felt is subjected at any stage of your process?"

V. Vilim: "We have nothing to go by. We do not use thermometers."

H. H. Arnold: "How do you heat your cauls?"

V. Vilim: "We don't use heat. 26 years ago we used hot cauls because the room was not warm enough. In the summer the glue came through the felt because too much glue was applied."

John H. Gerts: "I have come across a dozen or more old sets of hammers which had under felt to the treble and the last octave was cut almost through. I think that is the reason why they did away with the under felt."

V. Vilim: "It was really a nuisance to the hammer maker. It required more felt to run the under felt all the way through, and a German taper cannot be carried to the extreme treble."

F. E. Morton: "Is there anything that can be done after you have made that hammer and finished it that will affect its value?"

V. Vilim: "No. All must be done before it is glued."

F. E. Morton: "Do you submit the felt that you purchase to any tests other than the sense of sight and feeling?"

V. Vilim: "No. The only way we can tell is by putting into the molds to determine whether the felt has any life or not. If it comes up promptly it has life. If it goes to the bottom of the mold it is dead. Reinforcement is only a 'talking point.' I really think it injures the hammer."

Wm. Braid White: "How is it reinforced?"

V. Vilim: "A celluloid cement or shellac and French grey is painted on the outside after the hammer is finished."

F. E. Morton: "Given a warm, salt atmosphere, would a waterproofing keep the glue from giving way?"

V. Vilim: "No, it would not. I spent three years experimenting on waterproofing. A gentleman asked me if I could make a waterproof hammer and I spent two years trying to do it and after it was finished it could not be utilized."

Mr. Vilim then exhibited and described in detail a set of Grand hammers made from first quality Weickert; Weickert's No. 1 and No. 2 Uprights; Dittersdorfers' No. 1 and No. 2; American Felt Company's 1st and 2nd; The Felters Co. 1st and 2nd; Standard 1st and 2nd; also a piece of Neish's English felt.

F. E. Morton: "Is there any added value in a bleached felt?"

V. Vilim: "There is no advantage at all."

C. Arthur Brown: "Is there a disadvantage?"

V. Vilim: "I don't believe in bleaching. It ought to be left natural. It injures it; takes the life out of it. Here is a piece of white felt. We can tell the quality by tearing it open. You can see what kind of wool it contains."

Specific felts and hammers then were intimately discussed. Mr. Vilim stated that this year's makes of felts were inferior to felts made in the preceding years and exhibited samples of various domestic felts of the years 1915 and 1916, respectively, in proof of his contention.

Those present examined both sheets and hammers, noting carefully the faults in the 1916 product as indicated by Mr. Vilim. He pointed out that the 1916 hammer cut through and is less durable; is less resilient; less uniformity of fibre direction; shorter fibred; less perfectly carbonized; contains more hard spots and tar specks. He also pointed out that domestic felt came to him stretched from 8 inches to 12 inches in process of making, drawing it beyond its elastic limit and thus destroying its resiliency.

Asked about waste in cutting, he stated that the loss was about one pound to the sheet.

F. E. Morton: "I want to call your attention to the possibilities of the practical application of that which we have learned from the hammer maker. Up to date, the function of the hammer has not been determined. Going back to 1869 I find it stated that hammers are made softer in the bass than in the treble and that no doubt the manufacturer had some good reason for it or he wouldn't have done it. That seems to be about the sum total of the application of scientific principles up to that time. We know and have demonstrated that the longer the time the hammer contacts the wire the greater number of partial tones silenced. The hammer resting against the wire after having struck damps the partials whose crests are at and near the hammer line. That means if you want a crispness of tone, that crispness—I cannot find a better word—which comes from the presence of the 3rd and 6th partials, your hammer must rebound quickly from the wire. If you

mute those partials, you will eliminate that crispness of tone. That tone is more generally found in a concert grand than in an upright. It is easier to produce it in a 9-foot grand than in any other instrument, for in the grand you use the best hammer you can get,—a hammer of great resilience —a hammer which leaves the wire quicker than does a poor hammer. The points developed here tonight, when applied, show why a hammer contacts the wire after striking it. A poor hammer needled in an attempt to make it resilient, does not leave the wire as quickly as one of live fibre felt. *You can produce a better tone from a piano with poor wire and a good hammer than you can with the best wire made and a poor hammer.* I have demonstrated it frequently. This accounts, in a measure, for the interest of our company in the felt industry. The 'buck' has been passed to the wire maker and he is now passing it back. If we can find a means—and I am assured that response may be had from the felt maker through the hammer maker—to produce a hammer of residual resilience, an elasticity that is in the hammer and not imitated by the needling of a tone regulator, the tone of the piano will be improved and from that point tonal progress may ensue. In order to progress tonally, we must establish everything up to the present. The hammer now stands in the way. I ask you to make your individual experiments. Make a single section action, adjust the wire and use a hammer until it shows signs of wear. Half a dozen will give valuable data. This is the mechanical side. For the tonal side, you can try various hammers on the same piano. It is well worth while. A point will thus be reached where the piano manufacturer may specify accurately to the hammer maker, who in turn may specify to the felt maker. The hammer issue will be closed and then we can go on to further refinement.

"In the matter of striking point and the area of felt contacting the wire, those points now may be treated scientifically. Given a flat surface, a greater area of hammer is presented to the wire than one firmly rounded. More crests of segmental vibration are contacted and certain partial tones needed are muted and there can be no refinement beyond that point. A hammer should contact the wire *at a point* and immediately leave it. If I could secure the experiments of each man interested in this proposition covering two weeks' time, I feel certain I could evolve from it a formula translatable into felt factory terms, and thus establish a line of communication between the user of hammers and the maker of felt. When the responsibility for a faulty hammer lies with the man who specifies, there is hope of tonal progress. I want to express for the piano technicians, Mr. Vilim, our appreciation of your presence and we thank you for the great trouble you have taken in enlightening us and feel we have been well repaid."

Peculiarities of Wound Strings

December 21, 1916

F. E. Morton: "The subject before us this evening is bass strings. When it was found that the length of a piano did not admit of wire long enough to produce the required pitch, methods of weighting the wire were adopted. Brass strings were wound with brass wire the whole length, steel wires were first wound with iron, afterwards with steel (generally referred to as iron today by the trade), and then with copper. Then followed swaging, and the cessation of winding before reaching the bearing. Thus we have gradually evolved the bass string of the present day. The bass string maker has been thoroughly investigated, individually and collectively. We find their practice of winding is far better than the practice of specifying by the manufacturer. We have here in Chicago the John A. Schaff Company who make bass strings, and we have with us tonight Mr. Edmund Johnson of this firm who will give us the maker's viewpoint. Afterward I will endeavor to explain 'the why' of present practice, pointing out just how far we have gone in our experimentation to determine remedies for present troubles."

E. Johnson: "I did not come here to make a speech but only to answer such questions as you might ask, but I do think it well to make a sort of résumé of the evolution of the bass string during the past thirty years. Ten years ago 90 per cent of strings were iron wound. As you know, that has gradually swung around to copper. Within the past six months we have had considerable difficulty in securing material and we started experimenting again with the iron wound string. We have found that where we sold the iron wound string they had very little trouble,— in fact, none of the trouble experienced with the copper string. That is really the part of the discussion I want

to emphasize tonight—the adoption of the copper string. The theory prevailed for a long time that the density of the copper produced a better tone. I cannot give the theoretical side, but the iron string does possess a clearer tone—at least, that is our experience. I have brought with me three kinds of bass strings,— iron, copperized and copper. The copperized is the same as iron except that it is copper plated instead of tinned. Our experience with most piano manufacturers for years was they required very high tensile strength wire. Softer wire would be better for the manufacturers if the scale permitted the lower tension. As it stands today, however, we have not been able to use the softer wire. We have found a wire that will stand the swaging and loop. These are the principal tests. The wire mills give a much more severe test than we do before sending out the wire. In order to get the proper tension, it is necessary to make certain changes in the scale. Just how far a manufacturer should go with that we do not know. We have certain scales that have given us less trouble than others. We usually take them as models, taking the wire sizes used on these scales as nearly as possible, using them on any new scales that may be laid out. Of course, there is no set rule for doing this. We also try to anticipate the sort of tone desired by a manufacturer and work with that end in view. Some manufacturers require a sharp tone, others a tone more or less dull. If a dull tone is desired we find the copper wires act to better advantage than the iron."

H. H. Arnold: "Do you know whether at any time any manufacturer has taken a certain number of copper wound bass strings and a certain number of steel (commonly called iron) wound strings, using the same weight of wire with each and the same scale of piano and tried them out systematically, and come to a conclusion from that trial, and if so, which gave the better results?"

E. Johnson: "Only in this way: I have seen them use same weight of hammers using both copper and iron strings. We do not advocate an entire set of iron strings— the last ten strings should be copper. This is due to the fact that the diameter of the core is so much less than the diameter of the covering wire. On fine strings we have found where the same weight of hammers is used and on the same scale, the iron strings give better results. I do not know just what the reason is."

H. H. Arnold: "We hope to hear that later. We all know we cannot get exactly the same results from two pianos even if exactly the same scale and materials are used, but by taking a certain number— anywhere from six to twelve, half copper wound and half iron wound— it seems to me some average might then be determined upon and that average taken to govern the whole."

E. Johnson: "When my grandfather was making pianos he always used the iron string although at that time we naturally preferred to sell copper bass strings because we could make more money. In our own piano at home we had iron strings. It seems to me the copper string has come into favor more through salesmen's talk. Naturally everybody knew a copper string cost more than iron."

Wm. Braid White: "When you are about to make up strings for a new customer, what data do you ask for?"

E. Johnson: "We get the size of the last plain wire and then try as nearly as possible to weight our strings so they will be a trifle heavier. I think in most cases the last string of the treble is longer than the first string in the bass. Our experience covering the 500 to 600 scales we have in our Chicago factory, has shown that the shorter scales give less trouble than the long scales."

Wm. Braid White: "When you have obtained this data, including the length, do you ever find it necessary to inquire at what tension the strings are to be stretched?"

E. Johnson: "No, because I do not think the average piano manufacturer in the past has paid any attention to the tension of his strings. It was more or less a matter of hearing, as for instance our making a trial set of strings and following this up by trying them on a piano. Our method of evening up the scale was either to raise or lower the strings, finding at which point they seemed to vibrate the best and taking that as a basis."

Wm. Braid White: "Suppose some unusual manufacturer were to say to you: 'I have decided my strings shall be at a certain tension and give you lengths and weights' would you find it possible then to make up your strings accordingly?"

E. Johnson: "Absolutely yes. In rare instances weights have been furnished us. Unless the results are not satisfactory we use those weights— we would prefer it."

Wm. Braid White: "If you did it a certain number of times, would you not have a mass of data to put your own scaling on a more scientific basis?"

E. Johnson: "Certainly. If the tension was determined in drawing the scale that naturally would follow. A mathematical method of figuring weight would save us a lot of time and experimenting. We have also noticed that where the distance from the hitch pin to the bridge pin is very narrow we have considerable trouble with strings. They have very high tension and practically all life is taken out of the wire. You have a string like a bar, producing practically the effect of hitting a bass drum. Of course we are not scale drawers. As I wrote Mr. Morton a short time ago, a scale is largely a piano man's pet and when you start criticizing, it is like criticizing a mother's child. You are in trouble right away. So, naturally we try to get away from it as much as possible. We never were desirous of making copperized strings. They turn black in a short time and the mills do not guarantee the wire. As a result we must assume responsibility for the defects.

"I have here a copperized string and a copper string. I would like to see you pick them out." (Attempts to distinguish were futile.) "The copper string is much brighter. When first made the copperized string is a very good imitation. A good many manufacturers have insisted on copperized strings and so we have made them. Under ordinary house conditions a copperized string will not hold its color more than sixty days. If the weather conditions are dry and the climatic conditions right they will last for quite a while, but just as soon as a damp day comes they turn."

F. E. Morton: "Is there any difference in your practice, or any changes necessitated in gauge used, between copperized and steel covering wire?"

E. Johnson: "No, the gauge is the same. The difference in weight between a set of iron and copper strings, medium weight scale of 44 strings, and weighing approximately 6½ pounds is about one-half pound in the weight of the strings. They are copperizing wire better today than ever before. Our percentage of rejections is much smaller than it used to be. Take a copperized bass string and if the wire is hard you get a bright surface but covering wire has to be a dead soft to adhere to the steel wire. The result is they have considerable difficulty in plating. We occasionally get wire so nearly like copper it would be hard for an expert to tell the difference. But if the solution happens to have a little too much acid it streaks black. Nothing can be done to prevent copperized wire from tarnishing."

E. B. Bartlett: "Is it not true that the scientific reason copper is used on bass strings is because it increases the weight without increasing the size of the string? Copper is heavier than steel, about 10 per cent, bulk for bulk."

E. Johnson: "I think the real reason in the old days was that we had considerable trouble with iron wire, but the mills have made tremendous progress along that line. Today iron covering wire is softer than copper. The old iron string used to rattle after it was out two years. We used to replace the strings. That is not the case today. I think that was the principal reason for the change. It would not adhere to the core."

E. B. Bartlett: "The iron wire grips less firmly than copper wire and is less likely to stretch under vibration. It seems to me if it got loose after two years it would be because it loosened at the swaging rather than in the stretching of the wire. In our experience with bass strings the greatest percentage of trouble is in the shop, and any that we have afterward comes about after the piano is unboxed by the dealer. A bass string that will stand up for a year we never hear of afterward. I do not think we have been called upon to replace a bass string in a piano between the ages of three months and several years. Of course, after several years they get rusty and a tuner may get in a hurry and make trouble with any string, bass or treble. It is my impression that the weight of a string should follow the scale and if the scale is short, calling for a heavy string, you can get that weight easier with copper than with steel. On the other hand I have heard copper wound strings criticized after they have had two to three years' use and still nobody can be absolutely sure of the reason. The theory was that copper, being more ductile than steel, under the constant hammering of the piano would stretch, even though it was perfectly sound at the end. I never heard of such a complaint on steel. The winding might loosen at the end where it goes around the swaged part of the string but it seems to me much more difficult for the steel winding to get loose from vibration (except at the ends) than the copper."

E. Johnson: "I am basing my statements on the fact that we are replacing probably 200 sets of old strings per month. These strings are shipped in from all parts, and for a number of years we kept record of the kind of strings. I do not think one per cent of the strings coming in are copper.

I have seen covering wire that had almost the same tensile strength as steel music wire. You wrap it around the core and the pliers will tighten it down and probably hold it for some time, but the constant vibration will gradually loosen the ends. Steel has absolutely no gripping surface. You give that to it in the swaging, and if the swaging is not absolutely perfect you have a loose string. Tuners tell me that after the strings were out two years, they began to rattle. Covering wire at that time was stiff but the mills have progressed along that line and we do not have that trouble today. We have kept a record for several years of the number of strings replaced before the piano left the factory. Two years ago we got our extra string list down to one in every 46 sets and most of these were iron. Today the condition is just the reverse. I may say our replacements are about one in five or six sets. Of course, that is primarily due to the fact of the present day rush of business. None of this wire was American Steel & Wire Company's. We have had a lot of shoddy stuff, soft in spots and the copper strings seemed to go dead. On the other hand, we did not have that trouble with iron. We have used in a good many cases the same wire sizes on the copper as the iron. The fine strings would naturally be lighter and we would have less tension. We got better results. This proves low tension scales give better results. Mr. Morton's work on the low tension scales is not only a benefit to the bass string manufacturer but also to the piano manufacturer— we have not that tremendous strain all through the piano."

H. H. Arnold: "I would like to ask Mr. Morton if the fact of extreme tension and expansion of the steel wire string would not affect the outer ends. The climatic changes for instance going from extreme cold to extreme heat brings about contraction and expansion of steel. Would the length of the covering wire used, figuring from the center both ways, expand the steel covering wire so much greater than the copper wire so the action would have a tendency to push it up and loosen at the end?"

F. E. Morton: "The same temperature would also contract or expand the steel core wire insofar as its tension would permit. On copper I will ask Mr. Knight."

C. S. Knight, Jr.: "The contraction and expansion is just about the same— is not appreciable as between copper and steel."

T. A. Johanson: "Is foreign wire very much softer?"

E. Johnson: "The results in iron strings would show that. There are some manufacturers here who make their own strings. I want to call their attention to the looping of the wire. In the past most of the trouble in breaking strings has occurred in the joining of the loop—the first strand. To overcome that we have used what is known as a retarding hook. Instead of gripping two ends of the wire, jamming it down— twisting the steel itself, we have worked it back with a spiral arrangement. You will find the loop will hold as great a strain as the other loop."

F. E. Morton: "Please tell us the direction of the twisting and why."

E. Johnson: "We twist to the right. When you have a loose string you usually twist a number of turns to the left to tighten the winding. We therefore twist in the opposite direction."

E. J. Fishbaugh: "Are the beneficial results of twisting permanent?"

E. Johnson: "There is a certain manufacturer for whom we make strings who makes a practice of twisting his strings to the left. We have not noted any bad results. As a rule we do not advocate twisting strings. If the string does not stand up there must be a defect some place."

Wm. Braid White: "It is the common practice of tuners to attempt to cure a rattling bass string by letting the string down, unhitching it, turning to the left and putting it back. What do you think of the practice?"

E. Johnson: "It is because of some defect. It may be that the steel has a soft spot and has stretched. It may be due to the fact that the wire is not swaged enough, or the covering wire is too hard and will not adhere to the core. If the wire is too soft, it will continue to stretch. If the covering wire is too hard the results of twisting three or four times eventually will crop out. If the fault lies in the swaging it cannot be overcome."

John H. Gerts: "Can anything be done to eliminate the over tones in bass strings?"

E. Johnson: "We have had considerable of that in times past. We first make up a set of strings for a new scale and usually find a number of false notes. Raising or lowering the string in many cases eliminates the false notes."

Wm. Braid White: "Do you find in the majority of cases that the difficulty is in the scale and can be remedied by some change?"

E. Johnson: "Years ago we recommended changes in the scale which often remedied that

defect. I haven't had that experience and cannot do it. Some manufacturers make a change in the scale and get desired results. We always have had to contend with high tension scales and naturally we always had plenty of trouble."

Wm. Braid White: "It is well known that the ordinary scale does not permit the fundamental tone of the string in the lower bass. Do you find that on the whole the tensions in scales and resulting complaints are dropping?"

E. Johnson: "Yes, materially so. We have in the factory approximately 500 scales and at one time had a machine to test the tension of the wound strings. I don't know of any scale which ran below 185 pounds. Most of them ran from 225 to 275 pounds. The first size of wire generally used is No. 18. Our standard would require a wire having a breaking weight of 435 pounds. That is not the elastic limit. Take a No. 18 with a breaking weight of 400 pounds, 240 pounds would be the elastic limit. Your tension is almost up to the elastic limit of the wire. None of us are infallible, nor is the wire man. He sometimes slips, probably due to the stock. He has practically no leeway there. If the wire is not up to standard all the time you are immediately in difficulties. Complaints are in the nature of dead, broken or rattling strings. They don't usually call our attention to false notes. They take the poorest points of the piano."

F. E. Morton: "Then their complaints are rather mechanical than acoustical?"

E. Johnson: "Yes, except that of over tones, when our method has been to raise or lower the strings and find a point which is clear, then take that as a basis upon which to work."

E. B. Bartlett: "You get the results by change of tension then, and the predominance of over tones would be an indication of high tension?"

E. Johnson: "In moving the string to a lower note you reduce the weight. In raising to a higher note you increase the weight."

E. B. Bartlett: "Putting it on a lower note is equivalent to reducing the tension. Is there not another point? The striking point on the string seems to be another vital element to be considered."

E. Johnson: "We are never given the striking point and do not take it into consideration."

R. H. Waud: "Don't you often find that core wire is polished too much and you have difficulty in making the winding adhere to it?"

E. Johnson: "No, our difficulty was in having a wire polished high enough— a wire perfectly clean. If the wire is oily the string will go dead. A highly polished wire, if properly swaged, will give best results."

R. H. Waud: "I have seen string makers take a file and roughen up the steel core wire before winding."

F. E. Morton: "We have had complaints from string makers that our wire is too highly polished and asking for wire with less finish."

E. Johnson: "We have never complained."

Wm. Braid White: "I have seen a foreign grand piano in which the covering wire was brought up to an apex and fastened at either end some distance farther up and the bass strings were extraordinarily clear. Do you know that method?"

E. Johnson: "We occasionally have sets wound that way but I couldn't tell how it is done. Strings come in from old pianos where the winding runs up in the loop. They get the gripping in the loop itself."

T. A. Johanson: "How far should the wrapping be from the bearing?"

E. Johnson: "Three quarters of an inch; the same at both ends."

R. H. Waud: "That is after the tension is on?"

E. Johnson: "Yes."

R. H. Waud: "Now that we are all tuning to lower pitch maybe that is why you don't have so many replacements of strings."

E. Johnson: "I think it is rather because we have made progress in the manufacture of strings. The material today is better than we used years ago. Manufacturers have made great progress and I think our strings are made more carefully. I am not speaking only for John A. Schaff but for all the manufacturers. We do not have as much trouble as we used to have and the strings look much better than formerly. In first and second tuning did you use to pull the strings about concert pitch?"

Wm. Braid White: "My first factory fork was C-275; International Pitch is 258.6. Everybody now is putting out pianos very close to International pitch."

T. A. Johanson: "What bass strings give the best tone— single wound or double wound?"

E. Johnson: "In the last ten strings single winding produces a stiffness because a very heavy covering wire gauged as low as 13½ is required. Winding that on the steel with the covering at a high tensile strength compared with the finer gauges and the tone is similar to that of a bass drum It doesn't vibrate freely. With the double wound string this is not the case. It is very difficult for a tuner to distinguish the proper pitch of a single wound heavy bass string. There is one point I would like to emphasize. The value of copper bass strings is only salesman's talk. He is the one who went outside and popularized it. Later, when you offered your piano with iron strings, he told you everybody was using copper strings. A lower copper string is superior to iron. I recommend copper on the lower 10 strings, but on the finer strings better results may be had with the iron. From the bass string maker's point of view you will have less trouble and cost."

F. E. Morton: "Do you consider tinned under covering better than the plain?"

E. Johnson: "We do. We have had less trouble when we use the tinned under covering. Some manufacturers use copper."

F. E. Morton: "Mr. Johnson has spoken of trouble in making strings— trouble in replacing, trouble in meeting the demands of the manufacturer. This trouble is expensive to him. His recourse is price. That trouble reflects on the manufacturer and is his. He pays the bills and he passes them along. Trouble is expensive for all. Our interest in these troubles is commercial as well as technical. If you are a lover of horses and dogs, as I am, you have learned that a thoroughbred will not stand abuse. That holds true in the treatment of materials and machinery. A man said to me the other day, referring to two brands of wire which he was using for mechanical purposes: 'I want this "B" brand because "A" will not stand abuse.' Brand 'B' was an inferior product and yet he was very willing to abuse it and pay the penalty. That holds good in string making. What is the function of covering on a wire? The pitch is inversely as the square root of the weight and inversely as the length; therefore in order to secure a given pitch when added length is impossible, length must be made up in weight. So the sole function of the covering wire is weight— nothing more. If the covering wire vibrates it adds its own mode of vibration to that of the core wire, thus changing the tone quality. In determining the relative values of copper and steel covering wire we must consider whether either one oversteps its function. The weight of steel covering wire, commonly referred to as iron wire, is less than that of copper. Cover one string with steel and its unison with copper and you will find a difference in tone quality under the present day practice of covering wire making. A covering wire could be made which would have only a weight value, but it would require a practice with no factor of safety. Up to date no one has been able commercially to draw wire without an allowable variation. The copper covering wire functions as weight only when soft enough to have no vibration of its own. I made a series of experiments about a year ago with copper covering wire of two degrees of hardness and strung alternate notes on a piano with strings wound with each kind. A very decided difference was noted in the respective vowel sounds, the softer producing more nearly the desired effect. Copper covering wire now has been drawn to a point very nearly approaching the steel, but is so soft that it breaks in the process of covering the string. We have been able to draw a steel covering wire having toughness without hardness and with sufficient tensile strength to meet the mechanical needs of the bass string maker. There is probably no wire company today desirous of making copperized covering wire. The men feel they are imitating a product, practicing a species of fraud. Salesmen are not particularly proud of a large order for copperized wire. The hope has been expresse by sales managers of wire companies that the day of the copperized wire would end very soon. So far as its acoustic value is concerned, there is only a trifle of copper to influence in any way the vibration, but the process of copperizing does affect the steel. The acoustic value of the copperized wire is lower than that of the tinned covering wire.

"Mr. Johnson has stated he would like to work with a softer steel core wire. When a covering is placed over the core wire we must avoid stiffening the resulting product. Wire of high tensile strength is used at the expense of the prime or fundamental vibration. When we speak of a particularly hard piece of wire having a barlike tone we mean that it is stiff and it is only the stiffness

of that wire to which we refer. It is the stiffness of a steel bar that gives the characteristic metalli quality of tone. That applies to wire, whether it is caused by the method of covering or the harc ness of the core or covering wire, the same bar effect is produced and the acoustic value is reduce that much. The steel is more resilient than the copper and that is the reason why a steel covere string vibrates more effectually as a whole than copper. An analysis of partial tones given by ba piano strings shows very little of the fundamental. One who can listen well and distinguish partia easily can determine the poverty of fundamental vibration in the bass strings. You will note it in reproduction of piano playing in the phonograph. It is almost impossible to determine whethe there is any bass. Perhaps the phonograph recorder hears more accurately than we.

"Let me explain one or two points relative to buzzing strings and dead strings. If the coverin wire does not rattle and the string is dead, the cause of rattling strings is there just the same. Th covering wire has not responded to it for some reason, but the same cause produces both and tha cause is drawing the string above its elastic limit. Our mill men have a good phrase to express th condition of the wire after it has reached its elastic limit: 'Its back is broken.' It is not a piece c music wire any longer. If it is dropped below the elastic limit and then drawn again to the same poin the stretching process will be slow but continuous. It may take one, two, or even five years t stretch sufficiently to produce an ill effect, but it is only a matter of time. When you find some dea strings in your scale, the rest are subject to reasonable suspicion. They may not die on your hand but eventually they will die. The same cause always will produce the same effect.

"I cannot give you the relative proportion of elastic limit to breaking weight on other make of wire, but ours is about 60 per cent, and that is very high. If a wire is made for you that will g above the present standard of tensile strength,— our standard, if you will, because I think we ar right,— you are sacrificing acoustical to mechanical value in the wire. There is a point betwee mechanical and acoustical value and you will cross that line. A string maker said to me: 'I war a No. 17 wire which will stand a tension of 275 pounds for bass strings on Blank & Co's scale I said: 'You can get it. We can draw it for you special, but it will not be piano wire.' We ar making that wire for corset companies. I sent him some of the wire. Mechanically it didn't g dead but it sounded worse than dead. It was too stiff a wire. The tonal effect is identical with tha you are trying to eradicate by tone regulating. That string maker was trying to get the best r sults possible with a defective bass scale,— the first bass string from the break was too long. H probably could devise a machine by which he could wind a fine core with a 36 covering wire of ste and get around that, but there would not be enough mass to vibrate the sounding board, and th sounding board is a part of the wire.

"The function of the sounding board is to disturb the atmosphere and there must be wi mass enough to energize the sounding board. It cannot be done with a small string. If you wi make your first bass string from the break short enough to use a core wire not less than one numb smaller than your last plain wire, and your bridge and ribbing is correct, you will get a very muc better result than with a longer and smaller gauge string drawn to a higher tension. Anything a bove 175 pounds tension on your bass bridge gives a down bearing on the sounding board whic prevents it responding to the balance of the scale. The part of the soundboard which responds t the next to the last octave on your piano lies down in the region of the bass bridge and when tha bridge is being bound down tightly, the board cannot respond. The result is a weakness in th next to the last octave of your keyboard. If you do not have sufficient distance between your hitc pin and your first bridge pin you are by that means also binding the sounding board, holding down.

"You will find if you try a piano that is strung only in the treble that the sixth octave is muc clearer than after the bass strings are put on. The average bass scale is too high in tension and does not make any difference what the size of that scale may be, if you run a 27-note bass scal there is no reason in the world for the twenty-seventh being any longer in a large scale than in short one. If the tension on your treble strings runs 160 pounds the tension in your bass shou be 170 pounds. About 10 pounds more tension on the bass than the treble will reconcile tl difference in the composition and form of the strings. You will find false notes in a string n drawn to a sufficiently high tension and you will find them in one of too high tension, and tl higher the tension, the more false notes. I have occupied my time when in strange towns by sho ping for pianos to hear the sales talk. A salesman said: 'Note the uniform quality of to

throughout the piano.' I said: 'Do you mean the tone is the same throughout?' 'Yes'. As a matter of fact, a piano having the same tone throughout would be unsalable. It isn't uniform and we have accustomed ourselves to ununiformity.

"We do expect even graduation from one vowel sound to another. In a 4-foot 4-inch upright piano with an ordinary scale, which is a popular size, you will rarely have sufficient length of the first plain wire from the break to give you over 125 to 130 pounds tension at international pitch using No. 20 wire. To jump from 128 pounds directly to a tension of 200 to 265, which is common, is laying out more work for the tone regulator and there is no occasion for it. The bringing up of the treble end of the bass bridge and shortening that string will give you a better graduation down to the singles. It will also require less tone regulating; give greater tonal uniformity and durability. Giving a bass string three or four twists was done originally to make the strings stand a higher tension without becoming dead or breaking. It increases the tensile strength of the wire to twist it. Mechanically, it is good practice. The twisting of any piece of metal increases its tensile strength. That increase could be given it in the process of manufacture, but it would be at the expense of acoustic value. From a commercial viewpoint, the tensile strength of the wire provided for bass strings and for treble strings alike must meet the demand of the consumer—the piano manufacturer— but it does seem to me that a knowledge of the fact that an increase of the tensile strength beyond a certain point is at the expense of acoustical value should prevent its specification.

"I find from watching here and there in factories, particularly in rush times, the chippers and first tuners drawing the bass strings way above their pitch. I have heard them say: 'We simply pull it up until it pulls out straight and that is equal to five tunings.' They are doing that at the expense of tonal value. The best practice is to draw it up to pitch every time. It is a slow practice and therefore has no commercial value. Anything beyond that, however, is a compromise with tonal conditions. If the idea is to leave the piano at international pitch, the chipper and first tuner should not be allowed to draw the string above concert pitch. On a high tension bass scale, even this is impracticable, and in some it is impracticable even to draw it to international pitch.

"The proper way is to move the bridge, change the bass sweep and get a length that will save the cost of that change in a very short time in the time of tone regulation. This undoubtedly will be reflected in sales of the instrument. There is one cause for false notes or overtones which is the fault of the wire drawer. There is such a thing as 'overdrawing' the wire. Drawing it too far without annealing. It hardens the wire. The wire becomes less tough in that process and that is sometimes done on a coil or two coils of wire before it is discovered. The practice is being perfected to such an extent, however, that very little of that can occur unless it is the common practice of the mill. You will have less overdrawn wire in the future than you have had in the past.

"False notes in the treble may be caused by using wire of too high tensile strength. It may also be caused by too low tension with too hard a wire. I have seen three such cases in the past two or three months. When you find overtones around the bar break, take the measure— the length and gauge on both sides of the bar break— and you will find your answer in the tension. If it only comes with one coil of wire, if it is our wire, ship it back. It is your only hope. If the tension and gauge is right at that point, the fault is in the wire."

H. H. Arnold: "At the time the wire is drawn, is it placed on the coils at once or is it done afterward? The reason I ask is that I discovered two numbers on a single coil and I wondered how they could get mixed up."

F. E. Morton: "After the wire is drawn it is put into the bins to 'cure.' What you speak of was the error of an inspector in the packing department."

H. H. Arnold: "Where is the new mill and when will it be opened up?"

F. E. Morton: "It is in Worcester, Mass., and you are all invited to inspect it. We have no secrets. Piano wire drawing is a matter of skill, the practical application of scientific research."

Moved and seconded a vote of thanks be given Mr. Johnson for presenting his subject so clearly; also that a letter be dictated thanking the American Steel & Wire Company and Mr. Morton for the use of the laboratory and their helpful co-operation with the music trade.

Engineering Problems in Piano Construction

January 3, 1917

F. E. Morton: "I have been doing some experimental plate work. It is obvious to each man who is engaged in scale drafting that a great many vital points have not yet been defined thoroughly,—among them internal stress. I want to show you the importance of internal stress in the plate, first upon tone, then defer to our friends the engineers for a discussion of points of mechanical interest.

"If a wire be stretched to a very high tension it will vibrate segmentally to a high degree,—a very stiff rod at high tension will vibrate so that the 29th partial is audible, and that is an effect we are attempting to avoid in piano tone building. Those odd numbered high partials are inharmonic,—are inconsistent with the tone quality desired. High tension produces hardness. If a rod of high carbon steel is drawn particularly hard, tension is not necessary to produce the same vibratory effect."

C. C. Chickering: "What do you mean by internal stress?"

C. Arthur Brown: "Metals in cooling contract. One of the most beautiful illustrations of internal stress is the Rupert drop, a pear-shaped glass drop, cooled from the outside and leaving the internal mass in a high state of tension. Upon breaking the outer film, the drop will fly into pieces with a loud report. This is due to internal stress. When a metal is cooled, the outside chills first; the inside cools more slowly, resulting in a strain on the interior of that metal called internal stress."

F. E. Morton: "It is the effect of this internal stress upon the tone of the instrument that I desire to call to your attention,—the possibilities developing from its elimination or equal distribution; also through the use of a smaller quantity of material. The mechanical effect of this stress, while obvious to all, is not the vital point for consideration at this time, because it has been overcome in plate making to a degree affording a fair factor of safety from fracture. There is an effect still remaining which expresses in terms of inharmonic higher partials. Bearing in mind the effect upon tone quality, we will ask Mr. E. Salich of E. Salich & Company, Mechanical Engineers, to give us his opinion as to the possibility of practical application of general engineering principles to the manufacture of pianos."

Mr. Salich stated that a piano could be considered in the same light as any other machine and he dwelt on the importance of computing the resistance, tension and compression of all working parts and their exact relations to tensile strength, crushing weight and elastic limit of materials employed. He also called attention to the dividing line between the use of sufficient material for resistance and excess of material producing internal stress.

F. E. Morton: "Would you consider the designing and making of an energy resisting body such as this cast plate, an engineering problem."

E. Salich: "Certainly, and as such it may be solved."

F. E. Morton: "Is there a problem pertaining to any portion of its designing or execution which might not be solved by engineering methods?"

E. Salich: "It is simply a problem in resistance and therefore can be solved. The different parts can be so constructed as to resist the pull without reaching the limit of elasticity."

H. H. Arnold: "Would the use of different grades of metal in the casting of the plate have any material bearing on the tone quality?"

F. E. Morton: "The quality of tone is dependent upon the perfect reflection of energy by the plate to the vibrating member."

E. Salich: "Yes. All parts of the plate should be so constructed as not to give. Any material could be made to answer to the requirements. A poorer material would have to be made stronger by increased mass, or reinforcement."

C. Arthur Brown: "Do any of you buy plates made under specific analysis of the metal and with test bars produced at the time of casting?"

C. C. Chickering: "No."

R. H. Waud: "Foundries do that themselves. Each pattern is supposed to be strong enough."

C. Arthur Brown: "You are not furnished, then, with data of that kind and you do not specify mixtures or anything of that sort?"

E. B. Bartlett: "No."

H. H. Arnold: "I would like to ask, inasmuch as there is a contraction and expansion at various temperatures in metal, whether a plate pattern can be made so that, after the wire is properly strung on the plate, tension is even at all points?"

E. Salich: "That question is up to the foundry man. The temperature at which the iron is cooled has something to do with that."

H. H. Arnold: "Would the length of time of exposure have any bearing?"

E. Salich: "Yes. For certain pieces the sand is dried before casting is put into it. When it comes out of the oven where the mould is dried it is warm. It is then assembled."

C. Arthur Brown: "If you will take any plate, you will find that it has at some point or other —as far as I have been able to determine—a weak point. It will also have at another point a cross section much heavier than is required. The cross section with the larger amount of material will cool last and some foundry men in order to maintain an even cooling put in a heating bar or riser on each side of the weak spot so that the heat from the auxiliary molten mass tends to keep the weak spot from cooling too rapidly. This treatment has a tendency to relieve internal stress; to prevent distortion of the plate, and to make a better casting. When a malleable casting is contemplated, the completed casting is subjected to a high temperature for about sixty hours. In that process, as ordinarily conducted, there is a certain absorption from the 'skin' of the metal by the substance in which the annealing is done. When a casting is put in the annealing furnace, subjected to a heat that is somewhat lower than the malleableizing heat and maintained for a given period of time and cooled slowly, the internal stress is largely removed. The difference between cast iron and malleable iron is shown particularly in its tensile strength and the ability of the latter to résist shock. The tensile strength of ordinary cast iron varies from as low as 15,000 pounds to as high as 24,500 pounds per square inch. The tensile strength of malleable varies from as low as 35,000 pounds per square inch to as high as 63,000 pounds per square inch, being a little more than twice that of ordinary cast iron in tensile strength so that a given cross section of malleable iron would give a tensile strength as great as twice as much cast iron."

H. H. Arnold: "Is that difference caused by the composition or by the process of making?"

C. Arthur Brown: "Almost wholly by the process. In considering tensile strength we take no consideration of compression strength. You have tension on this member and you have tensile strength between your supports. These members are acting in compression. (Indicating Braces.) These members are acting in tension." (Indicating web back of hitch pins.)

F. E. Morton: "Just to get a little better basis, Mr. Brown, will you analyze this pattern for stresses."

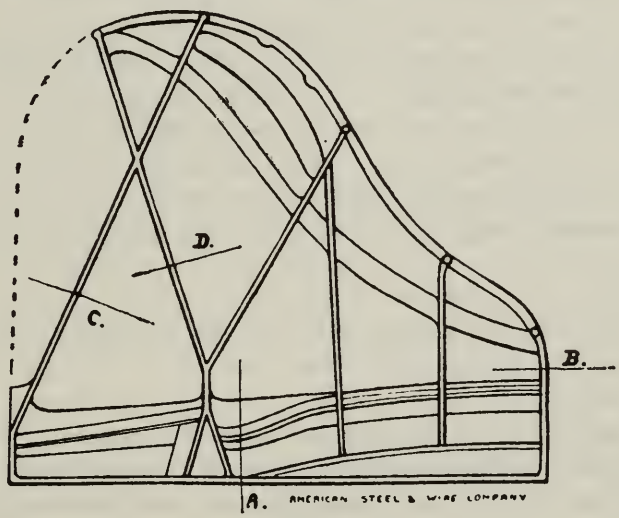


FIG. 4

C. Arthur Brown: "I made a rather hurried analysis of this plate this morning. You have, acting from the bass hitch pin end to the tenor agraffe extreme here, a tension pull of 14,130 pounds. On this portion, the treble, the pull amounts to 14,400 pounds, making a total pull in

the line of these bars D, (see Fig. 4) of 28,530 pounds; an average tension of 157 pounds through the tenor and 160 pounds in the treble, and across the bass section in line of C bar, 44 strings at 170 pounds pull with a total of 7,480 pounds. The total of those pulls comes to 36,010 pounds. You have a cross sectional area of two square inches of metal at A. At this section near the end of the tenor section, B, you have a cross section of 2½ square inches of metal. If you take the bending stress allowable in cast iron which is ordinarily given at 30,000 pounds per square inch with two square inches you have a 60,000 pound resistance through the minor cross section A. The total pull of all the strings is only in the neighborhood of 30,000 pounds, the leverage being ignored. I am inclined to think that the pull, angle and leverage of each string will have to be computed separately before we can arrive at an absolute knowledge of stresses, strains and resistances permissible before the angle, leverage, resistance and cross section of any plate can be properly computed. Every three unisons you are changing the length and angle slightly, and this must be taken into consideration. The casting from this pattern has shown some results that were not satisfactory. This part, B, as the casting came from the foundry, showed a drop of about 3/16 inch. There is an apparant tendency in the casting to buckle at A. That in itself shows that the internal tension due to unequal cooling brings about a bending movement there that is not satisfactory. The other scale on the drafting board is intended to be free from some of the defects in this."

C. C. Chickering: "If you put a little bead on both sides on the bottom of D you may eliminate some of the troubles. Rigidity is one of the foundations of tone production."

C. Arthur Brown: "In view of the resistance offered even by the poorer qualities of cast iron, it seems absurd to use the amount of metal we have in that plate when we could get the same result with a less amount of metal and better distribution?"

E. Salich: "The result can be obtained by the shape of the different braces and Mr. Brown is correct in saying that we can get the same rigidity with a less amount of metal and a better distribution."

F. E. Morton: "We have with us Mr. J. F. Reed of the Paragon Foundries of this city, who cast this plate. Mr. Reed, will you please tell us if there are foundry means of overcoming the buckling and internal stress of difficult castings?"

J. F. Reed: "In this particular plate, after looking it over and studying it about two hours, I told the men to go ahead, put it in sand and do nothing to it. There are plates upon the casting of which I can give instructions without examinations. This particular plate came out—I should say—perfect, from our standpoint. I don't think we have ever had less trouble in the first casting of a plate than with this one. When the plate first is put in, if it won't go through, it cracks. The day we get the plate out we make a chart. The superintendent looks at the chart to see that it is taken care of."

C. Arthur Brown: "How did you gate this plate?"

J. F. Reed: "Three gates in the head and three gates down the center with six up, a heat riser on this end and a riser on that end."

C. Arthur Brown: "Were there any heat members in the center?"

J. F. Reed: "None. We usually put a heavy riser wherever we think we may have difficulty. We get a lot of different propositions from the wood pattern."

F. E. Morton: "Assuming a slight bow of this bar (C) could that come from displacing the pattern in the sand?"

J. F. Reed: "Hardly."

F. E. Morton: "If the pattern itself was true and the first cast showed the bow, would you say it came from buckling?"

J. F. Reed: "Not necessarily."

R. H. Waud: "My experience on the bars has been to saw them in the pattern after it was cast. If we found a bar went crooked, we took the iron pattern and sawed the bar."

F. E. Morton: "Suppose that was sawed and replaced, would a casting from that be free from stress?"

R. H. Waud: "No, but you would only have one-half the stress."

R. W. E. Sperry: "It has one-half the displacement, but no change in stress."

F. E. Morton: "We are striving for a point beyond where stress means fracture. Mr. Salich, can the lines of stress in such a casting as this be fully reconciled with foundry practice?"

E. Salich: "Yes. It is merely a matter of careful design and study."

F. E. Morton: "Mr. Brown, can you describe in terms of energy the effect of vibration upon a casting having an internal stress? Does it effect its longevity?"

C. Arthur Brown: "A metal under stress loses certain qualities under repeated blows or stresses. Its ability to resist strain is gradually decreased and we call it 'fatigue' of the metal. Any metal under high internal stress will certainly become fatigued much quicker than one which is under normal stress."

F. E. Morton: "Is there a change in the molecular structure of the metal?"

C. Arthur Brown: "Apparently."

F. E. Morton: "What is the effect of torsion caused by unequal side stresses? Assuming there was a torsion in this member, D, for instance, what would be the effect upon that member?"

C. Arthur Brown: "The torsion would tend to harden the member."

F. E. Morton: "One thing is certain. The effect of torsion is observable in the ring of the metal itself. If the object is the retention of energy in the vibrating member, the sounding board being a part of the wire for that purpose, then any contacting material failing to reflect that energy through lack of rigidity is faulty. Agraffe and bearing must be perfect reflectors of energy. Any part of the plate which fails because of elasticity fails by just so much in performing the function of a plate. There must not be a greater degree of resistance in one part than in another. If one member of your plate in vibrating segmentally gives forth a greater number of higher partials than other members of that body, the resultant is inharmonic and is readily distinguishable in the tone of the piano. A member under torsion vibrates with a greater number of odd-numbered higher partials than one that is not under torsion, composition and practice being equal. I am certain a vibration test of castings is possible.

"I look forward to an apparatus with properly mounted electro magnets that will register and record the actual condition of the plate metal as it lays. I find points of relative stress and torsion in a plate now by tapping and listening. If that can be done, much more is possible. Mr. Brown, what is the best distribution, from an engineering standpoint, of the metal now contained in the web of the plate?"

C. Arthur Brown: "In the places where it would offer the greatest value to resisting the pull on the plate which would necessarily lie in the compression members and the tension members,—in other words, if you have sufficient metal to resist the tension pull of the strings at the tuning pins and hitch pins, the only additional resistance you need is in the compression members. The compression members are the bars. The equal, proportional distribution of that metal through the tension and compression members would be the best answer."

F. E. Morton: "How about the distribution of the metal to the outer section as in this case?" (Fxhibiting plate with wide flange.)

C. Arthur Brown: "That flange in itself is both a compression and a tension member. It is a compound member and would necessarily share in the distribution of the metal in taking it from the web."

F. E. Morton: "Would the addition of a flange to a plate of that sort add to its rigidity?"

C. Arthur Brown: "It would depend upon the distribution of the rest of the metal. One could be made as strong as the other with the same metal properly placed without that."

E. B. Bartlett: "What really bears the strain of the strings? Is it the plate or the wooden frame of the piano, or both?"

F. E. Morton: "I took this question up with a structural steel engineer. A stream was bridged by two timbers covered with planks. A farmer drove his wagon over it and said it was a little shaky. Steel trussed rods were thereupon put on the bridge, making it firm. I said to the engineer: 'Which is bearing the load, the steel, wood, or both?' He said: 'There could only be one instant in eternity when both could bear that load. The stress would be on the metal or on the wood, and there could be only one instant during a readjustment when it would come to both alike.' That is not an entirely fair analogy to the plate and frame relationship. It does bring out a very interesting point. The construction easily may be such that the plate will bear the

entire strain. It will only require a different distribution of the metal. The wrest plank is not necessarily a part of the frame."

C. Arthur Brown: "In such case, the tuning pin sets in the wood which takes the strain and transfers it to the metal. In that case both get the strain, although the wood is merely a member of transmission."

E. B. Bartlett: "If the plate and frame unite, the theory is all right. If the plate sustains the tension then we can eliminate one or the other without disadvantage, and if plates as now designed would have a tendency to be pulled out of shape if strung without being attached to the wooden back, would it be practicable so to design the plate as to equalize the pull if strung without the support of the back? Would that plate be any easier than if attached to a wooden frame?"

C. Arthur Brown: "That would be a question of the scientific placement of the material. I don't think I could answer that difficulty with a yes or no."

F. E. Morton: "To define the relationship of the plate to the frame would be to define the function of each?"

C. Arthur Brown: "Surely."

F. E. Morton: "Has the frame any other function than the retention of the plate and the resistance to the pulling caused by the bridge and agraffe bearing?"

H. H. Arnold: "Inasmuch as the strain acts from the tuning pin to the hitch pin and there is a great difference between the hitch pin and tuning pin where the end of the plate comes, the strain on the pin block and the tuning pin is equal to that on the hitch pin. The only difference is in a plate which has the pin block set in over it, then the pull of the plate is against the pin block and the pin block back support to that must stand its part of the strain. With bushed pins the plate withstands all that portion of the strain which is taken up by the bushing. If the plate is divided then the top of the back must bear its proportion of strain. The strain is less on the back when a bushed pin is used."

E. B. Bartlett: "The pin block must hold the back. There is a small factor there. The agraffe or bearing bar or whatever is used would change the strain as compared with the hitch pin. There is some friction and that might reduce it to a fraction."

H. H. Arnold: "I would hardly think it would reduce it. The pull is greater from the bearing bar than it would be from the bearing bar to hitch pin."

E. B. Bartlett: "Not enough to make any material difference."

F. E. Morton: "The effect of an open pin block has been observed and the results should be worthy of consideration."

R. W. E. Sperry: "I have experimented with one-half, three-quarter and full plates. The half plate piano had a very sweet, agreeable tone but 'stood up' the poorest. The three-quarter plate was the poorest as to tone and did not 'stand up' well. The full plate type was not so pleasing as to quality, but 'stood up' best. The difference between the half and whole plate type lies in the contact with the middle block."

F. E. Morton: "The quality to which we now refer as sweet, and which resulted from the use of the half plate, would hardly be acceptable today to the trade. At that time the idea of quality very nearly approached the simple tone. Another point, the bridge pin bearing should furnish a sufficient grip of the wire on the bridge so that the raise of the wire in vibration raises the bridge with it. On some pianos I notice an impoverished tone caused by a failure of the sounding board to travel up the full distance with the wire. The down bearing is not all, the board must respond to the upward movement as well. Pins should be well staggered.

"In a 10 foot grand, we have certain lines of resistance, tension and compression. In a 4 foot 6 inch, those lines are shortened. What change in the distribution of stress is required through shortening of this scale?"

C. Arthur Brown: "A lesser placement of metal in the compression members."

F. E. Morton: "Why?"

C. Arthur Brown: "Due to the shortening of the length of the compression members and a lesser tendency to buckle."

F. E. Morton: "According to that would a 4 foot 6 inch plate require the same amount of metal per inch as a 10 foot?"

C. Arthur Brown: "No. It would not require as much in cross section of the different compression members."

F. E. Morton: "On a plate similar to this, to what extent may the web function as the bar? Suppose this bar ceased at this point?"

C. Arthur Brown: "You have a transference there of the lines of stress from the web to the bar. There is only needed sufficient bar to take care of that stress, and any release of the metal from the web if put in equal compression resistance would function exactly the same."

F. E. Morton: "We have the carrying of the bar over the web for quite a distance. I would like to know as a principle of engineering to what extent then the web could take the place of the bar? At what point may we stop, and why?"

C. Arthur Brown: "Stop it at the exact point where the resistance of that metal is sufficient to take the torsion pull off the hitch pin web."

F. E. Morton: "That being the case, the old method of continuing the bar through, gradually sloping it down, was unnecessary?"

C. Arthur Brown: "It was unnecessary."

The informal discussion was continued until midnight. Some of the subjects and examples cited were held to be too intimate for publication

Varnish

January 17, 1917

Mr. Morton stated that the purpose of the evening's convention was a more thorough understanding of varnish, its possibilities and limitations and an appreciation of its value to the piano trade. He then introduced Mr. J. H. Shanley, manufacturing trade representative of Pratt & Lambert, varnish manufacturers of New York, Chicago and Buffalo.

Mr. Shanley stated that the officials of his company, not unmindful of the privilege accorded, had arranged to have their chief chemist, Mr. R. W. Lindsay, and Mr. J. F. Thomas, the technical superintendent, in attendance.

Mr. Lindsay is a Boston technical man who, during the ten years he has been with Pratt & Lambert, has been given wonderful opportunities for research work and has gathered information and pictures of materials and processes essential to varnish making from various parts of the world. He has exhibited these views and lectures before numerous educational bodies. Mr. Lindsay said:

"I am very glad of this opportunity of addressing you, gentlemen, upon the subject of varnishes, and although what I have to say may not be for the most part new, yet I believe that in reviewing once again the details regarding the various materials used in varnish making and also the process involved, that there may be many points which will be not only of interest to you, but at the same time will be of assistance in your business.

"Varnish as you all know is made up of four main constituent parts. We have in the first place the fossil resins, or gums as they are termed, which give to the varnish its brilliancy and lustre and to a certain degree its durability.

"Secondly, we have the drying oils which render the varnish elastic, durable and to a certain extent affect the lustre.

"Thirdly, we have the metallic driers which are incorporated with the oils to hasten the drying of the varnish film, acting as carriers of oxygen from the air to the drying oil.

"Fourthly, we have the volatile solvents which aid in the spreading of the varnish upon the work.

"I shall take up first the various raw materials used in making varnish, and describe the source from which those materials come, and later show you how these materials are used in the actual varnish process."

Mr. Lindsay, with the aid of the Stereopticon, showed the processes involved in the making of varnish from the gathering of fossil gums and resins from Zanzibar, The Congo, Benguela, Sierra Leone, New Zealand and the East Indies; through the production and transportation of

Linseed and China Wood Oil and Turpentine to the proper union of oils and gums in the varnish factory.

Mr. Shanley then introduced Mr. J. F. Thomas who has been with Pratt & Lambert for twenty-five years, having worked his way to the position of technical superintendent.

J. F. Thomas: "Varnish, as we know it from a varnish manufacturer's standpoint, is a material made of the various ingredients described by Mr. Lindsay. He has gathered all of the material essential to the manufacture of varnish and perhaps you will agree that there has been something romantic about it; then he has gone farther and built it into a varnish, and that also is interesting; but now he has taken the finished article and has turned it over to us and we have something to deal with that will protect and beautify woods, produce what is commonly known as a varnished finish, give us grateful lasting results, or, perhaps, he has given to us a matter that we will be told is too dark, too heavy, too thin, will not brush, does not flow, does not dry, will not rub, will not polish; it heaves, crawls, sags, runs, chips, shrinks and cracks, and has other evils too numerous to mention.

"We know that with a properly selected wood (inasmuch as we are dealing in piano materials tonight, we may specify veneer) and with a properly selected stain, filler and varnish we may be able to produce a sightly effect. The materials used will intensify the beauties of the wood by emphasizing the soft spots, as well as the high lights. The filler will fill the pores of the wood and correct the unevenness due to such pores. and the varnish will form a transparent coating of light amber hue over the whole, and will permit of our viewing the charming effect brought about by the veneer flake and finishing materials, and will protect this beautiful picture permanently for us.

"May we assume that this is a fairly accurate description of what you, as piano builders, bring about in the finishing of your instrument?

"It seems easy to the layman to take materials as we have described them and produce a lasting finish, but perhaps we may say it is only ignorance of the subject that would lead one to believe finishing to be easily learned.

"The staining of work to be finished is a voluminous subject in itself. The present condition of markets makes it difficult to obtain certain dyes, acids and chemicals. The man who produces these effects must be alert and resourceful. Fillers, of course, are selected according to their value, and it is fair to assume that any filler house should be able to supply a satisfactory article if their intention is right.

"There is such variation in piano varnishes used by different concerns that if we had not fairly studied the situation we would believe good judgment was not used in purchasing. Perhaps we would be more nearly correct in saying that humans are intensely human—that they do not care to be guided into one channel, but would rather think for themselves, that in the mind of an ambitious man there is something that causes him to avoid laid-down methods and formulate a method of his own that seems more in harmony with the entire picture of his manufacturing proposition. Whatever it may be, we believe that no time or teaching will ever change this condition and that whether a man be a manufacturer of pianos or other product, if he is a man of capacity, he will believe himself capable of producing effects better than those of his neighbors and by methods not used by his neighbor. We believe that all varnish manufacturers, like all piano manufacturers, are of good intent and that they try to produce goods of superior merit that will meet with approval and be sold profitably. Perhaps you, as piano manufacturers, could you bring about such a condition, would make one piano of one style and devote all of your energy to its manufacture and marketing and perhaps varnish makers would confine themselves to one particular varnish, and probably would do so were such a thing possible. On the contrary, however, there are hundreds of varnishes which, if we looked at the formulæ, might appear quite the same to us, but when given to a careful varnish maker and strictly adhered to, produce varnishes of entirely different character, designed for different purposes. For the piano industry alone there are many kinds of varnishes and the difference in the character of these varnishes is as varied as the difference in men's faces, and it is quite safe to say to you that we can tell who made a piano varnish by examining it.

"The finishing of a piano case should be and no doubt is considered by you to be one of your very important operations of construction. When one considers that the finished case is constantly before the purchaser, and that the majority of piano owners are proud of their piano

finish if it is good, then we may assume that the finishing helps considerably in the sale of an instrument. Finish should be given considerable attention.

"The layman, perhaps, is not a good judge of piano finish, but we believe that a finely finished case that will hold its condition over a period of years is a big asset to a manufacturer and a very good investment in goodwill and advertising. It is the feature of a piano that is constantly before the eye. If it is bad, the piano is bad; if it is good, the piano may be good.

"Varnish manufacturers today are supplying you with much better varnishes than they did ten or fifteen years ago. They have longer life, are less susceptible to checking and cracking, and we think you should be producing a much better and more lasting finish for your work. You should ask yourself if you are doing this.

"To produce a good varnish of any kind, the foundation must be right. We know that solid woods give a much better foundation for finishing than do veneer woods, but we also know that solid woods are not suitable for your purpose and that you must use veneered woods. We believe you will agree that the veneers that you are buying are very thin and not quite as suitable as they might be for the holding up of a varnish finish. We believe there is almost no difference in the methods employed by piano manufacturers to produce laminated or built up wood. We further believe that you know your business and that if a better method were obtainable, such a method would be in vogue. And now as to the best method of finishing a piano case, we offer this method as being ideal. You may be using all or part of it. We are not giving this as a rule, but as an ideal.

"First: Sponge the wood to raise the grain, and in twenty-four hours, or after the moisture has evaporated, sandpaper to reduce the bristle that was raised by the sponging process.

"Second: Apply the stain and after this stain is dry, sand lightly to remove any bristle raised by this operation. It may be that you are using a kiln for the removal of the excess moisture due to this staining operation, but whether kiln dried or air dried, sand lightly to remove the bristle and following this, the particles that the grain may contain due to sand from the paper or particles of glue that may be loose, should be thoroughly brushed from the pores of the veneer, after which the filler should be applied. We will not describe the filling operation other than to say it should be done very carefully and the pores not partially but thoroughly filled with the filler so there will be no air spaces permitting the soakage of the varnish causing what is commonly known to hard wood finishers as pitting. The filler should be permitted to stand long enough to be thoroughly dry. If a kiln is used, perhaps eight hours is enough. If a kiln is not used it may require forty-eight hours or more, according to the condition and temperature of the atmosphere; but whatever the drying condition may be, the filler should be thoroughly dry before the application of a coat of varnish. If this is not done, it will retard the drying of the varnish indefinitely and the finish in the end will have a 'dried in' appearance. This is one of the evils of finishing and is a source of constant annoyance to those who apply varnish over a filler that is not dry, or over varnish that is not dry. In using the term dry here, we mean HARD. Dry varnish may be considered as free from dust or free to the touch, while a hardened coat would be that which had dried to a hardened state, and would not ordinarily harden further.

"Number of coats vary. Some prepare cabinet work better than others and finish a case creditably with fewer coats of varnish than others. Some finish by fine rubbing, over the third and fourth coat and polishing without flowing, while others use four or five coats of bodying goods, permit their work to stand twelve days or more, after which they coarse rub, flow, fine rub and polish or dull rub, as the nature of the work requires, and finish according to what seems to them the best methods for their particular manufacture.

"When we are dealing with a prospect and endeavoring to make a selection of material best suited to his purpose, or when we are dealing with a customer who is desirous of changing his methods, we analyze the situation as thoroughly as possible to learn the capacity of his shop for handling the amount of work he is trying to produce, to determine the number of days which can be allowed for each operation, and in the end select a material best suited for the purpose."

H. H. Arnold: "Varnish applied, one coat after the other, dried in the kilns and after being taken out shows no perceptible softness, yet after being cooled the last coat can't be rubbed without showing marks similar to blisters, or water marks. After three or four days it may be rubbed. What is there in varnish to cause this condition?"

J. H. Shanley: "What you refer to is a sweat. No one has ever found relief from it. Your

kiln in the drying operation after staining will remove the excess moisture due to the staining operation."

F. E. Morton: "Would a difference in grade of varnish affect the period of time elapsing before the flow?"

J. F. Thomas: "Absolutely yes."

J. H. Shanley: "The better grade of varnish would require a little more time."

E. J. Fishbaugh: "Is there a good varnish that can be coated every day without skrinking?"

J. H. Shanley: "You might put on all your body of coats at daily intervals if you will permit that mass to dry out properly. In many kilns a temperature of 120 degrees is maintained and that softens the varnish in drying even down to the fourth coat. I believe if varnish is dried at 105 degrees, the result would be better."

J. F. Thomas: "That has been borne out by our experience. To obtain the very best workmanship I don't believe in coating each day."

H. H. Arnold: "Would you suggest leaving the work in the kiln or operate the kiln part of the time then let it stand under normal temperature to remove the heat from the stock?"

J. F. Thomas: "The latter."

F. E. Morton: "What would be the proper proportion of time?"

J. F. Thomas: "Kiln drying six to eight hours."

E. J. Fishbaugh: "Should there be 50 per cent humidity in the kiln?"

J. F. Thomas: "Yes. The best results are obtained by air drying. Using kilns you are apt to get the humidity too low and take too much moisture out of the wood."

E. B. Bartlett: "Where no kiln is used would you make any provision for obtaining uniform temperature and uniform relative humidity?"

J. F. Thomas: "I would if possible. All shops are very dry from steam heat in winter and humid in summer."

J. H. Shanley: "The drying of varnishes will do best in the condition in which man likes best to live."

E. J. Fishbaugh: "Why will a stain bleed through some varnishes freer than others?"

J. F. Thomas: "Due to the composition of the varnish."

F. E. Morton: "What is your experience as to temperature and humidity in kilns, Mr Waud?"

R. H. Waud: "About 108 temperature and 85 humidity."

F. E. Morton: "Mr. Thomas, what specifications would give such a varnish as when properly applied, thoroughly dried and finished, would move with a vibrating piece of wood and not disintegrate?"

J. F. Thomas: "It would be difficult to draw such a specification. The gum would enter into it to a large extent."

F. E. Morton: "Have you ever had specifications given you for sounding board varnish?"

J. F. Thomas: "Only for color."

F. E. Morton: "Suppose I buy a varnish from a firm regularly and continue to order month after month, can I assume a uniformity of product under present day practice?"

J. F. Thomas: " Yes, absolutely. There is no reason why you should not."

E. J. Fishbaugh: "Do you believe it good practice for the finisher to add any thinner in the finishing room?"

J. F. Thomas: "I do not."

E. J. Fishbaugh: "If you use shellac underneath would you thin your first coat?"

J. F. Thomas: "No. Where you do not use a shellac or similar substance, you should thin the first coat about one-third."

H. H. Arnold: "Do you use turpentine for thinning?"

J. F. Thomas: "Yes, to a certain extent. It helps the oxidizing."

F. E. Morton: "Does the laboratory check up scientifically the human element entering into the manufacture of varnish?"

J. F. Thomas: "Absolutely. The laboratory checks up each step and checks up the human element entering throughout. In addition to that, the varnish itself is run through by practical men. All the best manufacturers test each lot of varnish practically before making shipment of any part of it."

Chas. Stanley: "Does it injure varnish to spray it?"

J. F. Thomas: "No."

E. E. Beach: "Our experience may be of interest. We use four of the Pasha Air Brushes. We have never been able to tell the difference between air brush work and that done by hand."

H. H. Arnold: "What is the difference between a long oil and short oil varnish?"

J. F. Thomas: "A long oil varnish is used for outside varnish that is supposed to have long life. It is the oil that gives the elasticity. Sierra Leone gum is lasting. It seems to carry an oil in itself. When you make a varnish of that gum you get extreme durability. The Kauri gum is much harder than Sierra."

E. B. Bartlett: "Would you recommend Spar varnish on pianos?"

J. F. Thomas: "No. It won't polish out. Linseed oil will not evaporate. To the ordinary layman the Spar varnish might seem fine, while to you it would look awful."

J. H. Shanley: "We have a panel here that was finished over ten years ago. Perhaps the veneer on this panel is heavier than is used in practical shop work. You who are experienced can tell very readily by looking at it. This has never been coated since it was finished ten years ago. It has been cleaned up."

H. H. Arnold: "How many coats were put on at the time?"

J. F. Thomas: "Five body and one flowing."

H. H. Arnold: "Does the relative thickness of the veneer make any material difference in holding up the varnish?"

J. F. Thomas: "It does."

F. E. Morton: "Can you say why?"

J. F. Thomas: "With a thin veneer the glue works up into it."

F. E. Morton: "You are then applying varnish to glue. What is the effect?"

J. F. Thomas: "A shrinkage of the glue."

H. H. Arnold: "After the glue takes on moisture it expands and raises the varnish above the wood."

Qualities and Uses of Wood

February 7, 1917

Thure A. Johanson, general superintendent of the factories of the Cable Company, presided in the absence of Frank E. Morton, acoustic engineer of the American Steel & Wire Company, who was in Lawrence, Kansas, to address the students of the University of Kansas. Mr. Johanson announced the subject for the evening, "Wood," and in an interesting way told of the woods best adapted to piano making. Mr. Johanson said:

"The subject for discussion this evening is the various kinds of woods best adapted to the manufacture of pianos. Certain woods are selected for building certain parts of pianos, because these woods possess just those qualities or characteristics which best enable them to perform the functions required. Some of these properties or characteristics are tensile strength, rigidity, hardness, ability to expand and contract, resonance and beauty.

"The construction of backs requires strength and rigidity. For this purpose, spruce, maple, rock elm, beech, etc., are used, either in the solid wood or laminated.

"Wrest planks require tensile strength, rigidity and hardness, and the American rock maple laminated is without doubt the best wood for this purpose. Bridges of laminated ash and maple have proved to be very good.

"For sounding boards experience and experiments have proven that spruce is the best material. Some fine sounding board lumber comes (or did come before the war) from Bohemia and Roumania, but it has been found that spruce from our own Adirondack mountains and the Pacific coast is of such excellent quality that it may still be considered a debatable question as to just where the best is grown.

"For actions, strength, rigidity and hardness are desired and rock maple meets these requirements better than any other wood.

"Keys require a wood that is unusually strong in comparison with its weight, besides having

the least tendency to warp. Sugar and cork pine seem to be the materials best adapted to thi purpose. and perhaps basswood is the nearest substitute for these.

"Stiffness and strength are vital factors in the making of key beds and built up stock is use to good advantage for making these parts.

"Most of the lumber used in the construction of a piano enters its case making. The gran case rim requires strength and rigidity and laminated maple and ash are the most favored woods

"In direct contrast with the requirements of strength in grand case rims is the deman made upon the corewood or veneer backing used in upright cases. This corewood must be lumbe which, when thoroughly dried, will contract or expand the least and will best hold its shap under the varying climatic conditions as regards heat and moisture. Yellow poplar, chestnut ash and white pine meet the requirements for corewood better than other varieties.

"Among the solid ornamental woods none excel mahogany, walnut and oak.

"Various fancy woods are used more or less for face veneers. The most popular of thes for turning out cases that are truly beautiful are mahogany, rosewood, Circassian walnut, oak and last but not least, our own beautiful American walnut, which to my mind surpasses them all It is the king of woods. And let me say in passing that this American product of ours of whic we should be particularly proud, has not attained the degree of appreciation that it merits. What more beautifully figured wood can be found? Nature must have left walnut for the las in the production of its woods, for in it she has portrayed beauty surpassing that in all others.

"Needless to say in such a company, all the woods mentioned must be selected and treate with the utmost care in order to produce the best results."

Mr. Johanson then introduced L. L. Barth, vice president of the Edward Hines Lumbe Company; Mr. H. S. Dewey, lumber expert; Mr. P. W. Huston, also of the Edward Hine Lumber Co., and Dr. E. W. D. Laufer, associate agricultural commissioner of the America Steel & Wire Company. Mr. Dewey was the speaker of the evening. He has spent year in the study of the woods of the world, and his address was heavily freighted with excellen advice. He said:

"Few, if any, of the products of Nature are of such manifold utility as wood. Substitut have taken its place in many instances, but rarely with advantage, except as to first cost. S multaneously with these substitutions have come added requirements for wood, thus main taining an average annual consumption that runs into big figures, and enables the industry c manufacturing lumber and kindred products to retain its place among the leading industri pursuits of the world.

"The numerous woods in general use today offer wide opportunity for practical and inte ligent selection for quite every specific need.

"As a material in the arts, as well as for general structural and other purposes, the demand are so diversified and so divergent that to a student of wood values, the subject abounds wit interest and impresses the close observer with a versatility that is inspiring and arouses en thusiasm.

"The botanical interest in timber, its growth and development, has, until very recently occupied a too inconspicuous place in the realm of wood manufacture and manipulation. Ac cordingly there has been too little consideration given to the selection of certain woods to f specific needs for which they are especially adapted by nature, and quality has not been a important a factor in determining these selections as it should have been.

"Wood is produced only by the highest sub-kingdom of the plant world, the seed-bearin or flowering plants, subdivided into two distinct divisions, viz.: the Angiosperms an Gymnosperms. The Gymnosperms are all perennial trees and shrubs divided into three natur orders, two of which are valueless as timber. The third, the order of Coniferae, is so name from the general arrangement of its seeds on a series of over-lapping scales arranged in a con having narrow, rigid individual leaves whence they get the familiar name of needle-leaved tree The members of this order are the pines, larches, firs, cedar, balsam, spruce, hemlock, etc., c softer texture and more rapid growth, possessing in a large degree physical characteristics tha render these woods indispensable for certain requirements, such as house building, sash, door blinds, etc., and also pattern making, etc.

"The second division of seed-bearing plants, the Angiosperms, is divided into two classe

known botanically as monocotyledons, comprising lilies, orchids, palms, grasses, etc., of no economic value as wood, and dicotyledons, which include perennial members of the class of wood value, besides numerous plants that never form wood. The trees of this division having wood value include the oak, ash, birch, elm, maple, beech, gum, etc., of our own native woods, besides numerous woods of the tropics, such as mahogany, rosewood, ebony, Spanish cedar, etc.

"Dicotyledons, so named from having two seed-leaves to the embryo, comprise an immense and varied assemblage of plants, a very large proportion of which are merely herbaceous, never forming wood. In those perennial members of the class, however, which acquire the dimensions of trees or shrubs, the stem generally branches freely, has a separable bark and increases girth with age; the wood, though, as we shall see, differs in several important but very obvious characters, agreeing with that of conifers in being arranged in rings produced in successive seasons. These rings as they appear in a cross-section of a tree, or conically tapering sheaths surrounding the tree — as they in fact are — form on the outside of the wood of previous seasons and beneath the bark. This type of stem characteristic of gymnosperms and dicotyledons, is in consequence correctly termed exogenous, which means in simple English, to produce. The term, endogenous, still sometimes applied to the structure of the stem of monocotyledons, is less accurate.

"Dicotyledons are commonly of slower growth than conifers and their wood, especially that near the center of the stem, is often much harder. They bear, as a rule, also broad net-veined leaves and are known familiarly as hardwoods or as broad-leaved trees.

"It is then with the two classes of exogenous stems, those of the gymnosperms or needle-leaved trees, and those of dicotyledons or broad-leaved trees that we are concerned. Though as we have already said, conifers and broad-leaved trees present important differences in the structure and consequent character of their wood, their manner of growth is so nearly identical in its initial stages and broad outlines that we may treat them at first collectively. It is considered likely that the many branches and numerous small leaves exposed by means of these branches to a maximum of air and light in these two groups of plants as contrasted with the general absence of branching and the small number and large size of the leaves in ferns and palms, have determined the production of the progressively enlarging solid stem that characterizes them.

"It must be remembered, however, that the stem of a tree fulfills several very distinct physiological purposes. Besides bearing up the weight of leaves and foliage so as best to obtain the air and light they require, it is the means of communication between the root and the leaves. Through it the water and its dissolved gases and saline substances, taken in by the root from the soil, are conveyed to the leaves, which have been termed the laboratory of the plant, to be built up in them with the carbonaceous food-material taken in from the atmosphere into these complex organic compounds of which the whole structure of the plant is composed. Furthermore, the stem serves as a reservoir in which some of these organic compounds, the plastic material of the plant, are stored up for use in future growth.

"Every stem and every branch (and a branch is but a secondary stem differing only in position as long as it remains capable of elongation), is terminated in the groups of trees with which we are concerned, by a bud. A bud is the growing point protected by over-lapping rudimentary leaves.

"In the immediate neighborhood of this growing-point the stem in this, its initial stage, is entirely made up of structures which almost completely resemble one another. Whether we cut such a growing-point across or lengthwise it presents under the microscope the appearance of a delicate mesh-work of thin membrane filled in with a viscid, semi-fluid substance. These meshes, from their resemblance to honey-comb, were in 1667 named cells by Robert Hooke. The delicate membranes which form the cell walls, as they are termed, are composed of a substance or rather a group of substances known as cellulose. This substance contains the three elements carbon, hydrogen and oxygen in definite proportions, which the chemist represents as $C_6H_{10}O_5$, that is, in a hundred parts by weight, forty-four are carbon, six are hydrogen and fifty are oxygen. Cellulose, like starch and sugar, belongs to a group of compounds of carbon, hydrogen and oxygen in the proportions in which these two elements occur in water, which are known as carbo-hydrates.

"It is, in fact, the same percentage composition as starch, though differing from it in many properties. It is insoluble in water, flexible, slightly elastic, permeable, but only slightly ab-

sorbent and does not readily undergo fermentation. When treated with acid it passes into a starch-like condition, as is evidenced by its then turning blue with iodine, and under certain conditions in the living plant it would seem capable of being formed from, or of passing into, sugar. The viscid semi-fluid substance in the cells is of far more complex chemical composition. It contains not only carbon, hydrogen and oxygen, but also, though in far smaller proportion, nitrogen with traces of sulphur, and perhaps, always also, phosphorus and other elements. It is probably a mixture in varying proportions of some of those substances which from their resemblance to albumen or white of egg, are known as albumenoids, and, from the readiness with which they undergo chemical change, or decomposition, as protoids. Being the substance out of which all plant-structures originate, the sole constituent of the first germs of all living beings, it is known as protoplasm, from the Greek protos, first, and plasma, formed matter.

"Any collection of similar cells or modifications of cells having a common origin and obeying a common law of growth is known as a tissue. These young cells at the apex of the stem, of nearly uniform size and that extremely minute, with their as yet unaltered cell-walls, filled with protoplasm, form an embryonic tissue, one, that is, which will undergo change. Its uniform character causes it to be termed undifferentiated, while the various kinds of tissue to which, by different changes it gives rise are known in contra-distinction as permanent tissues. One change to which any cell is liable so long as it contains protoplasm is to divide into two divisions, a partition wall of cellulose forming across it. The formation of this solid wall is from material in solution in the protoplasm, and a correlative power, which, as we shall see, the living plant possesses, of dissolving a cell wall, illustrate that interchangeability of sugar and cellulose of which we have spoken.

"A tissue the cells of which undergo division is termed merismatic or meristen, from the Greek merisma, division; so that the embryonic tissue at the apex of the stem is known as apical meristem.

"Although its cells are all embryonic, they nevertheless at a very early stage commonly present such a degree of differentiation as to make it possible to distinguish three well defined rudimentary tissue systems. First, there is a single layer of cells on the outside of the growing point, with thickened outer walls and undergoing division only in planes perpendicular to the surface. If we trace this layer backwards down the surface of the shoot below its apex, we shall find that it is continuous with similar cells, which have lost their protoplasm and have even thicker outer walls. As this outer layer of permanent tissue is called epidermis, from the Greek Epi, upon the; derma, skin, the embryonic layer in which it originates is termed dermatogen from derma, skin, and gennao, to produce. In the middle of the growing point is a solid column-like mass of cells which are all somewhat elongated in the direction of the elongation of the stem. This is known as the plerome and the central axis of the tissues to which it gives rise, as the steel, Greek for a column. Between the outer dermatogen and the inner plerome there is a layer or a series of layers of cells which undergo division both in planes perpendicular to and in the planes parallel to the surface of the stem. These are known as the periblem. On tracing them backwards down the shoot we find them continuous with tissues which immediately beneath the epidermis are commonly green, and which often have their cells much thickened in the corners in herbaceous plants or shoots whilst still further back, on older parts of woody shoots, the green layer is often buried under one or more layers of brown cork. These tissues which thus originate in the periblem are known collectively as cortex.

"It is with tissues originating from the central plerome or stele that we are mainly concerned. If we cut a young shoot across, a little below its entirely embryonic apex, we shall see that, whilst there is a central whitish mass, which on being magnified exhibits a comparatively wide-meshed structure, there is around this a ring of patches of a grayer, closer tissue. These gray patches may be observed to be roundish or slightly wedge-shaped in their outline, their longer diameter lying in one of the radii of the stem, and they are wider across their outer parts. They appear gray on account of the smaller diameter of their cells. Longitudinal sections show these patches to be cross-sections of long strands or bundles of cells, narrower and more elongated than those around them.

"The central mass of tissue is the pith or medulla and these strands are known as the procambium or desmogen. The procambium strands extend from the rudiments of leaves near its

apex right through the stem into the root. They get their name from a Latin word, Cambio, to grow, being in a nearly transitory or embryonic condition. In monocotyledons the whole of their tissue passes into the condition of wood so that as the strand in its permanent form is termed being incapable of any further growth in diameter, is said to be closed or finished. In those trees, however, with which we are most concerned, viz.: gymnosperms and dicotyledons, whilst the inner portion of each strand becomes wood and the outer part bark, a band between these two parts remains embryonic. This layer is called the cambium. This cambium layer of wood is termed an open one which is familiar to us as the layer of delicate thin walled cells, full of sticky protoplasm through which we easily tear when we peel the bark from a tree or stick. Having what is termed the quality of perpetual youth, it remains recognizable in a stem many years of age, and with the pith of the tree furnishes us with a convenient rough classification of all structures of such a stem. From the pith or heart of a tree to the cambium, is wood; outside the cambium is rind or bark. The main function of the stem is to convey liquid nourishment from the root to the leaves and to carry back also in a diffusible form the material elaborated in the leaves to growing parts through vessels, which are elongated tube-like structures, formed by the absorption of the transverse or top and bottom walls or rows of long cells placed end to end.

"These are often referred to as vascular bundles. They also contain, however, cells which have not been thus fused into vessels; such cellular tissue when its constituent cells are not more than three or four times as long as they are broad, being technically known as parenchyma.

"As we have already stated, in addition to its function of conducting liquids, which necessitates these vessels or other conducting tissue, as it is termed physiologically, the stem has to perform the mechanical function of bearing up its own weight, as well as the weight of its branches, leaves, etc. The necessary mechanical strength or resistance is acquired by a change in the walls of cells, fibres and vessels, known as lignification. This consists in their impregnation with a substance known as lignin. Lignin consists of the same three elements as cellulose, viz.: carbon, hydrogen and oxygen, but in different proportions, its composition being 49 per cent of carbon, six of hydrogen and 44 of oxygen. Its chemical constitution, is however, as yet unknown. It is harder and more elastic than cellulose, readily permeable by water, but not absorbent, that is, not retaining the water.

"There is much of scientific interest which I shall omit, because of the need for more practical survey of the subject. We have considered the various elements embraced in the processes of wood growth, and the functions of the tree in its development. The conversion of cells into wood structure is caused by the lignification of the cell walls thickening as the infusion and infiltration of lignin with the protoplasm in the cells go on.

"There is a difference between the wood of conifers or needle-leaved trees and that of the broad-leaved trees, readily discernible in the difference in the texture, the wood of the conifers being softer and lighter in weight than the wood of the broad-leaved trees.

"In the wood of the conifers the sap-wood or alburnum contain cells that are in a sufficiently active state of vitality to store up starch, at least in winter, though growth is confined to the outer-most layer of all the cambium. The heart-wood or duramen, the cells of which are physiologically dead, serves only the mechanical function of supporting the weight of the tree, resisting the lateral strain of the wind.

"The annual rings composed of the lighter colored spring-wood, and the darker colored summer-wood, which is heavier and denser, show us each year's growth and the relative proportion of the denser and firmer summer-wood becomes a valuable aid in distinguishing heavy, strong pine wood from that which is light and soft.

"Of the conifers the woods most valuable in the manufacture of pianos and many other musical instruments are the soft cork White Pine (Pinus Strobus) so successfully utilized in the manufacture of piano keys, and the spruce (Picea Excelsa) so useful for sounding boards. The supply of both these woods, while not inexhaustible, promises to fulfill quite every need for your purposes for many years to come, therefore we need not concern ourselves about substitutes for them for two generations at least.

"When we examine the stem of a broad-leaved tree, such as an oak, we find the same exogenous arrangement of pith, bark, heart-wood, sap-wood and annual rings with considerably greater complexity in the variety and grouping of the elements of which the tissues are built up. The

pith in some hardwoods is extremely variable, and in some woods like the elder it soon dies and disintegrates, leaving the stem hollow, whilst in young stems of elm the inner portion of it has thin walls and loses it protoplasm, while the outer part becomes thick walled, but retains its cell contents.

"The pith rays of broad-leaved trees are in general far more conspicuous than those of the conifers. In oak the large primary pith rays extending from pith to cortex are often twenty or more cells in width, appearing as long, clearly defined grayish lines in a transverse section of a stem.

"I shall not dwell upon the distinctive features of the various hardwoods, and the elements of complexity and variety that distinguish them from the conifers. The processes of lignification proceed with much less rapidity, and with vastly differing and widely varying functions. There is, as a rule, among the woods of the broad-leaved trees no such regularity of radical arrangement of elements as characterizes the simple wood of conifers.

"In the hardwoods most used in the manufacture of pianos and other musical instruments those of even and uniform growth, of firm structure and strong fibre, have been deemed to be most useful. Uniform structure, density, even grain and elasticity are elements essential to your needs. In the dense, even fibered hard maple you find the wood suited to your requirements for actions. In the rapid depletion of the somewhat limited areas of maple forests, I perceive a possible shortage of this valuable wood in another generation, and the consequent need for seeking a substitute wood. It is possible, however, that you may even now have such a substitute in mind.

"In 1910, 1911 and 1912, I had occasion to investigate timber resources in Tropical Mexico and Central America, where I found a great many unknown woods, that impressed me very favorably indeed, as being suitable woods for many purposes where wood from our own forest resources are now being utilized. Samples which I happened to examine very carefully showed characteristics very similar to our American basswood, poplar, ash and maple, and while I had but limited opportunity to experiment with these woods, such limited experimentation as was made proved to me the likelihood of our utilizing in the years to come many of these valuable woods, particularly for requirements where woods of uniform density and structure are essential.

"Hard maple, for instance, is a wood that grows in very limited areas in the United States, and our available supply of this timber is rapidly diminishing. I firmly believe that many of these unknown hardwoods of the Tropics will in time to come be found to be fully as useful for a great many purposes as even the mahogany and Spanish cedar of the Tropics, which have long filled many practical needs and requirements. Just what one or more of these woods may possibly take the place of the hard maple I am now unable to say, but when the time comes that you are compelled to seek a substitute for maple, I think you will find it in the Tropics of Mexico and in various localities in Central America.

"For various of your other requirements for white ash, oak, elm, etc., it is not likely that for a matter of 20 to 30 years other woods will be required to replace them. However, the great forests of Venezuela and Brazil offer splendid inducements for investigation of the great primeval and untouched forests of those countries, so that I feel warranted in saying you have little or no occasion to be concerned about a source of supply in the event that our own American woods finally disappear.

"There is much diversity of opinion as to the limitations of wood and its general utility, but wood experts and those more widely concerned in the manufacture and manipulation of wood and lumber are inclined to view more complacently the conditions that confront us, namely: the rapid depletion of our forest resources, and the prospective opportunities for replacing the known woods of commerce from other sources of supply. As I have already stated, the unknown woods of the Tropics of South American countries have not found their way to market, except in very limited quantities, by reason of the fact that there has been little occasion for the pioneering work that is necessary to introduce them.

"The grandeur of the stately white pine, which has been so successfully used in piano construction in years past is not excelled anywhere in the great forest areas of the world, either in its primitive beauty or its superb action in every use to which it has been adapted for commercial purposes. The only specimens of the order of Coniferae that approach it as a utility when a soft wood of uniformly even growth and softer texture is required, is the sugar pine of Califor-

nia (Pinus Lambertiana)and a species of pine which I personally investigated in 1911 in the State of Michivacan in Mexico. It is my opinion that some of the requirements that previously have demanded the good old cork white pine of Maine, Pennsylvania, Michigan, Wisconsin, Minnesota and Idaho, may be filled satisfactorily, but I am doubtful about either of these woods ever fulfilling some of the extremely particular needs that white pine has served.

"Among the latter I choose to include the requirements for piano key stock.

"In the selection of a musical instrument, of first importance is the tone and quality, to which wood has been a modest, if indeed not an extensive contributor. Secondary only, and very closely associated with this first essential we find wood in some shape or form adding beauty and charm, and a conspicuous factor in supplying an exterior finish of exquisite luxuriousness of an instrument that is a delight to the eye as well as to the ear.

"You have succeeded so splendidly in your skillful efforts to blend harmony and pathos with the fundamental needs for beauty of design, that your work has been an inspiration and shall ever occupy its rightful place, not only in the world's commerce, but as a factor of potential influence in our social life."

Following the address woods were discussed exhaustively. Most of those present participated. Mr. Barth opened the discussion:

L. L. Barth: "In the construction of the back of a piano, Mr. Johanson speaks of spruce. If that requires hardwood, spruce is hardly classed in with hardwood. Mr. Dewey spoke of maple. The time is coming when you must obtain a substitute for maple. Rock elm would be next, beech next, etc. You could hardly classify spruce with maple. Spruce gives lightness and rigidity."

E. B. Bartlett: "It would be interesting if you could suggest substitutions—even if it is not necessary. If there is something else of similar classification, we would be glad to hear it."

L. L. Barth: "If white pine is more valuable and gives you the lumber you want, the amount required is not such as to make a great difference in price."

E. B. Bartlett: "Spruce is mostly used in sounding board construction."

L. L. Barth: "For keys you speak of sugar pine, cork pine and basswood. There is a difference between sugar and cork pine."

E. B. Bartlett: "There is more sugar pine being used than cork pine."

H. S. Dewey: "The area over which basswood grows is very limited. In a 100,000 acre stand you may find no basswood. If you start with basswood, then you will find you can't get enough of it because you have to be so particular. The cost is increasing all the time and you are going to get right up to the other cost."

E. B. Bartlett: "I think I am right in saying that more sugar pine is sold in this market for keys than cork pine. Several years ago, before we abandoned the use of cork pine, we arranged with a company to cut all their good logs for the season. I think their season's cut was about fifty or sixty million feet. Out of that season's cut they laid out about one quarter of a million feet. One of our men looked it over before it was shipped and he could not pick more than about 90,000 feet. That was the last serious effort we made to get this lumber."

H. S. Dewey: "In pine you have a wood that is really in a class by itself. I think, however, our greatest concern is about maple. We are getting right up against a real shortage ofmaple."

T. A. Johanson: "The wood to take the place of maple would most likely be beech."

H. S. Dewey: "Beech is very scarce. How would birch do?"

G. Lufkin: "What variety of birch do you refer to? White or yellow?"

Dr. Laufer: "There are several species of birches in this country. The red and white comes from Wisconsin and Minnesota, and there is also a yellow birch."

G. Lufkin: "The yellow birch is much tougher than white."

T. A. Johanson: "Birch may not be as adaptable as maple. Even in rock maple you will find planks that have not the resistance or hardness required in building actions."

Dr. Laufer: "In wrest planks, I believe that the solution will be found by using maple and birch lamination."

T. A. Johanson: "It would be a very hard thing to laminate different parts of an action."

Dr. Laufer "In the action itself, as the pieces are comparatively small, it would not require trees of such large diameter as are being used today."

E. B. Bartlett: "Would the wood from the small tree be as dense and hard as in the older ones?"

Dr. Laufer: "There is no reason why it wouldn't be if grown in a proper climate. If it was grown in a climate that was cold and moderately moist, the smaller timber would be just as good as the longer timber. It is difficult to get any tree to grow in a section where it is not at home. The government has tried to grow willow to replace basswood. There is quite a bit of willow sold as basswood. We are succeeding very well in growing willow in dry areas."

E. B. Bartlett: "Would willow be suitable as a substitute for basswood?"

Dr. Laufer: "Certain parts of the willow are doing very nicely as substitutes for basswood. It does not seem to possess some of the objectionable characteristics of basswood."

G. Lufkin: "Isn't willow rather brittle?"

Dr. Laufer: "Only certain varieties. Yellow willow is rather tough."

T. A. Johanson: "What is magnolia?"

Dr. Laufer: "Midway between a hard wood and a soft wood. It is similar to the Eucalyptus species."

H. H. Arnold: "Wouldn't the Eucalyptus, being a very fine, close grained wood and very rigid under certain treatment, take the place of maple?"

Dr. Laufer: "If you could dry and prepare it properly it undoubtedly would. We have not found a real method to do that. California produces Eucalyptus of 24 inches to 30 inches diameter. I believe that in the proper climate, 30-inch can be grown in fifty years."

H. S. Dewey: "The natural place to go for substitute woods is the south. Mesquite is an extremely hard wood and would, perhaps, with proper preparation act well to replace maple in certain places."

L. L. Barth: "Could yellow pine be used for piano backs?"

Dr. Laufer: "A piano undergoes great changes of temperature and yellow pine, due to its habit of growth, develops a great internal stress, and because of this, shell-like fractures occur which may cause the frame to splinter and ruin the tonal effect."

H. S. Dewey: "How would fir do?"

Dr. Laufer: "Quarter sawed fir would be a great deal better. Cypress is another wood which by quarter sawing might prove useful."

H. S. Dewey: "You are up against a waning supply there."

E. B. Bartlett: "Fir seems to have the necessary stiffness, but it chips off easily. It will check.

T. A. Johanson: "Would you consider fir stiffer and stronger than spruce?"

L. L. Barth: "Yes. It has greater tensile strength."

T. A. Johanson: "Have any of you any suggestions for building backs? I believe some manufacturers are using birch."

H. S. Dewey: "We know of nothing better."

C. C. Chickering: "We have used spruce altogether."

T. A. Johanson: "What do you say about spruce for posts?"

C. C. Chickering: "It is the best there is for tone producing."

Carl C. Williams: "What kind of spruce?"

C. C. Chickering: "We use the eastern. I don't think the back question is serious. All we need is something that will hold together—something that is true."

H. S. Dewey: "I should think birch would answer for backs. Furthermore, it is a beautiful wood. In interior finishing it stands just as well as mahogany."

T. A. Johanson: "Going from backs to wrest planks, I don't believe any of the manufacturers are using anything else than rock maple for pin or wrest plank."

H. S. Dewey: "It would be pretty hard to replace that wood."

H. H. Arnold: "One thing we must not forget in looking for a substitute for maple pin blocks If we use wood that is too hard and the fibre too fine, the hardness is of a crystalline nature and the pin wouldn't hold. Even in maple if we pick a piece with a swirly knot and get two of them together the pin would be loose in a short time because the threads of the pin are so fine they block readily. We find the qualities that grip the pin in a pin block found in the end wood. The qualities that hold the pin rigid are found in the long wood. The long wood part in the pin block will hold the threads of the screw when turned, whereas the pull on the pin rests on the end wood and that becomes very rigid. If we should take a piece of pin block material and laminate it our tun-

ing pin would not hold. The wrest plank must be of the same kind of wood, hard maple, and especially so if a thinner pin block is used so that the pin itself has a bearing in the wrest plank. I am speaking of uprights."

Dr. Laufer: "Maple is fatty, due to the fact that is it made up entirely of very close, hard-knitted wood fibre cells with practically no ducts in it. When your pin enters between those cells they form levers on that screw. If you get a wood made up of stone fibre cells, such as some of the nut woods, say butter nut, you find the condition you spoke about."

E. B. Bartlett: "Isn't it very likely that the peculiar cell formation of the maple is perhaps one of its most valuable qualities for pin block construction?"

Dr. Laufer: "Undoubtedly. It has practically no ducts in it. Because of its stringy, rope-like wood fibre cells it clings tenaciously to the pin."

T. A. Johanson: "The question has often come up between piano manufacturers whether the quarter sawed wrest plank or the plain sawed would be the best. What maple would hold best?"

Dr. Laufer: "A plain sawed maple."

T. A. Johanson: "Can you give us any suggestions regarding our core wood?"

H. S. Dewey: "What are you using for your core?"

T. A. Johanson: "The eastern manufacturers are using more white pine than we are. We are using more chestnut and poplar."

L. L. Barth: "You can get more white pine for veneering purposes than chestnut or poplar."

T. A. Johanson: "In using white pine for sides of a piano, one objection is its softness."

L. L. Barth: "Use Norway pine."

T. A. Johanson: "It is out of the question."

H. S. Dewey: "What is the thickness of your veneer?"

T. A. Johanson: "One-twenty-eighth of an inch for face veneering."

H. H. Arnold: "Norway pine is too knotty. You can't veneer over knots and obtain a perfect surface."

T. A. Johanson: "We are using perfectly clear poplar. Willow would warp more than poplar."

Dr. Laufer: "The yellow poplar and bass wood that you have been getting is largely willow."

T. A. Johanson: "In that case all of our piano manufacturers are being deceived."

Dr. Laufer: "The difference is just botanical. The grain and color of the two woods are so closely alike that the layman cannot tell the two apart, consequently it doesn't make much difference whether you call them by one name or another."

T. A. Johanson: "A very important point in the construction of a piano case for permanency is found in the core wood."

L. L. Barth: "How large pieces are used for core wood?"

Dr. Laufer: "Seven feet would be about the limit."

H. S. Dewey: "You are confronted with a rapidly diminishing supply of both chestnut and poplar."

T. A. Johanson: "There are certain parts of a piano case where pine cannot be used. The foot block would not be hard enough to hold the screws for the casters. The foot rail, on account of its cut in the center, would not be strong enough. We could not use it for fall boards because of the finishing of the ends and moldings. You could hardly use it for sides unless lined with poplar or some harder wood. Pine is apt to be dead and dozey to a certain extent and it is apt to shrink in."

H. S. Dewey: "You wouldn't get much of the dozey wood in the white pine."

H. H. Arnold: "If we use a narrow board from a small tree or a wide board from a large tree, we find the wide board has less tendency to warp. Why does the narrow board warp more readily?"

Dr. Laufer: "A small tree possesses a proportionally larger sap layer. A board six inches wide from a seven inch tree will have a greater proportion of sap wood than an 18-inch board from a 22-inch tree. The sap wood is capable of taking up more moisture than the heart wood and this larger proportion of sap wood produces a greater tendency to twist and warp in the nar-

row board. The sap wood takes moisture readily even after curing, the heart wood very much less readily. A wide board, sawed, glued and veneered, under ordinary conditions will last a hundred years. A narrow board, in about ten years, may cause trouble because the sap wood takes up moisture, causes the glue to swell and produces checking and sweating in the veneer."

E. B. Bartlett: "Is there a difference between sap and sap wood? In manufacturing we try to get rid of the sap."

Dr. Laufer: "The manufacturer calls that portion which is not solid sap. This is the spongy portion that may be found in a large number of otherwise sound boards. Sap wood, on the contrary, constitutes the outer edge of the board which has not matured to the consistency of the heart wood."

T. A. Johanson: "That brings us to the drying of lumber, and I would like to ask Mr. Barth and Mr. Dewey the best way of kiln drying wood for construction of pianos."

L. L. Barth: "Kiln drying of lumber is like baking a loaf of bread. It dries it on the outside and swells it on the inside. Kiln drying leaves the wood on the inside soft like the inner part of the loaf and the outside dry and hard like the crust of the loaf. It is a problem that the lumberman has been unable to solve."

Dr. Laufer: "From a tonal standpoint, if we seasoned our woods just as the old violin makers did we would approach perfection."

L. L. Barth: "Some pattern makers purchase their lumber three or four years before using and pile it under cover where it is absolutely dry and well aired. The pattern lumber they use today is four or five years old and absolutely dry. I can only say, buy your lumber far enough ahead and put it into a dry place."

Dr. Laufer: "The manufacturer should not use lumber unless he has had it for five years. Piling on ends under a shed would increase warping. No matter how careful you are there would be more moisture at one end of the board than at the other and hence the greater danger of warping. It would be best to pile it in the flat, well cleated so as to secure perfect drying. The manufacturer has lost sight of the fact that lumber is not just wood. It is not a question of 'what is wood'—it is a question of 'why is wood,' and that has been pointed out to be due to histological factors. Whenever you take a board and put it in a dry kiln and turn on a roasting temperature you have ruined that wood tonally, because you have developed inside the cells of the component fibre an internal stress, the same as exists in an iron plate or any manufactured product that is submitted to a wrong heat treatment. Wood is not living matter, but you have internal moisture—water with a mineral content. This mineral content will be variable. It will consist of salts, lime in connection with phosphorus, sulphur and nitrogen—all salts that are extremely soluble. In placing the wood in a dry kiln you dry the outer portion of the cells. You rapidly heat the lumen or the inside of the cell causing the cell walls to be fractured and disintegrated. It matters not if a certain proportion of the cells contain either air or water when heated artificially. You get the condition Mr. Barth pointed out. This tears every fibre of that wood apart, due to the internal stress you develop and ruins it for tonal purposes."

H. S. Dewey: "Perhaps some of you have found that oak honeycombs through rapid drying."

Dr. Laufer: "You can try that on any board. Take a board, put it through the planer and sander, look over it carefully and you will find a beautiful unbroken surface. Put it through the dry kiln and you will find little checks running all the way through it. When that occurs the internal stress makes puffed rice out of it."

L. L. Barth: "We sell kiln dried lumber only on the basis of its grading before it is kiln dried. It is possible to reduce the grading by kiln drying."

T. A. Johanson: "I believe you all appreciate the way we handle lumber is to have it in stacks from two to five years. If the manufacturer should maintain a five years' supply of all woods, some manufacturers would have millions of feet. That is quite an item when it comes to money. I believe most of us are keeping lumber up to four years. When it comes to core stock, it would hardly pay."

Dr. Laufer: "Don't you give it a short dry kiln treatment before using?"

T. A. Johanson: "We do. Would you air dry it down to the finish?"

L. L. Barth: "When you dry kiln it readily reabsorbs dampness because the pores are all open and the dampness goes in in spite of anything you can do to prevent it."

T. A. Johanson: "In air drying lumber, suppose it does not go through your dry kiln, what percentage of moisture would it hold?"

Dr. Laufer: "That is difficult to tell. I would recommend that the lumber be taken and air dried five years and then brought in to the mill room from one end and passed through a room in which a current of live air is circulating. In a week your lumber would be fairly dry. Vitalized air on lumber that has seasoned is very powerful. You bring your lumber from the yard and it goes into the air drying room and is moved slowly to the point of usage. By that time it has lost all the surface moisture it has accumulated and you have dry lumber which will not pick up much moisture."

H. S. Dewey: "The remaining moisture content would largely be in the heart of the piece and would not give one-hundredth part as much trouble as the moisture that would be taken on the surface of the piece."

T. A. Johanson: "Should it be dried in the open air?"

Dr. Laufer: "I would dry it in the open with a roof over it. I would pile the valuable lumber in the center, the next most valuable lumber on the sides and the cheapest lumber on the outside. In this way the maple is getting all the air but is not depreciating because the moisture and elements do not get at it."

Wood and the Piano Builders' Art

February 21, 1917

Mr. F. E. Morton, Chairman, introduced Dr. E. W. D. Laufer, Horticulturist of the American Steel & Wire Company, who presented the following address:

The object of this paper is to familiarize the practical piano builder with certain fundamental facts in regard to the structures that make up his most necessary material, as well as to correlate certain practices of the builder with their effects on the finished instrument. This necessitates tracing the development of the wood from its original cell through the various tissues to final perfection, taking cognizance of the chemical changes constantly occurring with varying intensity according to rapidity of growth, soil conditions, climatic environment, and the treatment of the timber after cutting. Careful study of the accompanying microscopic views will make clear these points.

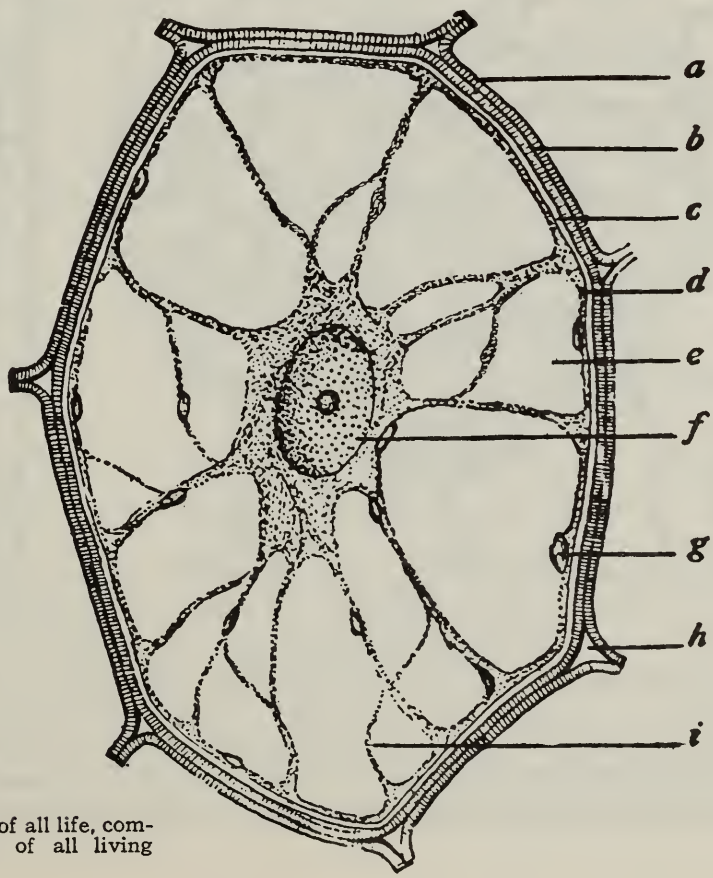


FIG. 5
A single cell, the basis of all life, complete in itself, capable of all living functions.

FIG. 5. Shows the cell which is the basis of all plant life. This cell is of the simplest form, being made up of a thin cell wall and living cell contents. The wall adjoins walls from other cells. This cell wall consists of cellulose and contains the elements carbon, oxygen and hydrogen. Cotton is a very pure form of cellulose with which all are familiar. Within the cell will be noticed a peculiarly formed body which, however, is not limited to this shape at all times. This is protoplasm or live matter. The rounded portion in the center of this protoplasm is the nucleus or center of cell life. Note also a still smaller body in the center of this nucleus. This is the nucleoli or germinal spot of the cell. When new cells are formed the nucleoli divides into two portions thus giving rise to two new cells; these two divide into four, the four into sixteen, etc. When a live tree is cut down the growing cells contain this protoplasm, but the older or heart wood is free from this substance.

Protoplasm is made up of the basic elements present in all nature. It contains compounds of nitrogen, oxygen, sulphur, carbon, hydrogen, phosphorus and other elements in varying proportions. When the tree is cut the protoplasm shrinks from loss of water and dies. If such a tree is not taken to the sawmill within a reasonable length of time or the bark removed, the entire outer portion will decay in five or six months. This is due to the fact that the reabsorption of water and heat causes the dead protoplasm to ferment, rupturing the cells and allowing decay fungus to enter, which at first produces the darker coloration known to the mechanic as "sappy spots." On the other hand, if the wood is properly treated these soluble salts are absorbed by the cell walls where they are capable of undergoing changes, giving rise to various phenomena in the finished product. These changes always occur in the outer or sapwood section of the tree. The difference then between sap and sapwood is found in the fact that sap is an indication of commencing decay, and sapwood is that portion which consists of the current year's growth made up of simple and slightly altered cells.

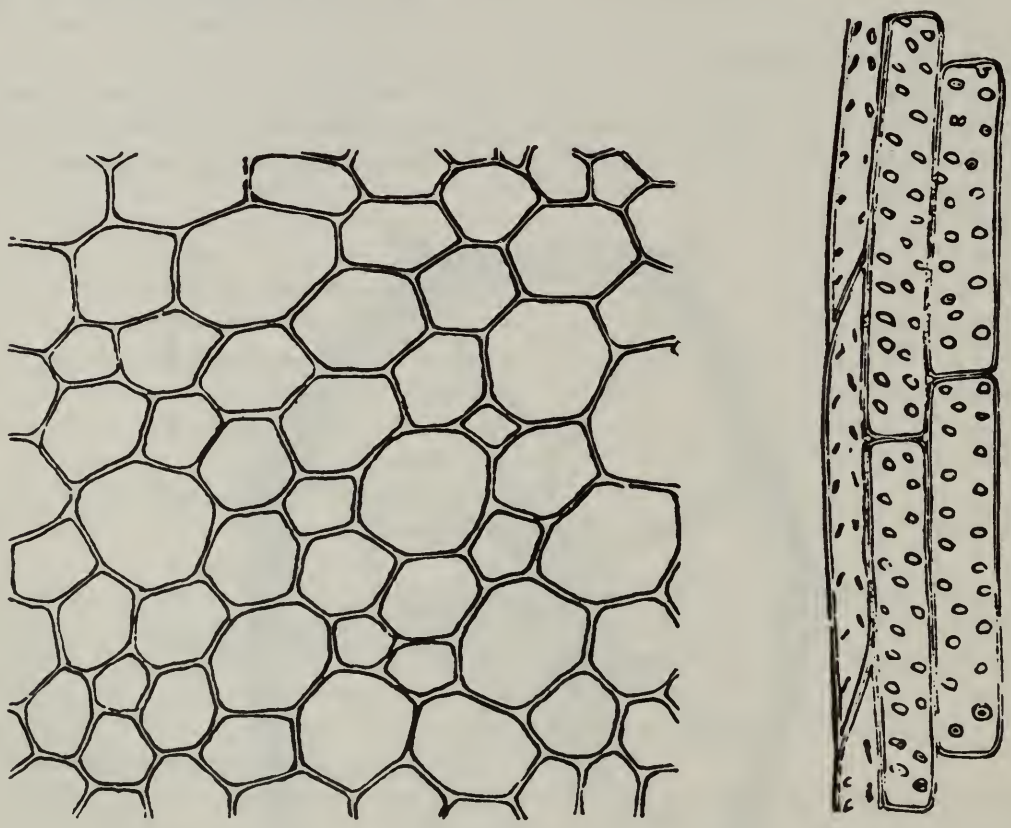


FIG. 6
Parenchyma or basic tissue—
An aggregation of unaltered or simple cells. In cross section on left, a longitudinal section is shown on right.

FIG. 6. This illustration shows the first or basic tissue of nature. It is known as parenchyma. It is simple in form, all cells having thin walls. One of its peculiarities is that its cells usually are of equal diameter in each direction. Some parenchyma lays close to the outer por-

tion of the plant whose cells are somewhat elongated as shown by the longitudinal section at right. This tissue is the fundamental tissue of all plants. No matter what kind of wood, be it the softest cork pine or the hardest maple, this is the first tissue that is formed, and on its structure the wood cell and all of the other forms are built up. All the walls in this section are simple cellulose. The section shows all of the cell contents removed. In this form it is closely related to the pith of the elder. The actual size of the cell of parenchyma tissue varies; this one shown would perhaps measure one-two-thousand-five-hundredth of an inch.

FIG. 7. Here is a tissue that is closely allied to parenchyma; changes have taken place.

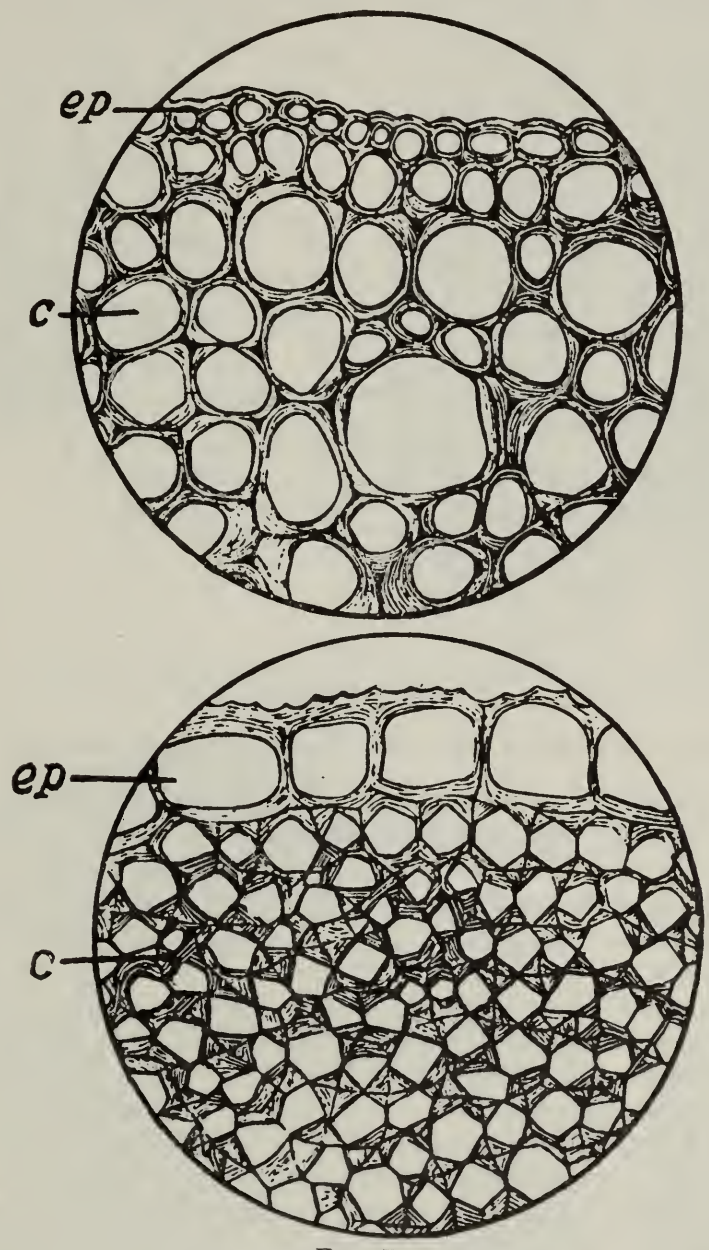


FIG. 7
Collenchyma or altered basic tissue.

The original basic parenchyma has become older; the plant has grown taller and now requires support. Nature provides that support by depositing either cellulose or a substance called lignin on the walls of the simple cell. This deposit does not always occur exactly in the way it is shown in the upper of the two illustrations, but has a tendency to deposit in the angles as shown in the lower illustration. This gives very small cell cavities and very thick angular walls. The various ways in which the deposits occur affect the section of wood cut from such a stem. On the upper edge note square-shaped cells, like bricks in a row, while on the extreme outer portion are little corrugations. This is the cork tissue of the bark. When these cells die they chip off.

This gives rise to the roughness of the bark on old trees. The name of this thickened tissue is collenchyma.

FIG. 8. This shows another view of collenchyma tissue both in transverse and longitudinal section. In this case the cell walls have hardened and thickened still more. As before noted, this tissue lies just underneath the bark and serves to give the plant its first support. When the

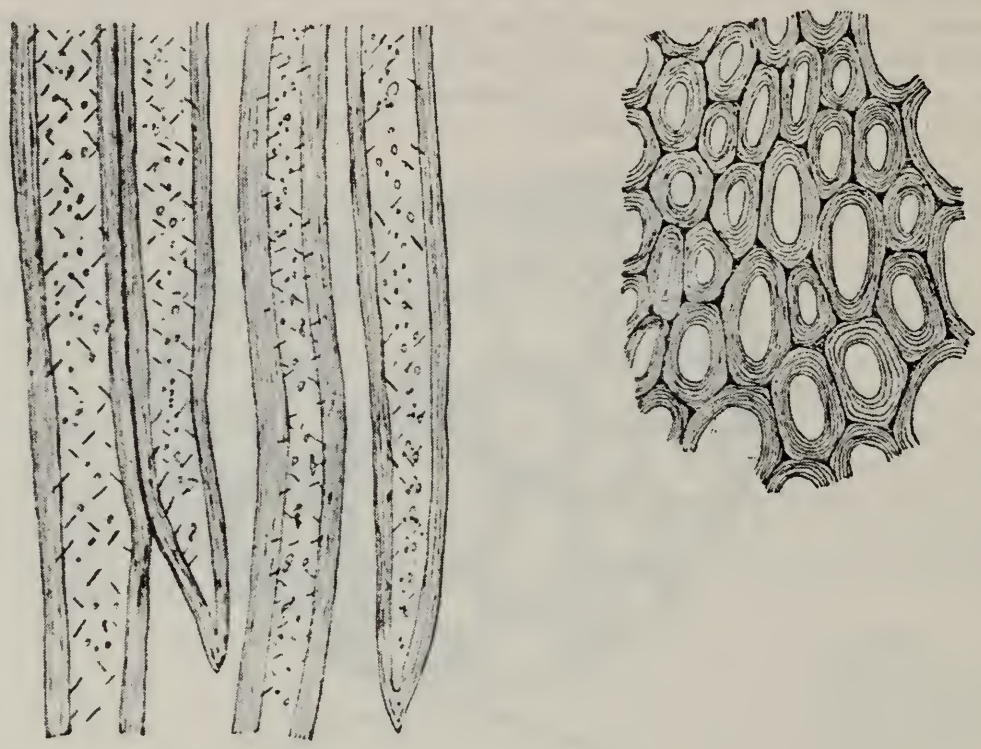


FIG. 8
Collenchyma still further altered than in Fig. 7. Here the basic tissue is becoming woody. This forms Bast.

tissue has reached this state, it is called "bast." If it occupies the position in which we find it here it is fibrous and tough. The cells are quite long. This alteration from the basic tissue is due to the fact that the intersecting walls between cells have broken away; pressure from within and without has compacted the cells into closely interlacing strands. It is this portion cut from basswood that is extremely tough, hence it is used in crossband veneering.

FIG. 9. This looks like a cross section of a pile of logs but really is stone tissue. These stone cells are parenchyma tissue which have rapidly taken on lignin (wood substance) and have absorbed mineral matter which makes them very hard. Note that the lumen or central cell cavity is very small. Owing to the rapid thickening of the walls the inner contents of the cell were placed under pressure in various diameters and this pressure has created fissures in the walls. This hard tissue it is which dulls tools so rapidly. It also causes difficulties encountered in the maple wrest plank. It occurs in all hardwoods, in the shells of nuts, and directly under the bark of mature oaks, sycamores and walnut. This particular section is taken from the pear because its cells are so decidedly characteristic. If in a maple wrest plank you find a section containing this tissue and attempt to drive a tuning pin into it, the small threads on the pin will fill with this wax-like substance causing a "jumpy pin." The transitional stages from the original basic tissue to the actual wood fiber and stone tissue are not quite so simple as they appear here, all gradations being found. It is sometimes difficult, therefore, to say where parenchyma merges into collenchyma and where collenchyma merges into bast and bast into wood fiber and stone cells.

FIG. 10. Gradually we get farther away from the simple forms. Here we have true wood fibers typical of all hard woods. They are not always of this perfect round form, but the true wood cell always has a thick wall and small central core. To the right are true wood fibers in longitudinal section. Running almost through the center of the section at *m* is a medullary ray. This is the divisional ray that always divides a block of wood into wedge shaped portions. Every

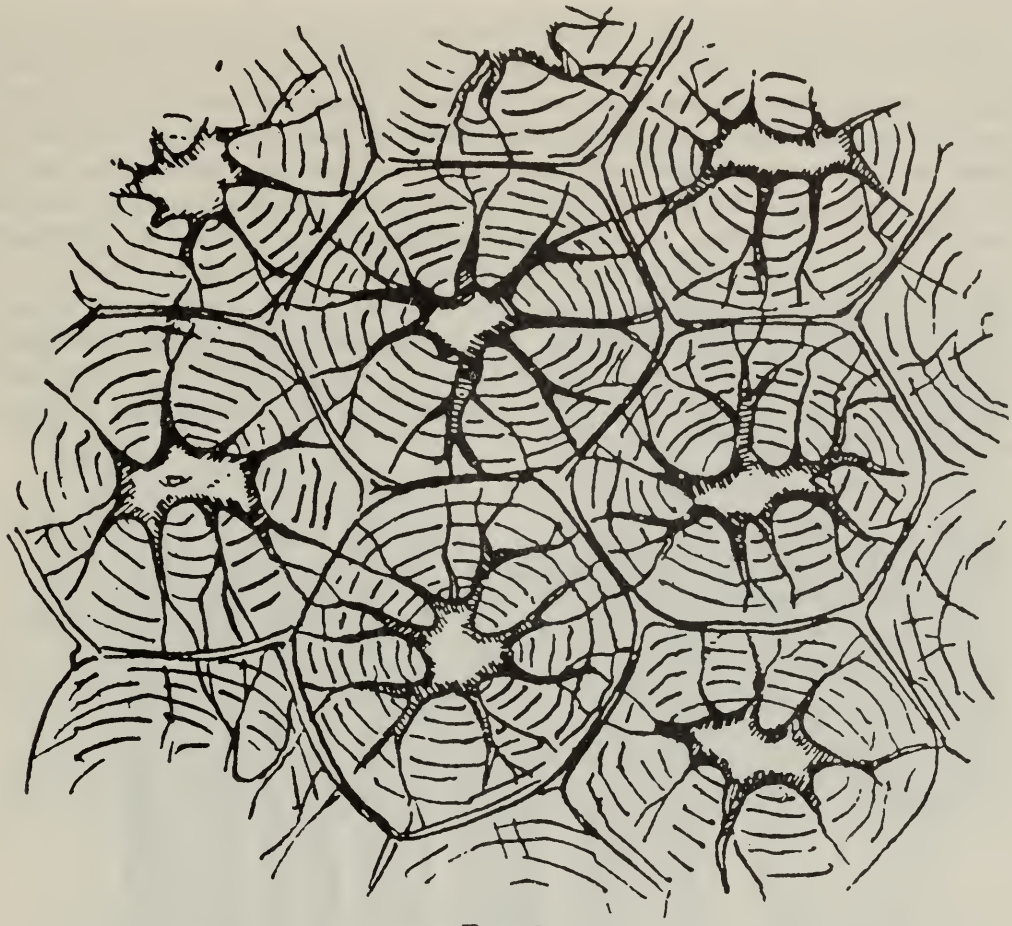


FIG. 9
Stone tissue. The altered tissue has become very hard through mineral and Lignin (wood substance) infiltration.

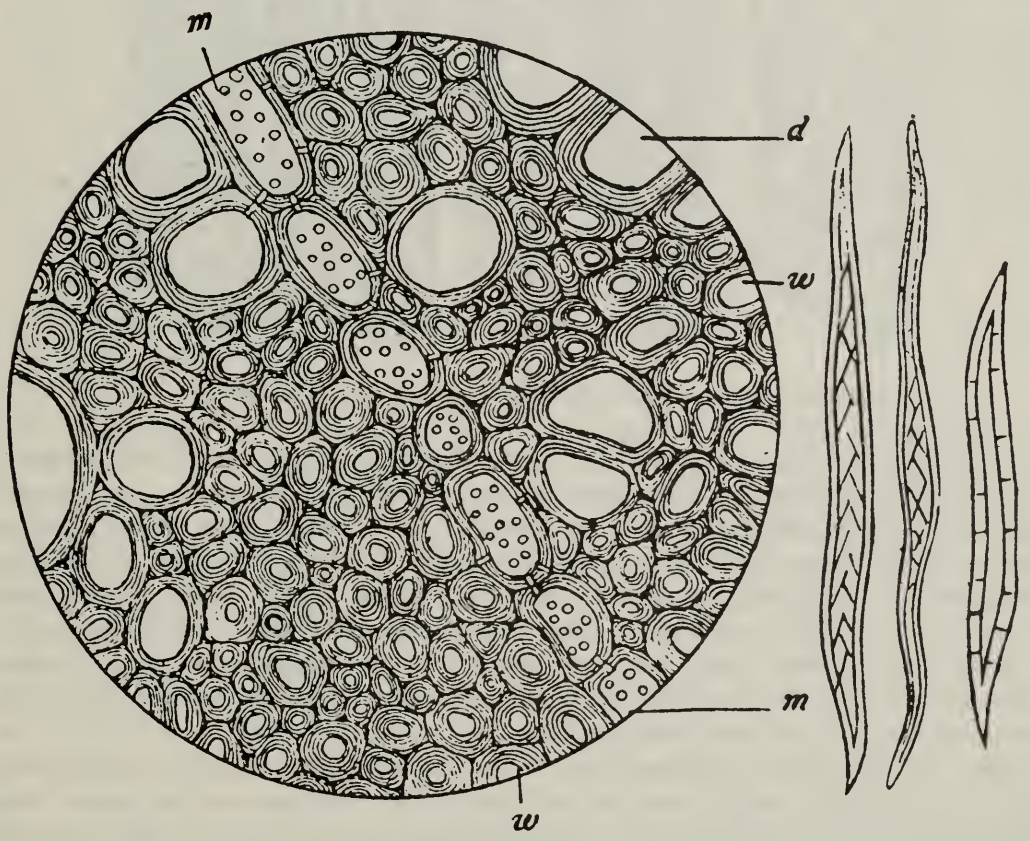


FIG. 10
True wood fibers. Basic tissue plus Lignin.

structure in the stem runs to a wedge shape. The wood bundles are separated by a row or two of these medullary ray cells. They consist of basic parenchyma tissue which has lignified but retained its thin walls, becoming much compressed by the adjoining wood bundles. If wood is rapidly grown under stimulative culture and climatic conditions with a large amount of water and heat, these ray cells will be weak and if a nail should be driven in a board where two of them cross, the board would split. If this condition obtains in a maple wrest plank, and the pins approximately follow the medullary ray, the plank will break before half of the pins are driven.

The course of the ray can be recognized by the naked eye from the duller color of the ray cells. Notice the peculiar shape of the wood cells to the right. The center core is always small and the walls thick, while the ends are pointed. This causes these cells to exert a binding, twisting, rope-like effect on each other. This is particularly the case in our maple as this wood is free from any large ducts, hence a close, bridge-like structure results. A substitute for maple should have these characteristics.

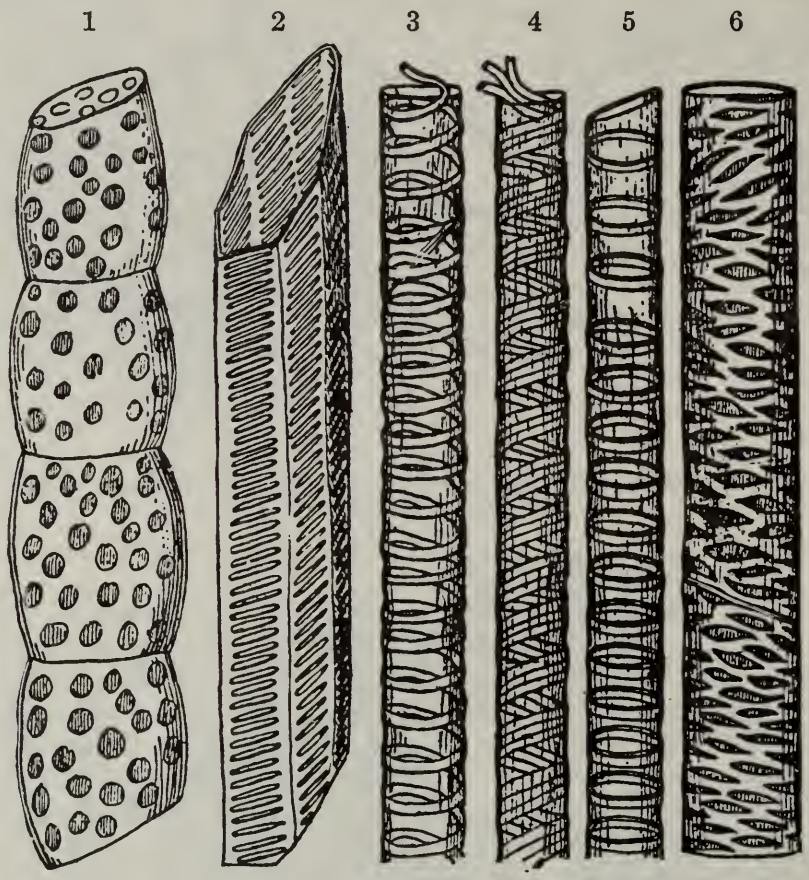
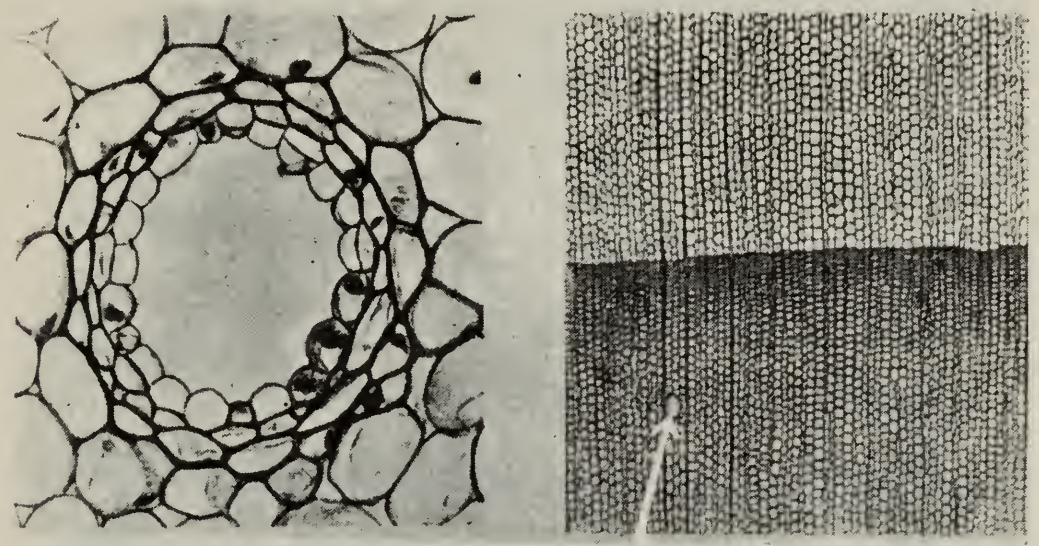


FIG. 11
Six forms of Ducts. These form the great arterial system of plants.

FIG. 11. These are ducts. A plant eats, drinks and possesses a circulatory system. These ducts are required for the proper functioning of this circulatory and absorptive system. Ducts may be likened to large open tubes of great length, reaching the remotest parts of the plant. In growing wood tissues we find that the spring growth is lighter in color and appears more porous to the naked eye. A transverse section of such a wood examined through the microscope shows a large number of holes between the cells corresponding to the ducts. The illustration shows some of these ducts dissected longitudinally so that their structure may be seen. Passing from left to right we find first the dotted or pitted duct showing constrictions at regular intervals. This gives great strength and carrying capacity.

This type of duct is typical of practically all of the hard woods having a thin growing layer where adequate moisture supply must be maintained in the least possible space. Number 2 resembles swell shutters on a phonograph, or ladders placed side by side to form a six-sided tube. All of the little slots appear as though sawed through the walls. This is the ladder or scalariform

duct. It is particularly abundant in the pine, number three and five; the spiral and annular duct respectively are also found in the pine. In the spiral duct we may find one spiral or any number up to six as in No. 4, either running in the same spiral as a broad band or in opposite directions. In No. 5 the spiral is reduced to single rings, while in No. 6 a net work, or reticulation, is found; hence its name,—"reticulate duct." These markings exist not only on the walls but actually form projections and grooves along which nutrition and moisture pass, and at the same time give support and strength to the plant.



R

FIG. 12
A cross section through a mature piece of pine, showing relative size of cells, from spring and autumn growth (annular rings) to the left a resin vessel corresponding to R.

FIG. 12. On the right is a section cut from an old piece of pine. It shows the relation of spring growth to summer and winter growth. Note that the cells of the spring growth in the lightest zone are large but gradually become smaller as it approaches the darker zone. The darkest, densest portion has been formed in late fall and early winter, making the rings of growth visible when a stem is sawed through crosswise. Under certain conditions more than one ring is formed in one season. The larger, hole-like opening at R in the lower left side is a resin secreting vessel. The larger illustration to the left shows a detail of this vessel. Later on these secretion vessels will be treated in greater detail. The relative enlargement of these figures is 50 diameters and 200 diameters respectively.

FIG. 13. This is a greater magnification of the transverse section seen in Fig. 12. The smallest cells shown at *a* correspond to those of the dense portion in Fig. 12, while the large cells are those of the current spring's growth.

FIG. 14. On the right are the cells of pine cut in a radial, longitudinal direction, making them appear as though covered with small rings or discs with a smaller ring in the center. The illustration on the left shows the same section cut at right angles to the one on the right, giving an idea of how these cells are shaped. They are more acutely pointed, having thin walls and comparatively larger central diameter; are not so densely lignified as wood fibers, but have a certain resemblance to ducts. No other family of plants possesses them so abundantly as the pines; as a matter of fact, they constitute practically all of the wood of the pines. This characteristic tissue of the pines is known as tracheary tissue and the cells are called tracheids.

FIG. 15. The upper left illustration is a transverse view of the tracheids of the pine *a* showing the position occupied by the small disc. At the extreme left is a view of typical wood parenchyma cells, divided several times by transverse walls. The illustration to the right shows four tracheids of the pine, much enlarged. Compare their acute angled ends with the sharp pointed ends of the wood cell. The bordered pit is shown at *a* while the cells of the medullary ray composed of basic parenchyma, lignified, cross at *m*. In the figure farthest to the right, a tangential view of the same cells is shown. Note that the bordered pits appear lens shaped where they meet

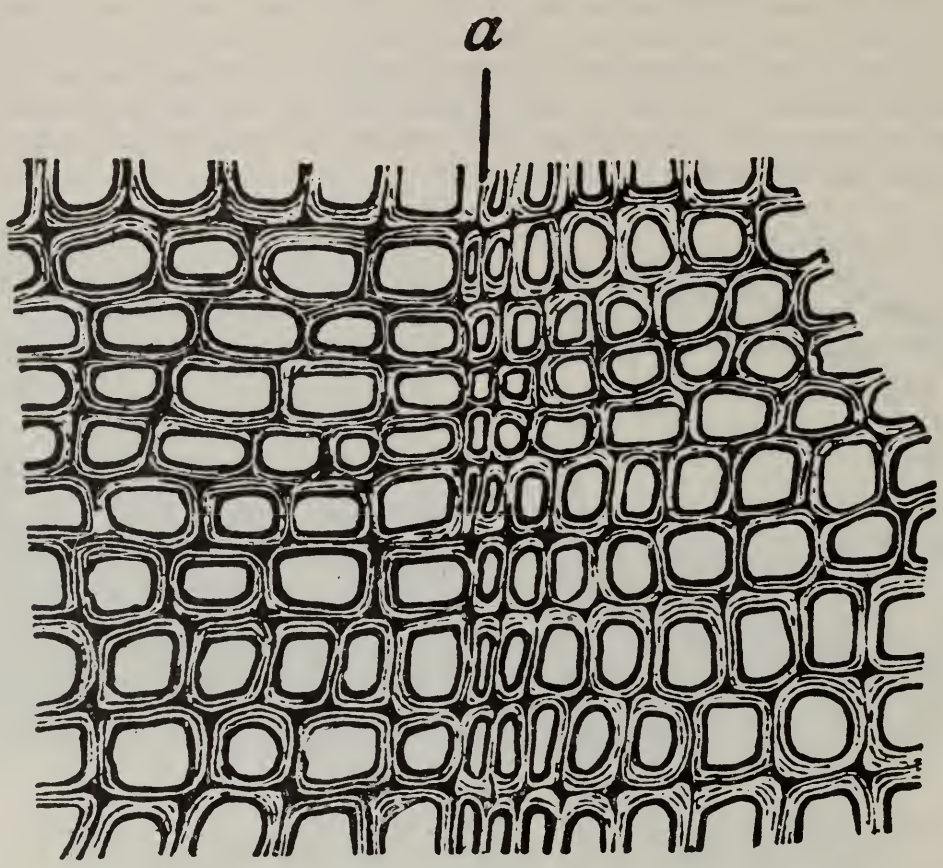


FIG. 13

The annular ring shown in Fig. 12 greatly enlarged demonstrating the shape of cells in cross section.

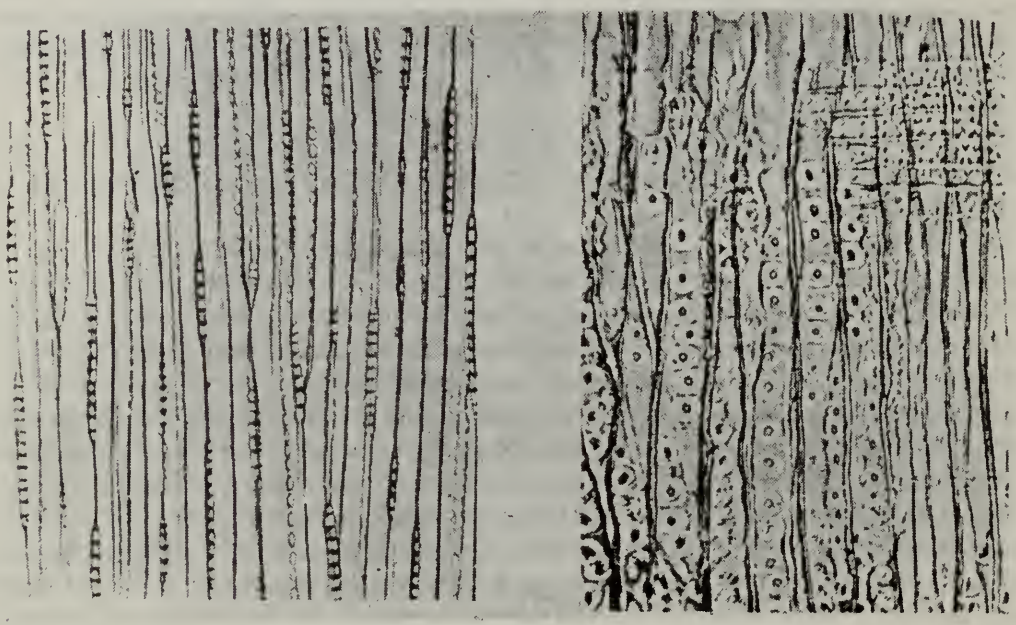


FIG. 14

The cells of pine in longitudinal sections. Right hand cut in line with radius of stem left cut at right angle to Stemradius These cells are called Tracheids.

each other as at *a*. The medullary ray is proved to be basic parenchyma from its isodiametric shape at *m*. Close observation will show that the tracheary tissue has developed from this basic tissue by the breaking away of transverse walls and their peculiar pitting. These pits are really little cups with holes passing straight through the walls in old dead wood. That this is important to the piano builder in his selection of woods having tonal value, such as pine and spruce readily can be demonstrated.

FIG. 16. Here is a tracheid of the pine greatly enlarged. At the extreme left, a flat view, in the center is a perspective of the little cup-shaped disc,—a minute hole cut on either side. In

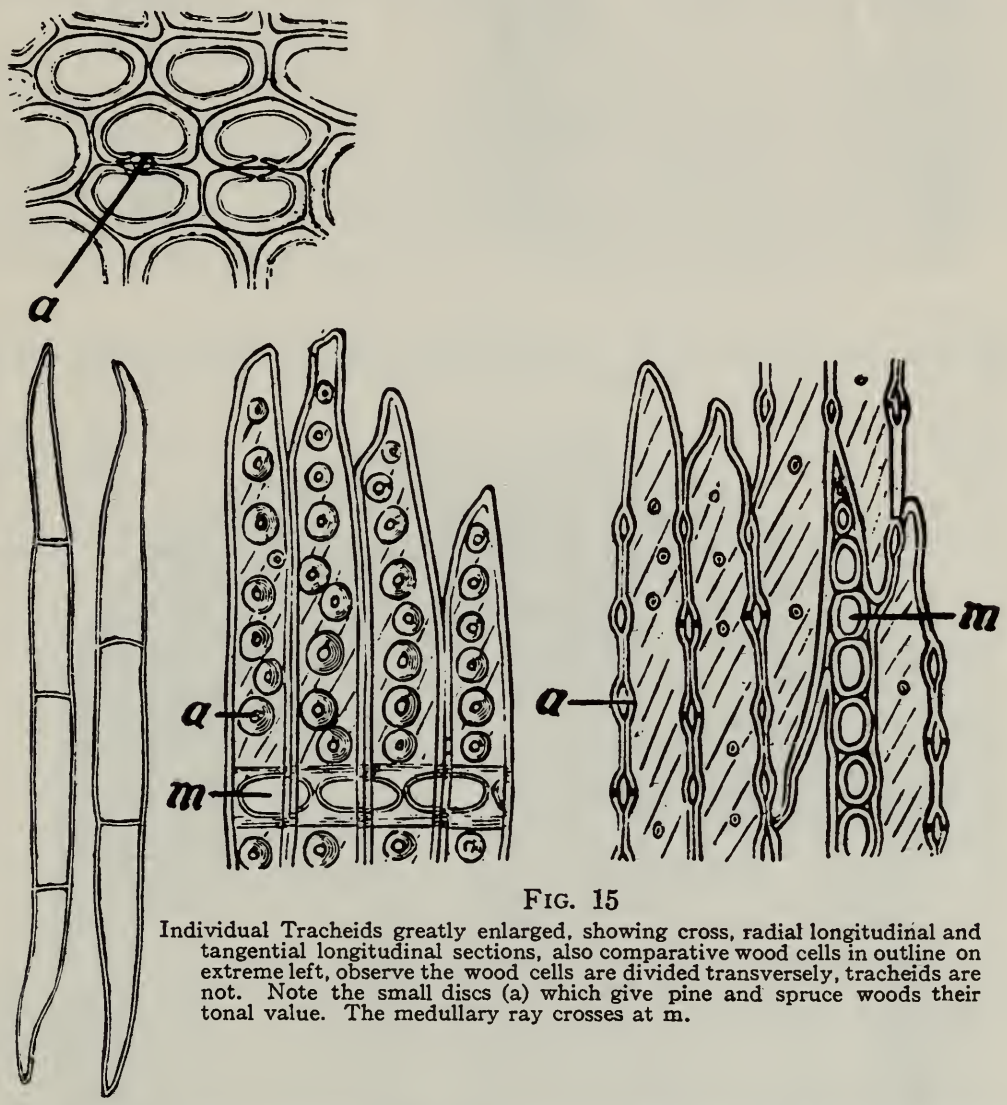


FIG. 15

Individual Tracheids greatly enlarged, showing cross, radial longitudinal and tangential longitudinal sections, also comparative wood cells in outline on extreme left, observe the wood cells are divided transversely, tracheids are not. Note the small discs (a) which give pine and spruce woods their tonal value. The medullary ray crosses at m.

its center is a small membrane septum, like the vibrator on a phonograph reproducer with a somewhat thickened disc in its center. This is shown in plain view in the illustration on the extreme right. It is this vibrating membrane that gives tonal value to the woods derived from the spruce, the pine and related species. There are billions of these membranes in every piece of pine, the view shown being magnified 650,000 times. If a log of spruce or pine is not properly cared for after felling, by being promptly barked, or if the lumber is subjected to careless kiln drying instead of being air seasoned, these delicate membranes will be ruptured, thus giving rise to inharmonics or destroying tonal value. All the crowning or pressure put on a sound-board of this material will not improve the tonal effect.

FIG. 17. This is a section of a three-year-old stem of basswood and shows the relation the various tissues bear to each other. Cross section is shown at *C*. In the center we find the basic parenchyma tissue, or pith. Passing radially from a common center and dividing the wood bundles we find the medullary rays (*m*) in cross section. At (*me*) we find the same ray in radial section as it shows in quarter sawed stock. R indicates this section while T shows a tangential view. The

outer layer of cells shows the epidermis or skin layer, underlaid with the small brick shaped cells of the cork tissue. This is nature's method of protecting the tree against evaporation and any undue climatic changes so that the growing layer directly underneath will not be injured. The

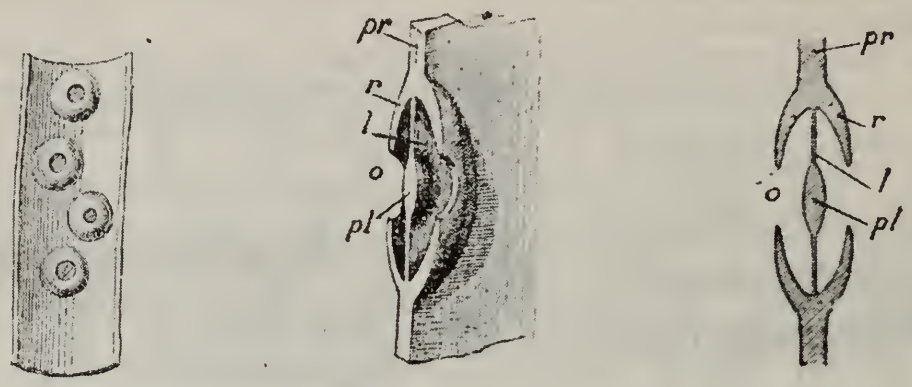


FIG. 16
The disc with the vibrating membrane in flat, perspective, and plan view. Every sound board of spruce contains millions of these resonators.

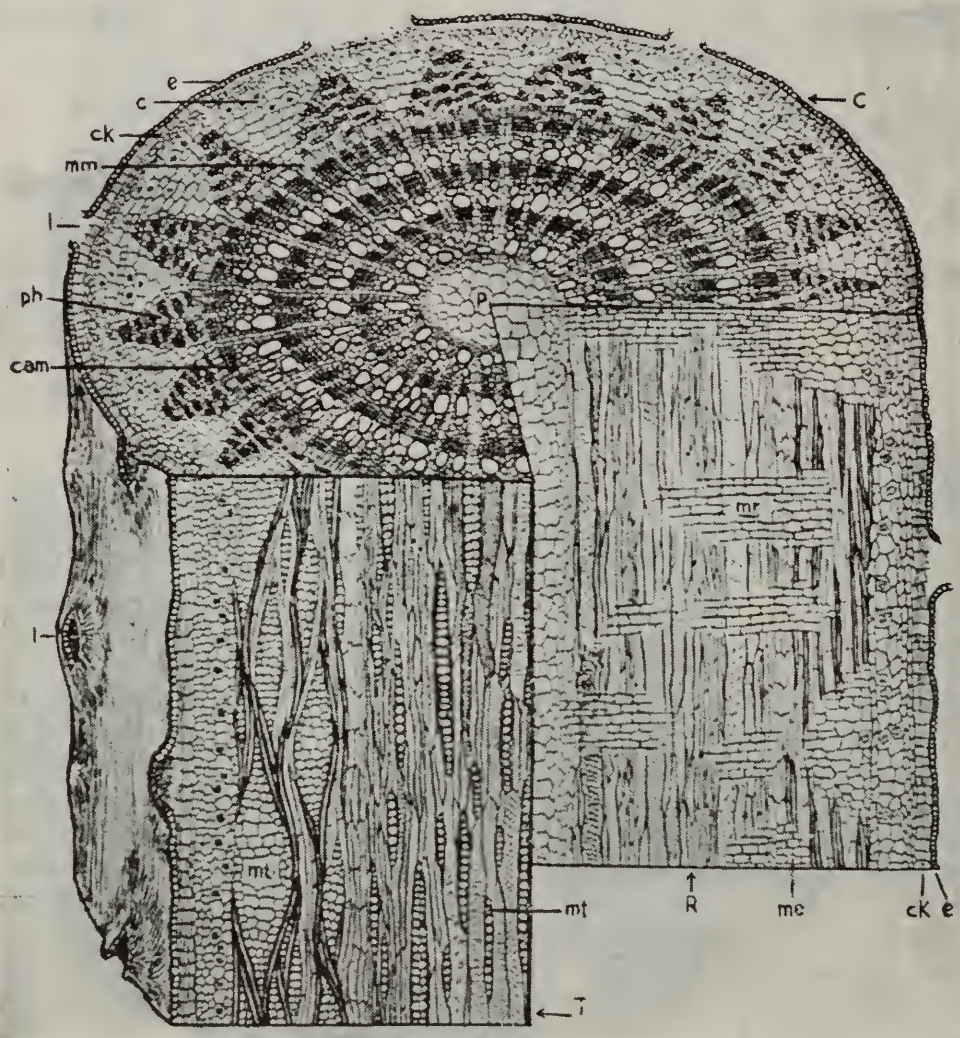


FIG. 17
The arrangement of the tissues in the stem showing transverse (C), radial (R) and tangential (T) cut, all illustrated on one section from a three-year-old basswood stem. This illustrates the effect of quarter, flat and cross cut sawing on the grain of the board.

growing or cambium layer is shown at (*cam*) the new growth spreading outward, thus increasing the diameter of the tree, while the cells toward the center lignify, mature and die, acting only as a support for the tree and finally becoming the timber of commerce. At *l* are small breathing pores or lenticels. These are particularly abundant in the birch, and give the bark its characteristic spotted appearance. They are nature's safety valves for overcoming internal stress.

A large amount of lumber is quarter sawed, the effect of this on the grain being shown at R. Note particularly the ducts of the spotted variety as well as one of the spiral type, while toward the center the softer basic tissue is quite noticeable. The medullary ray crossing the wood gives light colored or flaming spots. As basic parenchyma is the weakest and always can be found in the center of the oldest trees, it is here that the first decay takes place in a growing tree. This is styled core rot and soon destroys the valuable wood layers that adjoin the core by following the medullary ray cells between the wood edges. It should be borne in mind that these structures are not only present in the stem, but extend even to the remotest twig and leaf on a tree. More than this they extend to the smallest vein and capillary of the leaf. In the leaf these bundles radiate in all directions from the midrib and secondary ribs of the leaf, forming so fine a network that if the leaf is skeletonized it becomes the most delicate and beautiful filigree.

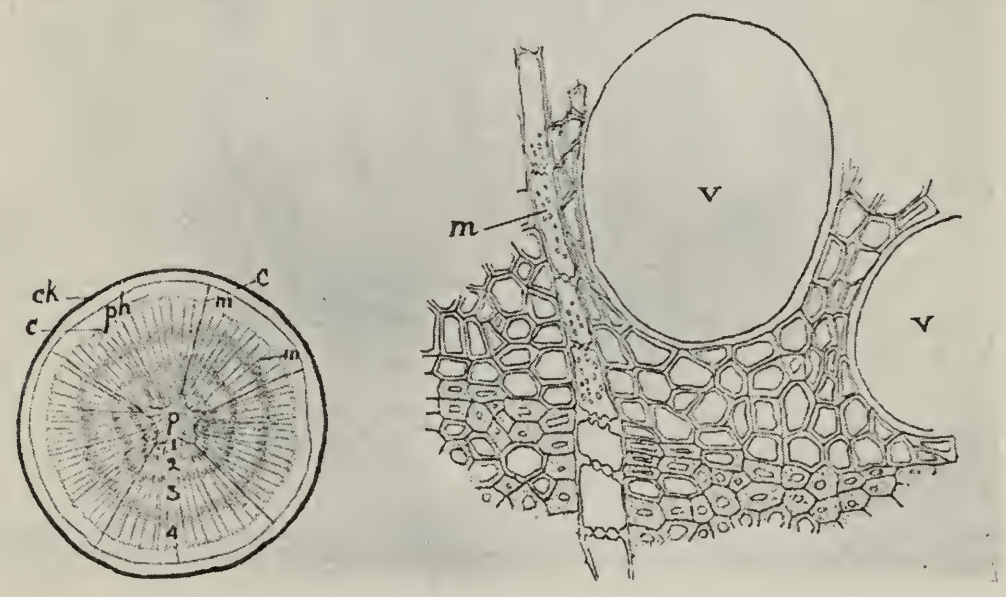


FIG. 18

Sections of Oak stem. On left plan view of stem showing relative arrangement of Bark (ck) growing layer (C) Pith (P) and the annular rings of growth (1, 2, 3, 4). On right is a greatly enlarged section showing the arrangement of wood cells, pith or medullary ray (m) and the large ducts (V) of the circulatory system, it is these that render the grain of Oak so open, that it must be well filled before polishing.

FIG. 18. This is a diagram of the stem of a black oak. The central portion is basic tissue pith. Numbers 1, 2, 3, 4 are annular rings of growth. *C* shows the growing portion, *c* the bark layer, *ck* the corky outer portion with the medullary rays at *m*. To the right is a highly magnified view of one of the annular bands. Note the thick walls of the cells of the previous summer's growth while the current spring's growth is shown in the large thin-walled cells and vessels. *V* shows these vascular ducts. *m* is the medullary ray of basic tissue. In using oak this soft sap wood should be cut off. If it is left it may cause trouble later on by absorbing moisture, swelling and warping.

FIG. 19. This is a section of the piano builders' friend, the maple. Notice the broad medullary ray *RM*, crossing at right angles between the wood fibers. Here the basic tissue has lignified rapidly, thus becoming wood fibre with close cells. This ray has been referred to in connection with the wrest plank as being the cause of splitting if a number of pins should follow its course too closely. The pith portion is at *P*, while the outer portion is at *M*. You undoubtedly have noticed in maple boards a small strip through the center where the wood appeared soft, being dented easily by the finger nail. This corresponds to the portion at *P*. From that point outward toward each side of the board is found solid wood fibre (*PL*, *VF*, and *T*) closely interlocked.

FIG. 20. All who have handled the beautiful hardwoods, such as walnut, butternut and mahogany have noticed that they dull edged tools. This is particularly noticeable in Circassian walnut. The reason is apparent in the above black walnut cells. One of these cells is so enlarged as to form a cyst or sack. This formation is due to infiltration through the cell wall of a drop of secretion material saturated with mineral salts. As this cyst ripens, the water is withdrawn by the

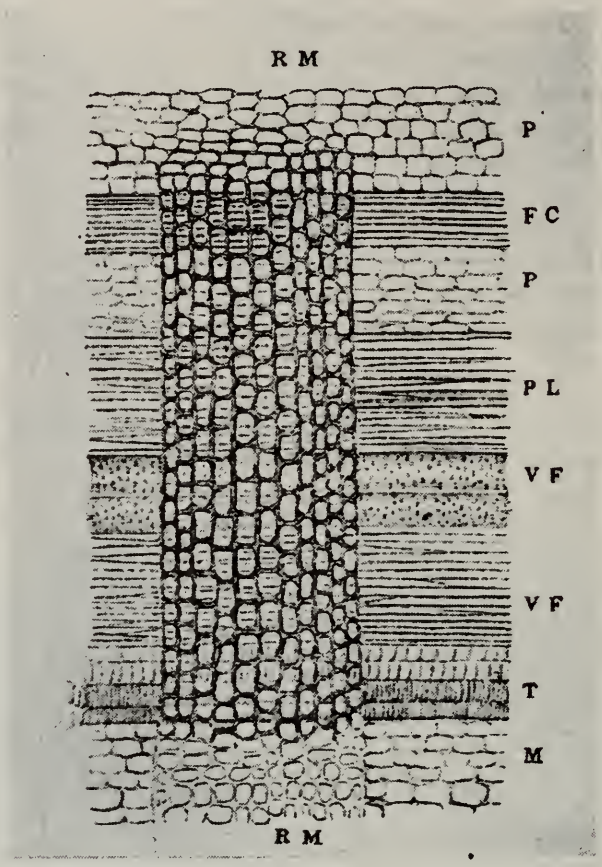


FIG. 19.

A section from a piece of hard maple closely knit like a rope and bound together by solidly lignified pith or medullary rays.

plant, causing the mineral to form in many-sided crystals. As these crystals are numerous in the above-mentioned woods, they produce the dulling effect on tools. These crystals being composed of either calcium oxalate or carbonate, are readily attacked by acids and other decomposing media in the filler, and on dissolving give off gases and form voids, causing a granular appearance in the finish, due to varnish absorption by the wood.

It is therefore advisable to use fillers closely approximating the composition of the wood to be filled. In these colored hardwoods the soil conditions and the relative amounts of moisture in which they are grown are controlling factors in giving brilliancy and high color. Examples of this are found in native walnut; that which is grown in the central states—Indiana, Ohio and Kentucky—with an abundance of water and rich soils, being of a rich reddish brown quite even throughout, while the eastern walnut has varied color spots through its heartwood due to mineral infiltration,—particularly iron compounds. On the other hand, the walnut from the Ozarks is dull grey without much color or luster, due to the alkaline reaction of the soil and an abundance of lead and zinc salts. When such wood is sawed and exposed to the light it bleaches out, losing the rich brown color so much desired.

FIG. 21. In going over all these cells and plant tissues, the question naturally arises where and how are all these tissues located in the plant. This illustration gives us a glance into the interior of a plant, from the bark to the pith. At the extreme left in the first bracket are the cells of the bark, viz.: the epidermis and the brick-shaped cells of cork tissue. Next is the tissue con-

taining sieve cells and the bast fibers of collenchyma or altered basic tissue. The sieve cells carry the nourishing stream to the growing cells; they have the power to pass through the crystallizable salts, and to hold back the colloidal matter for nutrition of the plant. Next we find five or six rows of cells closely compressed. This is the growing cambium of the wood bundle or phloem. Next, a number of ducts; first the dotted form, then one of the spiral followed by one of the an-

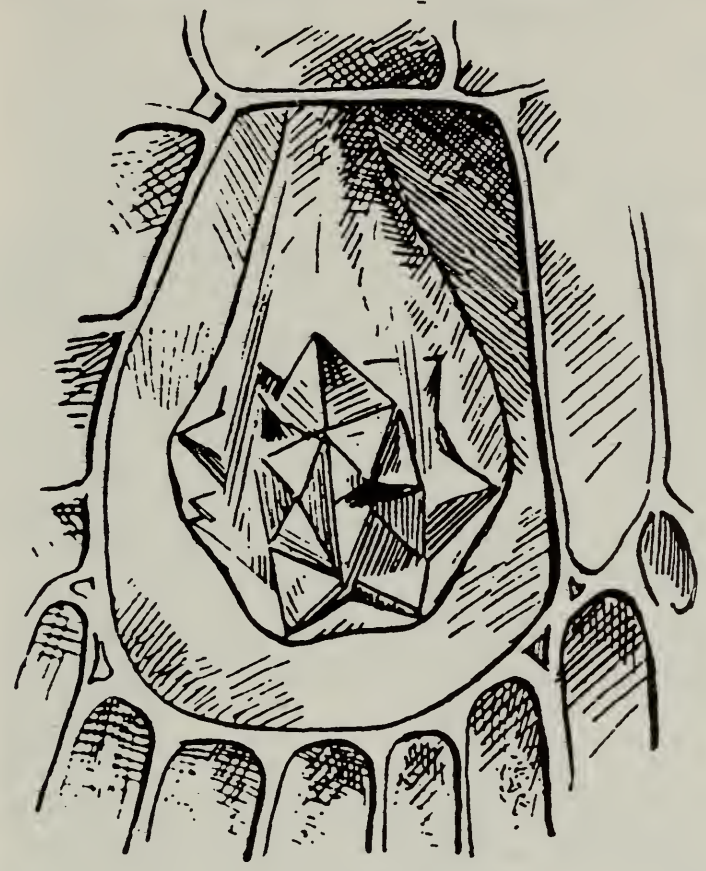


FIG. 20

Cell from the Black Walnut showing a crystal of Calcium oxalate. Note the sharp abrasive edges, thousands of these in the hard woods cause the rapid dulling of edged tools.

nular ring form. These are interspersed with true wood fibers, and finally in the last bracket is the pith made up of basic parenchyma tissue. The upper portion of the figure shows all these cells in transverse view and a comparison gives a clear picture of the shapes of these various cells. The magnification is 50,000 times.

FIG. 22. This will give a graphic idea of the size of sections with which we are dealing. It is a section of a pine needle cut through the center, enlarged 250 times. Here at *A* are the epidermal cells, the tissue of protection controlling evaporation from within, just as the skin of our bodies; at *bb*, breathing pores known as stomata, or little mouths. At *c* are shown thick-walled hypodermal cells corresponding to cork. Next at *d* is basic tissue or parenchyma cells filled with chlorophyll or green coloring matter. Underneath these are cells of parenchyma which are much folded internally, giving them an odd flower-like appearance. Still further in at *e* the endoderm or inner skin surrounds a graduation of pitted parenchyma tissue reminding us somewhat of the tracheid cells common to pines (*g*) and finally at *h* a fibrovascular or wood bundle. In the convoluted or plated parenchyma notice several ringlike openings (*f*). These are secretion vessels. It is here that the wonderful odor of the pine needle is manufactured to be liberated when the needle is subjected to heat.

FIG. 23. This shows one of these secretion vessels from the Scotch fir in cross section greatly enlarged; *r*, shows the resin passage. The small bodies surrounding this passage are the laboratories where the aromatic principles are manufactured. Through their walls they are transmitted to the resin passage, to be passed on and sweated out of the needles and bark in the form

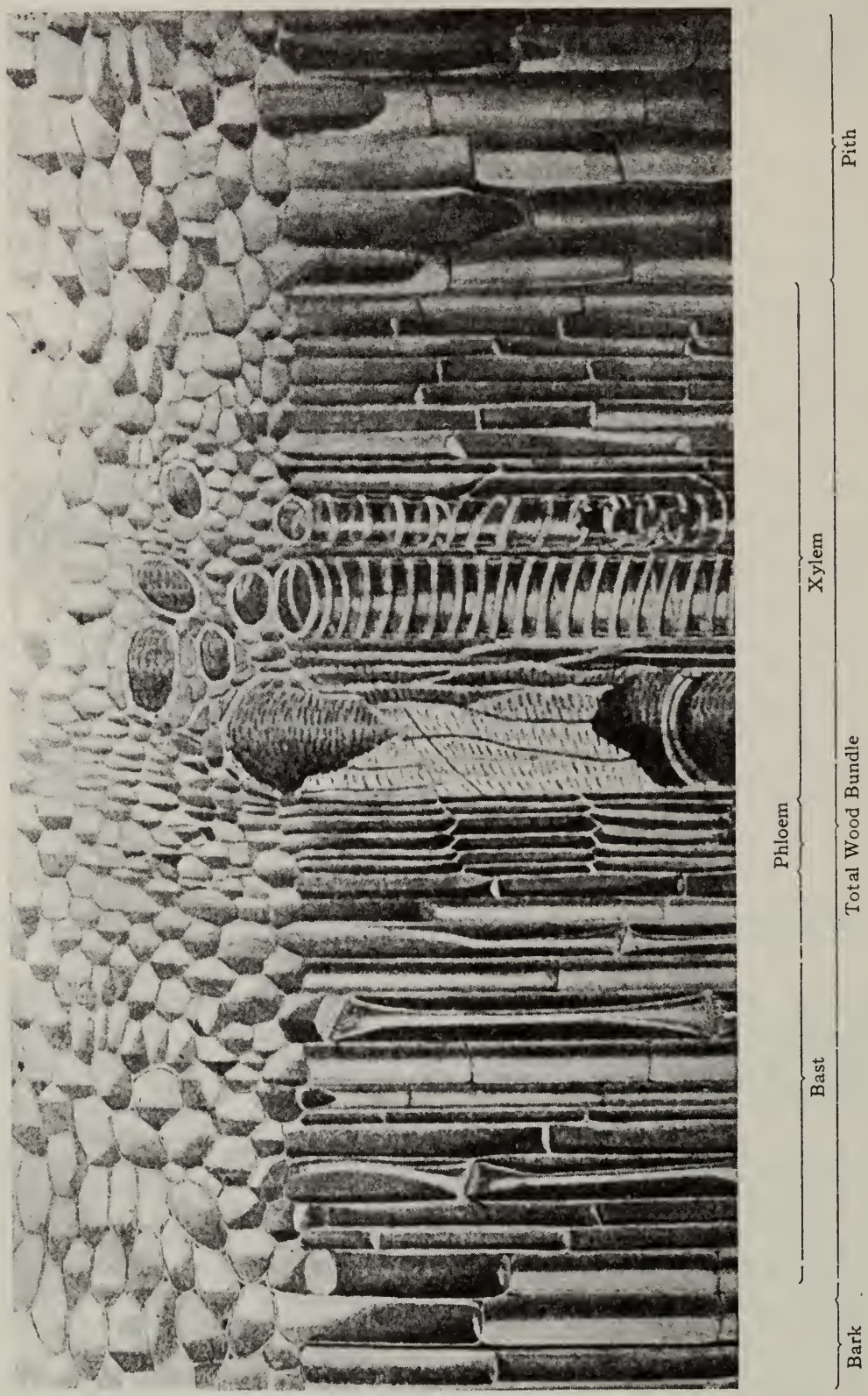


FIG. 21

Showing how all of the tissues occupy the plant stem from the outer edge to the center. Protective cells first, then strength giving tissue followed by the arterial system and true wood, with basic tissue in the center.

of small drops to yield the substance called resin, or to be stored in the old wood from which it later may be distilled to yield turpentine. In some plants these secretion vessels secrete a milky juice, when they are called lacteals as in the plant yielding rubber. In others they secrete gum as in the gum woods, and in still others they yield gum resins which furnish us our varnishes such as copal, damar, etc. It is owing to these vessels that gum woods continually absorb moisture, causing swelling and excessive warping as well as checking.

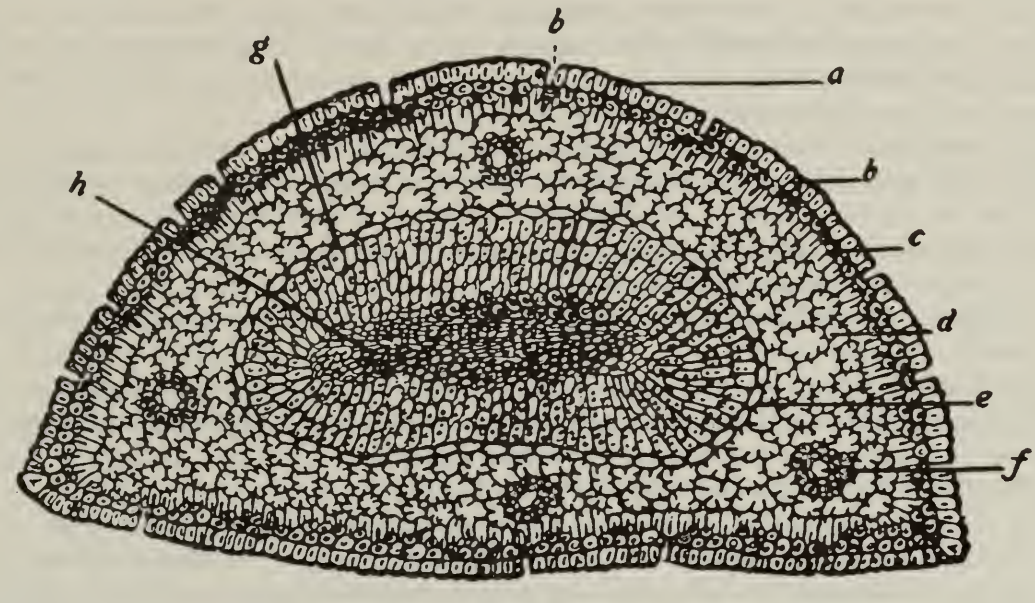


FIG. 22

This is a slice cut from the center of a pine needle enlarged 250 times. As everyone is familiar with the shape and size of a pine needle this is used to illustrate the size of sections we are dealing with.

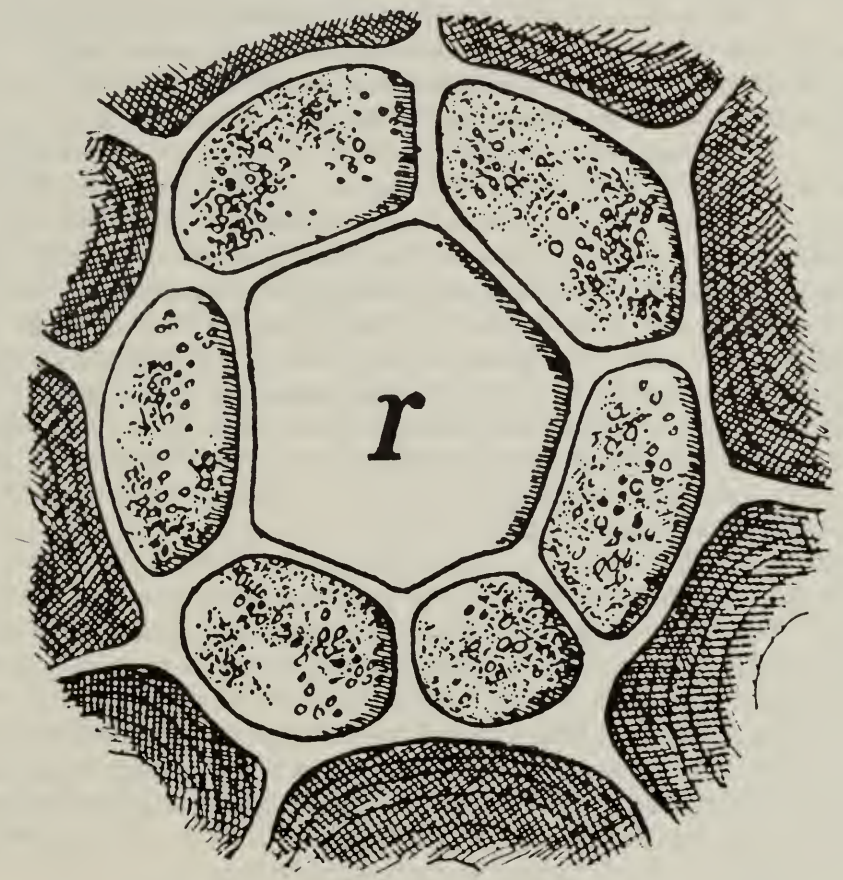


FIG. 23

A secretion vessel; this corresponds to (f) in Fig. 22 and gives rise to the secretion of resin and turpentine. r, the resin vessel proper.

F. E. Morton: "What is the relative action of glue and wood in crossbanding with basswood?"

Dr. Laufer: "Crossbanding with basswood is done to save on the core. Basswood acts as a strengthener, binder and smoother of the surface for the ultimate finish veneer. The glue is usually put on a little thicker than it should be and the water in the glue drives the fibres apart. Then the glue sets. The core wood absorbs the water rapidly—is thicker and can hold more of it; you put your veneer on top of that entire layer of glue and more water; that water gets inside. Now you have started a double action pump. As soon as a little moisture gets on the outside and the piece is in a warm room the pump starts to work, pumping through the basswood. The wood then swells and checks the varnish."

H. H. Arnold: "If the core wood is fully dried and glue is put between cross banding and core stock, then dressed down and the other veneer is put on top of that with a layer of glue between, either at the same time or after the first operation is finished and dried out—when this moisture is all extracted before the finishing process takes place—should not the act of finishing prevent moisture from getting into the stock?"

Dr. Laufer: "No, sir, because there is no known method of making something — not even a steel car wheel—without pores."

H. H. Arnold: "Then on the other hand, is not the crossbanding largely done to prevent expanding beneath the outer layer of veneer, which as a rule is very tender, simply to strengthen and prevent that expanding and tearing the outer veneer?"

Dr. Laufer: "That is the chief object of crossbanding."

H. H. Arnold: "Because the wood does not easily expand and contract endwise."

Dr. Laufer: "I would almost contend it would be as cheap to use heavier veneer and one glue instead of two because the better the core wood is seasoned the more water it will take up."

H. H. Arnold: "That might be all right if plain or long grain veneer is used, but take for instance burl walnut which checks very easily, is it not better to use the crossbanding to prevent checking?"

Dr. Laufer: "It will prevent fissures in such wood—actual tears. Glue being of an entirely different nature than the wood gives two vibration numbers, an animal and a vegetable vibration, the glue will disintegrate. Take an old piano case and it is surprising to find out how dead the glue is. In a case in mind it was dead after fifteen years."

L. L. Barth: "We brought up the question of core making from shop lumber. You take a No. 1 shop that will cut up 60 per cent to 70 per cent, cutting clear as we call it, it will cut as long as 6 to 7 feet clear. You will get some short pieces of course but a No. 1 shop will cut door sills and trimmings about 7 feet. Take a piece of shop which is naturally wide and no shake in it, comparing the price of shop and clear lumber, the shop is much cheaper. In cutting up this shop you will get a great many small pieces from which you will get a great deal of key lumber which is very valuable. We had a case a few years ago where we cut for the government 100,000 feet of 1¼″x10″x12′ absolutely clear. We got it out of shop, and of the lumber we cut off, trimmings we called it, fully 60 per cent sold in Chicago for piano key lumber. This convinces me that some of these gentlemen have not given that shop question sufficient thought and experience."

Dr. Laufer: "Due perhaps to the fact that they have not arranged their machinery for handling such lumber. Is this not the case?"

H. H. Arnold: "I do not know—I never worked in pine, but I have worked up some western spruce, what they call here No. 1 shop, and there is a large waste on account of knots."

L. L. Barth: "What can be used to best advantage and most economical purpose? It occurs to us that if some of our Chicago neighbors would do as we do, take 1 M or 2 M feet of ordinary shop, just as it comes and cut it up and see how it would work out in place of clear pine, it would prove less expensive. We experimented many times as we wanted to get certain kinds out of shop and other cuttings, keeping accurate account of the lumber and what it produced and what the product would be worth if cut out of clear lumber and found shop was the most economical. If they use clear lumber today it will cost $100.00 per M and even then there is going to be some waste."

H. H. Arnold: "You can figure 5 per cent to 10 per cent waste."

E. E. Beach: "I would like to get some lumber having a lower waste. Our experience on

waste is 25 to 30 per cent. The lowest percentage of waste I have ever known has been tank pine in key beds where the waste was 10 per cent. On the merits of redwood, outside of its being noncombustible we don't know much about it except that it checks or cracks."

H. H. Arnold: "Six or seven years ago I bought a car of 32,000 ft. We still have some of it on hand and if anybody wants to experiment with it they can have it. Our experience was when we had a piece that was quarter sawed and properly edged with another stock and heavy cross-banding we get beautiful results. But in the sliced or ordinary cutting, the veneer would pull the layers of the wood loose and we have had blisters for the full length of a piano top. Quarter sawed will not do this except where the edges are exposed. You have to glue a piece of close grained wood on the edge to cover the entire cross grain. The redwood absorbs moisture from the glue and that raises the grain. It will not show until after it is dried and gets the finish."

Dr. Laufer: "It should be a good wood and is in favor with manufacturers who have used it for several years."

H. H. Arnold: "I know a firm that does not use anything else, but it is all quarter sawed. A few years ago I had it quoted to me in dimension sizes at $42.00 per M."

Dr. Laufer: "The stress there is due to the contraction of colloidal formation of glue. Glue is spongy and when it takes water it swells."

H. H. Arnold: "The old idea of gluing something is to use just enough to be sure the surface is covered and then put enough pressure on to drive out all glue matter possible leaving none except what works into the pores of the wood."

Dr. Laufer: "While that seems a small matter, if it were placed under the microscope you would find the glue in large quantity. If you could regulate the quantity of the glue in such a way on a 1-28″ veneer that the glue would penetrate only 1-56″ you would get away from that trouble. But if you had a glue that would not absorb moisture, it would no longer be glue. There is a point where you must stop waterproofing glue."

H. H. Arnold: "We had some men fixing belting and they used a glue that water did not easily affect. There was a certain percentage of glycerine in it but I don't know the other ingredients. They told me this made the glue pliable."

Dr. Laufer: "Glycerine preserves pliability and binds the water to the glue. Glycerine has an affinity for water one hundred times greater than glue. One of the other ingredients might have been litharge because it forms a binder with the glycerine itself, and it might be possible the glue is bichromatized."

E. E. Beach: "The action of the glue is also due to the way the lumber is dried. Dr. Laufer spoke of the pumping action of the wood."

Dr. Laufer: "The point I make is you should try to fight the pumping action of the wood if you can. Here is one of those pumping spots in this pine. That little spot only penetrates one-half inch up into the pine but it caused that fracture to pass up the wood for 18 inches. It can swell to such an extent as to throw the entire structure out of kilter—can tear it apart."

R. H. Waud: "A man told me he was sellimg lumber to a concern using oak—old stock, that had dried and collapsed in the center. They said they could steam it and bring it out and afterwards put into a kiln and dry so the centre would be even with the outer edges."

Dr. Laufer: "It cannot be done."

R. H. Waud: "But you can steam it and let it swell to an even thickness and then gradually dry it."

Dr. Laufer: "It would be more scientific to put a planer on and plane it smooth."

R. H. Waud: "If you veneered over that, leaving the surface water absorbed by the core stock to be drawn up, would that not swell the stock so much more that you would get an uneven surface?"

Dr. Laufer: "No, because the portion that would shrink most is really your easiest portion, that is, the heart wood and that would take far less water than the rest."

H. S. Dewey: "If you are going to use wood with a certain portion of sap wood, why not rip the sap wood out?"

Dr. Laufer: "I said at the last meeting that the proper way is to get rid of the sap wood. The percentage of loss is the cheapest waste we can have because it is liable to create more loss if you keep it."

H. S. Dewey: "You have two kinds of wood fighting each other, due to different forms of cells."

F. E. Morton: "There is a question of substitute for maple that came up at the last meeting. There is going to be some trouble and we are not far away from it. I have had correspondence on this subject and the trade is interested. The characteristics of a wood that will perform the functions of maple for wrest plank stock, bringing these characteristics out and defining them thoroughly, would undoubtedly lead someone to research work."

L. L. Barth: "The only wood I know today that has many of the characteristics is green heart from the West Indies and some other points but it is very expensive."

Dr. Laufer: "Would it be well to make attempts to reforest maple? It will take fifty years to produce a good tree."

H. H. Arnold: "We can use a lot of the small stock maple because we can glue the pieces together and get desired results. There are a lot of tops going to waste now that would be desirable if properly handled. We could make use of limbs and branches and short ends that are now wasted and left to rot or are burned."

L. L. Barth: "There is not much wasted now. Most of it is used to make wood alcohol."

Dr. Laufer: "We have enough other wood to make wood alcohol without using this valuable wood."

F. E. Morton: "What particular localities would best produce maple?"

Dr. Laufer: "Northern Michigan."

L. L. Barth: "There are woods in Australia having much the same characteristics as maple; there is plenty of it and controlled practically by one lumber concern."

Dr. Laufer: "This country should learn to depend upon its own supply. We have millions of acres suitable for the cultivation of trees."

L. L. Barth: "Our Department of Agriculture should undertake this."

F. E. Morton: "Movements are started by just such a stimulus as this. We have in our company an Agricultural Department that is advocating just such things."

Dr. Laufer: "The farmer who plants ten acres to timber never sees the result. We have more farmer tenants than owners and tenants cannot afford to plant timber. The farm owner cannot afford it because he must make a living from the land he rents. Now in Europe taxation is not applied to timber until it is cut. They also determine at what diameter the trees may be cut. Lumbermen in this country would be glad to reforest if they did not have to pay taxes on the standing timber. One of the methods in Europe is to have lumbermen cut timber and pay part of the timber tax by replanting, and taking care of certain areas for a number of years. It spreads the tax over a long period of time."

L. L. Barth: "The fire hazard has been very great and we have lost millions of feet because there is no fire protection from negligence of people. The government has offered none. We cannot do it ourselves. From fire in the north and tornadoes in the south we lost a hundred million feet a few years ago. On the subject of kiln dried lumber, I have not much to show because there is such a difference of opinion as to the kinds of kilns. It is not safe to kiln dry lumber, particularly hardwood. Years of taking care of it, storing it, partly under cover, partly with stakes in between of same kind of wood as the lumber itself, is the only way to season it because the dampness is there and you cannot take it out by kiln drying. We will undertake, if you desire, to investigate and report to you the result of what we can find."

F. E. Morton: "I can say for all that we would be much interested and very grateful."

L. L. Barth: "It will take some months, but we will undertake it and submit the results to you."

R. Waite: "It will be of great interest for publication."

L. L. Barth: "The Department of Forestry at Madison is making reports on this." Mr. Barth then explained some experiences in kilns and continued: "In drying white oak we found it took ten months or longer on stakes. Other kinds of oak, especially that grown in swamps, is apt to break up in drying no matter what care is taken."

Dr. Laufer: "That sustains the contention that the thin wall cell is the one that breaks down first."

H. H. Arnold: "In taking lumber that has been only partly seasoned, say three or four

months, and steaming in low pressure steam for a couple of days to swell the cells of the wood out even again and afterwards begin to slowly dry, would it not permit the original moisture in the center cells to get out more readily than if it was put into a kiln at first?"

H. S. Dewey: "The tendency in drying is to coagulate and that forms a crust. All drying must start from the heart out and it must be gradual. We have a free moisture in wood in addition to its protoplasmic moisture. By putting steam to it you have the operation called osmosis."

F. E. Morton: "Dr. Laufer has shown you in the spruce the different cells and how the kiln drying fractures them. You will occasionally find this in your sound board stock and also that an undue bearing on your sound boards will fracture those cells in the same manner—slowly but surely will bring them down. The board goes dead. The point I would like to convey to the trade is that every piece of wood entering into the construction of a piano should be such as will assist in the resonance of the instrument. You have probably noticed that one style of piano put into a case of walnut, oak and mahogany, respectively, will yield different tonal results. It seems almost absurd that a thin layer of veneer on the outside should make a difference. A piece of wood to respond to every vibration regardless of pitch must have its cells intact and the air contained in those cells confined with only the natural pores of the wood for an outlet. In the breaking up of these cells through the process of kiln drying as described, or putting on a crushing pressure, the wood is destroyed for resonance. The ideal sounding board is in the harp, not crowned, but having a direct pull by the strings. We have a sounding board in the piano with a bridge across it and wires across that bridge. When the wire is energized by the hammer it should depress and elevate the board through the bridge. If you get too high a tension, or the board is crowned too much, or too great a bearing you get only half the motion. It gives way to a certain extent on the down turn of the wave but it fails to raise the board, and therefore you only get about 60 per cent efficiency. If the board is loaded too heavily, or if it has been fractured in its cell structure by kiln drying, you then get only about 60 per cent of that. Improvement in piano construction must take the line of getting a greater efficiency from the energy placed on the end of the key. If I strike the end of the key a ten ounce blow and the piano has a two ounce touch, including friction, I want that eight ounces expressed as energy in the sound board movement—the dancing up and down of that board.

"In this connection the drying of wood is a tremendous factor. All this points to the fact that the ideal piano is the one in which every part assists in expressing the energy put forth and that none of that energy passes off as heat. The energy from the sounding board also must be reflected from its edges and points of its own contact back to the board. If it is not received by an inelastic medium in case or frame, it passes off as heat. It is to stop that loss of energy expressing as sound that we are striving for when we try to improve the tone of the piano. The treatment and selection of wood must be with this end in view. Carried to an absurdity a perfect sounding board would continue to sound, sustaining like an organ pipe. The only 'resonance box' that the piano contains is between the sounding board and the front panels. There is a real tone chamber and we are filling it up today with player actions materially changing volume and quality. This argues the use of inelastic material insofar as is practicable in player actions. Player action stock can be made of such material and in such manner as not to absorb but to reflect energy. We are striving for resonance in the piano and the panel construction above and below have a real effect upon the tone. People do not always buy pianos on account of the wood in the cases, but because of the tone quality. All the retaining material in a piano should be insofar as possible, inelastic. The inside of the upright piano from the strings to the panels is capable of making a good resonance box and very materially benefiting the tone of the instrument."

H. H. Arnold: "You stated the veneers put on the different kinds of wood have something to do with the changing of the tone qualities of the piano if all other things were equal. If all other things were equal in that piano and the veneers used on the inside—for instance if the lining of the case was of a good hard lining—would the nature of the veneers have a bearing?"

F. E. Morton: "Yes. There is not a part of the entire case that does not affect tone. It may seem microscopic in some cases, but as a whole it is a big factor."

Problems of the Piano Action Maker

March 7, 1917

Mr. F. E. Morton, chairman, introduced Mr. A. T. Strauch of Strauch Bros., Piano Action Makers, New York.

A. T. Strauch: "Mr Chairman and Gentlemen: When Mr. Morton sent out his invitation to the action manufacturers I did not know exactly what line your thoughts were here and wrote asking for enlightenment. I told him we had these models showing the progress of action making. He said he thought they would be interesting to you so I sent them on. These models are exact copies both in the keys and action work and closely adhere to the size of strings used in those old pianos. As you know, the earlier action makers were the piano makers. The piano and the action were contemporary. As the piano manufacturer evolved advanced ideas, he built himself an action to bring about the results he was seeking.

"The earliest action we have is a clavichord action from Germany. It was operated nearly at the back of each key in an upright position. There was a tangent of ⅛″ at the top. A single quill action followed and then to obtain better results they put in a double quill operating one to the right and one to the left of the strings. After that there came actions as we understand them today. The first to manufacture a serviceable action was Christofori. In about 1720 he produced the first percussion action; the model upon which all grand and square percussion actions since have been worked out. About 1726 he perfected his original model, the first perfect under striking action for a piano. There followed a different type of action having a very crude type of damper. It has good escapement, good leverage and apparently good power. This is a primitive Viennese produced in Germany in the eighteenth century. This one was produced in the early part of the nineteenth century—a French model.

"Action making seems to have come up through Italy into Austria, Germany and France. Later, France and England were very extensively producing actions of different characters and with improvements. In 1716 the French harpsichord manufacturers were interested in manufacturing actions suitable for instruments built at that time. England later became interested in that kind of work.

"The grand action was first produced about 1776. The upright actions were first produced a little earlier, but were exceedingly crude. In 1821 Erard produced the grand action and the grand actions of today follow in detail that action he made nearly one hundred years ago. The only difference between that action and the action used today is some little devices added to it for simplifying the regulation, the methods of operating dampers and a screw in the jack for regulation. Otherwise the action is exactly the same as the original. Along about 1776-1780, the upright actions were first worked out, and along in the early 1800's they commenced to perfect them on this side. The upright action as it stands today is virtually an American perfection —not an inception. A few of them were made in 1873, but in 1876 the upright piano came into its own and from then can be dated the advancement of the upright action. Action making as a special trade did not begin in this country until somewhere along in the early sixties. It then became a specialty and was centered mostly in New York, with one house in Boston.

"Up to that time the piano manufacturers had almost all made their own actions and followed out in some cases individual types as is done today in Germany. Nearly every manufacturer in Germany has an individual type of action made for him. They have some individual idea in connection with an action which they use in their own piano. It may seem strange to state that in one hundred years there has been virtually no change in type of the grand action, and it is a great credit to and a wonderful inception on the part of a man that his invention can go through a century of tests without there being found opportunities of improving that action.

"When I speak of that I mean the type rather than the smaller improvements made that meet the current requirements of operation today. The same almost may be said of the upright action. The grand action, we all agree, is the most perfect type made for tone production in a grand piano. An upright action, we all agree, has weaknesses and it has often been remarked that the action makers are slow in making improvements. There have been a great many patents.

We have in our possession one of the fullest compilations of patents on piano actions taken out in this country. None, however, have been adopted nor successfully accomplished all the purposes for which they were devised. An adoption of one thing generally meant a weakness in some other part of the action. I know that possibly there will be a stand taken against that statement because we all differ in our opinions, but in my experience this has been the case. The result is that for all general purposes of producing a tone from the percussion of the strings in an upright piano, the present type upright action is the most perfect that has yet been put on the market.

"Now in regard to the relation of the action maker and the piano maker. Tonight, both my friend Mr. Abendschein and myself are ready to be catechized and to answer any questions. We are here to receive enlightenment as well as to give it. There are certain fundamental things in regard to an action. There is not an action built, but to obtain the best results out of it, you must set it a certain way. The results from more actions are spoiled from an improper setting than almost any other cause. It may seem like criticising a piano man, but I am simply speaking of conditions I meet. The brackets are made so the rails will set at certain angles, and it is well to consult the action maker to see how the action should be set. Sometimes you think ⅛" makes no difference, but it does. You have quite a bit of slant when you take the distance from the key to the hammer. Push your action out a little at the bottom and you will find that you must block up your hammer rail.

"It brings the butts over the center and you wonder why the jacks won't hold to the butts. An action is made of the driest of wood, felts and cloths. You sell a piano. The buyer pays you say $300 to $350. One end of the piano is placed at an open window; the other end is next the radiator where the steam is getting into the piano, and they wonder why the action does not work. The woods are dried thoroughly in the kilns and then given a thorough restoration in the factory at average temperature. That brings the wood back to normal conditions.

"Bushing cloths are chosen because of special qualities. You may think a bushing cloth is ordinary cloth which is bought anywhere. It is made specially for that purpose and no other. It must be of a certain class of wool, of good wearing yarn; tight and yet not hard. If we use hard cloth, we get noises and you cannot get results. We must use a cloth springy, firm and thoroughly shrunk.

"There is one thing in which you can assist an action maker very largely. Where it is known that pianos are going into especially damp places, and an action maker can know a little in advance of this fact, he can help you by loosening up the centers and making them very free. The best thing to do is to leave shakers in. If you find yourself 'up against it,' water the action. This may sound strange, but it is correct. If an action maker knew something better than water he would use it. His experience has told him an oil can on an action is the best way to destroy it absolutely. If you want to put the action out of business, oil it. Take a shank, flatten the end, dip it in water and touch the side of the center and then let it dry out. Put it in front of a steam box or let it dry out normally. You will find after that treatment the action will give you no trouble except in an extremely damp climate. These are the two things that come home closest to the action maker outside of the keys.

"There again we have another point that it is possibly well to take up because I feel reasonably confident to talk on keys, having had some sorry experiences along that line also. The key balance has a very great deal to do with the matter of the touch of an action. We have been very careful in taking measurements of keys of all standard makes of pianos and their divisions. We have found on uprights, a key that was divided three parts from the center of the front hole to the center of the balance rail hole, and two parts from the center of the balance rail hole to the capstan screw, will give the best results. A key balanced in that manner, three to two on an upright, will produce the most satisfactory results. Of course, the height of the rails will have something to do with it, but your balances will come pretty nearly giving you the very best kind of a touch. For the grand, two parts to the center hole, one to the capstan screw will give the best results. Those are pretty nearly standard measurements. If your keys are laid out along these lines, you will produce a satisfactory, pleasant and powerful touch."

F. E. Morton: "How grateful it is to hear from someone who has an experience instead of a grievance."

Mr. Morton then introduced Mr. G. F. Abendschein of Staib-Abendschein Co., makers of the Master Touch action.

G. F. Abendschein: "Mr. Chairman and Gentlemen, after listening to the acknowledged historian of the trade, there is nothing left for me to say about the construction of piano actions. He has fully explained the modern trials and troubles of an action maker. There is one point in modern construction that I would like to elaborate upon and that is why a balance rail should be placed where it is."

Mr. Abendschein then demonstrated by means of an action model the leverage powers which produced a travel distance of 1¾″ of the hammer striking point by a movement of ¼″ at the wippen abstract center, thus accounting for the division of the key from the front rail pin position to the capstan position in proportions of two and three.

G. F. Abendschein: "That is a further illustration of why balances should not be out of proportion by misplacing the capstan screws. The true set up of an action depends upon the blow line. To determine that correctly, the angle of the back makes no difference. Forward at the top is probably better because the blow strikes it without a downward dip. The butt center should be 2″ away from the perpendicular. If that center is set 1¾″ from the perpendicular, the balance rail position will be changed, and the action maker will be called upon to remedy flat touches, etc.

"Mr. Stauch has explained the possibilities of producing a conventional piano action. We befooled ourselves for years trying to improve upon them. After going through misery for about seventeen years, we realized that the ancients knew more about them than we did so we went back, insofar as centers are concerned. We attempted about seventeen years ago to eliminate one trouble as it was considered then—the bridle tape. We took this up with several inventors and continued experimenting until we produced what we call the Master Touch. In doing away with the bridle tape we conserved space, as you can see, if you will run a perpendicular line down from the hammer rail back, nothing projects. It also provides less food for our friends, the mice. We do not do away with it, but put it out of the way. Our bridle tape is this back check. A bridle tape is used to help repetition.

"When the key is struck, the bridle will help to draw it back quickly. We have the back check on the fly. One of the great faults of the regular piano action is its tendency to block. We believe we have produced an action that will not block."

Mr. Abendschein then removed front rail punchings and demonstrated that even under extraordinary conditions the Master Touch does not block.

G. F. Abendschein: "We claim greater repetition. Our fly is constantly with the butt. We claim this gives greater control and therefore better repetition. You will note every center is identical with the conventional action. In regulating there is no difference except in the back check. In the Master Touch we simply regulate the set screw, and a set screw places an object permanently at the point desired, whereas the long back check wire will recede upon a sharp blow. The catcher and the back check are without friction.

"Many people ask why one piano action costs more than another. It is what you cannot see that costs. Are you able to tell me by looking what bushings are used on these centers? Can you tell me which one of these costs a certain amount to needle and was done by hand, by thought or by automatic machinery? We believe in doing some things by ancient methods. In the needling of a butt, some do it by automatic machines. There is no piece of bushing cloth 40 odd yards long and 54″ wide that can be so fabricated that every inch of it is alike to one hair. There are no wires produced of the same thickness. I have found them No. 20 at one end and No. 21 at the other end, two one-thousandth inch difference. How are you going to do that with an automatic machine? Some parts of the piano action are reproduced by the mind as well as the automatic machine. We claim we have practically overcome all the faults that have been enumerated to us in this action. We claim that this action can get out of regulation and still keep on doing its duty."

J. H. Gerts: "I would like to ask Mr. Abendschein why there is no after touch on his action."

G. F. Abendschein: "To my mind the after touch is a fake. The only reason for an after touch is to prevent blocking."

Wm. Braid White: "Have you not found it to be true that the old way of laying touch both

at the finishers' and regulators' is almost always a matter of case work. A man gets into the habit of doing things in a certain way. A larger margin than is necessary is left in the after touch simply for that reason."

G. F. Abendschein: "In a sense yes. They use measurements which they place on a key and allow for the rest of it. That is not true in all cases. I have seen many places where they work on the actual touch. We have been endeavoring to produce something different from the present construction. We are working for betterment."

F. E. Morton: "Mr. Strauch, what is the tonal effect of setting an action at an angle rather than perpendicular with the string?"

A. T. Strauch: "If your action is thrown in such a way that the butt is lying over the center so that you have to block your action up you lose tone value. You cannot get the tone if you have a slippery action because you cannot get the force. You cannot control your action because it is out of your hand. An action is constructed so that at all times you can take hold of it and feel it under your hands. If your hammer is blocked up too high so your butt stands over the center or up on the center, just as soon as you strike a blow, your jack flies out and you lose your power and when you lose the power you lose the control of the tone of the piano.

"Mr. Morton and I were discussing some methods regarding actions and were speaking about grands and the opportunities there were of producing them more economically than today. He asked me what I thought of the modification of the grand to conform to the construction idea of the old square, whether a type of square action adapted to a grand piano would not be effective for the small popular priced grand. I know square actions because I came into the business when they were largely used. It was the best action made for the object for which it was intended. The three objects of a grand piano are to get the power and repetition out of the action and tone out of the piano. You can get but a limited amount of power out of a square action, consequently a limited amount of tone out of the piano. It is absolutely impossible to get the same power and repetition out of a square as out of a grand. In a grand when you strike a blow you bring down a lever. That lever supports the hammer. As soon as you release the back check, the hammer goes up. Your jack is now under the butt and you are ready for your next blow. That is where your repetition comes in. The lever always carries the butt up and just as soon as there is the slightest relaxation on the key to allow the back check to release, you are ready for the next blow. There is nothing of that character in the square action at all. In order to get repetition in a square, you must let the key up almost the same amount as you have to let it up on the upright. On the upright you can get your repetition before the key gets all the way up. You can only get repetition when the jack gets under the butt, and when you let up your key on a square you have to let it up nearly all the way before your jack can get under the butt. Consequently the adaption of a square action to a grand piano gives nothing but a square piano with the grand shape and with all the defects of touch of the original square."

F. E. Morton: "With a view to popularizing the small grand I had anticipated the possible commercializing of the grand piano action to meet the demand for a cheap piano. It seems to me the opinion of the action makers would be valuable in view of that fact. Do you hold the adaptation of the square piano action idea to the grand piano is impracticable?"

A. T. Strauch: "I do not hold that it is impracticable, but that it is not advantageous. I hold that you lose the advantages you have with the present type of grand action—those of power and repetition."

R. W. E. Sperry: "Why do you say you lose power?"

A. T. Strauch: "You have an action that is constructed powerfully enough to do the work in a grand."

R. W. E. Sperry: "Why can't you get the same power in a square action?"

A. T. Strauch: "It is not in the construction of a square action to obtain it. I doubt if, constructed as it is today, it will carry the weight of a grand hammer and carry it successfully without tearing the action to pieces in the attempt to get power. In a square you have direct action on your knuckle from the key. Your jack and jack bottom are screwed on the key, and the attack on the butt is a little further out than on a grand. In a grand action you have cumulative power through powerful leverages. You attack your action approximately in the center. Your jack is out at the end. The leverage of the key on the butt is all you have in the square,

direct leverage from the key to the hammer. In the grand you have the leverage of the key on the support. The jack is out on the end—another leverage. You come up quite close to your center on the drive and obtain a much more powerful drive. You have a double leverage in the grand action where you get cumulative power as against direct drive in the square action."

F. E. Morton: "What is the division length of a square piano key?"

A. T. Strauch: "They are all different."

C. C. Chickering: "Your original question was particularly in regard to the possibility of building grand actions to come near the cost of an upright action. It is my understanding that nearly all of the action makers are pretty thoroughly equipped at the present time with automatic machinery for upright actions. Is it true that they are equipped with automatic machinery for grand actions?"

A. T. Strauch: "I am glad you asked that. There are two things that have made the present prices of upright actions possible. When upright actions were first manufactured, we got $45 a set for them. In those days we had one planer; a molding machine, and they were two of the first machines ever built for turning out work of that character. We had the first planer that was used in an action factory. We had a machine, of which there were only three or four, for making square levers. We had power machines to drill holes. We thought we were doing pretty well. If we wanted to make a set of wipps we put them on the machine and made them in nine handlings. Today we take a wipp, put it on the machine (the machine costs $2,500) and it turns out about eighty or ninety sets a day. A machine for butts costs $1,800. We put the butts on and it turns them out finished with six operations. That is the progress that has been made in piano actions and has brought them from $45 a set to the price of today. If we produced then twelve to eighteen sets of upright actions per week, we thought we were doing pretty well. If a factory does not make at least two hundred and fifty actions per week now they wonder why there is not more business. That is what brought down the cost. Quantity enabled the action maker to put in the latest kind of machinery to produce in quantity and economically. Quantity brought down the price.

"If we do not make 20,000 to 25,000 upright actions per year we are not doing any business. The whole number of grand actions used throughout the country amounts to about 15,000 and roughly speaking I should say there is over half of that amount made by piano manufacturers. One house alone that I know of is making 4,000 grand pianos per year. Here is nearly one third in one factory alone. That leaves 11,000 actions to be divided among the other piano and action makers. The cheapest automatic machine will cost $750. When we come to put one in for a larger number of operations, the cost multiplies in proportion. If the country can give the quantity that will justify an action maker in spending the money to put in automatic machinery, there is no question but what grand actions can be produced at less cost than today. It is impossible to produce a grand action for anything approaching the price of an upright action, because as Mr. Abendschein says 'It is the things you do not see in an action that cost.'"

F. E. Morton: "If the manufacturers of pianos turned their contracts over to the action makers, would the present price of actions be reduced?"

A. T. Stauch: "Fifteen thousand divided among those specializing in the manufacture of grand actions would not give any of them a very large quantity."

C. C. Chickering: "Don't you think that if the action makers equipped themselves in such manner that they could make grand actions for less money it would stimulate demand?"

A. T. Strauch: "I don't believe any business man is warranted in making a dead investment. Equipment runs into thousands of dollars. The increase of grands is too small to spend a great deal of money on machinery and have it lie idle two thirds of the time. The demand creates the supply. It would be an awful job to go out with the supply and try to create a demand."

H. H. Arnold: "You and every other action maker are making a certain number of grand piano actions. I do not believe that you are very far apart in price. If one of you should equip your plant with modern up-to-date machinery whereby you could save money to the purchaser of grand actions, would the trade be increased?"

A. T. Strauch: "I should say no, because the other fellow would put his price down too. Then there would be one job of competition."

G. F. Abendschein: "You manufacturers can reduce the price by giving up your 'talking points.' Cut out the sostenuto pedal. The object of that is so that some one can hold a bass note and play at the top. If you stop talking about it you can make a saving of $2. Make the damper head simpler. It now requires eight runs. That makes another $2 for the head. You want rosewood. If you give up some of the ideas of rosewood and use other woods, it would be another saving. Cut out fancy curves, talking points and the action maker will help you too."

F. E. Morton: "Mr. Abendschein, how do player action attachments affect the upright action? Are the player action people or the piano manufacturers attaching in such positions as place the modern upright action at its best?"

G. F. Abendschein: "The best position is at the wippen, being near the point of the real constructive striking movement of the piano action."

A. T. Strauch: "There are 10,000 parts in a set of piano actions, keys and hammers, and every piece passes through the hands of an operator at least twenty-four times."

F. E. Morton: "We have action models here from a number of makers—Bransfield-Billings, Action & Supply Co., Wasle & Co., Wessell, Nickel & Gross, The Cable Co., as well as those that have been demonstrated. These makers have been kind enough to say that after they have served their purpose with you they are donated to the Acoustic Laboratory of the American Steel & Wire Company. We desire to express our appreciation."

E. E. Beach: "This has been one of the most entertaining and instructive meetings we have had for some time and I would move a vote of thanks be tendered Mr. Abendschein and Mr. Strauch for their attendance, and to those makers who have so kindly furnished these models." (Seconded and carried.)

Mysteries of Glue

March 21, 1917

Mr. E. J. Fishbaugh, superintendent of the Hobart M. Cable Company, La Porte, Ind., presided at the meeting in the absence of Frank E. Morton, chairman. The glue experts who attended the meeting were: F. W. Mehlhop, manager glue department, Swift & Co., Chicago; G. B. Morris, assistant sales manager, Armour Glue Works, Chicago; H. T. Taylor, Swift & Co., Chicago; R. J. Garvey, U. S. Glue Company, of Milwaukee; W. C. Valentine, Chicago branch manager, U. S. Glue Company, of Milwaukee, and S. D. Taylor, sales manager, Perkins Glue Company, South Bend, Ind.

Mr. Fishbaugh, in opening the meeting, said:

"We now have an opportunity to get some valuable information from the gentlemen representing the various glue companies — information on the manufacture of glue and how properly to use it. We will welcome any suggestions that will better our product.

"The strenuous competition of this age makes it necessary for the successful superintendent to inform himself as thoroughly as he may on all subjects directly connected with his every day factory procedure.

"It is essential that complete analyses of all materials entering into the product be made, not only that the best grade for the money may be procured, but also the highest possible quality for tone production.

"One of the materials that has always had considerable mystery connected with it and upon which much depends is glue, which we are to consider tonight. When one considers that the life of a piano is largely dependent upon the quality of glue used, it makes one scrutinize this subject more closely, for no matter whether the piano is placed in a steam heated flat, a house free from dampness the year around, or one at the seashore — wherever the instrument may be — we are relying upon glue to hold it together. The perennial summer trouble of piano manufacturers, varnish shrinkage, is attributed directly to the effect of atmospheric conditions upon the glue. In this connection it may be interesting to note that it is claimed vegetable glue is not affected to any appreciable extent by atmospheric changes.

"This importance of 'adhesion' puts glue on a pinnacle by itself in the opinion of most practical piano men and influences them into following the precepts of their forefathers, both as to

material and its application largely by reason of the fact that they have so accustomed themselves to using it. This has been brought about simply because they have not been well enough informed as to just what they had a right to expect or require of the glue manufacturers and of the glue itself. That situation is changing.

"In this world no man is considered good or bad and no thing is considered good or bad save by comparison with other men or other things. This truth applies equally to glue.

"The unusual advance in prices caused by the shortage at the source of supply and the many new avenues of consumption has, it would seem, made the testing and close inspection of glue imperative. I presume each of you test samples before letting your glue contracts. From personal experience I have found that we were able to maintain a grade of glue worth 15 per cent more for the same money after starting these tests. I have also learned that the glue companies uniformly furnish higher grade samples and live up to these samples after learning that glue tests are made. I have also discovered that where factory men were inclined to use 50 to 60-second glue for veneering purposes that equally as satisfactory work could be produced by the use of a 20-second glue, which at a much less cost gives a greatly increased spread per pound of glue used.

"The value of glue depends upon two properties — viscosity and strength. Viscosity determines the spreading capacity, and strength is very closely indicated by the firmness of the jelly.

"The viscosity test is made by taking a percentage mixture of known quantity and temperature and allowing it to flow through an orifice. The time it takes this glue to pass through the viscosimeter determines the body or the viscosity of the glue and by comparing this run with tests of the standard glue grades, the individual grade of the tested glue is obtained.

"In making the viscosity test, the solution we used is 33⅓ per cent. We find the most convenient batch of glue is 120 grains put into a stand test cup. Weigh forty grains of dry glue, pour this into eighty grains of water, allowing in addition 1.5 grains for evaporation and adhesion to inside of cup. The cup should then be closed and the glue allowed to soak in cold water for twelve hours. Then take a pan with false bottom, filling it about one-half full of hot water. When the heated water has come to 200 degrees F., put the cups containing the glue solution in the pan, allowing them to cook for twenty minutes. At the end of twenty minutes the water should be about boiling point; the glue about 190 degrees. Then open the cup and stir the mixture with a ladle, being sure there is nothing left undissolved. Lift out the cups, placing them upon the top of the support rack, at the same time taking the temperature of the glue. If it is above 186 degrees, stir gently until the temperature is reduced to that point. When a temperature of 186 has been reached, take the viscosimeter, insert the lower end well into the glue and draw in until it is full up to a standard point. Hold tube easily between the thumb and finger and with a stopwatch determine the time necessary to empty the bulb. (Pure water will take about five seconds to run out.) The time that this glue takes to run out, with the corrections made for loss of heat, is the viscosity of the glue.

"After taking the viscosity, the liquid glue should be poured into glasses or metal cups, an equal portion in each, and after this is cooled in a jacketed pan with cold water running through it reducing the temperature to about 59 degrees it is ready for the crushing or jelly test. It will take some time for this glue to come down to that temperature — anywhere from six to ten hours. The crushing of this jelly with a plunger completes the test, the cups being supported by a scale which indicates the required pressure for crushing.

"The above is a good commercial test and is close enough for ordinary use. The jelly test will expose any adulteration or impurities that will escape notice in the viscosity test. However, if one wishes to go further with a test and obtain more accurate information by a tensile strength test of dry glue, this requires skill and care, but it can be done and gives a most accurate gauge of the strength and value of the glue.

"We find that for our purpose a flat-tipped brass cone on a handle, allowing an even pressure, is practical for a crushing test. We place the glass or metal cup on a scale which will record the amount of pressure placed on the top of the glue, put our plunger carefully in the center of the glass exerting pressure on the handle, then from the scale learn the amount of pressure necessary to break this jelly.

"There are other more elaborate tests that can be made for excess of grease or other foreign substances in the glue, but we have never found it necessary to use these other tests. Either one of these suggested tests can be made to practical advantage without any glue table or scale so that a man may know to his own satisfaction which is the best quality of glue offered at a given price.

"The tensile strength of dry glue will average from 500 pounds to 16,000 pounds per square inch, some averaging less than 500. Cast iron has a tensile strength of about 20,000 pounds, therefore it is easy to see that the highest grade glue is not much below cast iron in tensile strength.

"A fair grade of joint glue should have a tensile strength running from 6,000 to 8,000 pounds. A fair grade of veneer glue from 5,000 to 7,000 pounds. The strength of a joint depends, first, upon the tensile strength of the glue in the joint; second, upon the percentage of the mixture. With the ordinary good quality of glue used with a spread of about 25 feet per pound of dry glue, end wood joints should require from 500 pounds to 1,500 pounds per square inch to break them. This weight should be a straight down pull.

"Long continued heating, or overheating will reduce the tensile strength very perceptibly. The loss of strength is in exact proportion to the amount of heat and the length of time the heat is applied. A couple of hours of excess heat will mean a loss in strength of 4 per cent computed in the purchase price of glue. A day's heat at 160 degrees would reduce glue about 15 per cent; possibly more. A glue in the work has then only a fraction of the strength that freshly prepared glue would have. In other words, a good joint glue left under excess heat for a day would not be equal in quality to a fairly good veneer glue freshly prepared and used at 150 degrees F.

"Every glue room should have a thermometer attached to its glue cooker and spreader, and glue should not be allowed to reach above 150 degrees. Likewise, the cooker should be kept covered in order that the least possible evaporation should occur. We have found it a very good practice at the end of a day's work to have some method of cooling the glue to a jelly. Pans with passages for cold water to run is perhaps the best method. It is also wise to prepare only the required amount for use, so as to have the least possible glue left after a day's run.

"The spread of glue varies greatly among different users, ranging from 18 to 32 square feet for each pound of dry glue. Testing so as to get just the right viscosity aids greatly in producing the largest number of square feet spread per pound of glue, and makes quite a difference in the cost of this material, which has advanced proportionately more in value during the past eighteen months than almost any other material entering into piano construction."

Mr. Fishbaugh then introduced Mr. F. W. Mehlhop, who detailed the manufacture of animal glues. He said: "Chairman and gentlemen: I hold no brief from my brothers here in the trade. I think we all manufacture in very much the same way. Glue can roughly be said to consist of two kinds — hide and bone. You probably use both if you use glue for veneer and joining work. The subject of bone glue is very much abused, incidentally. There are a good many kinds and grades of bone glue. There is one kind of glue used more generally than any other kind by piano manufacturers for high grade joining work, and I don't think I am violating any confidence when I say that, to the best of my belief and knowledge, that glue is a bone glue. The process of manufacturing glue is very simple. It has to be carefully done. Hide glue is made from hide cuttings and trimmings and fleshings before the hide is tanned. The process of curing is important. It takes from two to three months to put the raw material in condition to give up the greatest quantity and the best quality. The hide raw materials also comprise sinews. That is the general run of hide material. Bone glue is made in various ways. The ordinary bone glue is made from fresh bones from animals killed the day the glue stock is put into the kettle. That makes, as a rule, a cheaper and a weaker glue. It is not glue that any glue man would recommend for joining work in itself. It is, however, a glue that can very easily be combined with hide glue, which has greater tensile strength to make an excellent veneer glue, and most of you probably are using a combination of those two glues for veneer work. Bone glue has the body, and hide glue the strength. There is another method of making bone glue which is called acidulation method. It is used very largely in Europe and copied by our manufacturers here. The stock used in that process is dry bones, or cattle bones from which the tallow or grease has been extracted, and the bones then allowed to dry. Bones in this condition will keep indefinitely. The process of making bone glue is simply a process of cooking. You just make soup out of the

bones. We take the grease off and then what is left is the gelatinous matter in the bones. The glue liquor is secured from cooking kettles and is run into pans and cooled artificially into a jelly. The jelly is then cut by machine into thin slices. These are placed on racks of galvanized or aluminum wire frames and run into air tunnels and dried. After they are dried they become the glue you get when you order it in the flake form. There is nothing mysterious about it. The glue depends for its excellence upon the stock and the manner in which it is treated. Mr. Fishbaugh has gone into the matter of testing glue. The following test is a good one as a comparative test of two or more kinds of glue. There is a proper consistency at which glue should be used. The good bench worker knows what that consistency is, and it depends upon the kind of wood he is using. Porous wood will require a thicker glue than a close-grained wood. He will find, if he measures his materials, that it will take a certain amount of glue and a certain amount of water to produce that necessary consistency. To compare the glue he is using with another glue, all he has to do is to go through the same formula with the other glue and find out if, in order to produce that consistency, he has used more glue or more water, or less of either or both. He will then have his comparison as to the cost of his glue solution. It is to be assumed, of course, that a given quantity of glue solution will do a certain amount of work. If he finds that he has been obliged to use more glue of one kind than of another to produce the required consistency, he knows that this glue solution has cost him more, and consequently is not the glue to use from an economical standpoint. I am assuming in this test that he has satisfied himself that both glues will make a perfect joint. That is something any cabinetmaker can very quickly determine."

E. J. Fishbaugh: "Are there several cookings in getting different grades of glue?"

F. W. Mehlhop: "There are several different runs from each kettle of stock. The first run naturally makes the best grade of glue."

E. J. Fishbaugh: "How intense a heat is necessary for cooking the glue?"

H. T. Taylor: "The temperature depends on the stock and how previously treated. The ideal temperature should not exceed 140 degrees F. Sometimes it is necessary to go higher. Glue removed from the stock at a temperature of 140 is the best."

E. J. Fishbaugh: "In the shop practice glue will melt at 140 in its solution. What is your recommendation as a glue maker on the temperature at which glue should be used in the factory?"

F. W. Mehlhop: "Glue should be used as low as possible. There are better results from lower temperature than higher. It can be handled under 150."

E. J. Fishbaugh: "In getting these lower grades of glue in subsequent cookings, do you increase the heat?"

H. T. Taylor: "We do. The lower grades of glue are the last runs upon which the higher temperatures are used."

E. J. Fishbaugh: "Suppose a 50-second glue was being used by one man and a 20-second glue by another, would not the 50-second glue stand a very much warmer caul than the 20-second glue?"

F. W. Mehlhop: "When you speak of 50-second and 20-second glue, I don't know what you mean, except comparatively. The higher the viscosity, the better the glue."

E. J. Fishbaugh: "I am talking about shop practice. If a man is using a thicker solution than another man, wouldn't it stand a warmer caul than a thinner?"

F. W. Mehlhop: "If he is using a glue so thick that it leaves a film of glue between the two woods, he will get no joint at all. The object of the glue is to bring your wood together as one piece. The glue must soak into the wood. You will find in all good joints no film of glue. He needs either a warmer wood when making the joint or something to make up for that difference. If you chill the glue by putting it on a cold piece of wood you set it before you give it a chance to spread and absorb."

Mr. Fishbaugh called on Mr. G. B. Morris, assistant sales manager of the Armour Glue Works, who said: "Mr. Mehlhop has gone over the manufacture of glue extensively and there is not much left for me to say. In making tests we do not make every test exactly the same. We cannot arrive at an exact figure for each grade. There is a variation of three or four points to each grade which is not enough to make any significant difference in the working qualities, but in selecting a glue to send to customers for test, we select a lower rather than a higher test

glue in the same grade so as to have no trouble in supplying glue on order." Mr. Morris then stated that his ideas had already been expressed by Mr. J. F. Williamson of the Armour Glue Works in a recent address, and at his request Mr. Fishbaugh read this address:

"Glue is an article of such wide and diverse use that one might well say it is universally used. Yet how many of its users understand it as it should be understood? How many use it as it should be used? You buy glue and expect it to properly perform the work for which it is intended. You have a perfect right to expect that it will do so. Yet do you give that glue the opportunity to do for you all that it will do, all that it can do, all that it wants to do for you? If you do not give the glue all of its opportunity, you do not get full value from the glue which you buy and you have in consequence a waste in your factory which should be stopped at once and turned into a profit. You are constantly on the alert to stop leaks of any kind that may be found in your business. It is the exception rather than the rule that the experienced glue man does not detect a leak in the glue room of a factory before he has been there many minutes. He may not speak of it; he probably will not unless he be on terms of intimate friendship. I might say he dare not in many factories and for the reason that you perhaps would look upon his criticism as impudence on his part. It might look too much like he was trying to tell you your business and how to conduct it. Having given glue alone his attention for years he doubtless has many points about it and its use that may readily be turned into profit by the user. Let me at the outset call your attention to a fact which is always of prime importance when handling glue. It is an animal matter and as such is subject to decay or decomposition. Imagine for a moment the condition of a dead body whether man or beast which might remain exposed to the elements for even a comparatively few hours during the heated term especially. A near approach to this mass of human or animal flesh would be sickening. Glue, however, which is but a part of the animal after being subjected to a far greater heat than would be this exposed dead body or carcass is expected by many of its users to remain sweet indefinitely and properly perform its functions at all times. Failing to so act, it is complained of, frequently rejected and returned to the seller. The reputation of the seller for the quality of his goods is often jeopardized, if not lost entirely, with that buyer. There is but a single way by which glue may be kept sweet indefinitely, and that way is by having thorough cleanliness about your kettles. Insist upon them being perfectly clean. They should be washed every day during the hot weather and at least three times weekly during the colder season. The work of the day may not have used all of the glue which was prepared. It is not necessary to waste what may remain. Put it into another bucket or kettle during the time of cleansing the kettle that has been in constant use. If you are using an article reasonably sweet this left-over glue will be entirely fit for use the next day. If, however, it should be foul it will also befoul any fresh glue you may add to it.

"Have you ever given due thought and consideration as to the temperature at which glue should be used? It is one of the most important points that make for the satisfactory working of any glue. You cannot have it too cold. You must not have it too hot. If it be too cold it cannot secure a binding hold upon the wood. If too hot its fibre is destroyed and it cannot hold. The workman may be and doubtless is doing what in his judgment or experience seems to him perfectly proper and right. He may be a young man of little experience or he may be of mature years and have worked glue all his life and is satisfied that he knows all there is to learn about it. His sphere is a narrow and restricted one at best. Does he know all about glue? Has he had the opportunity to learn all about it? Is it fair of you to expect that he has had these opportunities and has learned all that he should know? Yet you demand of him perfect work. His excuse for imperfect work will not be satisfying to you. He has in reserve, however, one excuse which is usually unfailing and which you cannot combat without perhaps going into the matter personally and you feel you have not the time for it. His excuse will be that the glue is poor. It will not hold. It is not like the last he had. What is the result? The seller is blamed, your patronage probably withdrawn and a new source of supply is found. The necessity of the proper temperature at which your glue should be used is important. If you are using and will insist upon using the crude old-fashioned glue-kettle you can gauge the temperature of your glue solution by attaching to it a cheap thermometer allowing the mercury to be in the glue solution. When a temperature of 140 is recorded your glue is right to use. It should not in any case for your work be used at a lower temperature than 120 or higher than 145. Let me

give you a point: In the extraction of glue from the raw material the temperature of the glue liquor is most carefully watched, the glue maker knowing all the time that a temperature that is too high reduces the grade of his glue and necessarily lowers its value. It is just as necessary that the user retain the grade he buys as it is that the glue maker preserves his quality. The glue maker has made it his life study to perfect his goods, and a thermometer is one of his greatest friends in attaining his end. Have you ever given the matter any consideration at all? Why not try a thermometer and stop abusing your glue to that extent?

"How do you soak your glue? In cold water, warm water or hot water? How long do you soak it? Let me tell you what you should do. Whether your glue be ground or in flake form, let it soak over night in cold water always — not ice water — but the water you would draw from a well or a city main. Do not use warm or hot water under any condition and expect full value or good results.

"Do not put the glue to soak in the kettle you have used all day unless the kettle has been well cleansed and washed. If you do not use your kettle have a receptacle that will hold enough glue for the next day's use. Cover the glue with water and have the water an inch above the glue. Stir it well for a moment, especially if the glue be ground. By morning the water will have been absorbed by the glue. Put the mass into your kettle and turn on the steam, stir it for a few moments, and by the time your thermometer registers 145 your glue will be dissolved and ready for use, and by keeping it at that temperature you will get all the value there is in the glue, and that value you should have. Many workmen finding the glue running short will add glue from the barrel into the kettle of liquid glue. That is an abuse of glue every time it is done. You lose a part of the value of that glue. If you need more glue than is prepared at night, then put more to soak in the morning. Prepare it in the same way as you did the evening previous. By noon, if it be flake or unground glue, it will be ready for melting. Ground glue can be prepared in a much shorter time. Hence its convenience and adaptability. Frequently stirred, ground glue can be prepared in twenty minutes. Why then add unsoaked glue to your kettle and bring about just so much waste? That is an abuse of glue. You gentlemen here are extensive buyers of glue. Your glue bills run into quite a sum of money in the course of a year, and if you can reduce those bills, you have just that much added to the right side of your ledger. You doubtless have a man whose duty it is to prepare all the glue that is used in your plant. How much do you pay that man? Is he one of your best and most reliable men or just the man who prepares the glue? Don't abuse your glue. Don't abuse yourself or your employees or the house from whom you buy the glue because you do not get all the result you think you should. Instead of all this abuse look around you and select your best man who is intelligent and capable. Show him where he can be of great value to you by taking care of your glue. Impress upon him the necessity of getting every ounce of water into the glue that it will take and properly do its work. He can readily determine when he has reached the limit.

"The moment he exceeds it the operatives will complain that the glue does not hold. Let him go to the extreme limit where the glue does hold and then keep his solution at that point. The glue consumers of the country lose 20 per cent of the value of their glue because they do not work it to the limit. How many of you have asked a salesman: 'How much water will your glue take?' Have you ever had a direct answer from an experienced salesman? I doubt it. Why? Not because he does not want to tell you, if possible, but he cannot tell you and for the reason that he cannot tell whether you are going to use the glue intelligently or not. A bright, capable man working for your interest will make a good furniture glue work with 2½ to 3½ pounds of water, depending on the nature of the work; while the incapable man will use as many pounds of glue as he does of water. You know how many pounds of glue you use per day. Figure the difference and place the loss where it belongs. It will not reflect on the glue or the glue house. Neither will it reflect on the incapable glue mixer. He may be unacquainted with its value or proper use and doubtless did the best he could. There is blame attached, however, and to properly place it you must hunt out the owner of the business. Take him in the private office and have your quarrel with him alone. When you have reached an understanding with him and made proper arrangements for the mixing of your glue you will stop an abuse that is entirely too prevalent.

"Is your equipment for handling glue modern and up-to-date? Are you using jacket kettles?

Are they iron or copper? If iron, they will rust. When glue evaporates in the kettle, workmen add more water usually, either cold water from the hydrant or the warm water from the rusty jacket kettle. Either is wrong. The cold water quite likely reduces the temperature of the solution to such an extent that the glue cannot hold. If the water from the rusted jacket is added, the iron rust mixed with the glue prevents the glue from binding and also discolors it badly. If necessary to add water use clean water and of about the same temperature as the glue.

"You have all seen glue that has been covered with a thick scum when the glue solution is in open kettles, this scum being caused by the action of the air on hot glue. You doubtless have seen the workman who goes to the central station to replenish his individual glue pot, stir the glue and in that way mix the scum with the glue. This is another abuse of glue. The scum does not dissolve and again become a part of the glue solution. In fact, it is all but insoluble. It does, however, break into particles and these small bits are mixed throughout the glue solution. When the workman applies the glue, does he pick out all of these small particles? No. He goes right ahead. What is the result? Often joints that will come apart in the planer, shaper or sander. Let me call your attention to another abuse of glue that is so common still that possibly some of you may be guilty. Do you recognize that the lumber must be at least warm when the glue is applied? Do you not readily see that hot glue applied to cold wood can have but one effect, and that is to suddenly chill the glue or cause it to partially set, thus robbing it of its strength largely, if indeed it does not refuse to bind at all?

"Using open kettles causes you a loss of from 5 per cent to 7 per cent in evaporation. You can and you should buy for your own benefit and saving a modern glue heating apparatus which consists of a copper kettle and jacket which may be kept air tight, thus preventing the scum which I have heretofore referred to. To this kettle a thermometer is attached and heat is automatically shut off at whatever point you desire to have your glue solution attain. In the same automatic way heat is turned on when the solution has cooled to a certain point. Adjust this thermometer at 120 for the low point and 145 for the high and your glue is always right. This modern appliance has a warm water reservoir, furnishing a supply of clean water of proper temperature when it is desired to add water to the glue. It also provides an agitator by which the glue is thoroughly mixed and stirred, thus saving the time of a man for this purpose."

H. H. Arnold: "Why do some glues when properly treated and run into a spreader where the glue passes over the rolls have a tendency to foam?"

H. T. Taylor: "There are a number of causes for foaming glue. Very often it is the source of raw material. In such cases the manufacturer must take care of that in his manufacturing processes. At other times a glue will foam that is sour. Very often the water with which the glue is made will have a tendency to make it foam. Some localities can use the natural water and produce a good glue; in others it is necessary to soften water in order to overcome the tendency to foam."

R. J. Garvey: "We advocate a ground glue for veneering purposes because it is a mixed glue. The only way a glue can be mixed is by grinding. We have had better results in selling ground glue for veneering purposes than the flake. We are selling about 60 per cent of our glues in the ground state even those that are used for joining purposes. We do that because they can be brought up to our regular standards. As the boilings do not run over fifteen or sixteen barrels, it is necessary to grind them in order to make large mixes."

E. J. Fishbaugh: "Won't a good veneer glue answer for a good joint?"

F. W. Mehlhop: "Most good veneer glue will make a good joint and the durability will be just as good as the other. I think I can speak for all reputable glue manufacturers when I say that what we want is co-operation with the user of glue. If we can only get the consumers of glue to work with us to help us, we can help you and can solve the problems very easily."

Mr. Fishbaugh introduced Mr. S. D. Taylor, sales manager of the Perkins Glue Company, South Bend, Ind., who said: "No doubt many of you know something about vegetable glue. Probably some of you have investigated it, but I will endeavor to acquaint you with how it started.

"In the year, 1905, Frank G. Perkins first conceived the idea of making glue from a carbohydrate. He experimented with different starches but found that starch made from Cassava root gave the best results. After making experiments it was first tried in the making of three-ply

barrel heads. He found it worked so well and made such a good joint that he thought it could be developed for use in the making of higher grade veneered work, but before going into the higher grade of veneered work he realized the quality would have to be better and put in such form that a mixture could be made with less water because up to this time it required three parts of water to one of glue. This necessitated a little more thorough process in manufacture to turn out a uniform grade of glue. This was not perfected so that it could be used for better grades of work until the summer of 1907 and a large manufacturer adopted it for veneer glue. Later on the veneered door manufacturers were interested and it gave very satisfactory results. It withstood atmospheric conditions very well. The panel and top and furniture manufacturers were next interested and to do their work satisfactorily it was necessary to change from cooking the glue cold by the use of a solvent as the amount of solvent necessary seemed to stain the face of veneers used by these people. The percentage of solvent was decreased and heat used in connection with it. By preparing it in this way the matter of stain was practically eliminated. Vegetable glue is manufactured by a patented process. Being different from animal glue, it requires vegetable glue equipment for mixing and applying as it is very heavy when prepared ready for use and cannot be applied with an animal glue spreader or a brush."

E. J. Fishbaugh: "What is Cassava root?"

S. D. Taylor: "Cassava beet. Most of it is grown in the Isle of Java."

E. J. Fishbaugh: "How does it get into the form it is furnished to the manufacturer to be used as glue?"

S. D. Taylor: "From the beet it is milled into a flour. We receive the raw material in flour form. It is processed at our factory."

E. J. Fishbaugh: "When it is given to the cabinet man, do you people advise any solution for that glue? We have been talking about solutions. Is vegetable glue recommended with any vegetable solution?"

S. D. Taylor: "Yes. We recommend a mixture 2⅛ parts of water to one of glue. For the cheaper grades of veneered work a little more water can be used."

E. J. Fishbaugh: "What is your method? Do you go into the factory and recommend the percentage solution?"

S. D. Taylor: "As vegetable glue is different from animal glue, it is necessary to send a man to install the equipment and teach them to use it. The demonstrator is a practical and experienced man. He looks over the work and uses a mixture that will be suitable. We only recommend it for veneering but some of our customers who are using if for joint work find it gives very satisfactory results. As vegetable glue is slower drying than animal glue, it can only be used for joint work in factories where there is plenty of space and clamp capacity."

H. H. Arnold: "Will any of this vegetable glue be injected into the open pores of the veneer?"

S. D. Taylor: "Yes. The wood will absorb a certain portion of it. As no hot cauls are used, the glue is not drawn up into the veneer as when animal glue is used."

H. H. Arnold: "Would one being vegetable and animal matter and the other vegetable and vegetable matter affect the finish?"

S. D. Taylor: "As varnish is a vegetable matter, vegetable glue would not be apt to affect it any more than animal glue."

H. H. Arnold: "Are there any chemicals used that might become active under some conditions after the glue had properly dried?"

S. D. Taylor: "No. We have never experienced or heard of any trouble of this nature. Sometimes right after the glue has set on some woods a little stain may appear but the stain used in finishing will cover it."

H. H. Arnold: "In what kind of wood have you observed that?"

S. D. Taylor: "Mahogany would show the easiest, especially where a poorer grade of mahogany veneer is used."

R. H. Waud: "How long does the veneer work stay in the presses?"

S. D. Taylor: "In ordinary weather stock glued today should not be taken out until tomorrow but there are times during the summer months when we have very humid weather when it is necessary to leave the stock in the presses or clamps longer, but ordinarily 24 hours is enough."

E. J. Fishbaugh: "How about heating your core stock?"

S. D. Taylor: "The wood should never be warm and we do not use hot cauls."

E. J. Fishbaugh: "You made the statement that you used to cook this glue entirely cold. How do you cook it now?"

S. D. Taylor: "We still cook it cold in some cases, but that is where a heavy faced veneer is used. Where thin veneer is used we reduce the amount of the solvent chemical and use steam."

E. J. Fishbaugh: "Do you do high grade veneer work such as piano work?"

S. D. Taylor: "Yes."

E. J. Fishbaugh: "How do you mix it and cook it?"

S. D. Taylor: "First we weigh it in a proper amount of water into the mixer, then the proper amount of dry glue. We agitate this for about ten minutes with the heat off until it is thoroughly dissolved. We then turn on the steam and let it warm up and then dissolve the proper amount of solvent that is used. When this is dissolved we run this solution into a mixture of glue and water. We leave the heat on until the glue is cooked to a light amber color and is transparent. When cooked to the proper point, we allow the cold water to run through the jacket. We recommend that when the mixture is at the proper point and after it is cooled that the agitator be stopped. We never add water to it after it is cooked. It is almost impossible to add water after the glue has been converted."

C. Stanley: "Is it spread in a broad form?"

S. D. Taylor: "We use a corrugated roll. The glue being very heavy hangs together when spread on the piece which makes a continuous spread of glue. It is necessary to have a scraper arrangement to control the flow of glue. With animal glue you depend on the glue being thin enough to flow back. Vegetable glue would not do that. In the making of three-ply panels we recommend that a caul be put in after six or eight panels to stiffen up the bale and help to take care of the little variation there is in the veneer."

R. H. Waud: "When this is spread on the piece of cross banding, do you find it swells it?"

S. D. Taylor: "It will expand a little; not quite as much as the hot glue stock. It is bound to because the mixture in the glue will expand the cross banding. Because vegetable glue is cold and heavy, the cross banding does not absorb the moisture as much. The corrugations are lengthwise of the roll, not round and round. The corrugations are about 9½ to the inch. Some 9¼."

C. Stanley: "Are the feeds from the outside of the roll like the ordinary glue?"

S. D. Taylor: "Yes. The scraper is arranged so that you get a very fine adjustment with it. You can put on the piece with just the amount of glue you want."

H. Jarrow: "How will it compare with animal glue in covering surface?"

S. D. Taylor: "Some get considerably more and some less, but the average of all would run about 32 or 33 feet to the pound. With vegetable glue we usually spread about 45 feet to the pound."

Paul Reckow: "Is there any difference in cross banding your core stock first and then applying your veneers two or three days after?"

S. D. Taylor: "We recommend making it all in one operation. There is no reason why you should not get just as good a job by making a five-ply piece of work in one operation as in two."

J. H. Gerts: "Could this glue be used in gluing felts?"

S. D. Taylor: "The solvent used might attack the felt."

The Meeting of the Hammer and the Wire

April 18, 1917

F. E. Morton introduced W. S. Linn, western sales manager of the American Felt Company, Chicago, Ill.

W. S. Linn: "Mr. Chairman and Gentlemen: My enthusiasm for the work of the American Felt Company is such that today I have a fundamental conception of my job which I look on as one not so much to sell the product of the American Felt Company but rather to sell the American Felt Company. If I can convince a man of the scope, the resources and the ideals of the American

Felt Company, there will be no difficulty in selling him our product. I saw the passing of the old regime which a good many of you men will remember from the days when the company was Alfred Dolge & Son until the time of the reorganization. In those days, the felt was manufactured at the Dolgeville mill but was distributed through the New York store which was the general office, and I think it is safe to say that in those days the New York store of the American Felt Company was the center of the piano and organ industry of the country. When the American Felt Company moved to Boston and the new regime took charge, I believe there was a tendency in some quarters of the piano industry to feel that the American Felt Company got out of touch and lost sympathy with their problems. They continued to manufacture piano and organ felts but without any particular interest in the line as to whether or not they were manufacturing the felts best suited for the individual purpose, and were making no particular efforts to solve the problems of piano felts and improve their lines. As a matter of fact, the very opposite was true and when the company moved their general offices to Boston the company was born again. The men who took over the business were wool merchants and understood wool thoroughly, which is the great fundamental of the felt manufacturing business. They brought to bear on the American Felt Company all that money and brains can bring to any manufacturing business and their results can be best illustrated in some figures which show their growth. In the last five years, the American Felt Company has put into new plants and equipment $950,000, yet in the same period the charges to depreciation have been so liberal that the plant account has increased only 6 per cent. The result of this expenditure in plant and equipment is an increase in capacity of 62 per cent over what it was five years ago. It is needless to say that our sales have increased accordingly.

"I think you all know that the American Felt Company is one of a family of companies, all controlled by the one organization and these companies manufacture everything from textile machinery to felt shoes. Three of these companies are represented here tonight. A. E. Pfeiffer represents our Service Company in which we concentrate all our professional service and which gives to each one of the affiliated companies expert service. Mr. Pfeiffer will tell you later of some of the ramifications of the organization that he represents. Mr. E. H. Allen, president of the Boston Piano Supply Company—our hammer business—represents a user of modern American Felt Company products and ideas. I am merely here to tell you on behalf of the American Felt Company that while we have spent a great deal of money and thought on the development of piano felts and the solving of the problems of the piano trade, we realize that these problems are not nearly solved. We therefore distinctly appreciate the opportunity to co-operate with Mr. Morton and with you all in these fundamental efforts to find a solution of these problems. In the words of the owner of the American Felt Company, I am here to assure you that there is only one limit to our co-operation and that limit is the blue sky."

F. E. Morton then introduced Mr. A. E. Pfeiffer, production engineer of the Industrial Service & Equipment Company, Boston:

A. E. Pfeiffer: "It may seem irrelevant but I would like to bring out the scope of our organization. We have an engineering department composed of mechanical, electrical and other experts. The results of your investigations and particularly the subjects in which we are interested tonight — 'The Meeting of the Piano Hammer and the Wire,' comes under the notice of this department. We are working in the dark at present in determining just what the piano trade wants. It will be in their province to determine standards.

"In our service department we have a research laboratory, sales expert organization, a personnel department for welfare work, and our calculating, financial and auditing department.

"I might mention the American Felt Company had a factory at Dolgeville. After our investigation we moved this plant to Glenville, Conn. Today we know our piano felt is better than it was at Dolgeville. We can produce more in our Glenville plant and can go further toward meeting the specific requirements of the piano manufacturer than we ever could at Dolgeville. We analyzed the situation, made a definite report to the owners of the company and made recommendations. We shall do this in working with Mr. Morton, take advantage of Mr. Morton's research work and submit our findings to the American Felt Company."

F. E. Morton: "I want to say for the gentlemen who have been kind enough to meet with us that there are certain factors in the manufacture of felt and hammers which are well earned assets of the company utilizing them. We have no desire to gratify morbid curiosity, therefore in the

discussion which may follow, I only ask for them what I would ask for myself,— that the discussion be confined to those things which are of mutual interest. We are assured of full co-operation and that in itself is sufficient. I take pleasure in introducing Mr. E. H. Allen, president of the Boston Piano Supply Company of Boston and Norwood."

E. H. Allen: "Mr. Chairman and Gentlemen: The Boston Piano Supply Company is the largest manufacturer of piano hammers in the world, which means we are the largest consumers of hammer felt. As has been said, the Boston Piano Supply Company is a subsidiary of the American Felt Company. Naturally, as a part of the American Felt Company's organization, we might be expected to use American Felt Company's hammer felt, and it is a fact that 90 per cent or more of the hammers covered in our shops are covered by felt manufactured by the American Felt Company. It is also true that we carry at all times as complete a stock as possible of other brands of hammer felts. There are certain very good reasons in our mind, aside from the fact that we are part of the American Felt Company organization, why we should use the American Felt Company's felt. One of the reasons is that through the use of that felt we have been able to satisfy to the fullest extent the varied demands made upon us by the piano manufacturers of the country. In order that you may appreciate that the demands upon any hammer coverer are varied, I might mention that we have on file at our factory specification cards representing over two hundred different kinds of piano hammers. These are the specifications of our customers, and a comparison of these specification cards reveals the very interesting fact that no two are identical and that the piano hammers used by any piano manufacturer differ from those used by his competitors. The differences in many cases are slight; differences in quality, weight of felt; shape of hammer; colors of under felt,— some with and some without under felt; differences in boring and pitch. It is therefore seen that hammer covering is purely custom work. The hammer coverer cannot set standards of his own, and say 'These are the hammers we would like to have you use, or think you ought to use.' We have been limited at all times by the demands of our customers, and, purely as a business proposition it has seemed best — so far as possible — to give every customer those things which he seemed to need or wish.

"We have also been limited in a number of other ways. Wool, as you know, is the principal factor entering into hammer felt and wool is an organic substance. It is a variable and not easily controlled. It has been the greatest problem of the hammer coverer to turn out a uniform product — to be able to furnish a customer, say, 100 sets of hammers and have each one of those individual sets as nearly alike in touch as possible. The hammer coverer has been held responsible for the results of the manufacturer's specifications. Often another limit has been placed upon the hammer coverer — that of price. Certain results have been expected but the hammer coverers have been held closely within the limits of a price. As you probably all know, hammer felt is one of the finest textile fabrics that is manufactured. The more expensive the article, the more readily its value is affected by price limit, and it is very true that a difference of 10 cents or 15 cents per set in the price of piano hammers disproportionately affects the value. Again, the hammer coverer can control results only up to a certain point. He can use the best knowledge and best methods at his disposal to turn out a good hammer, and yet after that hammer leaves his hands and passes into the hands of the piano manufacturer there are still possibilities of things being done that largely determine the results obtained. Different tone regulators use different methods and I do not think you gentlemen will resent it if I say here tonight that there has been many a good set of piano hammers spoiled by a poor tone regulator. Most of you are familiar in a general way with the methods in use in the covering of piano hammers. While these methods may vary in some slight degree in different shops, the problems, practically the same throughout the world, consist of taking the sheets of hammer felt as they come from the felt mill, cutting them up into strips, putting them into a mold of a certain size or shape with pressure, leaving the hammers in this mold until the glue is sufficiently dry to allow for their removal and then the various operations which attend the covering, trimming, cutting of selvage edge, sanding, cutting up into individual hammers; boring holes for the wires, putting in wires and testing them and boring for the hammer shanks.

"We do not know how far each or any of these various operations affect the tone of the hammer. It is unquestionably true that practically every operation in a hammer shop from the time the coverer receives a sheet of felt up to the time the hammers are completed and wrapped in

a package, has some effect. It might interest you to know the methods of handling the felt as it comes into our factory. The felt mill delivers the felt to our receiving room where it is carefully inspected for resiliency, evenness of touch, any possible mechanical faults, and any foreign substances. All felt is examined and a separate report made on each sheet. We can look back any time over a period of years and place our hands upon a report showing the characteristics of any sheet of hammer felt used by us. No felt is used until it has passed through the hands of the inspector. Among the demands made upon the hammer coverer is the variety of touch. One piano man wants a hammer with a bass section of a certain softness another with the treble of a certain hardness. No two piano men will agree on the degree of hardness of their hammers in any one section of the scale. To give each man as nearly as possible what he wants, we must start with the felt. The man who inspects the felt has the specifications of each customer and as these sheets of felt pass through his hands, he determines which sheets are best adapted to the respective customer's requirements. Each customer has a bin of his own in our plant, and as fast as sheets of felt come in, they are placed in his bin and used for no other customer. After the felt has been taken out of a bin and cut up into strips, it goes down into the covering room. Here the strips are glued on to the molding. Various kinds of presses are used. Whatever the type of press, the principle is found to be the same in all cases.

"Probably no one thing entering into the covering is of greater influence than the care taken by each man having anything to do with the operation. This is particularly true of placing these hammers in the mold. It is necessary that a certain pressure be given this felt to obtain certain results. It has been customary for years, and as far as I know is customary today in most hammer shops, to leave this matter of pressure largely to the judgment of the individual. In general practice, a man screws the felt into the mold until he thinks it is about right and that is as nearly correct as may be determined. We have devised, and have had in operation for some little time a method and the necessary instruments which enable us to give a predetermined pressure to a certain number of hammers. Although this pressure is controlled to that extent, you can appreciate that this is of small value unless the felt is very carefully selected before being passed on to the coverer. You may think I dwell considerably on the matter of care, but really if there is any secret in hammer covering, that secret is nothing more nor less than care,— continual, infinite care,— care in the selection of the proper felt, care in putting that felt on the moldings, care in cutting the hammers up so every hammer will have the same thickness in all cases; infinite care that in the boring the angles shall be the same, and that the pitch shall be the same throughout the entire set.

"One of the difficulties with which the hammer coverer has to contend is the fact that at least 75 per cent of his work is done by hand. As I have said before, we do not know how far each individual operation of the hammer coverer affects the matter of tone. We do know the pressure does affect tone to a very great extent and probably the two factors that influence the tone most are the selection of the felt and the actual covering practice. It is true that if a fine strip of hammer felt has been selected and turned over to the coverer and if he has at his disposal only the crudest of tools, presses and methods, it is still possible for him to make a mighty good set of hammers. On the other hand, if the felt turned over to him is poor, is without life and resiliency, you can give him the best equipment in the world; you can let him give it all the attention possible and when everything is done it will be a poor set of hammers. In considering therefore the relation of the piano hammer to the tone, it is necessary for us to go back a step to the making of the felt itself. There must be certain very good reasons why one hammer felt is good and will give excellent results and another brand of hammer felt will not give satisfactory results. The answer to this question does not lie in any secret process. I am not a felt manufacturer, but I believe I have a very good idea of the methods and processes used in the making of hammer felt. There is nothing particularly intricate or strange about those processes. They are no more intricate than the methods of turning out certain other textiles.

"I think we will all admit that the thing most to be desired in a piano hammer is life and resiliency. The ability to get away from the string as quickly as possible. This matter of resiliency or life in the hammer is determined entirely by the life in the felt, and the life in that felt is determined principally by the life and resiliency of the raw wool used in its manufacture. It only seems reasonable therefore that the concern commanding the best means of obtaining the greatest

variety of wool from which to pick, that can command wool experts, can command laboratory experts and determine the various mixes, standards, grades and brands of wool to be used in the felt, will be in a position to turn out the better product. One of the reasons why the Boston Piano Supply Company has the utmost faith in the product of the American Felt Company as best adapted for piano hammers, is that the American Felt Company through the various branches of its organization is in a better position than any other organization that we know of to secure the best wools and the best methods of handling those wools. We have been making our experiments and investigations with the idea of determining the best felts and processes. However, we have been working more or less in the dark because the demands of our customers have been so different and we have not known precisely what the piano man wants us to give him. I want to assure you that we are in a position to give you certain results when you have once clearly shown us what results you wish to obtain."

F. E. Morton: "For a long time I have been trying to devise some means of utilizing a wire long enough and stretched to such a tension as to permit observation of the movement of the wire when struck with a hammer. A short wire acts so quickly that the eye does not follow it. A wire stretched to such a tension as is used in a piano acts so quickly that the eye does not follow it and therefore the function of the hammer is not visualized. What is this function and to what extent does the wire aid or retard that function, and what treatment may be accorded the felt that in the meeting with the wire each may perform its proper function? It is impossible to secure any mode of vibration from the sounding board that is not given it by the wire. As Mr. Allen so ably puts it, the ideal hammer is the one that gets away from the wire the quickest. The necessity for resiliency in the hammer is understood, but how about the resiliency of the wire and to what extent may the resiliency of that wire affect the meeting and parting of the hammer and wire? Before we may expect to set up a standard for the hammer maker, we must establish our own standard and we must define our present position before deciding upon the next move. Heretofore this position has been difficult of visualization. I have experimented with wires up to 25 feet in length, and while one knowing exactly what to look for and when to look for it, might observe, the chances of understanding through sight were small. Finally, the idea occurred to me that a wire need not necessarily be straight and so have succeeded in so arranging that you will be able to observe a wire 210 feet long in process of vibration and observe its movements.

Fig. 24

"Here is a piano wire in spiral form 210 feet long and I will set it in motion so that you may observe the travel of the impulse. This impulse is an expression of energy which in piano playing is applied at the end of the key. The energy directed to the wire will so express until conducted away by some elastic substance. An inelastic material only will reflect energy.

"I give this wire one stroke. Watch the impulse as it travels. There are numbers of movements caused by the returning wave or impulse overlapping the original impulse, thus giving rise to these segmental vibrations. (Fig. 24.) In the piano there is an infinitely small period of time in which the hammer may get away and not interfere with the return impulse. It is this segmental vibration and the relative intensity of the segments forming that is responsible for the quality of tone in your piano. You don't get tone quality from the construction work, sounding board, etc. You only get a magnification or diminution of quality already existent.

"The quality first is determined by the mode of vibration of the wire itself. If the period of time of contact between the hammer and the wire is disproportionate to the length and tension of the wire the hammer interferes with the return of the impulse. This is what happens when the hammer does not get away from the wire quickly enough. It changes the mode of vibration and hence the quality. The series of partials is broken and that is where the tone quality is changed by the hammer. Mr. Allen says we do not know to what extent these various operations on the hammer affect tone. The piano manufacturer has not sufficiently taken into consideration the action of the wire. If a wire, of a given gauge, is drawn to a certain tension and is struck with a hammer, the resiliency of the wire becomes a factor in this 'getting away of the hammer from the

wire.' The rebound of the hammer from the wire is affected as much by the wire as by the hammer, and if one hammer gets away in a certain period of time and the next hammer requires a longer or shorter period it may be because of a difference in the resiliency of two hammers or a difference in tension or resiliency of the two wires, or both. It is not unusual to find 30 pounds difference in tension between two adjacent strings. That means the impulse returns more quickly upon one than upon the other, and even though the hammers were possessed of identical qualities, they would not get away in the same period of time. The interference of the returning impulse by the hammer changes the mode and therefore the quality."

Mr. Morton then demonstrated the modes or segmental vibrations, visualizing the causes of differing tone qualities from nasal to hollow, also showing the part played by hammer and wire respectively in the tone changes effected. He cross referenced these visible performances with practical tone production, thus locating the responsibility for faulty results. He stated in conclusion that if the manufacturer should issue a particularly intelligent specification, the performance of which would be simple, it would be of no value unless based on a constant contained in the piano itself.

H. H. Arnold: "From the striking point to the short end is very much shorter than to the long end. The wave starts both ways. What is the actual condition — what happens as the wave passes back and forth?"

F. E. Morton: "A breaking up of the larger segments by the small ones."

H. H. Arnold: "Does that condition last as long as the wire is in motion?"

F. E. Morton: "It continues always until stopped. Practically until the energy is spent."

E. J. Fishbaugh: "I would like to ask Mr. Allen if we can approach very closely to the hammer that will need no tone regulator, and if that hammer will not be longer lived?"

E. H. Allen: "We believe it possible to produce such a hammer. We further believe that if such a hammer could be produced it would give those results without needling and that the life and resiliency would be longer. It is possible, we believe, to bring about that result, but it is first as Mr. Morton has so ably explained that the piano hammer coverer must know before he attempts to produce such a hammer just what the conditions are."

E. J. Fishbaugh: "Can you suggest or lend any aid along those lines, and will you?"

E. H. Allen: "We can and will. We want to assure you gentlemen that our Service Department will lend all possible aid along any line of experiment for the purpose of determining what can be done to solve the piano manufacturers' problems. It is just as much to our interest as yours that those problems be solved."

E. J. Fishbaugh: "You spoke about the blending of felts in order to arrive at that condition. Would any different blending of felts be necessary?"

E. H. Allen: "The selection to obtain certain results in hammer felt depends largely upon the selection of the proper wool in the first place and the selection of that wool would depend largely upon knowing in advance what result was to he obtained. That in itself would be largely a laboratory proposition. It might interest you gentlemen to know that when the American Felt Company undertakes to produce a certain result in its hammer felt, it is not necessary for them to take a batch of wools of different brands and make up a lot of felt and then find out what the result is and try and try again. We take those wools into the laboratory. We try them out on a small scale until we are satisfied that certain grades of wool will produce certain results. With that standard set, we go ahead in the actual manufacture of the felt along those lines."

A. E. Pfeiffer: "We know the relative value of the various kinds of wool before we go into our laboratory."

T. A. Johanson: "Is it possible for your hammer makers to make 100 sets of hammers exactly alike?"

E. H. Allen: "At the present time, it is not possible for the hammer maker to make 100 sets exactly alike. As I said, the wool is the factor that determines the resiliency of that touch and wool is an organic substance. It will not always work just exactly the same under given conditions. It has been our aim and we are still on the job to determine methods and processes whereby we can duplicate anything we have done once. I am willing to admit that at the present time I should not care to undertake to cover 100 sets of hammers that would be identically alike in the matter of touch."

T. A. Johanson: "In that case is it advisable to make a hammer a little harder than the general practice requires?"

E. H. Allen: "That would largely depend upon just how the tone regulator handled that hammer after it came into his possession. All tone regulators do not work alike. Given two sets of hammers as near alike as possible, give them to two tone regulators whose methods are different and it may safely be assumed that the results would be quite different."

F. E. Morton: "Is it good practice to allow for a considerable leeway for tone regulation in the making of the hammer?"

A. E. Pfeiffer: "That ratio is constantly decreasing. We are coming closer in our controls in the principal factors."

C. Arthur Brown: "How closely can you approach equality in 100 sets of hammers? In other words, what will be the maximum or minimum variation? Could it be put on a percentage basis? How widely would two extremes in that 100 vary?"

E. H. Allen: "I think you are in better position to answer than we are."

A. E. Pfeiffer: "How far can human touch go? We have not been able to get a machine but are still trying to get rid of the human element."

H. Jarrow: "How far have you gone to eliminate the unpositiveness of the organic matter of the wool?"

A. E. Pfeiffer: "We have started on educational service to the wool grower. Things that can be eliminated — dirt, vegetable matter, etc.— are being eliminated. Mineral matter is something we all have to contend with, and those are the points we cannot control in the manufacture of felt."

F. E. Morton: "It was stated by a felt dealer or manufacturer, that the treatment of the wool by the farmer, the ground on which the sheep fed, elements entering into its feed, climate, conditions, etc., were of no interest. Can you state whether it is true?"

A. E. Pfeiffer: "The hammer maker must disregard this year's clip. It is of a specific nature. Next year's would be entirely different. The hammer maker demands a certain article. The question comes up of the markets that are open. If the felt conditions are good, the wool will be full of life; next year it may be dry and a dry, lifeless wool will be grown in the same field. That is why we are trying to determine the actual conditions under which the wool is raised."

F. E. Morton: "Would your Department accept the proffered service of the Agricultural Department of the American Steel & Wire Company and would you consider it of sufficient importance to the industry to warrant the effort?"

A. E. Pfeiffer: "This would be very welcome."

H. H. Arnold: "In your laboratory, if you had two specific clips and they both showed the same amount of resiliency, would that insure the same amount of life?"

A. E. Pfeiffer: "We can only determine relative resiliency by that felt experiment."

F. E. Morton: "Given a piece of hammer felt compressed to a certain degree of hardness, a hardness in excess of that required for a working hammer and that hammer needled by any process in common practice, could the fibre be expected to retain its resiliency as it would had the hammer been made up of the required degree of softness in the first place?"

A. E. Pfeiffer: "The minute you have brought your wool to a certain point every additional process injures it. It will never come back entirely to the same condition in which it was in the first instance."

F. E. Morton: "That is of more importance to the tone regulator than is at present recognized."

A. E. Pfeiffer: "No hammer maker has ever gone beyond the customer's request. We have never taken into consideration anything except that we have given the customer what he has asked for."

F. E. Morton: "What would be the nature of your advice were it asked, and to what extent would you be willing to go for mutual profit in assisting a customer in formulating your specifications?"

A. E. Pfeiffer: "We would produce hammers, evolve a method and then observe those hammers under given conditions. We would determine all factors and the action of the felt under a given set of conditions and then work our own processes to reproduce that felt. As you know,

Mr. Brown, the one thing that stands in our way is the machine both you and I have set our hearts on. It has developed in the last two weeks that Mr. Brown has been attempting to perfect a machine we have been trying to get. When we get that, we will be able to produce 100 sets of hammers exactly alike,— just as nearly alike as it would be possible to turn out 100 steel rings exactly alike. How to measure the standard is a thing we do not know today. Twenty years ago in the rubber business they had a similar condition. Rubber was turned into the manufacturing department. Every department met the difficulties as they arose. Today the rubber business is a-b-c after it leaves the laboratory. They have a definite standard or series of standards to which or from which they can work."

R. W. E. Sperry: "I don't see how it is possible for any of us to contribute to any standard unless we have something on which to base our own judgment. We have no standard, therefore we have no basis for criticism. The fault lies with us."

C. Arthur Brown: "What is the first essential to establish that standard? My idea has been to find a starting point. Inasmuch as it has been pretty clearly demonstrated that wire can be produced of a fair degree of standardization that is the logical point from which to start. The felt meets wire of various gauges — in some instruments under very unequal tension; in other instruments more or less closely approaching a uniform tension. With the evidence as far as I am able to guess it, particularly that seen here tonight arguing very strongly in favor of uniform tension, it would appear that any standard test must take the wire into consideration. In other words, the test for the felt must necessarily be based upon some function of that wire and in the ideals which I have developed in my own mind as far as I have gone, the question of area of the felt coming in contact with the wire is a feature that might offer itself as a possible easy point of attack. In the testing hammer which I have in mind, there would be various types of hammers for testing various thicknesses of felt, for testing in the sheet, both for resiliency and for durability. A striking hammer could be made to correspond in area with the gauge of wire representing a given section. It seems to me that in working it out along that line we will arrive at a given standard, and measure the resiliency of the felt when a given number of blows have been delivered. Continuing the blows for another period of time and measuring the thickness of felt under that additional number of blows might enable us in time, and with sufficient hard work, to arrive at a curve which would show what the particular resiliency of that particular felt amounted to in comparison with a given standard. Continuing still farther to the destruction of that felt would give us a continuing curve that would be both a measure of resiliency under continued service and its durability."

A. E. Pfeiffer: "It is always advisable to eliminate every variable. If we start with the hammer itself we can give just as many thicknesses on the hammer as you could possible arrive at or possibly get in a sheet. If we start with the wire, take the first step back of that, etc. I think if we start with the completed hammer and experiment first with the thickness and quality of felt on the hammer; determine those factors as a completed article and getting its direct relation between those two points, we can safely guarantee that once having established those factors we can work back to the process and always come up to a finished product. In the steel industry, Midvale and United States Steel do not both follow the same steps, but will both guarantee to give the same standard. If you standardize your felt first you will then have to change the processing of your hammer."

F. E. Morton: "Assuming for the sake of argument that the results obtained in the analysis of wire performance are correct, we have found that in the common practice of piano manufacture, assuming the present form of scale as permanent, that with proper loading and with our present graduation of wire gauge in half numbers, one one-thousandth of an inch variation, that our piano wire drawn to 160 lbs. tension is at its best,— that it performs in such a manner as to produce the mode of vibration needed for the proper performance of the sounding board. Would that form a basis, or could it be assumed to form a basis for standardizing hammer felt?"

A. E. Pfeiffer: "I don't see any other point we could work from. The wire would be the only thing."

F. E. Morton: "We have found by analysis and synthesis that our wire is at its best at 160 lbs. tension,— that as soon as the tension is lowered or raised throughout a reasonably drawn scale the performance of that wire or its mode of vibration is adversely affected. Then why not accept the performance of wire at 160 lbs. tension and at the present relative weights of hammers, treble and bass and the present gauge of wire from 13 to 18?"

A. E. Pfeiffer: "I say that it is possible that you may have to change your piano practice."

F. E. Morton: "Those changes would tend toward a greater uniformity."

A. E. Pfeiffer: "No one can say definitely certain conditions can be standardized perfectly. We could take your wire at any tension."

F. E. Morton: "It would be a reasonable thing to assume that a given wire tension would form a basis?"

A. E. Pfeiffer: "To simplify matters it would."

C. Arthur Brown: "You must take into consideration the actual use of the hammer. For instance, one hammer strikes three strings; another two; another one."

F. E. Morton: "That has been covered by the mass of felt in the respective hammers. Insofar as I have been able to test out by tone analysis, the common practice in distribution of mass of felt over the respective hammers from treble to bass is correct."

A. E. Pfeiffer: "There is nothing in the standardizing that will prevent any man using his own ideas."

F. E. Morton: "One of the first things I stated to the technicians in conference was that there was no intent to standardize to the point of destroying individuality."

J. H. Gerts: "Don't you think we should take the piano action into consideration? If the hammer is good and the springs are weak, the hammer will not bring the desired result. Furthermore, I wish to state from my experience in tone regulating, that I don't think the hammer maker can make a hammer which will not require tone regulating. There will always be some needling to even up."

A. E. Pfeiffer: "We can simply standardize the hammer to give a certain condition. A combination of standards will always give definite results."

A rising vote of thanks was given the gentlemen representing the American Felt Company for their enlightenment and offer of co-operation.

Treatment of Piano After Leaving the Factory

May 2, 1917

F. E. Morton: "When the piano leaves the factory, what treatment will be accorded it by the owner and in what measure and manner may the owner be advised as to its proper care? We have invited you, gentlemen, as tuners for some of our leading retail piano warerooms to ask you what the manufacturer can do for you that will make your work more pleasant and agreeable, more profitable. When the manufacturer learns this he will understand that it is to his advantage to do it. He needs you as much as you need him. Your interests are identical. The tuner has been looked upon by manufacturers and dealers as a necessary evil. They may have in mind some specific tuner or an experience, but it is pretty safe to say that the tuner and the manufacturer and the dealer have not been co-operating. The conditions are different from those obtaining from twentyfive to seventy-five years ago. We are becoming organized and crystallized to a degree that one cannot be affected without all being concerned. When we secure a perfect understanding between tuner, dealer and manufacturer life may not be 'one long sweet song,' but it will be well accompanied. What is your experience with tuning pins that are too tight or too loose? What can the manufacturer do for you in this matter?"

E. G. Becht: "When the pins are too loose they are not properly put into the wrest plank. In many cases you will find that the tuning pin is hammered in instead of turned. In a case of that kind I would say to the manufacturer to turn the tuning pin into the wrest plank.

"A drill that does not correspond with the measurement of the tuning pin frequently is used. If a tuning pin is too loose there is nothing for us to do but put in a larger pin."

F. E. Morton: "In the case of a 'jumpy' pin, is the piano left in as good condition by the tuner as when the pin turns freely?"

E. G. Becht: "No."

F. E. Morton: "In the case of a loose pin, what is your experience in using shims?"

E. G. Becht: "It is customary to use bushing but I do not think favorably of it. In most cases the manufacturer uses the largest size pin at the start."

F. E. Morton: "If a pin smaller than the one in common use were used by the manufacturer, would it be of advantage to the tuner?"

E. G. Becht: "Yes; it would be a great help."

F. E. Morton: "Have you in your experience been able to determine whether a pin has been turned or driven in?"

E. G. Becht: "A first-class tuner can detect it."

F. E. Morton: "You would say then that driving a pin in is a disadvantage?"

E. G. Becht: "It works to a disadvantage in tuning. The piano won't stand solid."

F. E. Morton: "Can you tell the difference in time taken in turning pins and driving them in stringing up a piano?"

E. J. Fishbaugh: "It takes a man about two hours to string a piano by driving the pins."

F. E. Morton: "What is the difference in time in turning the pins?"

J. L. Voss: "Where a boy drives the pin a certain distance and the stringer turns the other three windings a man and a boy can string as many pianos as a stringer who drives them in all the way. Where the pin block is drilled by machine, if the drill is not kept sharpened it will drill just the same but it will burn. Drilling gives the proper condition; burning gives a 'jumpy' pin."

F. E. Morton: "Then we may assume that it is better to turn the pin part way than not to turn it in at all! What is the difference in time between driving and turning the pin in the whole way?"

E. J. Fishbaugh: "It takes double the time."

F. E. Morton: "Do any of you who restring have difficulties in adapting new pins to the holes after the old pins have been taken out, and if so what measures do you take to produce a proper relationship between the wrest plank and tuning pin?"

N. Boe: "In Norway where I learned my trade, after removing the old pins we made a drill out of a new pin and reamed out the block. We never hammered a pin. In Europe a pin is not hammered. You can tell by the top of the pin if there is a mark from hammering. European pianos stand in tune better."

F. E. Morton: "How is the tuning pin treated to make it into a drill?"

N. Boe: "We cut a thread on it and make a twist drill out of it."

F. E. Morton: "If the piano is strung, whether original stringing or restringing, it is customary in some shops to even up the tops of the pins by going over with a large hammer. Have any of you discovered anything detrimental to the piano in that process?"

N. Boe: "Driving is not good for a pin. It is unnecessary to drive a pin if a gauge block be used. This block should be placed around the pin and indicates the distance for turning before stringing."

E. G. Becht: "Strings are not all of the same gauge so you could not screw the pin in to the same gauge. The pins would be very uneven."

F. E. Morton: "The point I want to reach is: Is it proper or isn't it to drive a tuning pin under any conditions? It must be proper or improper or else the complaint of thousands of people is without foundation."

Wm. Davis: "If the block is in good condition it will not injure pin or block."

N. Boe: "If you turn it in you have naturally produced a thread with the pin. If you hammer it in you destroy that thread and it is very essential to keep the tuning pin from slipping.

"In regard to the different gauges of wires, we use blocks of varying heights in the different sections. We could not use the same block in treble and bass."

F. E. Morton: "The conditions under which the piano operates affects the tuning. The matter of humidity possibly is a big factor. I don't doubt that many of you have found pianos with a window on one side and a radiator on the other. Can the humidity be so regulated as to keep a piano in such condition that your tuning will be effective and give satisfaction?"

N. Boe: "I have studied that problem considerably especially in its application to the playerpiano. I had one player which took a trip to the factory every February or March to be tightened up. The man called on me and asked me if I could not remedy the trouble. I told him if he would assist me I could assist him. I took a Mason quart jar and filled it with water and put it at the bottom of the piano and another one at the back of the piano and told the man to see that those two bottles were kept full of water during the heating season. As soon as the heat

stopped they should be taken out. The piano has not taken a trip to the factory for a good many years. I have talked to a lot of tuners about that. They said it would rust the strings, but if the water is taken out when the heating season is over this does not happen. A hygrometer showed a humidity around 20 and sometimes as low as 12 where it should be 50. The water in the Mason jar will not rust the strings as long as the water is colder than the wires. The wires are warmer than the water during the heating season. The humidifier which is put on the radiator may be all right but it contains something like 60 cubic inches of water with 24 exposed to the surface. If the ratio were reversed it would be effective."

F. E. Morton: "A lack of knowledge of values on the part of the piano owner is the cause of a great deal of trouble, and it is up to the tuner to help educate him. Mr. Albert Strauch of Strauch Bros., action makers, gave a good illustration, and I give it to you for use among your clients. 'A man buys a watch for $75.00 and keeps it in a chamois case; is very careful not to expose it to extremes of temperature; puts it under his pillow at night; carefully winds it at the same time each day; takes it to the jeweler if it shows a second's variation and takes a great deal of pride in its care. The same man will buy a $500 piano and put it between a window and a radiator.' How can we instill into the mind of the owner of a piano that he has a valuable art product that requires attention? When a man buys a painting he is careful where he hangs it. He will send it to be varnished at certain times and watches it with great care. He does not have the same feeling toward his piano. The fault does not lie entirely with the owner. I do not think he has been given a proper idea of its value by the salesman. I have seen pianos exhibited in a manner to destroy all ideas of piano value; newspaper advertising of price cutting, an axe chopping a piano, entitled 'Prices Smashed,' etc.; the treatment of an art product by an alleged dealer as though it were a piece of junk is responsible largely for the attitude of the public. Neither public nor dealer have a correct estimate of the value of tuning. Mr. Charles Deutschmann of Lyon & Healy will tell us of some constructive work being attempted on these lines by the Tuners Guild."

Chas. Deutschmann: "We have been working for a number of years to evolve some method of educating the people to the necessity of taking care of the piano. The manufacturers didn't do it. We came to the conclusion that if a housewife was told that it was just as necessary to have the piano tuned as the windows washed and the rugs cleaned, she would do it. At our last convention we got this in tangible form and started by sending letters to manufacturers asking them to issue instructions to dealers and customers on the care of the pianos. To that letter there were sixty-six replies. This was followed up by a letter last week in which we advised the dealers and manufacturers to put some sort of instructions in the piano to the effect that if the piano is not properly cared for they will not stand by the guarantee.

"While some manufacturers have been doing this it has not been general. You all know the care the piano must have in the first few years of its outside life. The pianos are tuned five or six times in the factory. That does not fulfill the purpose and the piano does not get the proper settling. We want the public to know that the piano needs tuning. We want to co-operate with the manufacturer and dealer in bringing this about."

F. E. Morton: "Have you a plan to offer to the manufacturer that will enable him to co-operate with you?"

Chas. Deutschmann: "As Mr. Morton says, the tuner has been a necessary evil. We have not been co-operators. If the dealers will take into consideration that the outside tuner is one of his biggest assets and that many sales come through him more credit will be given him. They should not expect the tuning department alone to make money. It is a hard proposition to make money out of this department. If proper credit were given on the sales which are brought to his house by the tuner I think there would be some assets on his side, but it is forgotten. We advise the manufacturer to put some sort of instructions in the piano. I go to a house and tune a piano. I say: 'You ought to have this piano tuned.' They answer: 'They didn't tell me that at the store.' If I pull the pamphlet out of the piano and read it to them it backs me up. We want something that will substantiate our statements."

F. E. Morton: "There is another side to this proposition. I would like to hear the sales manager's side from Mr. W. H. Collins, sales manager of Lyon & Healy."

W. H. Collins: "I recently received a communication from the Tuners Guild that was a

revelation in my career as a piano man. Here I have been selling pianos and never admonished the customer that he assumed any responsibility. The minute I read that I said: 'The next man to whom I sell a piano will take this responsibility.'

"I have talked service since then and I have never talked with one who has not said: 'Sign me up for a year's service.' From now on I am going to instruct the sales service not to give anything free. I have communicated with my firm and they have confirmed it. We will take this matter up with every customer. He will be told it is up to him to take care of that piano. It is delivered in A-1 condition. If a defect shows up in the manufacture of the instrument we will replace it. The responsibility for proper care will be placed with the buyer. It has for too long been placed on the dealer."

F. E. Morton: "We also have with us Mr. Eugene Whelan, sales manager of W. W. Kimball Company. We want to hear his experience along that line."

E. Whelan: "One thought came to my mind when Mr. Morton spoke of the piano being placed between the window and the radiator. I wish most heartily there was an architect here. This is a city of apartments. It seems that the architect in planning an apartment makes up his mind that the people in it are not going to have a piano. Most of the apartments are built where the only available space for a piano is between the window and radiator. When the gentleman made the remark that he never heard of a tuning department that paid I swelled with pride We have one. A little over four years ago when we put in the one-price system we made it impossible for a salesman to give anything away and we almost had a revolution. We said: 'Boys from now on there is no such thing in our house as free tuning. It ends on October 1, 1912. The nearest you can come to giving a tuning is to sell a tuning contract for three years.' Consequently the customer has his piano tuned the same as he has his watch oiled. To prevent the salesmen putting it over' on us, we print at the bottom of our guarantees, 'This Does Not Include Tuning,' and I think it is one of the finest guarantees. Then we insist upon the salesman telling the customer that this piano must be tuned every six months and we sell them a tuning contract for three years. This is paid for as they like.

"We also give the customer a booklet in which in the largest type is written: 'No Free Tuning. You Must Tune Your Piano at Least Twice a Year. Would suggest you examine our tuning contract.' The salesmen have nothing to do with the contracts. They are attended by a young lady, and in case the salesman has overlooked this, the young lady says to the customer: 'Did the gentleman speak to you about this tuning contract? Have you thought of taking it?' If the customer says no, she immediately explains it. So there is no way a customer can get out of our store without having the plan explained to him. Our three years' tuning contract is a good talking point. Our salesmen can say: 'This piano is so reliable that we contract to take care of it for three years for a small amount of money.' The tuners in our house are not now a necessary evil but are necessarily good. When these boys go out on a job we make it an object for them to talk tuning contract, and I am here to say that there are very few tuners who go to a new customer and do not come back with a three-year tuning contract. We do not give free tuning."

F. E. Morton: "Would it be consistent with sales policy to embody in the guarantee of the piano the liability of the customer to damage to the instrument resulting from improper care?"

E. Whelan: "Our guarantee mentions that if it is neglected we are not responsible."

F. E. Morton: "Mr. Deutschmann, would it not be well for the Tuners Guild to advocate to the manufacturer a clause in the guarantee placing the responsibility for damages on the instrument resulting from non-attention upon the customer?"

Chas. Deutschmann: "I propose to put that in the next letter for their consideration. A good salesman said to me: 'One thing hurts our business. The pianos in hotels and other public places. If I ever sell a piano in a hotel I am going to tune it forever because when people look at the name on the piano and find it so badly out of tune they say: 'I wouldn't have a piano like that.'"

E. Whelan: "When we sell a piano in a public place or a nickel show we double and triple up on the tunings many times. I have sold tuning contracts monthly where the pianos are used from 11 in the morning to 12 at night. We have no trouble selling a contract where we double and triple on tunings and price accordingly."

N. Boe: "After tuning the piano three times the first year I never find any trouble to keep the piano up to pitch."

F. E. Morton: "The matter of service to the customer before and after selling is being given much more consideration by dealers than in the past. The up-to-the-minute firms today are giving service great consideration. Mr. Whelan can tell us something more of his ideas of service as exemplified in the Kimball warerooms."

E. Whelan: "I might tell you of our system of handling the piano when it comes from the factory. When the 'SOLD' ticket is placed on the instrument we have a place on the tag for the polisher to sign his name after he has polished this piano. We also have one for the tuner who has tuned it ready for delivery to sign his name. Then we have a man whom we call an inspector who looks over tuning and polishing, and it is this man we hold responsible for the piano when it reaches the home. If the customer calls up and says something is wrong we refer to the ticket and see who tuned it. (The tuners have a little book in which they keep track of the pianos by number). We call him up and find what he has to say. When the tuner looks over the piano he makes a written report which tells us all about it. In that way our service is well in hand and complete. All memoranda is made on a card. When the man goes out in three or six months he has all the facts before him and makes another report."

F. E. Morton: "What do you think of the idea of recommending to the owner of every piano the possession of a tuning fork and comparison between that fork and the piano from time to time — putting it up to the customer and stimulating an interest in the pitch of the piano? A card could be placed inside the piano on which the tuner can write his name and the pitch at which the piano was left so that the same tuner or the next man may know that pitch."

Chas. Deutchmann: "I don't think the fork would help."

F. E. Morton: "I am seeking to interest the owner. It does not take very long to show the owner of a piano how to determine whether or not it is in tune."

Albert Schenk: "To keep a piano up to pitch it should be tuned four times a year."

H. H. Arnold: "We have found so many different things in a piano that it would be hard to enumerate all the difficulties we believe the people have had in trying not to take care of the pianos, and of course in the majority of cases it was our fault, looking at it from the other fellows' viewpoint. One piano came back last summer in which we found seven large sized wasp nests. Some of them were on the sounding board and three underneath the key beds. We recently had a grand piano returned from Indiana with nothing the matter with it except that it would not stay in tune. When we got it into the shop we discovered water marks. When we got the plate off we found why it would not stay in tune. The pin block was blue. Water had penetrated through the first and second layers. We repaired it and charged them. When Mr. Dealer couldn't understand why we should make a bill we showed him our reasons and said he should charge his customer. However, in repairing we find it is frequently necessary when restringing a piano to re-drill all holes with a twist drill because even if you use a larger size pin it does not give perfectly satisfactory results for the reason that the wire is subjected to a tremendous strain which tends to make the hole oval in form. You will find you are coming in contact with wood which has been affected through pressure. If you ream it out you make a perfectly round hole and then by using a pin several sizes larger get the same result as you would in doing a new job. The minute you burn the wood by using a dull drill you are making a polished surface for the pin resulting in 'jumpy' pins."

F. E. Morton: "Which is better, a spoon bit or a twist drill and why?"

E. M. Evenhouse: "A spoon drill cuts only at the bottom edge. A twist drill will drill the hole and cut all the way down. You get a more perfect hole with a twist drill than with any other kind if the drill is kept in good order."

H. Gearman: "Speaking of pianos not standing in tune. The dealer is as much at fault as the manufacturer. I have not met a tuner on piece work who gets more than 75 cents or $1.00 per tuning and it takes at least 2½ hours to make a good job."

F. E. Morton: "The tuner has not taken the dealer into his confidence. The result is failure to co-operate. If we can bring this to the mind of the dealer in such a way that he will see where he can benefit by such co-operation he is going to do it. You have perhaps not shown him where his benefit lies. This movement of the Guild will have the active support of everyone interested.

"The condition of the piano when it leaves the factory has not been told here. What are you doing, Mr. Fishbaugh, to merit the co-operation of the tuner?"

E. J. Fishbaugh: "First of all, we are trying insofar as possible to get a low and equal tension scale, so that the piano will stand in tune. It is a very old and good saying that 'If the blind lead the blind they will both fall in the ditch.' We have, perhaps, in this industry depended too much upon hot air and too little upon facts. There are enough facts to merit the purchase of a piano by any discerning customer. When a tuner writes to us he gets a personal letter from one of our officials inviting him to write us at any time we may be of assistance. We believe that the more we can do for the tuner the more he can do for us. It has been the practice of manufacturers to employ a boy to chip. When he knew something he was discharged and another hired in his place. We take a boy and put him through three years' apprenticeship. He learns action regulating, player action work, etc. We then secure a responsible position for him with a retail house. He is then in position to give some adequate idea of responsibility and dependence upon the dealer and manufacturer to the ultimate purchaser of pianos. We are also giving a great deal of attention to the matter of bearing, construction of pin plank and make-up of sounding board that will make the piano with equal and low tension stand in tune the longest possible time."

F. E. Morton: "We have with us tonight Mr. S. B. Hohman of Lincoln, Nebr., who has been in the game a good many years and we should like very much to hear what he thinks of us."

S. B. Hohman: "I fully enjoyed meeting here with you tonight and have learned a great deal. I do not know that I can add anything to it, but so far as the manufacturers are concerned, it seems to me that they desire to treat the public fairly and give them the best they know how. As regards the tuning proposition, it might be a good idea to embody it in the guarantee but a great many dealers would pigeonhole it. If the manufacturer would burn it into the piano as they do the 'International pitch' the tuning would not then escape the attention of the user. A great many people say: 'We don't use the piano.' They think because it is not used it does not need tuning. They do not take into account the enormous tension there is on the strings. In the matter of humidity, it has always seemed to me the placing of water in a piano would create moisture and rust upon vital parts of the instrument. It would cause the sounding board to swell, which would throw the piano out of tune."

F. E. Morton: "A piano is at its best in a room in which a healthy man is at his best. Wherever a man can be most comfortable the longest time, is the place for a piano, and if you could once convey this idea to the man a bond of sympathy between man and piano might be established. The trade press is open to you for any constructive thought, but don't use up their valuable space in fault finding and complaining. Treat of causes rather than symptoms."

John H. Gerts: "I would like to get some opinions of the proper pitch of a new piano when it leaves the factory. What pitch is best for the tuner, manufacturer and dealer? My idea is Philharmonic. Every piano will drop more or less, and when it is next tuned the tuner will not have to pull it up."

H. Gearman: "That depends upon the length of time the piano stays in the factory. Ordinarily a piano should stay in the factory six months before being shipped. Sometimes a piano made for a special order is shipped after two months. This should be Philharmonic pitch. Instruct the dealer to have the piano tuned within three months."

Albert Schenk: "Philharmonic pitch is all right but I do not advocate anything above that."

Wm. Davis: "I think Philharmonic is about right. That is reasonable."

F. E. Morton: "If a piano is built with the idea of supporting a definite strain in pounds at International pitch, as soon as it is raised above that pitch, conditions have been changed throughout. It is utterly impossible under present practice to make a piano which is at its best at two pitches. If a scale is drawn on a basis of 160 pounds tension to each string at International, which is the present basis of figuring, and that piano is drawn to concert pitch, you can figure on from 5 to 15 pounds difference in the strain on each wire, depending on its position in the scale. Figure up the additional stress on that piano with from 5 to 15 pounds change in tension through the entire scale and you will find that the whole piano is subjected to a stress for which it was never built. A change in tension from 160 to 175 pounds changes the position of the sounding board and increases the down pressure on the bridge. If you have ever taken strings off an old piano and measured the height of the sounding board before and after, you found very little, if any

difference. You will find a great difference in the height of the board before and after its original stringing. This goes to show that the board adjusts itself to conditions going down but not coming back. A piano should not be drawn above the pitch at which it was originally designed to stand. There is a nice bit of engineering possible in the construction of a plate. It is possible to make a plate for a grand piano that will withstand a given tension, but the distribution of that tension is determined when the pattern is made and it can't be re-adjusted afterward. At that original tension the stress is properly distributed and the compression and tension members are equalized. When tension and compression are equal in amount and distribution there is no internal stress. It is possible to make a grand piano plate in which compression and tension members neutralize each other, making a nose bolt unnecessary. Build a piano of that sort and then change the original tension and you change the tension proportion or distribution. You are not getting a proportionate tension increase in raising extreme bass and extreme treble a half tone. You know from experience that a piano showing uniform quality at the tension at which you found it showed a different and disproportionate quality of tone when raised half a tone. Every manufacturer should stamp on his piano the pitch at which he desires the piano tuned. The pitch intended by the scale maker should be adhered to. The responsibility for unsatisfactory conditions could then be located."

Mr. Morton then announced that this would end the active sessions of the Technicians for this spring and summer. The meeting was adjourned to meet again at the call of the Chairman, due notice of which will be given by the Secretary.

Dinner and General Discussion

May 16, 1917

F. E. Morton: "After a winter's work, it seemed proper before breaking up for the summer months that we get together and informally discuss the idea upon which we have based our operations. The question at issue is: 'Has it been worth while and shall we continue?' The life of the piano from the raw material to the finished product installed in its home has been gone over roughly. It is not reasonable to suppose that a subject which requires a lifetime of study and work can be thoroughly reviewed in a few weeks. After collaboration we have found that the constant has been lacking in nearly every equation and must be found before proceeding farther. This it is which has made practically impossible a final solution of any of the problems we have taken up, but I think we can say we have made progress. Is it worth while—is it worth the effort? Are we getting value received for the time and energy spent? If we are it is a good work and we should continue.

Give your ideas full expression. I want to state that, while the trade press has been magnificent and the music trade has been loyal, your co-operation has been hearty and clean and I have felt grateful to be among real men who treat in good faith what they receive in good faith, yet I have been placed in a false position. I am only a medium through which the executives of this company may operate, and it is only because of their broad view of the interdependent industries of this country that this has been made possible. I want you to know one of these executives, Mr. Frank Baackes, Vice-president and General Sales Agent of the American Steel and Wire Company."

Mr. Baackes: "Gentlemen, I am glad to meet so many of an industry in which we have taken a very lively interest. It is true that you are not very much to us from a tonnage standpoint or a dollar standpoint. This whole industry probably means 1000 tons of our output of 2,400,000 tons per year, but you have been of very great help to us from a scientific standpoint. It is through you that we have learned to make piano wire and its accessories, which is no little job, and while our people have learned this they have improved the quality of other goods; so really in having you to take care of we probably have benefited more than you have. We are not philanthropists, we are business men and we are doing this from a strictly business standpoint. When we know our limitations and yours we also will know what to do to enable you to use what we make. We also are manufacturers and the easier we can make it for ourselves the better. Mr. Morton, who came with us a few years ago, has done excellent work, not alone for our company, but I believe

for yourselves. We have learned more of the piano wire business since this work of yours has gone on here than our people have ever known and I hope, therefore, that you, gentlemen, will keep on co-operating in this business for your own good, because co-operation today is more necessary in all industries than ever before. While in the past co-operation has been forbidden, it is now very much desired by our own Government. A few weeks ago we were called upon to deliver to the United States Government and the Allies 24,000 tons of wire in six months. That may not mean much, but when you consider an industry only producing 100,000 tons annually of that particular product when taxed to its utmost, 150 per cent demand with 100 per cent capacity, it is a job. We had to mobilize the industry. Therefore, if co-operation is a good thing in time of war—in time of need, what a blessing it must be under proper regulation in every industry in time of peace.

"We are living in a very serious time. I feel that the American people up to date do not realize that we are in a state of war. It is appalling to me. It means that every business man must think straight. In my opinion it is not a war of bullets and swords, but a war of economics. It is up to the business men of this country to guide our nation to win this war, and at the same time not let that economic ship of ours go to pieces on the rocks. For that purpose, therefore, every thinking man (and every business man is a thinking man) if he wants success, must think straight, just as straight as his faculties will permit. Our first duty is to be loyal to the nation. Everybody regrets we are in this war. It is not for any one of us to ask why. We are in and we must win with honor. Therefore it is up to the business man to do his full duty. I believe there is enough of every kind of foodstuff and material to continue every industry if we will be less selfish. Selfishness today is one of the greatest difficulties with which I have to contend and I have made up my mind that I am not going to consider in any instance the feelings of any one man. I am only going to be considerate of the essentials. Not so much in this industry, but in others I find that people care only for the dollars they can make. This great nation is only one hundred and thirty-six years old, has over 100,000,000 people, and no other nation in the world has accomplished so much in that period of time. We, therefore, owe this country a great duty and we should control selfishness and do that duty in every respect. As I have said to many people, *don't sell goods just for the purpose of getting a big profit.* My policy today is this: I absolutely refuse to sell a pound of steel to any man until I know what he wants it for. I have said to every manufacturer 'be passive. Don't crowd. Don't sell anything, just because the customer thinks it is a bargain. Don't sell a man a carload of nails when you know he can't use it in six months; sell him twenty-five kegs.' That is the policy that must be pursued in every branch of business today in this country. The reserves of every kind are gone, but if we are all a little less selfish and more loyal I know we will get through and keep every industry going. A piano may not be considered a necessity, but in my opinion in the struggles that are before us, in the hour of trouble, music is a great comfort to a man's soul. I hope the piano industry will be kept going, and as far as we are concerned we will keep it going. There are people in Washington who say that if the piano industry goes under they can make munitions, but you can't make a tailor out of a blacksmith or a blacksmith out of a tailor. If the piano industry is shut down it means your people will be idle. It means purchasing power will be reduced and a business depression follow. We business men know that, but unfortunately all our legislators do not. As I have said so many times, they do not talk the same language we do. Their vocabulary is different.

"There is not much more I can say except *be patriotic.* Let us all do our share and help this great country, because it is the greatest country in the world and we ought to be thankful that we live under this great American flag. I am very glad that I have met you all and now let us put shoulder to shoulder and we will come out victorious."

Short addresses endorsing the Technicians' Conference and advocating that it be continued were made by Mr. E. B. Bartlett, President of the National Piano Manufacturers Association, Mr. Frank W. Teeple, President of the Music Industries Chamber of Commerce of America, Mr. James F. Bowers, President of the Chicago Piano and Organ Association, Mr. Eugene Whelan, President of the Piano Club of Chicago, and others.

Mr. Morton for the American Steel and Wire Company offered the facilities and services of the company for a meeting on the first Wednesday in September. Upon motion by Hobart M. Cable the invitation was accepted.

Mr. E. J. Fishbaugh moved that a vote of thanks be tendered the music trades press for their able co-operation and assistance. The motion was seconded and carried unanimously.

Moved by Mr. Bartlett that a rising vote of appreciation be tendered the American Steel and Wire Company and Mr. Morton for the facilities, uniform courtesy and the very helpful interest taken in the work. Carried unanimously. Adjourned.

Sounding Boards

October 3, 1917

F. E. Morton: "At the last meeting I told you I expected to devote this summer to experimental work, based largely upon the sounding board. When less than half way through the summer, it developed that the results were of most interest to the lumberman. If the proper tree is selected and the timber handled in a scientific manner throughout the entire operation, your interest in the process is lessened because you then get satisfactory sounding boards. The results of this work, therefore, have been given to the lumberman. This research has been of a nature, however, to develop ideas which may be of value to you and we will take them up in their order.

"The general conception has been that the sounding board simply furnished an area exposed to the atmosphere to make up for the lack of area of the vibrating wire. My interest in that theory was increased by a series of experiments in employing other materials — steel, aluminum, various sorts of hard and soft woods. The difference in effect could not be accounted for in any manner by a difference in area nor yet in the elasticity of the material. Fig. 12 in 'Wood and the Piano Builders' Art,'* shows a diaphragm of which there are thousands in a square inch of spruce. That is the cue, and we have followed it. The material efficiency of the sounding board depends upon the intelligent treatment of the wood. A wood similar to spruce in every other particular, but lacking those little diaphragms, isn't a sounding board.

"We think we have developed the proper practice in treating spruce. The tonal difference between two boards with and without diaphragms lies in the uniformity of responsiveness to partials. A good tone is one having 50 per cent or more fundamental intensity. A poor tone is one having less than 50 per cent, therefore uniform responsiveness to partials becomes a matter of paramount importance."

R. H. Waud: "What do you mean by diaphragms?"

F. E. Morton: "The little membrane in the wood cell. There are millions to the square inch. In the live tree they are surrounded by resin. In spruce the resinous liquid volatilizes and there is left a dry membrane. If that is ruptured in kiln drying or by crushing, the tonal efficiency of the wood is affected."

E. B. Bartlett: "Do these membranes lie in the same plane or at right angles?"

F. E. Morton: "They run with the grain of the wood. The effectiveness of these cells in spruce is shown by comparison with other woods. Pine every other way conforms to the requirements of spruce, yet there is a lack of resonance. Another point which will be brought out later is the difference in summer and winter growth. The summer growth, the pithy layer, if too thick acts as a shock absorber. Experiments are now being made in an attempt to use other woods having the same cell structure.

"The co-ordination of the bridge and sounding board is a big factor and one that we perhaps should discuss at some length. Let us have your experiences and opinions. Given a board of a certain thickness, supposed to follow the movement of a stretched wire and respond to every movement freely, we have glued over it a piece of maple usually of a thickness and height which in itself would seem to preclude the possibility of responsiveness. I have cut away parts of the bridge underneath where no board response obtained. I have narrowed the bridge from one-eighth inch to one-fourth inch, set bridge pins closer together and found very much improved responsiveness of the board. I do not think that the width and thickness is the vital point. It seems to me that the rigidity of the bridge prevents the undulating movement of the board. At the break end of the treble bridge a great deal of trouble has been experienced. Some of this trouble has been attributed to the proximity of the bridge to the rim. The bass bridge also has

* See Fig. 16, page 78.

given a great deal of trouble. Metal bridges have been tried with partial success. One feature of the metal bridge is the possibility of an overhang while still retaining rigidity. The elasticity of wood prevents this treatment and result."

Wm. Braid White: "During this summer I have been making experiments upon the sounding board with a manometric flame to discover a proper method for approaching the problem of the sound board vibration. The sound board itself is the true vibrator. Everything that is done for the purpose of weighing down the board should be examined very carefully indeed. We are not dealing with an area. I am quite sure Mr. Morton is right. We should relieve any drag on the vibrator."

F. E. Morton: "I have stated repeatedly that the area of the sound board was not the important factor."

C. C. Chickering: "Why, in a big grand, is the tone larger than in a small one? A big grand will give a greater volume of tone."

F. E. Morton: "The amount of air space in a room determines the amount of air you must contact with any energized body. If you want to set in motion a great volume of atmosphere such as is contained in a great auditorium, you will more easily effect it with a large board than a small one, the practice being the same in both cases. Twenty-five years ago, the idea of a grand sound board three feet long would have been considered utterly impracticable, but the treatment of the board has changed. If you compare the small grand piano of today with the large piano of forty years ago, you will find it has greater volume and even better carrying power, not because it is small, but because the treatment of the board has been improved very materially."

C. C. Chickering: "Don't you think that may be due to the fact that the old board lost its vitality?"

F. E. Morton: "I remember that the tone then was considered good. Today they would not be salable. We have met a demand with the five-foot grand which was formerly met by the eight-foot grand. I have made actual comparisons and am certain that this statement is demonstrable."

C. C. Chickering: "In your experiment was a new sound board put in the old piano?"

F. E. Morton: "Yes, by the same treatment the original was placed."

C. C. Chickering: "Was the method of attaching the sound board to the rim of the case the same then as now?"

F. E. Morton: "No, we did not have the same rigidity of retention."

C. C. Chickering: "Is the modern board improved by a wider gluing surface?"

F. E. Morton: "Yes, and a more rigid retention. It is simply a means of conserving energy in the board itself. Given a certain amount of energy of percussion carried to the board, the board being set in motion, that energy travels to the rim. A firm, rigid retention of the board returns the energy, while an elastic contact conducts it away."

R. H. Waud: "In the old fashioned grand, when we spliced up we had no continuous vibration. We now build with the grain of the wood running all the way around."

F. E. Morton: "Your five-foot six-inch grand, Mr. Waud, has a much more brilliant tone and one which carries better than ten-foot grands, which I recall having worked on and assisted in developing for artists twenty-five years ago."

R. H. Waud: "We used to make our rast three inches wide. On top of that we built one and one-fourth-inch rim. We attempted before we glued on that top rim to bevel the rast to crown our sounding board right. Now we build our rast and belly it before we put on our outer rims. We also treat our bridges differently. That brings to mind the difference in tone we get in the lower end of the treble section if we step out our bridges. If we make our bridge contact to our sounding board exactly at the point the rib crosses and leave the rest of our sounding board free, we get an entirely different tone — more of a harp tone. When we step it out it seems to allow the board to vibrate and move more freely. If we stepped out our bridge from rib to rib we would gain."

J. E. Jennings: "Two sizes have been made by the same scale. The larger one has a greater volume. The same piano also has the bridge stepped out. The same firm made another piano with solid bridge. Experiments seem to indicate little difference with the bridge stepped out and not stepped."

F. E. Morton: "In these two scales, which we assume are identical, in the larger instrument are not the treble strings next to the break longer than they are in the shorter one?"

J. E. Jennings: "Identically the same strings clear through and the same number of wound strings. One has three inches more clearance below the bridges. I made some experiments. We have in the factory one on which I made the bridge one inch high and one inch wide. It was a very fine piano. We have had other pianos just as good with one and one-fourth-inch, which is the size we are using. We formerly used a light bridge with nine laminations. By adding two more laminations, the tone is improved. I agree with Mr. Morton that it is a question of rigidity."

F. E. Morton: "Don't you think the real point we are after is a conservation of energy in the board itself for a longer tone? During the early part of the summer I had two bridges made for one scale. One was stepped; the other solid. The result was a different quality of tone. Others claimed the stepped bridge produced a much better tone. Certain it was that the tone was longer and not so dry."

Wm. Braid White: "It seems fairly obvious that the sound board is the true sound maker — that the analogy applies to the board. The thing to be desired in the bridge is rigidity. The business of the bridge is to do the one thing that it is supposed to do."

C. C. Chickering: "If your theory of rigidity at the end of the board is correct, the strength of the construction and weight of plate enters into all these matters of rigidity. A light plate then would detract from the rigidity, a heavy plate bettering the tone."

F. E. Morton: "Is it a matter of weight — volume of material — or disposition of material?"

C. C. Chickering: "Weight makes rigidity and if you distribute your weights properly, it ought to add to your rigidity and length of your vibration."

F. E. Morton: "I think we agreed that the plate was most efficient when the tension members and compression members were complementary. When we have a greater volume in compression member than tension member, we have too much plate, or we have too little plate, depending upon whether it is the distribution of material or the volume which makes it most effective."

R. H. Waud: "In going through our factory, we could discern when a man was tuning at the lower end a stepped out bridge or a solid bridge. The carrying power of the stepped out bridge is greater than that of a solid bridge."

C. C. Chickering: "Instead of stepping out the bridge suppose we use a solid one and add two inches or three inches?"

R. H. Waud: "A stepped out bridge gives a sweeter tone and more carrying power."

F. E. Morton: "Julius Bauer & Co.'s new construction grand secures this effect by means of small posts. It certainly is effective. I fully agree with what Mr. Waud says about cutting out the bridge between ribs, for I have tried it where the piano apparently has been hopeless and it has given it life."

R. H. Waud: "It is in effect the difference between a snare and bass drum."

C. C. Chickering: "In one of our little grands we thought we could improve the break between the treble bridge and bass section, doing away with what we called the 'tubby' tones. We cut out the corner of the board entirely, stopping it at the last rib. We tried that on perhaps four or five of our small grands and at first we thought we had improved them. We got to running the piano through on the older types of construction with sides glued down and couldn't see any practical difference. I merely mention this to show that sometimes apparently freeing up the board does not give any practical improvement that can be discerned by the ear. I have in my own home a six-foot grand built in the same way, which is a very satisfactory instrument, but do not know that it is different from any other. Many of these experiments at first promise well, but ultimately we find they do not work out in practice to allow of the extra work. It would seem theoretically that it ought to free up that corner of the piano."

R. H. Waud: "With stepping out the bridge down to the lower end and tapering it down as thin as possible you will find a very great difference. Taper it off and lead it into the upper end of the bass bridge. This is a good way to 'break the break.'"

C. C. Chickering: "That is true, but on a piano five feet long there is little room for that extension."

R. H. Waud: "There is room. From the last string you can get four inches without getting into anything."

E. E. Beach: "I once came across a piano that had a dead sound in the upper part of the bass bridge that could not be accounted for. The strings had the proper bearing and everything seemed to be all right. I took a hammer shank and cut it so it set firmly but not too tightly. I found it had corrected the trouble. I think if the treble bridge is properly planed to conform to the crown of the board, it often improves the tone. I tried a board which was not blocked but glued. Contrary to all theories it turned out well."

F. E. Morton: "Mr. Deutschmann, what is your observation of the different methods of bass bridge construction?"

Chas. Deutschmann: "I cannot say very much about it. I notice the violin bridge is stepped out.

W. F. McClellan: "If the board is good, the bridge set the same, etc., suppose we spoil that with too much side bearing, has it ever been determined what the effect of side bearing would be? Has there ever been any investigation as to how much side bearing is necessary or beneficial? Generally we find that the board is anchored — there is too much side bearing. It seemed at the time to give results. I have at times complained that the treble part was absolutely dead and on changing the side bearing very noticeable effects have been obtained. By side bearing I mean the angle across the bridge — the stagger of the pins."

J. E. Jennings: "The usual practice is to set the pins exactly in line with the center of the string. I know a piano where the front pin is so set as to increase the angle. The bridge will 'pull' a little. You cannot easily notice the forward pull, but the bridge will tilt toward the bass side. To offset that I insert the first pins a little toward the bass side to get equal angles on both sections of the string."

R. H. Waud: "The heavier bridge pins we put on the greater the angle. My experience is that the bridge crowds toward the bass. Any stretch from the back string will tend to pull the bridge forward. If set toward the bass side it will be equalized."

F. E. Morton: "Pins are staggered to give the string lifting power. A sounding board is supposed to follow the motion of the wire. If the pins are not staggered the wire will carry it up only one-half the distance and you only get fifty per cent efficiency. When you have gripped the string with the bridge pins sufficiently to lift the board, the function of the stagger is accomplished."

W. F. McClellan: "My attention was called to a grand where the bass bridge was staggered reverse."

R. H. Waud: "That was put in to save the draw on the bass bridge all one way. You will find the single strings are drawn one way and the double the other. That equalizes the side pull."

F. E. Morton: "I made a few experiments on bridge bearings and the addition of any metal apparently cuts the sounding board out of that much work."

J. E. Jennings: "You spoke of a narrower bridge with the pins closer together. Were they kept in line?"

F. E. Morton: "Insofar as I was able I kept the same relative position and angle as in ordinary practice."

R. H. Waud: "Have you done any experimenting on the gluing surface of the bridge to the board? Do you get better results with less gluing surface on the sounding board?"

F. E. Morton: "Not as much as I expected. I think, however, that with a narrower bridge if allowance is made in the setting of the pins, setting them as you would with a bridge of full width, the effect is good."

C. C. Chickering: "Make the bridge V-shape so it has a small surface at the bottom?"

F. E. Morton: "No. It doesn't seem to me that you can get as good an effect. In a grand where the tone was unsatisfactory in the bass and lower part of the treble, cutting one-eighth inch from the bridge and bringing the pins to the same angle did have a very good effect and removed a great deal of the difficulty. There is no question in my mind but that a narrower bridge in the case of the small instrument, where you are obliged to use a stiffer wire (whether

made stiff by tension or excessive winding) you will find a decided benefit from narrowing the bridge. I have not tried it on anything but the small grand."

C. C. Chickering: "I had an experience on a four-foot ten-inch piano. We turned this piano out and the bass was awful. We immediately began to look around for a reason. We changed the bridge to get different striking points. We finally found that there was a section in the scale that was particularly bad and sent to the string makers for a certain number of strings. The new strings were absolutely all right. The piano was then good, no matter where we set our bridges. The trouble was 'rotten' bass strings. When we got this section of good strings everything was all right."

R. H. Waud: "What have you found out about the height of the bridge? Is there any difference at the treble and lower end?"

F. E. Morton: "I have not found any difference of value."

R. H. Waud: "Why is it on the violin the bridge is set closer on the E than on the G end?"

F. E. Morton: "The greater amplitude of vibration of the G string demands more room. There is a great deal of talk in retail stores about the opening of the plate, etc., 'allowing the tone to come out.' I have heard this expression and people seem to believe it. So far as I have ever been able to determine, the size of the opening is just about as important as in the case of the human voice. When you consider the organs of speech, sounding board, resonance boxes, etc., and then note the relative size of the average mouth, it rather gives the lie to that sort of thing. The freedom of the board is the most important factor. Resonance is obtained by the vibration of a confined body of air. In an upright the resonance box is the space between the sounding board and the front of the case. You know from experience that it is rather unsatisfactory to play the average player upright manually. The resonance box is filled up with soft, elastic material, felts, rubber, etc., and the energy is absorbed. The interior has ceased to be a resonance box. If you listen well you can tell by the tone whether or not it is a player piano. In a grand we have a resonance box between the plate and sounding board. If the under construction is filled up with player mechanism, its resonance is destroyed in the same manner."

E. E. Beach: "Wouldn't it be better to leave the top down than to raise it?"

F. E. Morton: "For tone quality and with sufficient space between cover and board, yes, and you will be surprised at the pleasing quality of tone you will get from a grand piano with the top down. I am speaking only of quality. The resonance idea has received less attention than it deserves."

Wm. Braid White: "Inasmuch as the bridge is merely a conductor and nothing else, it would seem, other things being equal, the narrower you can get it the better."

F. E. Morton: "On a sonometer with a thin, narrow bridge, I get a free, full vibration of the board as indicated by spreading sand over the board. If the bridge is glued, the board vibrates less freely and the fundamental is very much weaker. The odd numbered partials come out plainer. When the wire is set in motion, electrically driven, the first sound audible is the fifth partial, then the third. When the string is set in vibration fully, the third partial may be heard very plainly. That is an indication of a poor tone."

J. E. Jennings: "What is your practice in height of bearing?"

J. Klepac: "The height of bearing is generally in proportion to the height of crown. If I crown my board too high I have to keep the bearing in proportion. When my board is crowned less, then I take less bearing. Make the bearing proportionate to the crown of the board."

F. E. Morton: "To what extent does tension enter into your practice of bearing?"

J. Klepac: "The more tension the higher the bearing. The crowning of the board has very much to do with the tone color. Some people like an instrument very sharp. They should not have much bearing on the bridge. A higher crown gives a more 'round' tone. When I know what is wanted I am able to satisfy by changing the crown of the board, sometimes changing the weight of ribs as well as changing the bearing."

F. E. Morton: "What does the tension have to do with the rib?"

J. Klepac: "A higher tension requires a larger number of ribs or else that the ribs be heavier."

F. E. Morton: "The same effect would be given by a greater weight as by higher tension. The loading of the scale effects that as well?"

J. Klepac: "Yes."

F. E. Morton: "The distance from the bridge pin to the hitch pin is a big factor in bridge responsiveness. If the hitch pin is too close to the bridge pin a down pressure on the bridge results, anchoring it and allowing less freedom of vibration. This may account for improved conditions with the same scale in a larger piano over a smaller."

C. C. Chickering: "We used a bass bridge that came down to the board with good results. Now we are using an overhang which is very good. You can take a great deal of liberty with the construction of a piano."

F. E. Morton: "I don't know whether any of you have seen a metal bridge that has been constructed and patented. I think it is called Vanadium. It is made of aluminum stiffened with vanadium. I have experimented with it. One result was rather agreeable.

"Two instruments, one with a wood bridge, the other with this aluminum bridge, were made insofar as practicable the same. The metal bridge added something like fifteen or eighteen seconds tone sustaining over the wood bridge. That was tried in six pairs of pianos with the same result. As to the quality of tone, I will leave that to individual taste. The fact that it sustained longer was accounted for readily by its inelastic condition. If you were to make a bridge of rubber you would have as inefficient a bridge as practicable. Carrying that to an inelastic substance, as an Aluminum with two or three units of Vanadium to give it rigidity and stiffness, gives the other extreme. It gave a sharp, not a crisp tone. I don't think the tone quality we are after in pianos indicates the use of metal bridges. I do think, however, it indicates the necessity of change in wood construction."

Sounding Boards

October 17, 1917

Dr. E. W. D. Laufer, associate agricultural commissioner of the American Steel & Wire Company, presided in the absence of Chairman Frank E. Morton, who was out of the city. Dr. Laufer started the proceedings by an interesting talk on sound board woods and the processes of selection and construction which make for good or bad sound boards. His talk was illustrated with interesting stereopticon views of spruce in its various stages of growth as well as the finished sound board product. Several sound boards were also exhibited. These included the ideal board and others that were practically impossible for piano purposes.

Dr. Laufer's address was punctuated frequently with illustrations, and before it began, photographs of the four sound boards pictured and later displayed were given to each of his hearers. When the first view was flashed on the screen Dr. Laufer began:

"I suppose you all recall this picture from the booklet 'Wood and the Piano Builder's Art.' It is the basic cell with its protoplasm shrunk, due to drying. (Fig. 5, page 69.) That cell is the basis of all life and is made up of the simplest tissue. This second slide shows basic tissue of an equal diameter in all directions. (Fig. 6, page 70.) When the cells become longer, they modify into wood fibres, getting harder and harder, finally giving us the stone tissue you find in hard woods. This, the third slide, shows the characteristic tissue of the pine. (Fig. 14, page 76.) We have tracheids, which you notice are long cells with no transverse walls in between with a little portion of the medullary ray crossing. These are the little discs or vibrating membranes that give to needle-bearing woods their peculiar tonal value. I would like to correct a false impression that may exist in your mind. We speak of wood as a 'tone wood' and wood that is not a 'tone wood.' As a matter of fact, tone is non-resident in wood. Wood has no tone. It simply possesses the power of reflecting tonal waves or vibrations that are transmitted to it. Wood has tonal value but does not possess tone. You must have a body capable of reflecting the energy applied at the key. This, transmitted through the bridge to the sound board and thereby rendered into audible tone waves and re-coordinated, constitutes a true resonance board. This is the true function of the wood in the sound board.

"In this plate we have the same cells in outline. (Fig. 15, page 77.) The disc here is seen in the flat and for comparison alongside of it are ordinary wood cells which are divided by transverse walls.

"Again we have this little tonal disc. The center portion of that vibrator is thicker and runs

off to a fine membrane on either side. (Fig. 16, page 78.) It is like a cup with a hole through it, and this thicker portion occupies the exact center of the hole that passes from cell to cell. When you interfere with that portion in any way, whether by heat, glueing or covering with varnish (such as shellac) or by overheating or drying too rapidly, you will interfere with that little body and it will not work freely.

FIG. 25

"This view is of a piece of old pine showing the annular ring. (Right hand of Fig. 12, page 75.) Notice how close the cells are. I call particular attention to the variation on both sides of the densest portion. These cells are continually getting smaller as we approach the zone of density. If you could have examined this before magnifying you would have found a dark line, indicating a resin portion. Early spring grown cells are quite large and then get smaller as the season advances. The large cells were formed in the early spring when growth was very rapid and stimulated by a great deal of moisture. In forming these bands of well ripened wood, a certain amount of pigment and resin was deposited in these storage cells. The plant

must deposit a certain amount of storage material in these cells so that nutriment can be given to the daughter cells. The greatest amount of nutriment is contained in the annular ring. In the actual board the large cell layer is clear, lying alongside of the resinous grain of a sound board.

"In this plate is the same thing, much enlarged. The center portions are small and the walls thick. They get thinner on the edge and become compressed. (Fig. 13, page 76.)

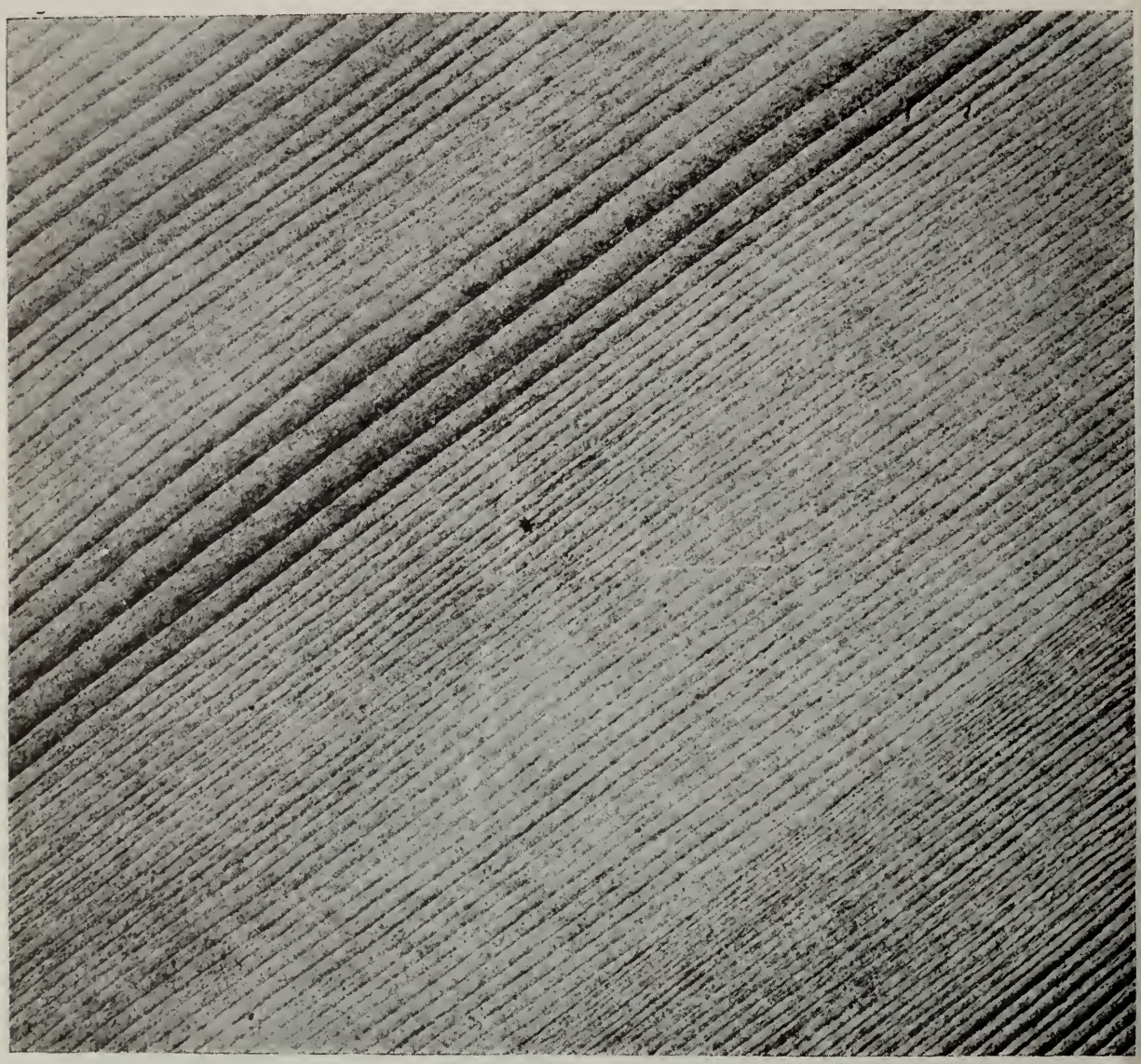


Fig. 26

"This picture is a transverse section through a resin passage. (Left hand of Fig. 12, page 75: also Fig. 23, page 83.) Here are cells on either side. The walls are greatly magnified. This shows the structure of the cell itself, and here is where the starch and coloring matter gathered by the sun are changed to the substance which we know as resin. If you use a cleaning solution composed of alkalies you are apt, on very fine, thin sections of wood, to change the constitution of cells containing resin. If an undue amount of resin is present (shown by resin-bearing cells in the lines of annular growth) or if the annular growth has slowed up too suddenly and the spring growth has been very short, you will secure from it a sound board that has a basic vibration of its own. Such a board will respond with great brilliancy only to the harmonics of its own key note.

"The remedy does not lie with the manufacturer alone, but with the selection of the tree. To produce a good sound board we should start in the forest. Start with the intention that the

tree we are going to fell is to make sound boards. After felling the proper trees, it is necessary that the wood be properly handled from the source to the finished instrument.

"This slide represents a sound board, the original of which I have here. It is a duplicate of Plate No. 1 that you have in your hands (Fig. 25). This board, with an adjusted scale, crown, etc., would make a good sounding instrument, but for a perfect scale and a perfect wire under the proper tension, such a sound board would be worthless.

Fig. 27

"This Plate No. 2 shows the grain of that sound board (Fig. 26). This portion here is a resin line that on Plate No. 1 occupied one one-thousandth inch. This line (D), belongs to the resin layer. Here is where the summer or autumn growth is commencing. If this board were throughout like the section (A) in the center of this view, the board would be good. Here is another piece glued on the board to carry out the beautiful pattern effect (B). For about half of its width it would have made an ideal sound board. It is not so much the wood itself but how selected and put together. There is another thing which might take place with this board—that is the relative moisture absorption would be very different. The continued re-occurrence of those resin strips would at all times allow certain sections to absorb moisture more rapidly than others and cause checking.

"This corresponds to Plate No. 3 (Fig. 27) in your hands and is an ideal sound board or as near ideal as you will find. As regards color, Eastern spruce is whiter; Western spruce darker.

The ideal shade lies between a peculiar pinkish yellow and a yellowish flesh tint all over the board. This should be the ideal for which we should strive because the pigmentation in such wood has taken place equally throughout all of the lumber used in the board. Even this board has its defects. The light lines on the edges of some of the component parts are undesirable, as they are too soft and spongy. The most beautiful part of the board lies through the center. The

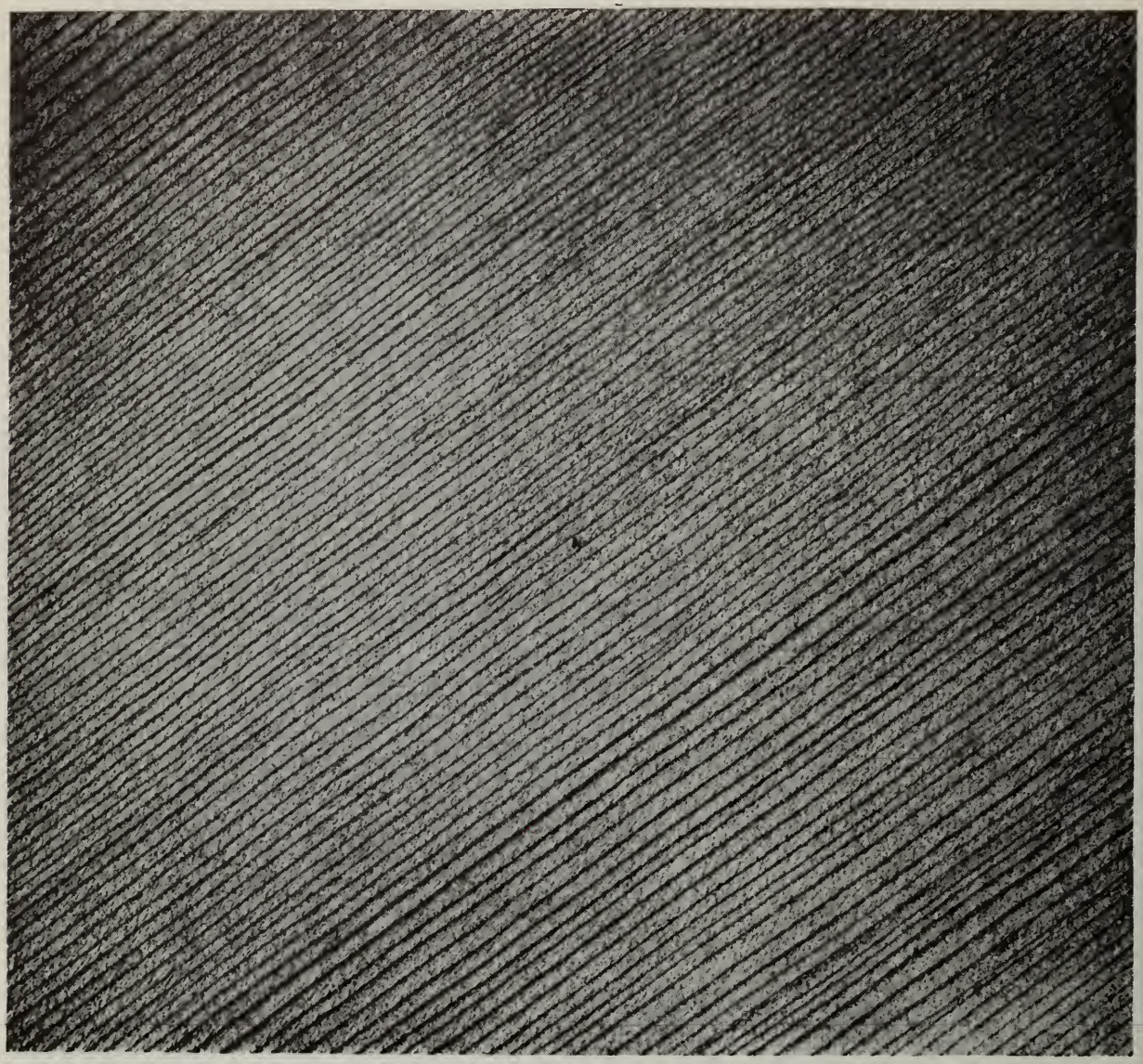


Fig. 28

width of the spring, summer and fall growth is about the same. The cushion effects of spring growth are overcome by resin bodies and vice versa. Fall grown bodies are cushioned by soft spring growth, hence this board is uniformly responsive. It is neither loud nor soft; neither dull nor raucous. With an ideal scale, this board will make an ideal piano, all other work being properly executed.

"Plate No. 4 (Fig. 28) shows an enlarged section of No. 3 (Fig. 27). The general appearance of the grain reveals that the wood that went into it was grown slowly. It took many years to perfect the tree or trees from which this board was put together, and more than ordinary precaution was taken in selecting the wood.

"The question has been asked: 'Why can't we use pine for sound boards?'

"There is no dominance of the annular rings of growth. It is all cushion. A dull tone would result.

"(Board No. 1.) Here are the boards themselves. Notice the lines of growth are not straight. Those are the lines the vibrations will follow. It has not yet been determined which is the livest part of a sound board. Is its livest part in the exact center or its greatest undulation at the sides? If that board in its vibrations is livest in the center, then all waves would run toward a false center. The longer the fibre, the better its tone carrying power, consequently there may come a day when we may have to revise our accepted standards of glueing up sound boards and we should strive to leave the board as free as possible to go through its undulations.

"(Board No. 2.) Notice the beautiful evenness of that board. There is a light streak running through the center. That is sap wood. That should have been ripped out. It grew too rapidly. Another thing is the width of some strips. The putting together is at fault. The ideal board should be made up of strips of equal width. The grain should all run one way. Many times the reverse on a grain will cause a section of the board to appear whiter than the rest. I should like to see that board in an instrument with an ideal scale. It promises an ideal instrument.

"(Board No. 3.) Here are spots showing the result of insect depredations. Spots of that kind are apt to result in certain tones being dull."

C. C. Chickering: "How did you arrive at the conclusion that the spots on the board were responsible for dull tones?"

Dr. E. W. D. Laufer: "There are no resonating bodies there. The discs are destroyed and their places filled with cork tissue. If you vibrate one of those lines, you will find the vibrations will not come through. We are working under great difficulties because to microscopically treat a board is practically impossible. It takes a very sharp eye to discern this difference in the entire board. When making a microscopic section you must take off a slice that is so thin that it is transparent. To make it more transparent, it must be treated, and as soon as it is treated it loses its value. It is rather a question of taking two and two and putting them together that determines these factors than the actual demonstration. Mr. Morton, Mr. Brown, Mr. Klepac, myself and various others have worked hard to get something that we could show you graphically."

C. C. Chickering: "I got the impression that you thought the varnishing of the board was a detriment."

Dr. Laufer: "A certain violin maker said he had constructed an instrument which he believed would be wonderful if not ruined in the varnishing. That is a confession. Shellac is the worst thing to put on a sound board because we are creating a shell over the board. It is resin, hence it possesses dominant vibration of its own. Instead, we should use a gum resin or a common resin that is soluble in spirits or in turpentine. Give the board a coat of raw linseed oil, which is vegetable substance. Instead of using a brush, rub the board all over; also sear the exposed edges of the board with a hot iron. It is impossible to dry out any board to such an extent that no water remains in the cells themselves. A certain amount of water always is present. Your sound board should be protected at the edges rather than on the outside surfaces only."

C. C. Chickering: "Do you believe that rules and regulations in a violin belly are applicable in the piano sound board?"

Dr. Laufer: "Yes. The small volume and comparative area of the sound board of the violin is one of the greatest keys to the resonance-producing properties of a sound board."

C. C. Chickering: "You produce a tone so differently in a violin. One is drawn by the bow, the other emanates from a blow."

Dr. Laufer: "The tone of the wire is produced by its commencing to vibrate and then to segmentate. If we bow the wire to cause it to segmentate, if we blow it with air, or if we hit it with a hammer which quickly flies back, the result is the same, namely, vibration. We must re-coordinate the energy applied to the wire or string into audible tone waves by the sound board no matter whether it be on a violin or any other instrument."

C. C. Chickering: "Would it be your theory that a sound board would improve with age and use?"

Dr. Laufer: "Yes, if properly constructed. We all may differ there. I have seen old instruments that are better today than when built. The reason for deterioration is in the varnish and the ribbing of the sound board. It is not in the inherent quality of the board. Most of the boards we are speaking of have been mistreated and the board is carrying a lot of shellac. As the shellac disintegrates, it affects the value of the sound board."

C. C. Chickering: "If such a thing were possible as disintegration, it has always seemed to me that the old board has lost its vitality."

Dr. Laufer: "A violin is carefully placed in a case or in a bag. A piano is put anywhere. It is wet, dry, hot and cold. It is true that such conditions will de-vitalize the wood. Where the breaking down of the wood itself takes place, your contention is correct."

C. C. Chickering: "Don't you think the old piano loses its belly?"

Dr. Laufer: "Yes."

H. H. Arnold: "I would like to ask your opinion on one point. Inasmuch as the bellying of the board is largely created by the ribbing, there is a certain tension. You offset that by bridging on the other side, which leaves the board in a cramped position. Will those fibres become crushed together in time?"

Dr. Laufer: "When the board is new and is first placed under tension, it is between the two and offers a resistance to both sides. With constant vibration sooner or later a point is reached, neutralizing effective vibration."

H. H. Arnold: "If the ribs were taken off an old board very carefully, the board cleaned up and re-ribbed, would it then be a better board on account of its age?"

Dr. Laufer: "It should. As a matter of fact, I would like to see that tried out. Without being too emphatic, I believe you could take a board out of an old grand piano, cut an upright board out of it and put it into a new piano and get a fine tone."

C. C. Chickering: "The practical maker would take the bridge off and put it back on a new board."

Dr. Laufer: "The contention was that the board had not lost any of its energy and that it had improved in carrying power. If the vital energy of the wood when converted from the tree to a sound board is destroyed by the process, it had better not be put into an instrument."

H. H. Arnold: "That being the case, the old violins have certainly got a thin piece of wood for a sounding board and, besides, it is very old, consequently it must take a long time to disintegrate wood."

Dr. Laufer: "Such wood simply retained its original vitality."

H. H. Arnold: "According to this, then, if we didn't destroy the vitality at the beginning and it was left in there when the piano was completed, it should take a long time to disintegrate."

Dr. Laufer: "Yes."

H. H. Arnold: "Have you tried out the difference between the sounding board constructed of fir and that of spruce?"

Dr. Laufer: "No. I do intend for the next meeting to take up the question of substitution of woods for sounding boards."

H. H. Arnold: "We did use a fir some years ago. We found the tone qualities in such boards fair—in fact, if anything, more brilliant than the finest of spruce, but owing to the fibre of the wood not knitting as closely or as permanently as it did in spruce, we had checks. The color also is very much darker, which was an objection, but it seems the annular growth of fibre was not knit as closely as in the spruce."

Dr. Laufer: "That was undoubtedly due to the crossing of the medullary ray. The medullary ray produces the grain of silver grained spruce. In other words, the medullary ray in the spruce is so perfect you can hardly quarter saw a good piece of spruce without producing that characteristic cross grain which causes the knitting. Mr. Arnold is correct when he says that fir does not possess this grain to the degree spruce does. We have those medullary rays in pine but they split into strips rather than wide bands that extend through the same layer of cells."

H. H. Arnold: "We did find, however, that the fir has a longer fibre than the spruce and, because of this, has a tendency to give out a clearer tone."

Dr. Laufer: "There may be woods in existence that will give better results than spruce. As Mr. Arnold stated before, the color of fir was a drawback. We may have to revise our ideas of color. Linseed oil also would darken the color somewhat."

H. H. Arnold: "If you were to thin the oil a little with turpentine, thereby giving it a greater penetrating power, would it do any harm if it went through the board?"

Dr. Laufer: "If you carry too much linseed oil you might produce a gummy condition of the vibrating membranes. That would be just as bad as putting on shellac. In regard to grading, it must commence at the saw mill, not in the dried lumber pile. It should commence at the tree. The result will be all light colored spruce or whatever other lumber is used in one pile; medium in another; darker in another. Dark would be preferred for loud, brilliant instruments. Medium would make an ideal instrument. Light would cater to a tone that some like for a small room."

H. H. Arnold: "Would you think, then, that the so-called first cut of the tree after it was felled would be the ideal cut?"

Dr. Laufer: "If I were going to fell a tree that was grown under normal conditions, I would not use the first eight feet over the stump. Out of a one-hundred-foot spruce there is usually sixty feet to the first branches, and I figure I could get thirty to forty feet of good sounding board stock from this. When the tree is felled, the method of handling the bark on the tree would be a great factor. We have starch, sugars and cellulose to deal with, all capable of fermentation, hence we must be careful to bark the trees at once. Perhaps you have run across old instruments where the board has crumpled. Fermentation has taken place in the wood and it has pulled the individual fibres all apart. There is no cohesion between the fibres."

F. Schumacher: "Have any experiments been made with vibratory metal?"

Dr. Laufer: "Sounding boards have been made out of metal but apparently without success."

H. H. Arnold: "Do you believe that in the ribs you should use a long fibre wood, or doesn't it make any material difference?"

Dr. Laufer: "I believe you should use a long fibre wood. You should use a wood that is in growth very closely related to the wood you are ribbing. If you are using a light colored spruce, it would be advisable to use a light rib—a rib that has grown rapidly. If you are using a slow growth wood, use a slow growth rib."

C. C. Chickering: "Do you consider that the dark colored wood, irrespective of where it is grown, is hard?"

Dr. Laufer: "It is harder than the light."

C. C. Chickering (indicating two sound boards on display): "Is that a harder board than this light one?"

Dr. Laufer: "Yes. The dark color is due to minerals. Undoubtedly, the mineral in the board that gives the reddish color is iron, hence the iron oxide that is formed within the cell itself gives to each of the cells a harder wall than is the case where the pigmentation has not taken place. I am speaking of the general color. These darker zones owe their quality to the resin. The general tone of the board is due to the deposit of pigment rather than resin. Take a piece of yellow pine. You might have a piece of Georgia pine which looks pretty light. If examined it would be found to carry more resin passages than one that would be considered darker."

C. C. Chickering: "In a general way you would consider the Washington spruce harder than the Vermont?"

Dr. Laufer: "Yes, if grown under the same condition."

C. C. Chickering: "The question of color is not final."

Dr. Laufer: "No, but you must remember that pigmentation is also a carrying power. We have a lot of little molecules. The mineral is seeking to combine with the carbon of vegetation, hence there is a vibration between those two. When the vibration of the wire starts on these millions of atoms you will get two vibrations in juxtaposition to each other until the point of neutrality is reached. Then it will express itself in co-ordination. Your pigmented wood, then, will give a louder, more forceful and resonant quality than the lighter, because the resin and pigment transmit more quickly from point to point."

H. H. Arnold: "Wouldn't the wave traveling back over the board check the vibration?"

Dr. Laufer: "Yes. Probably you have all seen Mr. Morton's illustration with the jumping rope. It breaks into segments. That also takes place on the sound board, hence a perfect board must be capable of recording the segmentation with equal facility and rapidity, as the first fundamental impulse."

Substitute Woods

November 7, 1917

F. E. Morton: "The question of substitutions came to me through statements that first grades were becoming second and third grades and that certain woods were becoming scarce. While I am not in favor of that substitution in time of plenty for the purpose of evading de-

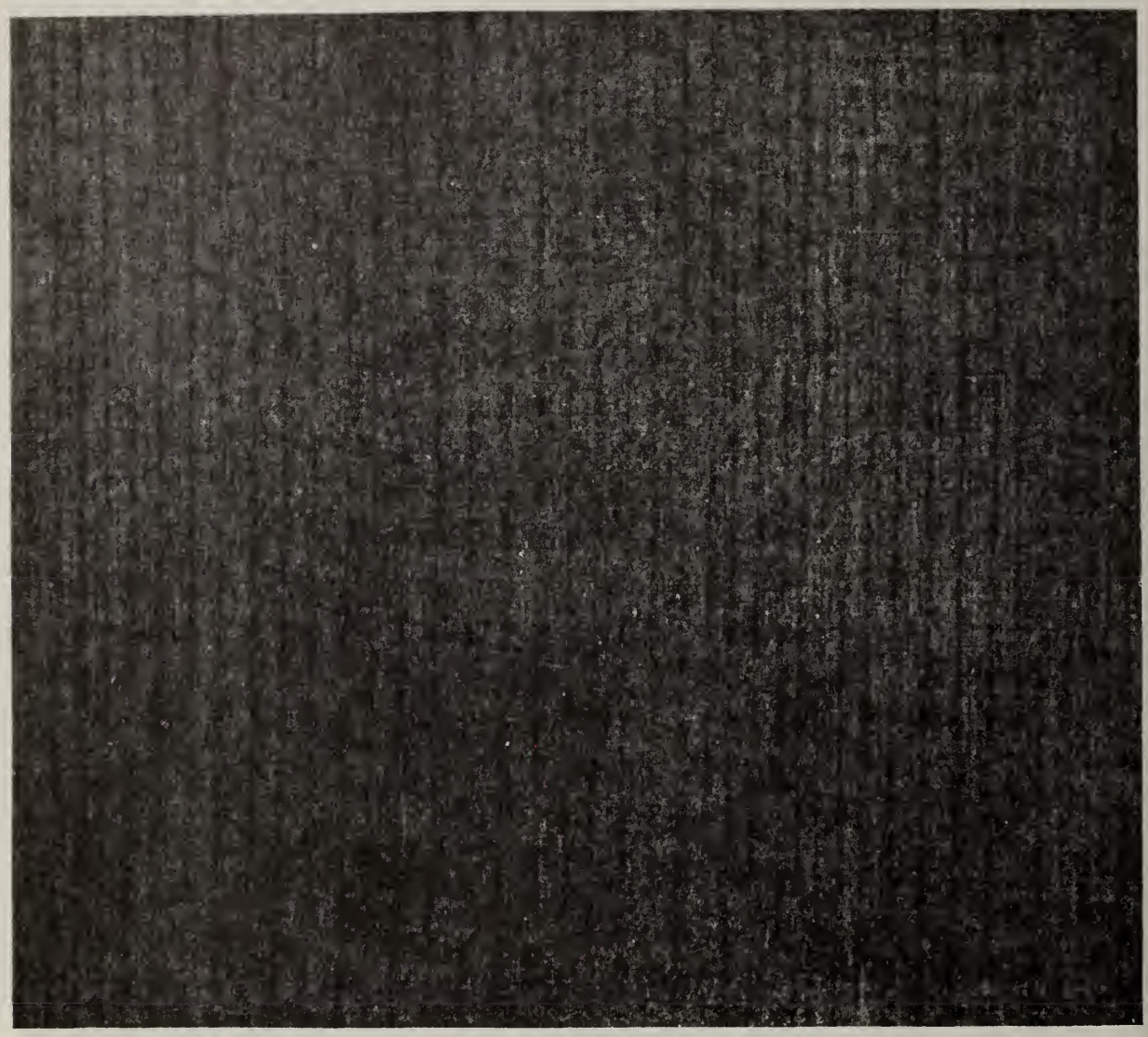


Fig. 29

mands or reducing costs at the expense of the consumer, I recognize the necessity of anticipating the scarcity of any material which we must have in our daily work. I therefore have confined the research of the summer to that alone. Twenty-five or thirty substitutions have been suggested to me—more than half of these offered by those interested in their preparation or sale. Out of the fifteen or twenty examined, a very small proportion have proven practicable. In our laboratory we are working with small units. We will work out the theories insofar as we are able and give you the deductions. The practical application of these theories or the possibility of adapting these theories to your use should be discussed here and are presented for that purpose.

"You have been shown the requirements of an efficient sounding board wood and the character of responsive and unresponsive boards. You have been shown alternate layers of vibrating material and 'shock absorbers,' respectively. In some of this week's music trade papers and

this month's lumber journals you will find a summary of that which we have discovered, but the information contained therein is for the immediate attention of the lumberman—the man who furnishes you with your sounding boards. They are not directly addressed to you because the process has been finished before you get the boards.

"It would seem, however, that the indirect value makes it worth while to the piano manufacturer. If you know exactly what the lumberman is supposed to do for you, when you receive your boards you will be able with the help of those directions to check up on the material furnished and become a more scientific specifier to the lumberman. I have conferred with a number

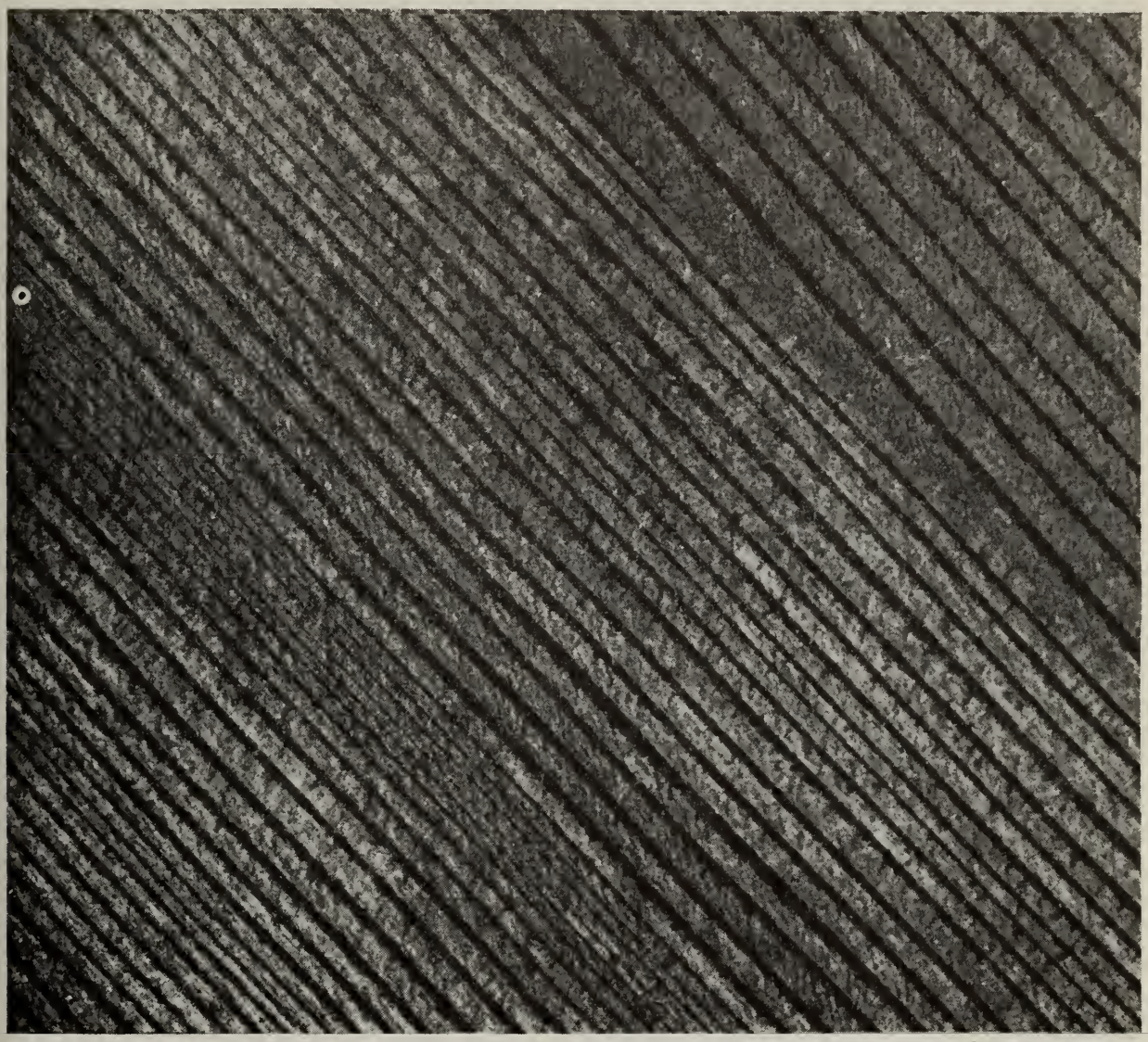


Fig. 30

of the larger lumber manufacturers and all have expressed their willingness to co-operate with you. Heretofore they have been unable to do so because they did not understand your requirements. We have tried to bring you closer together. In the article referred to we have made a resumé of the operation from the growing tree to the finished sounding board, describing each process—what to do and what not to do and why. We require in a good sounding board that every particle of wood responds fully and freely to every key on the piano; wood that is not too hard, because if it is too hard it will only respond to its own key note. If too soft, it will not respond to any key. With a soft piece between two harder ones the center piece becomes a 'shock absorber,' and the energy in the two outside boards will be communicated to the middle board—the vibration of the particles of that board are one upon another—and a friction created so that the energy passes off as heat.

"Here is a photograph of quarter sawed cedar (Fig. 29). A man purchased some of this cedar and made a violin from it. He wrote a letter extolling the virtues of this wood and its great tone value. On the strength of that letter I made an exhaustive study of this wood. Some of the results from this wood were excellent. Dr. Laufer, will you tell us the distribution in that wood of the hard and soft portions?"

Dr. E. W. D. Laufer: "The distribution of hard and soft layers in that wood is exceptionally good. It is about equal. If you will examine the photograph you will find there are no definite lines of contrast. The darker lines represent harder portions, the lighter representing softer portions. There seems to be no definite softness in the soft bodies. The spring growth is almost as dense as the fall growth in this wood. It closely resembles spruce because it has medullary rays running crossways of the grain, giving it very close adherence resembling silver spruce."

F. E. Morton: "Treating this cedar, in the form presented in the sample, and for the immediate present, would it make a good sound board?"

Dr. Laufer: "From a standpoint of vibratory action alone it would."

F. E. Morton: "This is photographed from a fir sounding board which has been used for some time, and here is the board from which this photograph was taken. (Fig. 30.) Will you describe the vibratory action and construction?"

Dr. Laufer: "Here we find a strong resemblance to spruce. The spring and summer growth remind one of the 'wool strands' in the ideal sound board. It differs from spruce in that the strands are nearly as wide as the winter growth. In this particular section of board there is a very narrow band that closely corresponds to that found in spruce where the cells are close together, but there are not enough of them.

"A broad band appears on one corner. The wood appears shell-like. It is not a clear tested 'wool strand.' Looking at the lower portion we find a sort of twist around a common center. Another thing standing out prominently is the lines which are not intercrossed by medullary rays as in spruce. The cohesion I spoke of before is not present in this wood. The general appearance (and tests bear it out) is that this board would produce a round and brilliant tone."

F. E. Morton: "Would you say you had a greater proportion of shock absorbers than shock conductors?"

Dr. Laufer: "Yes."

F. E. Morton "Then we might say if the selection only took in the finer grain, the closer grain, we would have a sounding board closely approaching spruce in its immediate vibratory effect. Can we say that fir and cedar may have, through proper selection and treatment, those characteristics essential to a good sounding board?"

Dr. Laufer: "Yes."

F. E. Morton: "That is for the immediate present. Merely tested for sounding board purposes, properly selected wood gives excellent results. If that were all you would have a substitute right there and a good one. There comes another point. Given a piano with a sounding board of either one of these materials, what is the piano going to sound like in five years? Please tell us, Dr. Laufer, the experience we have had in investigating that side of it."

Dr. Laufer: "In this wood I want to call attention to the fact that the wood constantly gives off a volatile oil. The peculiar camphor-like odor is due to the ebullition of this oil. The oil is what makes the wood staple. When the oil is gone, the wood is of another nature than at present. The inner portions of that wood, especially thick pieces, would retain the oil for quite a long time. A sound board is naturally of small section and it might be possible, with proper protection, to retain that oil indefinitely. The wood also 'shells out' in the form of short bands between the winter growths. The summer and spring growth is apt to chip off in little layers. This is demonstrated in this sample at the sawed edges."

F. E. Morton: "That would be the process of disintegration of the wood after the oil had volatilized?"

Dr. Laufer: "Yes."

F. E. Morton: "This process, then, of disintegration begins at the point where the evaporation is greatest. Given a piece of that wood in a room heated to a temperature of 78 degrees by steam heat with the sawed end free, open to the outer conditions, how long before it would begin to disintegrate, the constant use of the piano acting as an irritant?"

Dr. Laufer: "It would not stand two weeks."

F. E. Morton: "To what extent would that apply to the fir?"

Dr. Laufer: "The cedar does not disintegrate within itself. The fir breaks."

F. E. Morton: "The evaporation of volatile oil or sap will begin at what point?"

Dr. Laufer: "The sap produces cohesion between the cells. The transitional stage from winter growth to spring growth is pithy. The line of break will follow the line of winter growth. You could rip out every dominant portion of that sound board."

F. E. Morton: "How about the effect of expansion and contraction in transition from summer to steam heat?"

Dr. Laufer: "It would split into slivers instead of breaking into pieces. That is the cause of splitting sound boards."

F. E. Morton: "Isn't it true that if the cedar could be protected at the sawed ends, the sides and the edges of the board be mechanically protected from the outside atmosphere, that board would have considerable life?"

Dr. Laufer: "I believe if the flat sides were coated with a substance more or less waterproof, as an oil or certain glue size, ordinary room temperature would not produce volatilization. The protection of the edges would largely be a process of searing. Simply to iron it with a red hot iron would effectually protect it."

E. J. Fishbaugh: "Is it a fact that a preparation of China wood oil is a protection?"

Dr. Laufer: "China wood oil might answer. As a matter of fact, I should say if you want to preserve the quality of the wood I would not varnish it. You will spoil the tone carrying and reflecting qualities."

E. J. Fishbaugh: "If China wood oil is capable of keeping out the moisture wouldn't it be all right to put it on the end?"

Dr. Laufer: "No. The tops are open. You would simply pour oil in there and saturate the wood."

F. E. Morton: "Summed up, to make a good sounding board of cedar cover the surface with some waterproofing substance and sear the edges. To what extent will that process apply to fir?"

Dr. Laufer: "I think that fir is almost a forlorn hope. It gives brilliancy but lacks cohesion."

F. E. Morton: "From the samples submitted of cedar, will that, under proper treatment, make key frames?"

Dr. Laufer: "Yes."

F. E. Morton: "There is nothing in the makeup of them that would give them any disadvantage over any other wood?"

Dr. Laufer: "No."

F. E. Morton: "How about back posts?"

Dr. Laufer: "I have not seen specimens of this wood in the large cube. It is a question of selecting, cutting and preparing on the part of the lumberman."

F. E. Morton: "The real value in cedar lies in its adaptability to the making of key frames and has the advantage of a big talking point. No moths; no mice. There is your mouse, mothproof proposition, and as such I know would be accepted by the people. Mr. Whelan, from a salesman's viewpoint, would that be a valuable asset in a piano?"

E. Whelan: "Great."

E. J. Fishbaugh: "Is it hard enough for action rails?"

F. E. Morton: "Dr. Laufer, will that wood stay put?"

Dr. Laufer: "The thin pieces have acted pretty well under steam. The quarter sawed has stayed put so far—that is, in thin sections."

F. E. Morton: "It would be a valuable asset to introduce volatile oil in a piano. Have you found any particular use for the fir in the piano?"

Dr. Laufer: "In heavy sections it might be useful—any place where you required a board approaching the dimension of a plank, but not as good as other woods."

G. Lufkin: "Fir is used in making key beds."

E. E. Beach: "How does it compare in price?"

F. E. Morton: "I haven't dared think of price. I want to leave that to the man who sells it. We may be able to get some information on cedar."

E. J. Fishbaugh: "Would that make available core wood in the lower grades?"

Dr. Laufer: "It should. It would be fairly free from knots."

F. E. Morton: "What would be the effect of glue on that wood with the volatile oil in the wood?"

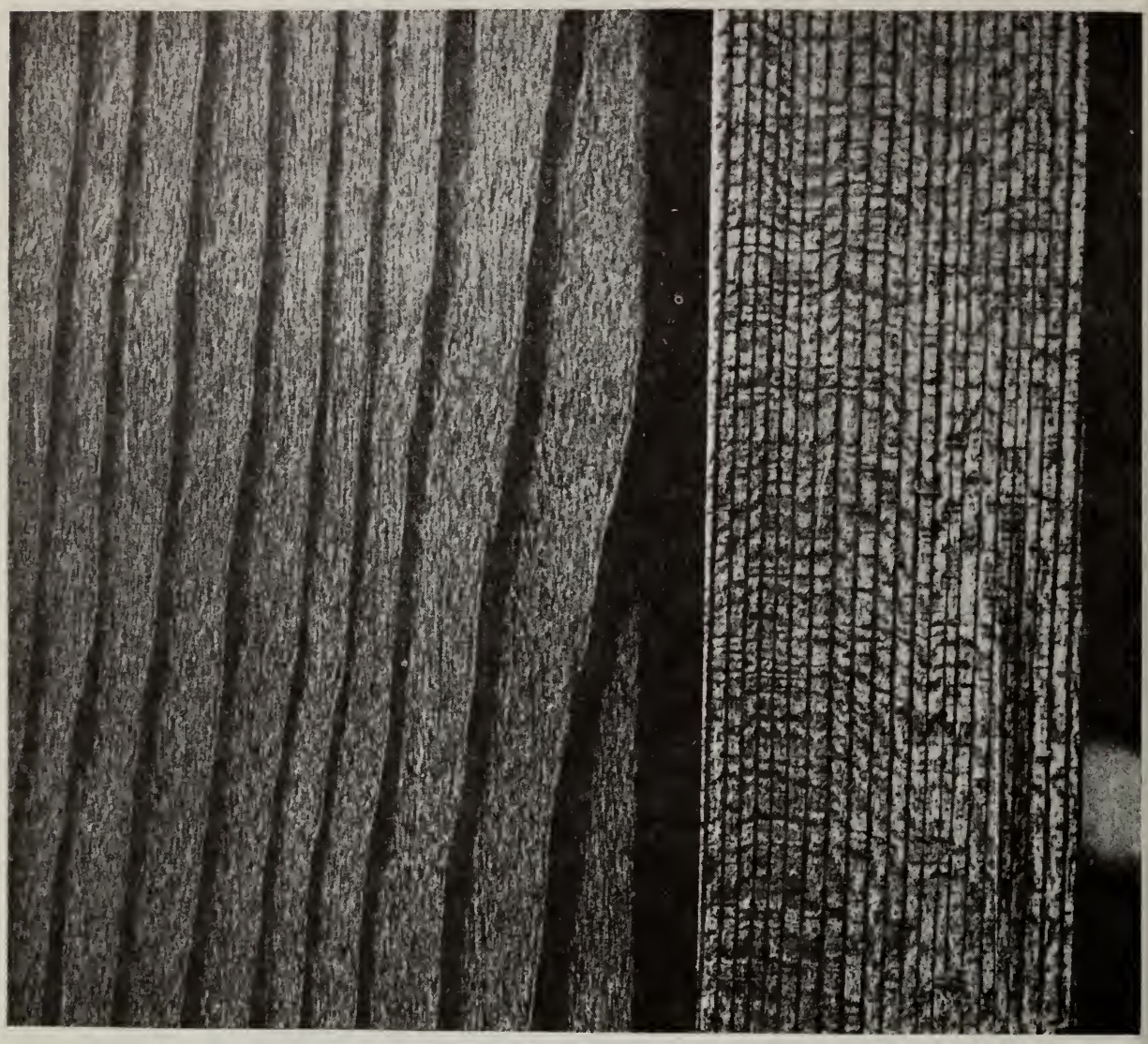


Fig. 31

Dr. Laufer: "The upper portions would be sufficiently free from oil to take glue thoroughly."

E. B. Bartlett: "Would it be equally effective with glue?"

Dr. Laufer: "Yes, it would."

F. E. Morton: "How about a casein glue?"

Dr. Laufer: "I had in mind a casein glue for treating it. Probably a casein glue could be found. It would be the ideal way of preparing the wood."

E. J. Fishbaugh; "Is linseed oil porous?"

Dr. Laufer: "No oil is a better protective than linseed. You have been led to believe that all paints depend upon lead or zinc for protective value. This is not so. Boiled oil differs in that it is apt to become more tacky. The raw linseed oil is absorbed more readily. The drying properties of raw linseed oil are practically the same as the boiled. Lanoline is the preservative of the oil. Your glue joint would be made before the linseed oil is applied. Don't put it on with

a brush. Rub it on with a cloth. The basic treatment is linseed oil, otherwise it wouldn't stand. It fills the pores. It is the greatest oil we have for that purpose. There is no substitute for it."

F. E. Morton: "We have here another wood—larch. This is a good picture showing flat and quarter sawed. (Fig. 31.) What is the relationship of the quarter sawed to the cedar?"

Dr. Laufer: "This wood differs from the cedar, as you will see by the photograph, in being much closer grained. It possesses one of the most beautiful quarter grains. When we pass this specimen around you will agree with me. It also possesses cohesion. If you will saw a piece of this wood one-eighth inch thick and try to split it you can't get more than one-half inch or three-fourths inch off at once. It will not split freely like the fir. It is tougher than the cedar but it is decidedly more heavy. This wood, as its name indicates, comes from a tree that is not a true needle wood. It belongs to the conifer family. It loses its needles in fall and gets new ones in spring. It possesses the vibratory properties of a conifer or evergreen and the cross grain of a medium hard wood. It acts very much up to the analysis. It shows all the properties of a close grained wood and at times is liable to be erratic. If it were not for its great weight I should say it would make a good sounding board. It would make a good sound board for the bass section. We have not made a sounding board from this wood."

F. E. Morton: "It would, because of its hardness, be a very excellent reflector of tone. It might be used to good advantage for back posts—unless we find some point not covered."

E. J. Fishbaugh: "Will larch wood stay put?"

Dr. Laufer: "There is no reason why it shouldn't stay put."

F. E. Morton: "Mr. Hall, is there an ample supply of that wood?"

Sam. A. Hall: "Yes."

F. E. Morton: "Is the price such as would make it interesting for that purpose?"

S. A. Hall: "The clear grade in the wood 8 and 10 inches wide S 2 S to $\frac{25}{32}$ inch is worth at the present time, $35.50 delivered, Chicago."

E. J. Fishbaugh: "What would 12/4 be worth cut clear?"

S. A. Hall: "We have never cut this thickness except in common dimension. There is no reason why it shouldn't cut to 12/4 clear. It would be between $50.00 and $60.00. I would not recommend it for core stock. We use that wood in manufacturing silos. We find there is less contraction and expansion than any other wood we have."

E. J. Fishbaugh: "What would be the effect of taking it from a temperature of about 80 degrees, steam heated, and putting it into a temperature of about 40 to 60 degrees?"

S. A. Hall: "They use it for drop siding on buildings in Dakota where the temperature varies from 40 degrees below to 106 degrees. This fills the bill. I would not recommend it for core wood but it would be all right for posts and backs."

F. E. Morton: "One thing is certain. You may strike a two by four piece of that larch and it rings like a bell. Used as a bearing for vibrating wire it reflects like an agraffe. That means tonal value in the back. As to whether it would 'stay put' is up to the lumberman."

H. H. Arnold: "Have you had any experience in kiln drying larch?"

S. A. Hall: "We don't attempt to kiln dry it."

F. E. Morton: "What length of time is required for air drying such as the sample submitted?"

S. A. Hall: "We can put that down to shipping weight in about sixty days in proper drying weather."

H. H. Arnold: "What weight would you consider the wood should be if in shipping condition?"

S. A. Hall: "One inch, surface one side or two sides 2200 is the association weight. Timber and plank about 2800 lbs. 2-inch dimension surface to 1⅝-inch to 3⅝-inch 2400 lbs. association weight."

F. E. Morton: "If in sixty days it will come to shipping weight, what is the relative prospect of air drying for the purposes noted?"

Dr. Laufer: "The wood would have to dry from three to five years, properly seasoned under cover. It should be dried on cleats. It should not have more than 5 per cent moisture."

J. E. Jennings: "What do you think of the wood for ribs?"

Dr. Laufer: "It has the reflecting property and strength. If you could season it to the proper condition, it would make excellent rib stock. It has the proper weight."

W. Hehr: "I made a few pianos and used larch for rib stock. The results were good. I have a piano in my own home made from the same rib stock. It has been on hand for ten years. We use a small kiln with an oil stove to re-dry."

Dr. Laufer: "It breaks up into little chips. Its binding properties are wonderful."

F. E. Morton: "How do you find the wood works, Mr. Klepac?"

J. Klepac: "I have found it very easy to cut in any direction. It is good working wood."

F. E. Morton: "Here is some Idaho cedar. How is that for volatile oil?"

Dr. Laufer: "It hasn't any."

F. E. Morton: "How would it differ in its tonal value from the other cedar?"

Dr. Laufer: "It hasn't the tonal value of the other cedar. Its grain is shorter. It hasn't the length of fibre of the other cedar. The Idaho cedar would respond only to partials."

F. E. Morton: "In my experiments with phonograph tone chambers, I have found that this cedar would be excellent stock and give gratifying results. The few characteristics that seem to stand in the way of its value for sounding boards seem to be particularly adaptive to the needs in tone chamber work. I made a tone chamber of Idaho spruce on which I believe to be correct angles to bring about a completed resonance and the wood responds to all the frequencies of vibration. Tested with a phonendoscope the response is uniform all the way through. An uncompleted resonance gives the effect of sound in a box. A completed resonance gives the effect of sound free from the box and seeming to be in the room. It is the difference between the voice of a 'throaty' singer and one who sings over the teeth.

"We have ribbed our pianos in the past according to the scale loading. What hasn't been done with loading as a guide has largely been done as a matter of tradition. It is possible and can be demonstrated that the board may be ribbed at points that will not interfere with the undulation of the board and that undulation is what we are lacking at present in our boards. We bind it with a bridge and we bind it with extra high tension over the bridge. We interfere with its tonal value by boring holes for nose bolts. We have treated the sound board badly. If I hold this board and strike it here (illustrating) it vibrates segmentally and there are lines of quiet. The vibration, passing from end to end crosses at a point, say two-fifths—a nodal point. If you were to contact at that point you wouldn't interfere with its vibration. Also in stepping out bridges, those points of contact of the bridge and the board may be determined to the enhancement of tonal value. It is not at all improbable that the points will be the same and, therefore, the bridge support point will follow those of the ribs. I want your experiences at any time you try this out. We may establish a rule worked out mathematically whereby, given the area, the thickness and the material from which it is made, a ribbing point may be determined mathematically for the greatest efficiency."

F. Schumacher: "Is there any relationship between the velocity and tone value?"

F. E. Morton: "If you speak of sounding boards the tonal value does not lie in the conduction but in the organization of the wood itself. We have discussed alternate layers of energy conductors and shock absorbers. Velocity is greater lengthwise. There is less resistance lengthwise of the sounding board grain, so the greater the velocity in that case the greater the tonal value."

J. E. Jennings: "Doesn't the velocity change with the thickness?"

F. E. Morton: "No; with the molecular construction. It is only applicable to specific things at a specific point. The conduction of sound by water is good, but water would not make a sounding board. If you don't take into consideration the practical use of the substance, computation amounts to nothing. The value lies in utilization. As Mr. Chickering remarked, 'We take a great many liberties with the sound board.'"

J. E. Jennings: "A number of years ago I made a sounding board with cedar ribs. It was brown in color. The result was very fine. The firm for whom I made it were enthusiastic and wanted some more made. I hunted through all the lumber yards for it but couldn't get any more of that cedar."

Dr. Laufer: "That was Spanish cedar. Would that correspond with Mr. Morton's theory that you were not holding down the sounding board to the extent that heavier ribs would have held it?"

J. E. Jennings: "Yes. Most anything which changes the resistance of the ribs will change the tone. Mr. Morton mentioned another thing—having the bridge connect with the board at the same point where the ribs connect. I made a bridge which connected at points between the ribs. The result was poor."

H. H. Arnold: "Relative to the possibility of ribs made from a lighter weight wood being better—that would be contrary to the statement that the larch wood ought to be a good ribbing wood."

J. E. Jennings: "That could be equalized by making the larch ribs smaller. It is a strong wood."

F. E. Morton: "It takes a larger rib in cedar."

H. H. Arnold: "Inasmuch as it is the aim not to cover as much of the board, that probably would be an advantage, using the ribs smaller in size, not covering as much surface."

F. E. Morton: "Bear in mind the function of the rib is distribution of vibration over the area of the board from the bridge. When a piano is found with a split sounding board near the bridge cutting off from it all the board on the other side and effecting very little difference in its tone, this means the ribbing was not effective on that board or else the ribbing was so very effective that it carries by the split. In any event, the rib is the distributing factor, and as such must be able to carry sufficient energy to energize the area of board through which it passes. It is true that conducting with a smaller area gives an added value to the board."

J. E. Jennings: "The idea of the board vibrating segmentally lengthwise to grain, does not that conflict with the general practice of ribbing closer in the treble and wider in the lower end of the board?"

F. E. Morton: "Isn't it just as nearly probable that in any hit and miss fashion in ribbing you are missing the same undulations? It is not improbable with a varied distance you may be performing a service?"

J. E. Jennings: "We have secured results by ribbing the treble closer than the bass."

F. E. Morton: "You need a better conductor. A higher pitch has greater traveling power than a lower pitch."

E. B. Bartlett: "Is there any sense in the idea that you need a stiffer board in the treble than you do in the bass?"

F. E. Morton: "Not necessarily a stiffer board, but a better conductor. If that can be given by the ribs it need not be given by the board."

E. B. Bartlett: "In speaking of the board, I mean board, ribs and all."

F. E. Morton: "Yes, in that case."

J. E. Jennings: "Is it your idea that a thin board, heavy ribbed, will give just the same result as a thick board with fewer ribs?"

F. E. Morton: "Not the same results, but if your bearing will permit, I think you will get better results with a thinner board. Make your board as thin as your bearing will permit."

J. E. Jennings: "My experience has been that heavier ribbing tended to brilliance. A heavy board would tend to be smoother but lacking in life."

F. E. Morton: "I am speaking relative to the bearing which has to do with the tension. In a high tension scale you require a heavy board, and in a low tension scale you can have a lighter board. Dryness of tone is effected by a lack of bearing. A short tone comes from the excess of board mass."

E. B. Bartlett: "I was interested in what you said about the nodes in a board. It is practicable to secure a lumber of sufficient uniformity so that the nodes would appear in the same relative position every time? Have you gone far enough to determine that?"

F. E. Morton: "I can say that the mass of the board will determine it."

E. B. Bartlett: "The need for substitution is greater in the parts of the piano where greater quantity of wood is used."

F. E. Morton: "We have been led to believe that only a certain spruce grown in a certain area can be used for first-class sounding boards. I find that Oregon, Washington and Idaho spruce is raised that makes excellent sounding boards. I have some. I also find that in making up boards one strip of poor spruce has spoiled an entire board. The board was condemned because of one poor piece. The man who made the board didn't know that would result or that putting a slash

grain in with a piece of quarter sawed would spoil the board. I have in my laboratory a grand sounding board made of slash grained spruce. It comes nearer being the opposite of a good sounding board than anything I ever saw. We have not informed the man who can be of most value to us just what he can do for us. I found in the Idaho spruce magnificent specimens. There is plenty of spruce in the country that is good for sounding boards if we can tell the lumberman just what we want. He has the finest spruce for sounding boards but hasn't been delivering it.

"I have found during the last few weeks by shopping, that salesmen would like to know something about a piano and I found also in numerous cases he didn't know much about the piano. I have been asked by salesmen personally and through correspondence for such points as would enable them to sell more pianos; to be of more value to themselves and their employer. Salesmen are reading these reports and the interest of the salesmen in these talks is established. How much are we interested in the salesman? If it wasn't for the salesman we would not be making pianos. In turn, cannot we be of a little more value to the salesman by giving him the points he needs, and isn't this the place for it?"

H. H. Arnold: "I agree with you and I have been pleased to see some of the retail salesmen up here regularly. They appear to have an interest in their work and are looking for points of information that will profit them."

F. E. Morton: "That is the point exactly. We owe to the salesman anything he wants that will benefit him. By benefiting him we benefit ourselves. I propose that the next meeting be in the hands of the salesman and sales manager, and that they put you people on the grill and ask you such questions as will enable them to sell more pianos, that will stay sold, with an understanding between buyer and seller. If I am right in the sales proposition, what we want is a sellers' market, not a buyers' market. Let us have the sales managers here. Let us have one night when we can get the producer and distributor together and have an understanding. Let us take the 'bunk' out of the piano game."

Salesmen and Technicians Meet

November 21, 1917

In the absence of Mr. F. E. Morton, the Chairman, Mr. James F. Bowers, President of the Chicago Piano & Organ Association, presided. W. C. Heaton, western manager of Kohler & Campbell, was the first salesman called upon by Mr. Bowers. Mr. Heaton said:

"I find that most organizations do all they can to help the salesman, and that the majority of the salesmen are to blame themselves. I have asked 90 per cent to tell me about their particular piano and they were unable to do so. The dealer himself is also to blame because of his lack of co-operation. He does not give the salesman the ammunition the manufacturer sends out in the way of catalogs, literature and selling letters. Pianos have increased 25 per cent in cost and they are better than they ever were before. There is no excuse for backing down or being weak-kneed when asking prices. People do not buy pianos, they are sold. Keep in touch with customers — follow them up. Too many salesmen are to blame for allowing repossessions. There is no reason why a customer should become dissatisfied with a player-piano. It is not the piano they get tired of but they tire of the music rolls they have. If you keep the customer interested in his player through the music roll, you will have less repossessions. By studying your own product, and getting good talking points and becoming familiar — thoroughly familiar — a great deal can be gained. Most salesmen would rather lose a sale than ask someone else to help them. You cannot have enthusiasm unless you know your own product."

James F. Bowers: "We will hear now, if you please, from Mr. Eugene Whelan, secretary of the Chicago Piano & Organ Association and a shining light in the great house of the W. W. Kimball Company, who has some nuts to crack."

E. Whelan: "A number of questions have been given me by different salesmen on the street, but before I ask any questions I want to read a piece that was written by the oldest active

salesman we know in Chicago. He is on our floor today, having sold pianos for forty odd years — Mr. George Schleiffarth:

MISTAKES.

"When a plumber makes a mistake, he charges twice for it. When a lawyer makes a mistake, it's just what he wanted, because he has a chance to try the case all over again. When an electrician makes a mistake, he blames it on 'induction' because nobody knows what that is. When a doctor makes a mistake he buries it. When a judge makes a mistake, it becomes the law of the land.

"When a piano factory superintendent makes a mistake the salesman sells it and the superintendent — well, he should worry.

"But a salesman, he is different. He has to be careful. He cannot turn his mistakes into profit or into a profession, as other people do.

"In fact, my boy, you've got to 'go some' to be a piano salesman.

"Mr. Heaton touched upon my pet peeve slightly — the cost of production and cost of selling. Both are much higher than of yore. A man and his wife came in to look at a piano. It was $400.00. He said.: 'This being war times, you ought to be glad to get $200.00.' The buying public thinks we are making an enormous profit and that everyone in our company is a multi-millionaire. I think that the boys in showing their goods should start their customer on one of two things: That music is not a luxury, but an absolute necessity, or with the fact that an instrument costs a great deal to produce and that it is a beautiful, artistic product. It seems to me that salesmen, as a whole, do not give enough attention to that subject.

"One of the first questions that has been handed to me is: How can you tell celluloid keys from ivory keys? Is it a fact that there is no more ivory in the country?"

E. J. Fishbaugh: "I anticipated that question and I brought a little evidence. I have here a cross section of ivory. I would like to have you all examine it. I also have here five pieces representing five grades of ivory. These samples are marked A to E inclusive. I would like each man to state which one he considers the best grade of ivory. While these are being passed around, perhaps you would like to know how ivory keys are prepared. The ivory tusk comes into the key factory and is sawed up in sections, the length of heads or tails to a piano key. The saws are fine and run through water to keep them cool. Eventually when it gets down to small, thin layers, such as you see on a key, they are put in jars of peroxide and bleached. They are then spread on trays under glass and bleached to the whiteness you see on a key. When the fall-board is closed week after week on a piano, or the man of the house smokes his cigars in the room where the piano is, the keys get yellow. Then you are told the keys are not ivory Originally the ivory is yellow and is only bleached to give it the whiteness. After the keys are bleached they are sorted into sets so that each set has the same uniform grain throughout. There are five grades of ivory and there is very little real first grade ivory used. The second, third and fourth grades are used on most of the better pianos. The lower grade is also used on some good pianos, too."

R. H. Waud: "To further go on with your question as to the grades of ivory nowadays as compared with years ago, I might say that we are not getting the finer grades because the ivory is harder now, due to the fact that when they first began to collect the tusks they were found in the valleys. The elephants used to congregate in the valleys and fight and kill one another. The ivory laid there for years and the dampness of the valleys made the ivory soft. We could get 30 or 40 per cent of No. A. The elephants now go in the mountains and the ivory procured now is harder and has coarser grain, due to the dryness of the mountain atmosphere. The softer ivory turned more yellow than does the hard ivory of today.

"Another point we should take up is the complaint about keys turning pink. At one time the manufacturers laid down on the job and said pink ivory was the same as 'pink eye.' This is not a fact. Ivory is turned pink sometimes by reason of a dye transferred to the keys from a dress or some article of furniture. A person playing the piano will every little while reach down and grasp the bench to pull it forward or put it back. Their perspiring hands come into contact with the stain on the bench and it is transferred to the keys. Gradually the stain thus transferred turns the keys pinkish. Then there are many people with uric acid in their systems.

People afflicted with rheumatism especially have this uric acid. When they play the piano their hands perspire and the uric acid in the perspiration acts on the keys, turning them pink. It is hard to make people believe this.

"The question was asked how to distinguish between celluloid and ivory. There is an easy way to tell that. Ivorine or celluloid has certain proportions of camphor, while ivory is a bone. Scrape a key. If it is ivory, it will smell like bone; if ivorine or celluloid, the odor will be like camphor.

"In spite of the talk of shortage of ivory, I am told there is just as much ivory as spruce. I understand in India and other places the elephants are not allowed to be killed for their tusks, but I presume there are millions of tusks in the world. There is also a substitute ivory used — seal and walrus tusks. They are harder and bluer than elephant tusks and do not bleach to the whiteness that elephant ivory does. The grain is just as fine as the majority of the elephant tusks we are getting today."

John H. Gerts: "I would like to mention one experience with ivorine. We tried one sample. Later we got some back which had turned black. Ivorine is like celluloid. As Mr. Waud said, it is not a bone but a preparation."

R. H. Waud: "Celluloid is rolled out in a single sheet and is made of camphor and coal tar products. In ivorine there are three or four thin sheets of celluloid rolled on top of one another to make the thickness and give a semblance of grain."

H. D. Bennett: "Is all ivory fossil ivory?"

R. H. Waud: "It is all African ivory — dead ivory. Ivory is cut up into heads and tails for the reason that the tail is narrower than the head. Celluloid is stamped out in sets of four white keys and three white keys with no cut between. Many are deceived by the knife cut there."

E. Whelan: "Now to go back to the five samples of ivory which Mr. Fishbaugh passed around. These are marked A, B, C, D, E. The following have been chosen as the best ivory: Two salesmen have chosen A, none B, 23 C, three D and three E."

E. J. Fishbaugh: "I notice twenty-three for C. Now, this is not ivory, but ivorine. D and B were the ivories. They are No. 4 ivory. I picked poor ivory on purpose."

J. H. Gerts: "May we say a word about ebonies? How can you tell a real ebony?"

R. E. Davis: "You cannot tell ebony on the piano. Ebony sinks in water."

E. Whelan: "Is a bushed tuning pin superior to one not bushed?"

R. H. Waud: "No. As far as I have been able to trace it, pins were bushed when the plate manufacturers became careless in the manufacture of their plates. It is hard to cast a plate 4 feet 8 inches perfectly flat and get a uniform thickness. The bushed pin drags down and I never could see that it amounted to anything except in a very thick iron plate."

E. Whelan: "In the course of time, will an unbushed pin lean against the plate?"

R. H. Waud: "If it is a thin plate, as it ought to be, it won't; but it will if the plate is too thick."

Wm. Braid White: "In reference to the last question, the majority of those engaged in piano tuning do not handle tuning hammers in the right way. I have seen tuners who hold their hammers in such a way when they tighten the string that they drag it down. Five years of such grinding down means a pin bent out of shape. The piano then does not stand in tune."

L. W. Peterson: "Then the question is decided — there is no benefit from the bushed pin."

E. B. Bartlett: "My understanding is that the bushing is a make-shift. We depend upon the end wood in the pin block to supply the necessary friction to keep the pin in place. It became advisable on the part of some makers to run the plate up over the pin block instead of cutting it out or stepping it at the lower end of the pin block, in order to make a neater job."

E. McKeever: "In regard to the bushing. It was patented by a certain firm and they used a plate three-quarters of an inch thick. It was considered a great talking point. After the patent ran out it was used by others."

E. Whelan: "What is the standard weight or touch of a key? Many people come in and ask, 'Is that key standard?'"

R. H. Waud: "There is a difference in the feel. You can feel a little difference, although the weight is just the same, 2⅜ ounces in the extreme bass, 2⅝ in the center and 2¼ in the treble.'

E. B. Bartlett: "I think you are a little high."

Wm. Braid White: "There have been three steps in the evolution and progress of weight in the piano action. One hundred years ago the piano for the music of Beethoven, Mozart and Mendelssohn was made without an iron plate and the weight was as little as one and one-half ounces. In the English action, which was adopted by the Boston manufacturers, it was nearly two ounces. When Liszt began to make his reputation, in the year 1850 or thereabouts, heavy pounding began and a piano was designed for the pounders and the weight ran from three ounces in the treble to four ounces in the base. Since that time it has been going back to about an average of two and one-half ounces, running a little less in the treble to a little more in the bass. General practice is just a shade less. The piano has now reached a point where we are trying to get tone."

E. Whelan: "What is meant by a twelve or fourteen-pound hammer? Salesmen say: 'This is a twelve-pound hammer on the upright — the finest made, and sixteen-pound on the grand.'"

E. J. Fishbaugh: "They mean the weight of a sheet of felt from which the hammers are made."

E. Whelan: "But there is no difference in quality? Why are there holes in the plate of a grand?"

James F. Bowers: "One gentleman said to let the tone come out."

E. B. Bartlett: "The plate of any piano is designed to sustain largely the tension of the strings. Of the metal you need enough to do the work. The reason why there are holes is because the iron is not needed at the places where the holes are and for no other reason."

James F. Bowers: "It is a matter of economy then?"

E. B. Bartlett: "Yes, saving of freight also."

Wm. Braid White: "On all pianos made some years ago you will find that the plate is an extremely elaborate proposition. On some, the plate was made of a solid sheet of metal. There was scarcely any iron taken out anywhere. Then they used a higher tension scale with a higher pitch. They had altogether too much iron. Little by little, this has been coming down. The original plates covered the entire space. They were tremendous things, sometimes with six enormous braces. In the course of time, it occurred to somebody to design a plate to take up definite stresses in definite lines."

R. H. Waud: "A salesman once explained why a grand piano plate had holes. He said a grand was so much better than an upright because the tone waves moved in segments, came around, and as the waves circled around, the tone came through the holes." (Laughter.)

E. Whelan: "In making this canvass of questions, I talked with a salesman who had just lost a sale, and I don't know of any worse time to meet a real salesman. I said: 'Why did you lose the sale?' and he said: 'I lost it because the lady asked me if it had German blue felt hammers and I said I didn't know. She asked me what it meant and why the piano didn't have it.' What is meant by German wire and German blue felt? Are there many pianos built with German wire?"

R. H. Waud: "We have some German wire, but are not using it."

W. C. Heaton: "I once told a customer about imported hammers. A few days later she complained about the foreign tone it had. This tone she complained of was due to the bric-a-brac that was standing on top of the piano."

E. Whelan: "Is a small grand, 4 feet 10 inches, an upright piano laid flat?"

R. H. Waud: "No."

Wm. Braid White: "The small grand has a better tone than an upright. Even a badly built small grand is preferable to an upright. The mere fact that the action of the grand piano is so far superior to the action of the upright makes a difference, and then the manner in which the hammer strikes the string is more natural and gives a better response. It has everything in its favor. If that piano is built so that the bass bridge does not go down to the very edge and if the scale be an even tension scale, then no upright piano of the same size can compete with it."

E. Whelan: "Mr. White has unconsciously answered the next question, and that is: 'Is a large, full-sized upright to be preferred, from a tonal standpoint, to a small grand?'"

W. C. Heaton: "That would depend upon the length of the string."

Wm. Braid White: "No matter what the length of the string, the grand is better from a tonal standpoint."

E. Whelan: The next question was asked by one of the sales managers: "Why don't superintendents take the salesmen into consultation relative to the style of pianos the public wants?"

R. H. Waud: "They do, as far as I know. Where I have been they always have. They are the ones who decide the finished product."

E. Whelan: "Is there a uniform measurement for sizes of grands; for instance, is there a standard measurement, such as concert, medium and small?"

R. H. Waud: "That is determined by each manufacturer within very narrow limits."

E. Whelan: "How many factories are there in the United States that make every part of their pianos?"

E. B. Bartlett: "None."

E. Whelan: "Here is a question that is one of the best given me: Do keys of all pianos stick?"

Wm. Braid White: "Give them time and they will all stick. There are some climates where conditions are even too much for cork pine. I tuned pianos in northwestern Pennsylvania in the natural gas and oil regions. Everybody burned as much gas as they pleased because it was cheap, consequently all the houses were very dry. In the summer when the gas went off, the climate changed about the same time. The whole country turned into a marsh. All the pianos there — from the very best to the cheapest — swelled in the summer and shrunk in the winter. Given the conditions and you will have sticking. It is nobody's fault."

E. Whelan: "Will all varnish check?"

R. H. Waud: "Always. There is a remedy to a certain extent. There are two reasons why varnish checks. One is the swelling and shrinking of the wood, which has of late been overcome by up-to-date kilns. The other reason is the drying out of oils in the varnish. The best way to keep varnish from checking is to oil it off. Dampening it with the oil will stop the checking."

E. J. Fishbaugh: "Also heat and cold have an opposite effect on varnish and wood. Lack of heat expands wood and shrinks varnish. The gum in a varnish gives it the polished appearance. The oils give elasticity. As long as polished pianos are demanded, the amount of oil must be reduced and they are bound to check by quick changes. If every piano were made dull finish more oil could be put in the varnish."

E. Whelan: "Would twenty-five pianos built alike in every detail have the same tone?"

R. H. Waud: "No."

E. Whelan: "Then every piano is an individual piano. That is the way we sell them and I wondered if it were a fact."

Wm. Braid White: "Yes."

James F. Bowers: "The original question is: 'What Can the Manufacturer Tell the Salesman That Will Enable Him to Sell More Pianos?' I would like to hear some questions."

S. M. Wessel: "I would like to know what the dimensions of a perfect scale would be — would like to know the length of the strings."

Wm. Braid White: "That can be answered in twenty different ways. It is not a question of length. There are three factors, one depending upon the other. The result of compounding those factors is to obtain a certain mathematical figure which can be obtained in as many ways as you please. If you change the length, you change both the length and thickness. You must then compound the other two factors accordingly. Roughly speaking, the proportion of change of length from octave to octave is a little less than one to two. A great deal has been said about the bass of small grand pianos being tubby. This is only due to poor design."

Francis Moore: "Do the manufacturers have any particular pitch? International pitch is A-435. Why should it be international pitch when all standard orchestras use 438 5–10?"

Wm. Braid White: "Any tuning fork which is originally made for 435 is nearly always found to have gone up a little. The piano, as a general rule, is always about international pitch. The practical pitch is considerably nearer 438 than 435."

James F. Bowers: "Mr. Fishbaugh, I understand you have one or two very interesting points. Will you be good enough to proceed?"

E. J. Fishbaugh: "It was my pleasure during the last summer to go through fourteen factories, and I saw some of the very best pianos. In every factory I visited there was varnish shrinkage. I didn't see a piano either in a wareroom or factory — and I looked at some of the best — but what had varnish shrinkage. There is a gray appearance and it looks as though the wood sticks out of the varnish and looks at you. That is varnish shrinkage. You have all kicked about it in July and August. What makes it? The manufacturer is not to blame when the varnish shrinks. Varnish is porous, so is the wood and glue. In the summer the atmosphere has a great deal of moisture in it. That is a natural condition which no manufacturer can contend with. Any manufacturer is glad to remedy this condition or teach the dealer. You can rub it with rottenstone and water and felt on a block and then the man who knows how will polish it with his hand and it will come back to its original body and lustre. In regard to mahogany, have you ever gone into the wareroom in the morning in the summer and found that the mahogany has all turned blue? Do you know what causes it?"

H. D. Bennett: "Moisture."

E. J. Fishbaugh: "Yes. The moisture in the atmosphere. Just the same as the moisture in a bathroom from the hot water causes the film on the mirror. Water and chamois will take it off. Should a walnut cost as much as a mahogany or oak, everything else being equal?"

E. Whelan: "It costs more, I would say."

E. J. Fishbaugh: "There is 50 per cent waste cutting walnut and perhaps 20 or 25 per cent cutting oak."

James F. Bowers: "How can you tell the difference between mahogany finish and mahogany veneer?"

Frank Albright: "The grain will always show. As a general thing, an imitation is easily detected because the mahogany grain is not there. There is a big difference in cost between walnut and mahogany. Walnut is wasteful. You would have to get more money for a walnut. I was talking to a man from Louisville who builds up. He told me the best he could get out of oak was 60 per cent waste. Oak is narrow and has to be cut up and matched. Mahogany is the cheapest wood the manufacturer can use, for the simple reason that it is a nice-running wood. Walnut is also apt to check. They have to cut away from the bottom of it to get away from the end wood."

H. D. Bennett: "Is it true walnut checks more easily because of the unusual figuration of the grain?"

F. Albright: "Yes. In a piece of walnut the grain is right straight through."

James F. Bowers: "Is Circassian scarce?"

F. Albright: "It is very scarce. It comes from the fighting countries and we don't get any."

E. Whelan: "The furniture houses are making a great deal of Circassian lately."

F. Albright: "There is some wood which they call Circassian. We get walnut from Virginia, Maryland and some other places which has all the qualities of Circassian, but it won't take the polish Circassian will. The public is not asking for Circassian. They are taking the American walnut instead. If offered the real Circassian they wouldn't buy it."

E. Whelan: "The demand for Circassian has increased 60 per cent with us in the last six months."

F. Albright: "I am surprised. They are after the imitation Circassian. The American walnut has all the colors and character of Circassian. I suppose they are asking for Circassian pianos to match their furniture, as the furniture men are using it."

H. D. Bennett: "Where does the best mahogany come from?"

F. Albright: "The best comes from Africa — both coasts. The man who uses mahogany today will find it is not the grade it was before the war. It is soft and spongy."

James F. Bowers: "I am sorry Mr. Morton is not here, because he could suggest and bring out matters and points we have not touched upon, and we might very profitably touch upon more things at an early future meeting. It is very gratifying to see this gathering tonight, and a little later on when Mr. Morton returns we will take occasion to repeat it. The gentlemen here will receive invitations to the meetings from time to time and I would earnestly recommend that they attend. I don't know of any better way of profitably spending an evening."

Trade-In Pianos

December 17-19, 1917

F. E. Morton: "Collaboration between salesman and manufacturer still is a dominant factor in the trade. A better understanding between the man who produces and the man who distributes is as desirable as an understanding between the distributor and the consumer, whose minds must meet before any exchange may be effected. Can we by some means establish communication between producer and consumer? One of the difficulties in the piano trade today is due to the fact that we have not taken the customer into our confidence. The making of a piano is an engineering proposition, so is the manufacture of automobiles. The automobile trade has profited tremendously by taking the public into its confidence. The public reads the automobile page in the daily newspapers and because it is interesting to the public the newspapers publish it. A man will trade in his 1916 car for a 1917 model because he feels he must keep abreast of the times. He has been instructed to think thus. The progress of engineering in automobile construction now is a matter of public import. This condition we can bring about in the piano trade by co-ordination of effort. It is to this end that we have thought it well for the sales managers to meet with the makers of pianos. Let the salesman know the possibilities and limitations of piano construction. Let the maker have news from the front direct that he may, wherever practicable, meet the demands. Every man naturally is a buyer. Salesmanship largely consists in giving the prospective purchaser a good excuse for parting with his money. If his excuse is plausible, logical and scientific, the customer remains satisfied after purchase; if not, there comes a time when the customer learns the truth and is dissatisfied.

"The situation thus depends upon the continuity of that element of justification. Boys and young men now read scientific and mechanical literature. They are your future customers. What are you going to say to them? What changes in present methods do you propose? Manufacturers, what is there in your particular method of construction of your product which will sell it to the salesman? If you don't make him a satisfied customer his chance of reselling to a customer is lessened."

Eugene Whelan: "I agree with Mr. Morton that the time has arrived for the entire piano industry to revolutionize their methods of selling. The shortage of cars, coal and material will compel us to do three things — adopt a one-price system; eliminate the excessive 'trade-in' cost, and pay no commissions. From the time I was taught to sell pianos, one of the first arguments used in selling a piano was that it was a beautiful instrument — an exquisite production. We made a long talk and finished by saying, 'It will last a life-time.' Everybody who owns a piano says, 'It is as good now as it was twenty years ago.' It was so impressed upon them that it would last that they now have an exaggerated idea of the value of the instrument, and instead of being satisfied with $25.00 or $30.00 in exchange they want $100.00 or $150.00, and we as a selling organization allow them to come into our store and dictate prices and terms to us. When a sale is made with a big allowance on the old one, your second piano is sold at a loss.

"What is the real life of an average upright piano?"

H. H. Arnold: "The main thing affecting the life of a piano is where and how it is kept. The next thing is, how it is treated. A great many people when they purchase a piano expect it to stand up as it did when new, irrespective of the use it gets. They never think of spending $10, $12 or $15 for a general overhauling or a new set of hammers — whatever the cost may be. They think the piano ought to last as long as the case. The main abuse is keeping it in a place alternately dry and damp. These extreme conditions keep the pianos out of commission. The fault is ninety per cent the owner's when the piano does not last twenty or twenty-five years. A piano needs a thorough overhauling every two years, if not more often. With proper regulating and use, a piano should last twenty or twenty-five years. It depends upon the people whether they want it that long. Some people like to change on account of the case. It is up to the salesman or retailer to set a price on the old instrument and only allow what it is worth. I have never traded in my life without telling the customer what it was worth to me to resell."

F. E. Morton: "If the lifetime of a piano is twenty-five years, would that form a basis upon

which could be computed a re-sale price? In other words, could we deduct so much per year and arrive at a re-sale price?"

H. H. Arnold: "Hardly. One piano might be entirely out of commission in two years, while another would be in good shape after twenty years."

F. E. Morton: "Assuming that pianos were properly priced — which must come first — then the re-sale price could be established on that basis. Suppose we had in Chicago a clearing house for used pianos, owned and operated by the piano trade of this city — which would be a logical carrying out of this idea — could there obtain by agreement of the dealers a schedule of prices according to the serial number?"

H. H. Arnold: "I hardly think so. Only a short time ago we had returned to us a rented trade-in used in a hall for two years. The ivories were intact but worn down to the wood in the middle section. The hammers had been played through and the action was wobbly. Other pianos of the same age used in private homes could be fixed up at a nominal charge and would be just as good as new. The wear and tear of an instrument differs so greatly that one can only allow for the instrument what it is found to be worth after giving it a thorough examination irrespective of its age."

F. E. Morton: "Then such a clearing house must be in charge of an expert. Mr. McClellan, what difference in cost of reconstruction would be fair between a piano subjected to the wear Mr. Arnold has described and one having family use?"

W. F. McClellan: "$60 or $75."

H. H. Arnold: "Would that include the refinishing of the case?"

W. F. McClellan: "No."

F. E. Morton: "It seems then a basis can be established. It has been done with other products presenting difficulties as great as this."

R. H. Waud: "With the automobile after one year from date of purchase whether you run 3,000 or 30,000 miles the machine deteriorates fifty per cent. If such is the case why not pianos?"

F. E. Morton: "Mr. Ayers, is that fair in automobiles?"

B. B. Ayers: "Yes. An automobile loses its purchase value the next week after you buy it. It is fair from all sides."

A. D. Bolens: "I made a rule of thumb plan by which to govern the trade-ins when I first started in the retail business. I deduct ten per cent per year from the time the piano had been out. If the piano was sold for $300.00, $30 the first year, $60 the second from the date the piano was bought. I adhere to it to this day. In all the years I have been retailing in my home town I have never had a trade-in where the piano was only one year old. Most of the pianos were up to the ten year mark. I used that as a talking point — that machinery depreciated ten per cent per year."

F. E. Morton: "That means refusing to take in a piano over ten years of age?"

A. D. Bolens: "Yes."

F. E. Morton: "Mr. Heaton, what is your experience?"

W. C. Heaton: "Say a person bought a piano for $250.00 and within a year wanted to trade for a player $550.00. The piano could not be taken for $225.00 and sold without loss. It could be sold for $175.00. The cost of selling is $100.00, so $75.00 would be a fair price to allow. It depends on how much backbone the dealer has and whether he has his goods priced correctly in the beginning. One company had a ruling whereby it was necessary to allow as little as possible because it was charged against that sale. One couldn't allow on any trade more than the cost of the instrument less the overhead, cost of sale and a fair profit. The dealer has many fictitious prices. The dealers have got together in the East and I learn they have set a fixed price on instruments according to age. They figure on the cost of the instrument when new. The dealer should set an absolute price for the salesman, not allow the salesman to dicker. One firm has established minimum terms of ten per cent down and five per cent per month. Salesmen call on many people simply because they are easy to approach. Instead of wasting time and car fare on numerous people who will visit they should call on a few good prospects."

F. E. Morton: "There is an apparent conflict of interests between the manufacturer and the repairman. I would like to get the tuners' and repairmen's viewpoint. Perhaps they can be reconciled."

William Braid White: "There always has been an exaggerated notion as to the life of a piano. Mr. Bolens hit the nail on the head when he said he never permitted a customer to trade in a piano over ten years old. A piano is just as bad as an automobile. A week after you buy it it deteriorates. After a year it shows definite traces of wear. In the home of the average wage earner they do not believe in the piano tuner as an institution. In five years the piano shows serious signs of inferiority. Without elaborate repairs it would not be possible to make that piano stand up in the light of a new piano. Although a piano fifteen years old will play, still no amount of repairing will make one twenty-five years old fit for anything except a bargain sale. Cease considering the piano as something which lasts forever, but regard it in the same light as an automobile. In other words, 'junk them.' "

W. C. Heaton: "The average retail house does not figure cost of repairs properly. There is no system of cost cards showing expense of light, heat, insurance, advertising and general overhead."

William Braid White: "The people who do the repairing themselves are not the sort to be entrusted with the preparing of such data. We are in a difficult position."

W. C. Heaton: "I was put in charge of a concern which had got into poor financial condition. We repossessed 527 instruments, and the man in the shop had been there many years and had his own ideas. In our estimates we were very far apart. What he figured as $10 I figured at $50. We re-organized the shop, however, putting in new men, and sold a great many of the pianos at some profit. From the time the instruments were taken in to the time of re-sale I added a cost of $10 per instrument on account of increased value of new goods."

F. E. Morton: "What is the attitude of the manufacturer to the re-sale proposition? Are his interests served or injured by the re-sale habit?"

W. C. Heaton: "The trade was once criticized for burning up the squares. It was a good thing."

F. E. Morton: "If a piano is rebuilt and sold, does it injure the manufacturer of pianos?"

W. C. Heaton: "No. Suppose you allow $25 for a piano; put it in shape and sell it to a family who cannot afford to buy an expensive one. It is a 'Music in the Home' idea. Pride does not permit the family to keep this instrument long because neighbors have better ones, so after a certain length of time this piano is exchanged for a better one."

F. E. Morton: "You have expressed my idea. I have been looking for a long time for something to take the place of the good old instrument which did the missionary work — the reed organ. Desire for a piano came through learning the limitations of the reed organ. How far does the second-hand piano serve that interest? Does the rebuilding and reselling cut the manufacturer out of a piano sale or make more sales for him?"

A. D. Bolens: "That depends upon the salesman. Sometimes the salesman sells a second-hand instrument where he can as well sell a new one."

E. J. Fishbaugh: "I worked for a man who didn't try to sell certain squares, but gave away fifty to one hundred every year. He kept their names and later sold numbers of uprights to the people to whom he gave the squares. He only gave the square to people who had children, who, when they became older, became his customers."

W. Hehr: "As Mr. Fishbaugh says, let out the old pianos to get the children interested and there is always a prospect ahead. The more you can get out, the better for the trade. As a rule a piano of that kind will last a short time. They soon tire of it as to style and want something better. One neighbor tries to outdo the other and it will be only a short time before they come in asking for something better."

F. E. Morton: "Approximately, Mr. Bowers, what is considered a fair percentage for advertising to the volume of sales?"

James F. Bowers: "It will run pretty close to five per cent."

W. C. Heaton: "Many houses allow five per cent."

F. E. Morton: "Assuming this treatment of second-hand pianos to be in the nature of advertising, is it expensive, or is it good business? Will it run more than five per cent?"

James F. Bowers: "I should think not. That could only be approximated at the best, but five per cent would be good."

E. J. Fishbaugh: "Why shouldn't it be free advertising by paying its own way?"

F. E. Morton: "Fault has been found because of loss on second-hand pianos."

E. J. Fishbaugh: "I know a house which is prosperous which has a stated amount compared to its wholesale price that they will allow salesmen to take up. They make a profit on any old instrument they handle."

W. C. Heaton: "There are one or two houses where a salesman cannot take an instrument in until the expert who understands cost makes an estimate."

William Braid White: "The whole thing comes back to the question of real valuation. It is fairly well established that the re-sale of second-hand pianos is not a profitable business. If it is a matter of advertising, how much are you willing to lose? Just as long as the public is being fed up with ridiculously low prices on second-hand goods, just so long will it be difficult to maintain fair prices on new goods."

F. E. Morton: "This goes back then to the original sale. The representation made by the salesman that at the end of so many years, 'this will be in fine condition — as good as ever,' is exaggerated. There is one other factor, and that is the effect on the trade of an offer by the selling party to exchange at any time within a given period, a year or two years, for any other new piano and allow all that was given for it. How does it affect the manufacturer and dealer? One cannot be injured without injuring the other?"

W. C. Heaton: "The proposition the dealer makes to the customer on closing the sale is merely to clinch it. It is not good salesmanship."

R. H. Waud: "While we have the chance let us send the old pianos to Canada, where they want them, and we will be rid of them."

F. E. Morton: "I once wondered what became of the old straight scale squares. I found them in Mexico. Perhaps the market will be good there for our discarded uprights?"

William Braid White: "We have been educating the public to think just what Mr. Whelan was taught, that their pianos will last forever. Can you imagine an automobile salesman saying: 'This automobile will be as good at the end of ten years as it is now?' "

F. E. Morton: "That has been made impossible by reason of the manufacturers having taken the customers into their confidence at the start."

William Braid White: "When are we going to make up our minds that we will educate them another way?"

Eugene Whelan: "Right now would be the time."

W. C. Heaton: "Yesterday I was called to the 'phone to answer a lady who said she had a piano that needed tuning and that a tuner said it would cost $5 or $6 more to tighten up the action. She told me from where it was bought. I said: 'I am surprised the tuner didn't say $10 and that it should be tuned again. How often do you grease and oil your car?' She said: 'Every time we use it.' I said: 'Do you think because your piano has been tuned once or twice that it doesn't need tuning again? I advise you to have him go over the piano thoroughly.' After the tuner was through with this job, she said: 'He charged me $9 and now I have a fine piano.' At first she felt she was being imposed upon, but my putting it in that light helped her realize the benefit to the piano."

F. E. Morton: "If the tuner were backed up it would help."

A. D. Bolens: "It would be an ideal situation if we had a market for trade-in pianos. About twelve or fourteen years ago I went into a dealer's store in Massachusetts — a man on whom I had called a number of times to interest him in my line of pianos. I found he was loaded with old organs. He had about eighty-five. I said: 'I will take the whole lot at $5 for the poor ones and $10 for the good ones and we will sell them to the negroes if you will take my line of pianos.' That whole section was scoured for organs and they were shipped to us. A couple of good negro salesman were put on the job and the organs were sold for from $15 to $50. There was a market established for second-hand organs and that trade continued for a long while with that house. Following that out, I met the treasurer of the concern here in Chicago, and he told me they were hearing from that sale to this day. They now want pianos. Wouldn't it be an ideal situation for the trade if second-hand pianos over ten years of age could be marketed by the trade in such a manner?"

F. E. Morton: "That was why I suggested a clearing house for pianos. If on Wabash avenue a clearing house for second-hand pianos were established, a customer coming in and desiring

to trade could be directed to this place where he could be paid for his piano the price set by the clearing house expert. Co-operation between tuners, dealers and manufacturers bids fair to develop through the Music Industries Chamber of Commerce. We are going to learn that our interests are mutual — that one cannot be hurt without hurting all."

H. H. Arnold: "What are you going to do with the man who has to make up copy for a piano that used to be $300, was $150, and is now $49?"

F. E. Morton: "Put him at work where he can make an honest living. The clearing house under the direction and control of the reputable dealers as a whole would take care of that very proposition and make it very thin picking for any independent who started a sale of second-hand pianos. The campaign which is bound to be waged by the manufacturers and dealers is going to teach the people piano values, and I can say from experience both in selling and shopping that the customer has had few opportunities in the past of establishing a basis for a knowledge of piano values. That the people now are interested is evidenced by inquiries that come in from all directions — through the knowledge that we are meeting here and that there is literature to be had on the subject. Taking the public into your confidence brings good results. There is no mystery today in steel making. Uses of steel have been increased by teaching the people the nature of steel. Those who have held secret the process or the possible value of component parts of mechanism have limited the demands for those products."

William Braid White: "There is no doubt that the individual repair plant is a wholly inefficient thing. If we could bring about the condition Mr. Morton speaks of, we would not only reduce the cost of the piano but at the same time we should do the work a great deal better and solve the problem of allowances because this institution would be so arranged that when the question of a trade-in came the expert would make his report on the piano and it would be put into proper shape on a scientific basis."

W. F. McClellan: "Isn't that the plan advocated by Mr. Wamelink at the convention in Cleveland? It seems to be acting in the minds of people in other parts of the country. In a paper read at the Ohio convention two years ago the plan was worked out in detail. It seemed worth while when read."

F. E. Morton: "I do not know. I did not attend that convention."

James F. Bowers: "Was it ever adopted?"

W. F. McClellan: "No; I think not."

Eugene Whelan: "I was wondering, on a piano that was practically rebuilt, what would be the result obtained, for instance, by a child who had talent? Would it help or spoil it? Take a piano fifteen or twenty years old, repair it in the way we do now, which is repaired as cheaply as possible, and suppose it were given to a child, would the touch be so bad as to affect the child's talent?"

William Braid White: "Without a doubt. One of the great difficulties is to be found right there — the bad influence of badly kept pianos upon the beginner. That an old piano is good enough for a beginner is very, very wrong. When a child is accustomed to hearing a piano that is not in tune, how can you expect him to appreciate a good piano?"

J. Klepac: "What about the pianos of Beethoven, Bach and Mozart?"

E. J. Fishbaugh: "You have sold one piano and you have gotten the desire in the child's mind for a better piano when he gets old enough."

William Braid White: "Every child should have the best kind of piano. Everybody knows perfectly well that one of the most difficult things in the world is to make the ordinary layman understand where the value of a piano comes in. One of our duties is to educate the public in regard to the value of an instrument. If we don't give the public the best possible, then how can we expect them to like anything better? Every tuner knows that you can put the best piano into any home, leave it five years and if it is tuned three times they are doing well."

James F. Bowers: "We have to deal with things as they are — not as they ought to be. Personally, I am strongly in favor of Mr. Morton's idea of a clearing house if humanly possible. Only today Mr. Collins told me that a large room at the back of the floor where we have our made-over and second-hand pianos of any value whatever, was absolutely gutted. He had nothing. They were cleaned out. What are we going to do with that condition? We are not going to refuse to sell those pianos. Aren't those pianos in their own way doing missionary labor?"

E. J. Fishbaugh: "One of the reasons why so many pianos are out of tune is the lack of backbone of the salesman. Every manufacturer and every retail merchant should have printed on their pianos that that instrument needed care every so often. It is the business-like thing, and it is only fair to the customer that when he puts $300, $400 or $500 into an instrument it needs as much care as any other piece of mechanism. We have not co-operated with the man who has handed us the money. He is not to blame for the fact that nine-tenths of the dealers are running a repairing department at a loss. The dealer himself is to blame. If he would educate that man when he bought the piano he would want the piano tuned because it would last longer."

Eugene Whelan: "In regard to tuning, I mentioned our system of tuning at a former meeting. For a number of years we have worked along that plan. We never allow one of our organization to make a sale without he has thoroughly explained the service contract. To prevent him passing the buck when the contract is signed we have the young lady who makes out our contracts ask the customer if he or she has been told of the service contract which takes care of their piano every six months. That contract is sold separately. This plan has been so successful that it has made our tuning department stand on its own feet. Even if we sell a piano for $150, we go after them on the service plan. The automobile trade has taught us how to do business. We have taken the service end from the automobile fellows and the typewriter men. If every retailer would go after that tuning contract and make his tuning department one of the important factors he would have it on a paying basis. We also have a booklet of three or four pages, the title of which is: 'The Home Care of a Piano.' We talk about atmosphere, tuning, regulating, and tell them how to keep the piano looking bright, not to put liquid veneers on it, etc., and we take no chances of the salesman not handing out this little book, so the young lady gives it to every customer and we instruct the customer to take it home and look at it. We also devote a page to the tuning in case it has been overlooked."

W. S. Jenkins: "Anything that is universally done is never objected to by the public. In trading for a talking machine it is generally conceded that $50 valuation for an old piano is right. If we could get together and decide upon a definite proposition it would be adopted. United effort is required. One woman told me that a friend of hers had a piano that had not been tuned for five years and when the tuner was called in he was surprised at the good tone. Missionary work could be done among the tuners. The policy of getting together is good."

F. E. Morton: "The trade has been driven from vicious practices — not only this, but other trades — in sales and manufacture by publicity through the press and various trade associations. Very few men will persist in any vicious practice when the details of it have been made public. What does the customer want to know about the piano? What does the salesman want the customer to know about the piano? How far can we say the salesman is assured he is right and in making these statements is co-operating with the manufacturer?"

William Braid White: "We have undoubtedly assumed from the start as manufacturers, retailers and theorists that the public understands the beauties of the piano as well as we do. We have quite neglected to tell the public anything about the care of the piano, not because we did not want to annoy the public but because we forgot. The automobile people have taught the public to such an extent that almost everybody can talk about an automobile. It has been done slowly and gradually. The advertising has been fascinating. We have never done anything of that sort — haven't begun to do anything. Suppose we consider the possibility of adopting something of that constructive work in our advertising and begin at the beginning. Let us teach the public something of the instrument when they get it in their homes, and what it really means to keep it in good condition. There is not one piano salesman in three on Wabash avenue who has much understanding of the problems on which the tuning of a piano depends. If everybody had some of that and if all the public were being educated, we should have solved a big problem and should have eliminated waste."

F. E. Morton: "That is what I meant when I said: Take the public into your confidence. One thing has been developed, and that is well worth while — the key to future business in the piano trade, as in other trades, lies in service and the nature of the service rendered. Service, to seeffective, should not only precede a sale but follow it as well. I am under the impression that a balesman should call on the party he has sold with as much interest as he now calls upon the prospective customer. The salesman of the future, instead of being an order-beggar, is going to

be a consulting engineer — the piano salesman of the future is the man for whom the customer will send, asking his advice and counsel. He will specify, and that specification will be final. The statements will be recognized as true or false, as when an architect is called, his advice paid for, accepted and acted upon. His position necessitates the scientific treatment of his subject and the faithful serving of his customer. We are bound to come to that. The vital point, however, has not been touched very heavily yet. It was suggested only by a phrase or two. If I point out a particular object and say 'look' at whatever it may be, describing it to you to acquaint you with what I expect you to see, you are satisfied or gratified upon perceiving. If I say to you 'listen,' and I strike a key on a piano, you are not helped one particle by the demonstration; but if I say 'listen,' and tell you why you are listening — to what you should listen — and you observe it for the first time, then you have profited by the demonstration. Carried further, the result becomes interest in tone quality. The individual will decide what partials he may desire combined in a general tonal effect, but until you take him into your full confidence, having first a knowledge of tone composition and tonal effect, the sale of a piano is effected on the same basis as a common product and this basis is reflected in its use. There is so little knowledge of tone values in the pipe organ that to find an organist in the average picture theater using anything other than two or three string stops and the ubiquitous tremolo would be astounding. The people who attend have not been told the possibilities of the instrument and their demands are not in evidence. We have gone to extremes. The love of tone — the real joy of listening — only can follow a knowledge of tone composition. The manufacturer, through his publicity department, should put forth as a talking point the analysis of his tone values that the public may know what they are expected to hear and become discriminating patrons, for after all the piano is an instrument to be heard.

"Strike one key on the piano and listen until you have absorbed every component part of that tone. I cannot tell much of the tone of a piano by hearing some one play. Let me suggest as the first step in this work, which I know must come, that you sit down at your own piano and strike a single key and listen until you get acquainted with the tone. Take another piano and listen to the tone of that key until you can distinguish the difference between the two. If that is too narrow a margin, compare it with the other man's piano. The basis of discrimination is listening. Get well acquainted with the tone of your own piano — put your efforts on that first."

Composition of Tone

January 16, 1918

The meeting was opened by F. E. Morton, who recited some of the difficulties encountered in establishing a practical working plan for the study of tone composition. He said, in part:

"Artists tell us one-half the art of drawing is seeing things as they really are. If we hear things as they really are, we will then have accomplished 50 per cent of our tonal studies."

He contrasted general listening with selective listening and the degrees of interest inspired by each. He said:

"A knowledge of acoustics may be had by anyone who can hear. In instruments and voices we learn to recognize certain combinations of those partial tones making up the entire tone and without specific analysis we hear a sound and say: 'That is the sound of a cornet or the sound of John's voice.' When we understand why we can tell one sound from another the pleasure of hearing and comprehending is multiplied. There is not a sound that you hear during the day that is not interesting from a scientific viewpoint. The fact that a sound may be reproduced,whether the characteristics are quite the same or not, is a matter of tremendous interest, from the days of the little cylinder with the tin foil around it up to the present day, when the sound and reproduction are so nearly identical. That it is not exactly the same in quality as recorded is obvious to the listener. I have more respect for the phonograph now that I know its limitations than I had before I learned them. I also know more of its possibilities. We will hear the natural voice and then the reproduction on this phonograph.

"The recording studio is a factor. Any room is a reverberating chamber and hence there are echoes. The diaphragm of the recording instrument possibly has a better trained ear than we have and the echo is recorded. The better the reproduction the more obvious the echo. The voice

energy enters a receiver—a horn. That horn has a certain number of cubic inches of air, which determines its pitch. The column of air vibrates more intensely in response to its own key note than to any other. The horn material also responds with a greater degree of intensity to its own key note, which may or may not be the same as the column of air contained. The diaphragm also has its key note to which it responds with a quality peculiar to flat bodies. It responds to odd numbered high partials with greater intensity than to other partials. In reproducing the process is reversed but the same conditions obtain. If the reproductions were made by the same diaphragm through the same horn and into the same room as that in which the record was made, each augmented partial would be doubled. If reproduced through another instrument having another horn of different cubical content, a different key note of horn material, a different key note of diaphragm other odd numbered higher partials would be augmented, as would also the reverberation in the room. And so it is that we have a number of sounds foreign to the one recorded.

"After repeated experiments there is no doubt in my mind that a phonograph record of a banjo number gives a better banjo tone than the banjo itself. The same is true of the xylophone. Those partial tones characteristic of the banjo and xylophone are the ones augmented. There are certain voice qualities which are improved by recording and reproduction. There are other voices and instruments which are not improved, but all are changed. With a knowledge of that change we have no difficulty in appreciating all. You recognize another's voice, but it is doubtful if you would recognize your own voice recorded and reproduced.

"Let us go back to our accepted piano tone composition, having a relative intensity of 50 per cent in the fundamental and the other six partials in sequentially decreasing intensity until only a trace of the seventh is audible. A heavy stroke on a piano key brings out partials to or above the twenty-fourth. By means of resonators they may be heard."

James F. Bowers: "For the benefit of those of us who are not high-brows, what do you mean by the limitations of the phonograph?"

F. E. Morton: "The augmentation of these partials by the column of air contained within the horn. The horn material and the diaphragm are loads carried by the phonograph and constitute its limitations. If these loads were eliminated a true reproduction would remain. Break a phonograph record and with a microscope observe the track of the needle and you will find there truly recorded all the tone it was given, and more, because it recorded the vibrations of part of its own material."

James F. Bowers: "If all the tone has been given, why isn't it reproduced?"

F. E. Morton: "It is not a limitation of failure to record but of faithfulness. If a horse hauls a wagon weighing a ton and the contents weighing one-half ton, the limitation cause of hauling capacity is the weight of the wagon, or one ton. The horse hauls both. I am not criticising the phonograph. It is a wonderful instrument. Mr. E. H. Rose will now sing for us alternating with his own record on the phonograph."

Mr. Rose (Prince Lei Lani, Hawaiian Tenor) sang "Pau Sabinia," "Aloha Oe" and the "Rosary" taking one period with his voice, the next with the record and so on throughout the number.

F. E. Morton: "Applying the same theory to the reproduction of piano tone I confess I spent many hours trying to find the cause of some apparent distortions. I couldn't understand why a piano record sounded so much like a cross between a banjo and a xylophone. The limitations are not failures to record or reproduce, but are caused by added partials. In volume I think we could approach very closely the volume of the original instrument. The augmented partials would become more obvious than in the phonograph of smaller tone chamber, or horn. We can't magnify the good without magnifying the evil. The relative intensity of partials contained in a tone determines its quality. If that relative intensity is disturbed, the quality is changed. The mere increase in intensity of one partial above its normal degree would change the quality, and this factor would account for distortion. It is wonderful that we get as true an effect as we do with that handicap. If you have a nasal toned piano, with odd numbered high partials, you put your tone regulator on the job expecting him to make a perfect toned piano. When such tones appear on a phonograph record we are apt to condemn the phonograph. By the collaboration of the piano manufacturer and the phonograph manufacturer that fault may be eliminated.

"We are fortunate in having the assistance of Mr. Harold Triggs, who will play for us. We will then have the reproduction of this number on the piano itself--an instrument not yet on the

market, a Brambach Electric Player Grand—and reproduced by the Autograph roll, then reproduced on the phonograph."

Mr. Triggs played the "Polonaise Militaire" then reproduced on Electric Player Grand.

F. E. Morton (at the phonograph): "I am repeating a sustained portion of the composition where the echo occurs. It is in effect not unlike a 'shake' which follows what sounds like a plucked tone. It is not improbable that this results from the reflection of energy by the walls of the studio, and that this 'shake' is really an echo. You could build on the tone of a piano almost any combination by addition. The upper part of the register is much better than the lower."

James F. Bowers: "What is a partial?"

F. E. Morton: "One of the component parts of the tone. Tone is composite and is made up of a number of sounds called partials. The first is called the fundamental. That it is which determines the pitch. A good tone is one in which the fundamental is 50 per cent of the whole. The next partial is the octave above, and the next partial is the fifth above that; the next is the double octave and so on up. We will be able to demonstrate this clearly with the apparatus I am now constructing."

Wm. Braid White: "I have been listening for a number of years to phonograph records of piano tone and have been struck with what you have said with reference to the defect of reproduction of the low tones. There seems to be a relation between the wave length of the fundamental and the ability of the machine to reproduce. Sound travels at the rate of 1,100 feet per second. The middle C on the piano in ordinary normal tuning gives something like 258 double vibrations per second. The impulses of that sound would follow at the rate of 1,100 divided by 258. The wave must be something like four feet. An octave below that middle C wave length will be eight feet, an octave below, sixteen feet. At about one-twelfth below middle C, on F, the phonograph recording diaphragm fails to take up as it should. There is a considerable field for investigation."

F. E. Morton: "That is what I was going to point out. Note particularly the difference in the lower and upper registers (demonstrating). From about middle C up the tone more nearly approaches the tone of the piano. From middle C, the farther down the less fundamental is observed. Analyses have been made of the tone of the various parts of the piano scale. By means of Dr. Dayton C. Miller's phonodeik it was determined with whatever degree of correctness the instrument might show, that the low notes—wound strings—had very little fundamental. If I recall, down in the next to the last octave there was barely a trace of the fundamental. That seemed unreasonable because we note the pitch of those strings and it is the fundamental which determines the pitch. A possible explanation might be that the carrying power, is not so great as in the upper register. At the same time, I am under the impression that, given a piano of such size that bass strings of correctly proportioned length and pliability may be used, the recording diaphragm will respond with sufficient intensity to influence favorably the reproduction. If we get a stronger fundamental with a long pliable bass string than we do with a short stiff one, it would be fair to assume that a balance of tone would result, and also that any company making records would be glad to pay the price for a piano that would improve the reproduction."

Wm. Braid White: "Some time ago I experimented with very long strings. The result bears out what you say. I stretched some cords from twenty-four to thirty feet long. I found it possible with care and using a piano hammer with a long stick to tap them, to get as few as four vibrations per second practically pure. One could watch the vibrations and count them as low as four per second. There is no question but that if you can make the strings long enough and overcome the engineering problems the fundamental would be materially increased in intensity."

F. E. Morton: "In a piano having very short bass strings—in a small grand—I strike one of the lower bass notes and observe the pitch How much of that is direct and how much resultant?"

Wm. Braid White: "Ninety per cent resultant."

F. E. Morton: "Where does it get its other partials?"

Wm. Braid White: "The short, stiff, heavy wound string tends to vibrate more like a rod and less like a string. Mr. Deutschmann or any other tuner will say that when one gets down two octaves below middle C the tuner works, whether he knows it or not, on the partial tones and not on the fundamentals, because the fundamentals are not there."

F. E. Morton: "One can't tell the pitch of a low bass note on a very short scale. Doesn't the phonograph hear better than we do? Isn't the absence of the fundamental in the short bass string truly recorded?"

Wm. Braid White: "We are all selective hearers."

F. E. Morton: "A camera sees better than the eye. One can't tell much of the real tone of an instrument by hearing someone play. For a tone analysis, strike a single key until you have heard the partials that go to make up the tone. Listen only for the partial tones."

Chas. Deutschmann: "Don't those low notes go beyond the perception of the human ear?"

F. E. Morton: "I don't think so. Mr. Milner, don't you think we actually hear a sixteen-foot C at thirty-two vibrations per second?"

F. T. Milner: "Yes. It is doubtful, however, if we hear the thirty-two foot pipe."

F. E. Morton: "It is generally considered that the human ear will respond to at least thirty vibrations per second. Whether or not we determine pitch readily with that number is open to question. The ear does respond to it."

Wm. Braid White: "The lowest A on the piano at International Pitch is twenty-seven and one-half vibrations per second. If you take a tuning fork which is built to give exactly that pitch you can scarcely hear anything but a low drum. With a larger tuning fork you cannot hear it at all. Twenty is the low limit."

F. E. Morton: "I am going to advance a theory—a something upon which to work. Mr. Milner will tell you that given a pipe which gives thirty-two vibrations per second and one which produces forty-eight per second, by regulating them to the proper relative intensity you will produce an effect of sixteen per second, that is known in pipe organ nomenclature as a resultant. Given a bass string having length, weight and tension that will give sixty-four vibrations per second. That string vibrates in segments of one-half and also produces vibrations of 128 per second. It is also vibrating in three segments, each producing 192 vibrations per second. It is not at all improbable that the resultant sixty-four is caused by the octave in the tone together with the third partial in the tone, forming a true resultant, thus giving the effect of sixty-four. We may be enabled through the use of this theory to strengthen the pitch-giving fundamental."

Wm. Braid White: "Experiment was made a number of years ago whereby an acoustician listened to two tuning forks which were tuned one-twelfth apart, one sixty-four, the other 192. One was held close to his ear, the other at a telephone receiver in the next room. One was received through the telephone; the other direct. Those two waves couldn't cross."

F. T. Milner: "What has been done to overcome the limitation you have mentioned? I refer to the reproducing receiver and the material of which it is made."

F. E. Morton: "As far as I have observed such things as wrapping horns in tape to prevent the vibration of the horn itself. One of our men is engaged in making a horn of concrete which would really make an ideal horn because of its rigidity. Numerous experiments have been made with diaphragms of various materials and shapes."

E. B. Bartlett: "If we assume that the diaphragm in a phonograph corresponds to the string of a piano, doesn't it clear up one problem? A string suitable for a high note will not be suitable for a low bass note. We have to have eighty-eight different strings of different lengths and varying diameter. Isn't it reasonable to infer that a diaphragm suitable for reproducing very rapid vibrations would not be suitable for the slower ones? Is not the diaphragm a compromise from the start?"

F. E. Morton: "The diaphragm responds to its own key note with greater intensity than it does to another pitch. A diaphragm is flat. Any flat body vibrates in odd numbered segments. Take a rod, suspend it by a string and strike it, and you hear what you assume to be the pitch. With a phonendoscope you can get the fundamental. It is much lower than the pitch determined by the ear alone."

F. T. Milner: "It is the same as in bells. You get the partials first, which makes them sound out of tune."

C. C. Chickering: "It would seem to me from the trend of the talk so far that the impression obtains that the predominant partof the piano is from middle C up. The lower register, to my hearing, predominates in the average instrument."

F. E. Morton: "The higher the pitch the farther the tone carries."

C. C. Chickering: "In the average piano if it has a weak place it is the upper register. The short string lacks the quality we want in the tone."

F. E. Morton: "Might it not be true that it is because of the penetrating character of the upper register that these faults are more easily determined?"

C. C. Chickering: "It may be that what we all look for and strive for in the piano is singing quality and we can't hope to make the short strings hold their vibrations as well as the long strings. As I hear an artist play a piano it always seems that the treble is lacking as compared with the bass. If that is true, and that impression obtains with other listeners, then your theory that the phonograph doesn't get the bass is not true."

E. B. Bartlett: "It is a question of volume and sustaining quality. The fundamental determines the pitch and is less in evidence as you go down in the bass."

F. E. Morton: "I was referring only to quality, not volume. I suggest to those making records of male quartets that the second bass be placed closer to the horn, the first bass a little farther, etc. It would rid us of the predominant tenor and gave us the grateful fundamental. I feel that the public will be much more interested in all records having full strong fundamentals, however produced, than they will in the average present records, both orchestral and vocal. If those in charge of studios will understand that when the public says, 'This is a good and this is a poor tone,' and we analyze both it will be found that the one which the public says is good has a dominant fundamental and the one which the public says is poor has little fundamental, they will effect a grateful change."

C. C. Chickering: "I would like to ask what instrumental records sell the most readily to the public?"

E. H. Rose: "Cello, violin and harp."

F. E. Morton: "There are some very excellent tones reproduced but their relationship is distorted. Take two violins, viola and cello. The cello is usually too light. We glory in a passage where it comes out strong. We like to hear a male quartet with a good substantial second bass.

To determine in a flat vibrating body the true pitch—the fundamental—you can use this instrument, known as a phonendoscope. You can locate sounds foreign to the desired tone in your piano, vibration of case, plate, etc. When you get through with it you can put it on your car and locate engine trouble. It is an aid to listening, and any aid to listening is very well worth while. And now to return to the phonograph, the diaphragm being flat and vibrating in odd numbered segments, the attempt has been made to crown it. Just as soon as you near the arch you approach the unresponsive. It has too much resistance. It is not practical. Some day we will get away from the diaphragm entirely. The horn idea will never be entirely satisfactory as a true recorder or reproducer. The horn idea, or tone chamber, is distorting and until you would enjoy a Tetrazzini singing or a Kreisler playing through a megaphone you will not be entirely satisfied with the present form of phonographs. In the meantime we have records today that couldn't be replaced by any other means. Think what the record of ancient history would mean in our phonograph studios today. Think of some of the great speeches by Roman Senators handed down for us today as phonograph records. If there is anything on earth that should be encouraged it is the phonograph industry and everything pertaining to it. Give it its proper place. It has a big place and is one which will redound to our glory if we back it up strongly. The phonograph doesn't take the place of the piano. It never will and never can. It is no more fair to say that the phonograph is a substitute for the piano than that a reaper is a substitute for the plow. The reproducing piano probably is the closest we can come today to a reproduction of an artist's work. The gradations are not as fine as we would like to have them, but we are progressing.

"During the past few months the piano trade has been placed in a difficult situation. The existence of the piano trade during the period of the war has been an issue. At one time the piano was placed third on a list of a few hundred products of industry and those industries were labeled nonessential. The disorganization of capital and labor seemed imminent. The Music Industries Chamber of Commerce and Allied Interests, through its counsel and general manager, went to Washington on an educational campaign and succeeded in placing the piano industry where it belonged—among the essentials. The great credit for that achievement is due the counsel and general manager, whom we have with us tonight—Mr. George W. Pound."

George W. Pound: "Mr. Morton and Gentlemen, when the president of the Chicago Piano

and Organ Association, after my last visit here several weeks ago, wrote me, as Brother Morton says, to come 'back home' to Chicago on the occasion of your dinner here tomorrow night, I accepted as quickly as a hot knife will go through butter. We have had strenuous days at Washington. The industry was in peril. The very life, foundation—the fundamental—of the industry was at stake. I am pleased to say we have been able to present that issue and our industry to the authorities at Washington in such a way that they have restored us to our proper position in the industrial world of the country. We have ceased to be a nonessential.

"They tell us there is a wonderful mosaic in Italy, and as the tourists gaze at this great work of art they see what seems to be a number of half circles, but the better and more discerning eye of the lens and the camera reveal that the half circles are complete circles, each entwined in and dependent upon the other. So it seems to me that this talk tonight begins at the very foundation of this circle of music. What is here discussed is the first entwining of the circle from which must finally come the completing of the instrument. Mr. Morton's talk has been more than fifty per cent fundamental. Music after all is the one beautiful gold note which makes the tired ears young again. Our aim in our new work is to make America the greatest music loving and the greatest music producing country in the world. Fate has struck the hour for us. Somebody said when Napoleon was defeated at Waterloo the clock of ages was turned back sixty degrees. The great Imperial Senator Roscoe Conkling said, when the powers that were defeated the nomination of Grant the last time that the political history of America had been moved back. If Washington had placed us and kept us in the non-essential list and had driven us backward would it not have turned back the clock of ages and of progress? (Applause.)

"Music is in everything if we can only see it. In its final analysis everything in life is melody. It is for us to teach the people and bring them to this great thought and perception.

"Oliver Wendell Holmes said the time to begin the education of the child is one hundred years before it was born. Prior to the war, Germany exported ninety per cent of all the musical instruments of the world. Today America exports seventy-five per cent of the musical instruments of the world. France this year is making—my information differing somewhat—between 14,000 and 19,000 pianos. England is making but 20,000. In our industry we make nearly 300,000.

"Our industry is in its evolution. In the days that are not so far gone the musical instrument in the farm house was our good old friend the square piano in the parlor which was never opened and the curtains were never drawn back except perhaps on two occasions—a funeral or a wedding. Gradually the daughter of the house went to the high school and college and the square piano was discarded and the upright substituted. The father said he must have his music. Daughter hadn't practiced or she left her music at the neighbor's and couldn't play without it. This brought father to the point where he wanted his music when he wanted it and so purchased a player-piano.

"If we say now that the production of the player-piano as against the straight piano is fifty-fifty, we can readily foresee and prophesy that while the straight piano will always be the instrument of the music loving, the public demand will perhaps remain and abide with the player-piano.

"I thank our gifted friend, Mr. Morton, for what I have learned here tonight. It was Vice-President Marshall who once said that you only went upon a mountain top for a vision. After you had your view you descended to the dead levels of life, but after all, we must go to the mountain tops for our vision. I wish to hear and absorb from the great and practical minds of the industry their vision and point of view. In this work of mine I want your sympathetic support. Come over the top with me and let us do this. When this war is over America will surely be the music loving country of the world. With the great future that is before us, let us make our industry the most essential of all, and make America its climax and its hope." (Applause.)

F. E. Morton: "We will continue in coming conferences the synthesis of tone that we may better understand tone quality, that we may be able to know of what it is composed. I am not a prophet, but if I can judge effect from cause, in a comparatively short time there will be no accidents of tone in piano construction. I know and you know that some scales are cherished very largely for the reason that they couldn't be replaced if destroyed. I have been told so by their owners. One manufacturer of note said to me: 'We will not touch this scale under any circumstances. It has a distinctive quality of tone. I don't know what it is and no one in the factory

knows what it is, but if we ever lost the pattern it would be irreparably lost.' That condition obtains largely in the piano trade. Mechanical contrivances formerly were classified that way. We understand mechanics better than at that time and we don't have non-replaceable patterns. On the assumption that the piano manufacturer is a tone builder, we will continue our investigation, study and discussion of tonal problems and try to keep as closely on the track as practicable although there are interesting by-paths."

The Hammer and the Wire

February 6, 1918

F. E. Morton: "In a moving picture the image is flashed before the eye at the rate of sixteen per second; where quick action demands, the number per second is increased up to 128, all in order to retain the impression of a continuous movement. In sound, the number of impulses must follow at the rate of about thirty per second before the impression of a continuous tone obtains. Greater energy is required to produce the same degree of intensity at a lower pitch than at a higher pitch. Applied energy being the same, the higher the pitch the farther the tone carries.

"I made a statement at one of the first meetings, simply as a basis for further theorizing, that the generally accepted American piano tone is that in which the fundamental, or first partial, has an intensity of at least fifty per cent and the partials above the first decrease in intensity sequentially up to the seventh, of which there is only a trace. Let us now approach a few problems from a new angle and thus become a little more intimate with them. Let us take for granted that there is no such thing as a foolish question; there is such a thing as a foolish answer. Some things most obvious to those daily associated with the technique of the trade have never been given general currency. It is difficult for the dealer to talk to the public about the tone of the piano because he has never been told by the manufacturer in words meaning the same to both. Helmholtz coined words and terms and their translation necessitated borrowing from the vocabulary of other trades and professions and coining as well. The principles involved were not understood. Helmholtz demonstrated them, and to give the public the benefit of his demonstration was obliged to coin or compound words expressing his deductions.

"In the 1912 edition of Helmholtz there are still many terms misleading because unfamiliar. If those terms were generally accepted, brought into our public schools and made a part of the curriculum, it would be as simple and easy to discuss the relative merits of piano tone as it now is to discuss shades and tints and colors in a dry goods store. We should give all currency possible to our technical terms. One term constantly used is 'partial.' It is a contraction of the term 'partial tone.' When a stretched wire is set in vibration by a blow, by plucking or electromagnetic drive, a wave or undulation is started over the wire, the wave length depending upon such properties as composition, tension and weight of the wire. That wave travels to the end and is reflected. On its return the arc is changed, forming two segments. As it reaches the end it is reflected again in three and then again four, five, six, seven, etc., the number and intensity with which it responds depending upon the weight, stiffness and the composition of the wire. Having to do only with the first movement of that wave, we have this effect. (Illustrated with the 'Spiral Wave Demonstrator,' see Fig. 24 Page 105.) We strike the wire at this point. Watch it break into segments. It is now vibrating not only as a whole but segmentally. I now strike this wire two blows instead of one. Notice one wave following the other. These points that do not oscillate are called nodes—quiet places. The points between the nodes are called crests. This wire is about 225 feet long, so you are really observing the traveling of an impulse over 225 feet of wire within a compass of twenty feet. This spiral demonstrator I am putting up now is 190 feet long. We will assume that the wire vibrating as a whole — so — moves at the rate of 108¾ times per second, giving a pitch of A. That would produce this sound (illustrating with large tuning fork). Vibrating in segments of two we get 217½ vibrations on each side in addition to the first. The combined result is this sound (illustrating with two forks). Vibrating in thirds each one of these thirds vibrating three times as fast as the whole, each one would be vibrating 435 times per second and these vibrations are simultaneous."

Mr. Morton then, by means of the Spiral Wave Demonstrator and a set of harmonic forks

with resonators, visualized the movement of the vibrating wire and made audible the effect of each partial added until seven forks were heard in unison.

He continued:

"Notice each one enriches the tone a little. If it were not for the fact that increasing the intensity of the fifth partial in practice throws in the higher odd numbered partials, giving a rough, cutting tone, it would be a decided improvement. The seventh, which vibrates 761¼ vibrations per second, adds another delightful quality, and which gives the characteristic tone of the concert grand piano. It doesn't require very much of it to give that delightful horn-like quality. It is like a bit of seasoning to the tone, and were it not for the fact — as in the fifth — that a generous modicum of the seventh throws in the ninth and eleventh partials, we could obtain that effect in drawing our scale by adjustment of the ratio of length, weight, pitch and tension. The hollow effect comes with the ninth and eleventh and is due to the dominance of these odd-numbered partials. Suppose you were to string your piano with wire of too small a gauge, use hard hammers and strike a hard blow, you will produce these high odd-numbered partials and get a nasal tone. If we strike this wire at one-eighth with a hammer of the proper degree of hardness, we get just such segmental vibration as we require on the piano today up to the seventh (illustrating). If we strike closer to the bearing it breaks up into more segments. Using a hard wire drawn to high tension and struck with a hard hammer we get partials audible with the resonators up to twenty-five."

C. C. Chickering: "What part of the piano do you use for this sort of experimenting?"

F. E. Morton: "It is more easily observable in the middle of the instrument — say a little below middle C, although they really are present in all parts of the piano. It is difficult to observe cause and effect on a wound string owing to the distribution of weight. I have here an example of the effect of hard, stiff wire in a little bar of steel. Here are inharmonic high partials, and the general effect is what tuners call a 'false note'."

E. B. Bartlett: "The fundamental disappears very quickly."

F. E. Morton: "Even with a light tap we get the inharmonics. It is sometimes possible to get rid of a 'false note' by changing the striking point. If you can strike the node of the inharmonic partial and make a crest of it you may eliminate the inharmonic (illustrating with steel bar)."

E. L. Stryker: "What is a 'wolf'?"

F. E. Morton: "It is the difference between three perfect thirds and three equal thirds producing an octave. Here is a perfect third, no beats in it. That difference must be distributed throughout the octave. That has been called 'the wolf.' The pipe organ tuner deals with sustained tone and can spend whatever time he pleases in distributing the wolf."

G. B. Demes: "In the bass of some pianos you will find a note that seems to stand out sharp and that can't be voiced. The note next to it can be toned down but this one has what we call a 'wolf' tone. What is the cause?"

F. E. Morton: "Has it a beat?"

G. B. Demes: "It has a peculiar quality — a hollow, metallic sound."

F. E. Morton: "This quality of tone — if I have the same thing in mind — can be produced by using a covering wire which is too hard, by giving too much weight to the covering or core wire or both and making up for it in tension. It also may be produced by a wire that is not cylindrical."

C. C. Chickering: "Does the question refer to a tone produced on all pianos of some particular scale?"

G. B. Demes: "On certain scales it occurs on the fourth note—A—and sometimes the fifth. One can't check it. It always seems to be in one locality."

F. E. Morton: "If it is a case of scale work and not a fault of wire or string, there wouldn't be beats, but it would be attributable to the relative bearing of the bridge on the sounding board and the position of a rib. Such a condition may be changed by changing the position of the rib. It may be produced by certain arrangement of rib, sounding board and bridge. Mr. Waud has taken up that matter in a scale which he has designed and which has produced a beautiful result."

R. H. Waud: "It is corrected in the bass notes by using a lighter covering wire on the notes giving that trouble."

G. B. Demes: "Take the B flat, which is No 17 core wire and No. 30 covering wire. The A below it is No. 17 and No. 29. Why should that difference be in the two notes?"

R. H. Waud: "I would advise that you try different winding and different core wire."

W. B. White: "Change the tension."

F. E. Morton: "Have you changed the load?"

G. B. Demes: "No."

R. H. Waud: "No one wants to change his core wire at that point because he wants to step down. The only thing to do is to put on a lighter covering wire."

F. E. Morton: "A scale was made for steel covering wire and changed to copper of the same size. It brought the tension up and gave a bass with the peculiar quality you describe. It is not practical to remedy it by voicing."

R. H. Waud: "The old factory name is the 'wolf' tone. It is the predominant tone of that scale."

F. E. Morton: "An old gentleman in the Knabe factory in '85 or '86 called it the 'howl.' It is a weakness of fundamental caused by wire stiffness."

Wm. Braid White: "In the attempt to fit into the scale the size required, all sorts of difficulties have arisen. The tension has been up on one, down on the next, and there is a different quality in every string."

E. E. Beach: "Don't you think the quality is produced by certain peculiarities of felt and hammer?"

F. E. Morton: "It could be produced by a hard hammer. I doubt if a felt could be made hard enough to produce it alone. We start with the idea that the fundamental must be fifty per cent to give a substantial whole. The fundamental is weak — lessened by the ability of the wire to vibrate as a whole. If you will conform to a lower uniform tension throughout, you will obviate that defect. Not only must the tension be reduced but thickness of sounding board and the position of ribs and general construction throughout, together with the weight of hammers and striking line, must conform. The weight and tension should be the first consideration."

C. C. Chickering: "What would you consider the proper hammer weight for a low tension scale?"

F. E. Morton: "A man who supposedly is a thorough expert on hammers made the statement that he could produce better results with a twelve-pound felt than with a fourteen-pound. He explained that the disposition of the felt on the hammer was very much more important than the weight of the sheet from which it was cut. He could get a much more desirable effect with a twelve-pound felt except in the case of a concert grand where there was great length of string in the bass and more weight required there. I don't think the weight of the hammer felt should go beyond twelve pounds. The disposition of the felt, the tension of the felt over the hammer are all vital, for the ability of the hammer to get away from the wire quickly is the one consideration."

C. C. Chickering: "Another thing that has interested me is an attempt to secure brilliancy in the upper sections. The hammer makers appear to have difficulty in getting felt hard enough to get that result. In order to get what the manufacturer calls for they stretch the hammer over the molding so hard that the wool is gradually disintegrated. In time the treble gets soft and mushy, although it started out perfectly hard, pleasant and brilliant. This is due to the stretching of the felt too much in manufacture. That is a feature upon which the manufacturer should be coached. I have been very much disturbed to observe the effect on pianos of our own manufacture. We call for a hard hammer and they overdo the stretching."

R. H. Waud: "Is it in the extreme treble?"

C. C. Chickering: "It is an octave and a half down."

F. E. Morton: "If we can determine the ratio of resiliency to hardness, it should be practicable to adjust the tension of the hammer felt whose resiliency is known, to the tension of the wire with which it comes in contact. A condition exists where the hammer gets away in the shortest time. We hope to find out where that degree of resiliency lies."

R. H. Waud: "In how many pianos have you found this trouble, that is, in what proportion?"

C. C. Chickering: "I have supposed that if it occurred in one of a certain lot of hammers the same would be true of all."

R. H. Waud: "Hammers should stay a certain length of time in the press to get molded and hardened. If left in too long they will remain hard too long."

F. E. Morton: "Do the hammers cut through?"

C. C. Chickering: "No. I have a piano at home which at first had a bright, clean-cut treble. It is now softer."

Wm. Braid White: "To what extent are the hammers cut in?"

C. C. Chickering: "Not very much. The hammer pushed out, due to the fact that it was pressed too hard in the manufacture rather than stretched over too hard. A good many grands, particularly in the raw state, showed pleasing quality, but when the tone regulator took off the outside of the felt and pricked it the tone didn't seem to respond and you couldn't 'feel' it under your fingers. When the hammers are right and the strings are right, there is a certain response that one feels through the fingers. I have often wondered at it, but have not arrived at a satisfactory conclusion."

F. E. Morton: "You can account for it by the greater spread of the hammer over the wire after being voiced. It should strike at a point. If it touches the wire on either side of that point it destroys certain nodes. Take the node of the seventh, which is desirable, and on a string, say, twelve inches long; on striking at the eighth you are only about one-fifth inch from the seventh node. It isn't difficult at all by a little overhang of felt to damp the segmental vibration."

E. E. Beach: "It is possible to voice a piano accurately with a warm iron by placing on the upper or under side, as the case may be, and change the striking point just a little."

F. E. Morton: "I have a piano in which a good set of hammers of good felt were put and never voiced. I have been pounding away at it for over three years to observe the effect. The hammers are standing up beautifully. I doubt if the tone has changed materially."

C. C. Chickering: "Then the less you doctor the hammers the better."

F. E. Morton: "I had those hammers made under my direction and left certain parts in longer than others and the pressure properly distributed."

C. C. Chickering: "If we can get our tone regulators to that point we will get away from a good many of our troubles. When I hear that a man has taken two or three days to voice a piano I always have a notion he has taken a lot away from the hammers."

F. E. Morton: "Wouldn't it be well, where enough pianos are made, to establish a standard on each piano, to have C voiced by a master voicer, as do the organ pipe makers, and then have the tone regulator work up to that standard? It might make a little work for the scale draftsman."

C. C. Chickering: "I don't know whether that is a practical thing or not. The tone in the middle is not what we want above and below. As it works up toward the treble the hammer should become harder."

R. H. Waud: "Mr. Morton meant a number of C's."

F. E. Morton: "Mr. McClellan, what is your experience in the homes in regard to the condition of the hammers in various parts of the instrument?"

W. F. McClellan: "It has always appeared that the felting was not close enough — not so much the pressure around the hammer but the felting itself. The fibres are too short, and the result is when you take a little off the surface to get the outside skin off, the wire goes through to the wood while between the wires it is just the same as before."

F. E. Morton: "I selected a sheet of felt that was very full from a hammer maker's stock. It had been felted to the extreme and was considered an especially fine piece of felt. The fibre was excellent, but it had been felted to the limit. I had a set of hammers made from it and put on an upright piano and tested out. The felt wore down almost as though there was a scuffing movement of the hammer. It looked like a cut, but an examination showed that it was worn through. There evidently is a point of felting beyond which they should not go in the manufacture of hammers. There is a certain wool known as F. F. that gives a very beautiful quality of tone, but is not practical from the wearing standpoint."

C. C. Chickering: "The fine felt goes into the F. F. It will not wear as well."

F. E. Morton: "There is not enough resiliency to the felt itself. The relationship of resiliency of hammer, when caused by tension of felt over under felt, to the tension of the wire, is a big factor in tone production. Personally, I think hammers are going to be made by hammer makers that will not require sanding or picking up at all. Certain it is, if we do we will have a durable hammer and better quality of tone. I want to bring your minds once again to cause and effect relative to differences in tone quality. Wire first must be right in its mode of vibration. If the wire vibrates with a large number of odd numbered higher partials, that is expressed by the sounding board, for the sounding board travels with the wire just as the impulse on the diaphragm records on a phonograph record; so the matter of weight of wire, length of wire, and tension of wire are the first things to be considered. Following that is the attachment of wire to the bridge. The bridge is actually carried and we may say that the sounding board simply furnishes area which the wire has not. The board, then, must respond fully to *all* movements of the wire. If you reduce the tension or weight you must reduce the thickness of the board to make it responsive. Here also are the safeguards: The energy conveyed to the wire must remain in that area between the agraffe and the plate bearing until fully expressed in board motion. This means reflectors of energy must be so perfected that when the wave is transmitted to the bearing or agraffe, it returns as energy. When we say we want a piano with singing quality of tone — a good sostenuto effect — we mean we want a piano in which the energy 'stays put,' — continues to express and is not absorbed. Any condition which necessitates the weaving of pieces of felt or tape into the wire between the bridge and hitch pin means lost energy and is taking away from the sostenuto effect of the piano. That energy sets the felt in vibration and the friction of fibre against fibre produces heat. We should avoid all things which lead away that energy. On the agraffe side the presser bar should be rigid. Rigidity is the main requisite in a presser bar. You can get greater rigidity with a heavier bar. The rigidity can be increased by lugging it to the plate. I have taken off a floating presser bar and put on a heavy lugged bar and the difference in tone quality was very noticeable. In the case of small grands the suspension bridge is effective down about two octaves. From that point on it is doubtful. There is a point where energy applied at the key will free the wire from its bearing, which means a failure to reflect. In some cases it may show itself by a little jarring sound. If you strike the key hard it does not sustain as well as when struck a light blow. To a great extent efficiency in piano building to the end that a good sustained tone may be had depends very largely upon responsiveness of sound board; rigidity of construction and a perfect reflection of energy at the agraffe and plate bearing."

E. B. Bartlett: "What ratio do you recommend as a distance from the sounding board bridge to the hitch pin or plate bearing?"

F. E. Morton: "The requisite there is responsiveness of the sounding board — a free movement of the bridge both ways. The wire must carry the bridge with it both up and down. If you have too much bearing on the bridge the board movement is only one way and therefore only about fifty per cent efficient. If the bearing is caused by a bridge too high, the effect is the same as though the distance from the bridge to the plate bearing is too short. The minimum distance on the average upright piano can safely be put at three inches until you get to the last octave. Then it is fair to make it two inches. I have found by experiment that three inches was very satisfactory, while any less showed very plainly in lessened responsiveness of board."

C. C. Chickering: "Is there any objection to getting more than that?"

F. E. Morton: "There is a point to which we should not go because of the board's failure to respond to the higher partials."

Felt Resiliency

February 20, 1918

F. E. Morton: "At the last meeting I mentioned the possibility of accurate measurement of piano hammer resiliency, in the near future, by means of an instrument known as the resiliometer, invented by Mr. S. W. Widney of the Widney Company. The special appliance for the finished hammer is not yet completed, the instrument at present being adapted to flat material only. At present no means of determining the relationship of resiliency to hardness, either

before or after putting the felt on the hammer, obtains. We have in the completed hammer three factors — the hammer butt, the under felt, and the over felt. The resilience of the wire we now can determine; we can measure by length, weight and tension, with the aid of tables and formulae which we have prepared. The ultimate problem is, How quickly does the hammer get away from the wire after striking? Hence our interest in the ratio of resiliency to hardness."

H. H. Arnold: "Hasn't the flexibility of shank a lot to do with that?"

F. E. Morton: "It may have. There is also a question of difference in resiliency with and without shank in the hammer butt. A test should be made before and after the shank is put in. In actual practice this is a constant with a standardized hammer shank. Suppose you find a hammer that exactly suits you; one which gives you precisely the result you desire and you want it duplicated. What can you tell your hammer maker about the hammer? The only test at present is a destructive test. Any device that will give the ratio of resiliency to hardness will supply that missing information to the hammer maker. The hammer maker will welcome this as he has other suggestions. He will then be able to take the hardness and resiliency measure of the hammer with under felt, then of the flat hammer felt and then of the hammer felt on the hammer. From such data he may determine what quality of felt will give the desired result. Mr. Widney expected his latest model tonight, but it did not arrive in time, so he will demonstrate with one of the earlier models."

S. W. Widney: "Mr. Chairman, as I told you, I hate to come up here and make any apologies. This model I have here will show all essential principles. The ones we are building now are an open type, self-contained. What prompted us to get it out in a completed form was government specifications. When we produced our first model, we knew it would meet with obstacles, but that people who saw it would give us ideas for improvements. When we put the first one before the government engineers they told us to make it open and self-contained, so the ones we are now building are very much easier of access. You might be interested to know how the instrument was first conceived. Shortly after I entered the felt business I encountered misunderstandings regarding hardness. I soon found that no two men's ideas were the same. When I got samples from a customer I tried to determine the hardness. That usually is the big factor in the common usages of felt. The first method of determining this was by the use of an ordinary caliper. With the jaws of the caliper we would get the normal thickness and then force the jaws of the caliper down as far as they would go. If we had two pieces of material of the same thickness, after forcing each one down as far as human pressure would permit, the one that went down the farthest was the softest, etc. Later on we got the dial micrometer. In making tests for hardness, I noted the possibility of observation for resilience. Immediately we relieved the pressure on the dial gauge, we could see the rebound. It was just a simple question of working it out mechanically. We got busy one day and our first move was to get a lever and weight. With the regular lever and weight we could observe and get exact measurements and thereby eliminate the human element. We then decided it was a commercial proposition as well as a good thing for anyone handling felts or any resilient material. When the government specifications came along we had a great deal of trouble with them on account of their being so incomplete and incomprehensive, so we proceeded to work out a proposition that the other fellow could use as well as ourselves. This instrument is the outcome. Hardness is the power of a given body to resist penetration. Resiliency is the power to react toward the normal position after compression. For instance, we take a given material. The first operation of the machine is to give the normal thickness. We will say that it is .100 inch. We relieve the spring catch and apply the pressure. Under pressure the reading is .050 inch, or one-half the normal thickness. We then say it is 50 per cent hard. If it went down to .025 inch it would be 25 per cent hard; if .075 inch then 75 per cent hard. That gives you a positive reading. We ascertain the resiliency by relieving the weight pressure and observing how far it springs back. In this instance it goes back to .080 inch, that is, 3/5 of the possible 50 points, and it, therefore, is 60 per cent resilient.That is all there is to the machine. If anyone wants to ask questions or make tests I would be delighted to answer them or assist."

E. J. Fishbaugh: "What is the highest point of resiliency you have found in hammer felt?"

S. W. Widney: "About 98 on the hammer. I have not been able to make any observations in the sheet because we have not had a dial gauge of sufficient capacity."

E. J. Fishbaugh: "Which, in your estimation, would have the greater percentage of resilience, a hammer with underfelt or one without?"

S. W. Widney: "I wouldn't want to say."

E. J. Fishbaugh: "If you did want to say, what would you say?"

S. W. Widney: "It would depend somewhat on the underfelt, whether live, fine, all wool underfelt or cheap, low-grade underfelt."

E. J. Fishbaugh: "I am speaking of the highest grade underfelt you could put on."

S. W. Widney: "It would probably increase the resiliency."

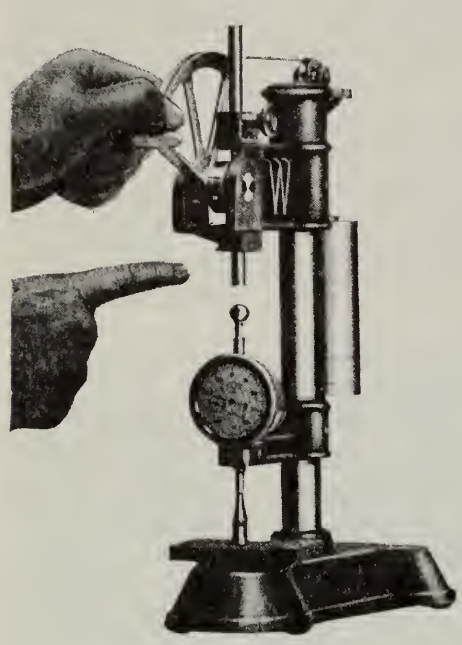


Fig. 32

F. E. Morton: "Have you made a test to determine whether this would result?"

S. W. Widney: "No."

E. J. Fishbaugh: "Why would it increase the resiliency?"

S. W. Widney: "You are adding more body there."

E. J. Fishbaugh: "Could it be made more resilient?"

S. W. Widney: "Yes. Some top felt today is made very low in resiliency."

E. J. Fishbaugh: "On a good hammer?"

S. W. Widney: "No, I wouldn't say on a good hammer."

E. J. Fishbaugh: "I am referring to good hammer and underfelt."

S. W. Widney: "I can furnish underfelt as resilient as top felt."

F. E. Morton: "One point should be taken into consideration and that is the ratio of resiliency to hardness, so resiliency is not a lone factor. Suppose a test is made on this machine — first of the hammer butt, then of the underfelt in the flat, and then of the hammer butt with underfelt applied; then of your overfelt flat; then of the entire hammer complete; a knowledge of the three processes will establish a practice of great value to the piano trade. Being a matter of ratio between hardness and resiliency it would seem to me that unless these other factors were known the result would be a guess in any event. If resiliency alone could determine a standard, then an answer to such questions could be made with assurance."

Wm. Braid White: "If I understand you clearly, Mr. Widney, you have provided us at last with a basis for figuring. If the piano maker, the hammer maker and the felt maker each has one of your resiliometers and the piano maker decides a certain run of hammers in a certain scale is giving proper results, he may take readings of that scale, pass them to the hammer maker; the hammer maker will make readings and pass them to the felt maker; the felt maker will then have a definite basis for work. In other words, we are beginning to see a scientific system in hammer making."

C. H. Jackson: "Would you say that you could measure the finished product?"

S. W. Widney: "Yes."

C. H. Jackson: "Wouldn't you get a different test from each hammer? As you graduated wouldn't you find one hammer different from another?"

S. W. Widney: "A difference will always be found in the upper treble and lower bass, and it has to be worked out in your own way. If you wanted the measurement on each hammer you would also have to give the specification on each hammer."

H. W. Jarrow: "The hammer maker is unable to work on each hammer separately."

C. H. Jackson: "As long as you are getting it down to so fine a point why not go through with it?"

Wm. Braid White: "Last year we said that the time must come when the hammer maker will have to have means of knowing how many pounds pressure he puts on a hammer."

H. W. Jarrow: "The hammer maker has means of knowing how many pounds pressure is

put on the hammer. Unfortunately, he has several unknown quantities with which to deal. One is the 'touch' of the felt and the power applied. That alone won't help him, but it is a step in the right direction. The most interesting thing is the get-away of the hammer."

F. E. Morton: "That is the relationship between the hardness and resiliency of the wire and hammer."

H. W. Jarrow: "Some felts take time to come back, but hammer felts should come back on the instant."

F. E. Morton: "The same hammer won't come back in the same length of time from a piece of wire of a given weight and tension as from a wire of the same weight and different tension, lengths being the same. Resiliency of the wire also is a factor."

S. W. Widney: "I think I realize what Mr. Jarrow is getting at, and that is the instant come-back as against the sluggish come-back. This will tell you that precisely. It registers on the dial gauge."

H. W. Jarrow: "As I see it now on your dial gauge you are depending on the eye. That gauge is quicker than the eye."

S. W. Widney: "After you have made a few observations, you will find that it is not difficult. Some of the felts will creep back slowly and keep creeping back. If you will observe for ten minutes you will see they are still creeping back. Its total rebound will make itself evident in a quarter of a second."

F. E. Morton: "What are the variations in the reading of your dial?"

S. W. Widney: ".001 inch."

H. W. Jarrow: "Take a piece of sized felt and put it under there. Won't you get a pretty quick resiliency test from that as compared with live felt?"

S. W. Widney: "No. My experience so far is that sizing kills the resiliency."

H. W. Jarrow: "Sizing is a very resilient material."

S. W. Widney: "Not as compared to real, live wool."

F. E. Morton: "Are you speaking of the relation of resiliency to hardness?"

H. W. Jarrow: "No, the resiliency itself."

F. E. Morton: "This is only determining the ratio of hardness to resiliency."

H. W. Jarrow: "There would have to be a relationship then?"

F. E. Morton: "Yes."

E. J. Fishbaugh: "How would you express the ratio of resiliency to hardness?"

F. E. Morton: "The final reading of the dial is an expression of that."

E. J. Fishbaugh: "I would like a statement as to what you would say the relation of resiliency to hardness is from the time the wool leaves the sheep, is made into a beautiful hammer after going through the different processes, until the tone regulator comes along and knocks the tar out of it."

F. E. Morton: "We are inducing the farmers to stop branding their sheep with tar."

E. J. Fishbaugh: "I believe the nearer right the hammer is made in the first place, the better for the hammer. Is there a point where we ought to stop between hardness and resiliency?"

F. E. Morton: "That is the very reason I welcome any instrument that promises to help us out of that problem. When we took up the matter of felt last year we all floundered helplessly. No one floundered more helplessly than the felt man. There was no single factor that was standardized. The human element entered into every operation, from the shearing of the sheep down to the putting on of the hammer and tone regulating. We promised at that time that there would be things done. Since that time things have been done. It has been a slow process because we had to start with no known quantity. The felt makers have been willing to co-operate and have received our proffer of services very graciously. They have established laboratories, put in competent men and have made great strides. The felt maker and piano manufacturer express in different terms. Mr. Jarrow spoke of the 'touch' of felt. That doesn't mean anything to your tone regulator, necessarily, and it doesn't mean a thing to the farmer. His idea of 'touch' is entirely different. All along the line there was apparently a lack of knowledge of what the other parties at interest wanted. It was exactly the same in the piano trade when I tried to discover what wire the manufacturer wanted. A manufacturer would say: 'This wire gives 'false tones' Our mill man would say: 'That wire is over drawn.' They didn't speak in the same language. It was necessary for me to work out certain formulae both for the trade

and mill and so bring them together. The same thing can be done with felt. We are progressing. Mr. Widney's invention gives us one basis — the ratio of hardness to resilience. With that we can go much farther than with the 'Tone Regulators' Chart,' which I got out some time ago. You will recall that Mr. Brown, our sanitary engineer, stated that a device for the measurement of tension of the felt on the hammer could be made. Before it could be made practicable this resiliometer was needed. If we don't know the hardness and the resiliency, what good would it do to know the tension of the felt afterward? I believe your interest in this resiliometer is going to help you as much as it does Mr. Widney. Resiliency is only one factor; hardness another. Ratio of resiliency to hardness is what we desire in solving this problem."

H. H. Arnold: "Mr. Widney, assuming that your machine is now completed, inasmuch as you have demonstrated it, will the felt manufacturer have an appliance for this machine on which he can test out the life of the wool which in itself will demonstrate the resiliency before the felt is made up? For instance, a certain lot of wool is bought and on account of past practice they presume this wool has a certain amount of life and it ought to make a certain grade of felt. Is there any way the raw wool can be tested on a machine or device of this kind before he attempts to make that wool into felt? Or doesn't manufacturing the felt to a harder or less hard degree largely regulate the resiliency afterwards? Is the percentage of resiliency increased or decreased through the amount of pressure that is brought to bear in the manufacture of the sheet felt before it gets into hammer form?"

S. W. Widney: "That is strictly a manufacturer's problem and I am not here to say anything about the manufacture of felt, because I am not a felt manufacturer. All I know about this instrument is that it will tell him the hardness and resiliency of the finished product. As to his determining the possibilities the wool might have for resiliency before being made into felt, that is his problem."

H. H. Arnold: "Couldn't a given quantity of wool be taken from a lot to be placed in a certain form of a certain size and then the thickness and hardness be determined by a machine of this character?"

S. W. Widney: "I can see those possibilities. They are simple. Knowing what resiliency that ball of wool would have in the raw state, the possibilities after having been made into felt is a matter of experiment."

H. H. Arnold: "The resiliency might largely be determined by the laying of wool?"

S. W. Widney: "That would be a factor, at least."

H. W. Jarrow: "As far as wool is concerned, the determining of the value of certain wool in a certain grade of felt is a constant — a laboratory process."

F. E. Morton: "Whether or not this will measure the ratio of hardness to resiliency in raw material is to be seen. I have some raw wool here which you may try out."

S. W. Widney: "To test the raw wool you would have to have a positive container."

F. E. Morton: "Would the element of thickness enter there?"

S. W. Widney: "Yes."

F. E. Morton: "Why?"

S. W. Widney: "The hardness and the resiliency primarily is ascertainable only after the thickness is known."

F. E. Morton: "Given a piece of felt one inch thick, make a test for hardness and resiliency, then take from the same felt a piece ⅛ inch and test for resiliency and hardness. Would that be the same?"

S W. Widney: "Absolutely.'

F. E. Morton: "Why?"

S. W. Widney: "You could explain it better than I to the understanding of these gentlemen. I myself know from actual demonstration."

F. E. Morton: "I doubt my ability, for the reason that I spent about two hours trying to get that over with a skilled engineer on a mathematical basis. After he had worked it out he was convinced. It is true that the ratio of hardness to resiliency is the same whether you test ⅛ of an inch or two inches."

C H. Jackson: "That was the point I was getting at."

Wm. Braid White: "In the case of an ideal material, absolutely uniform throughout, that angle then would always be a right angle?"

F. E. Morton: "Yes."

Geo. Lufkin: "I understand, then, that the percentage of resiliency of a half inch piece of felt would be the same as the percentage of a quarter inch of the same material?"

F. E. Morton: "The ratio of resiliency to hardness would be the same. Another thing you may find of interest is the front rail punching."

R. H. Waud: "It would be a matter of interest only so far as it applies to the packing down afterwards."

Wm. Braid White: "What is the relationship between that and the after touch?"

R. H. Waud: "The after touch is more important."

F. E. Morton: "Would not the length of time it takes to come back determine the durability the front rail punching?"

S. W. Widney: "It would establish the proper relation of hardness and resiliency. That remains to be worked out."

J. H. Gerts: "We ought to have something that absolutely stays — something that doesn't pack in the front rail punching."

F. E. Morton: "I think the quickness of the 'come-back' determines that. Suppose under your resiliency test your dial comes back very quickly — immediately springs back to place — and on another punching comes back very slowly, wouldn't it be reasonable to assume that the same condition would obtain longer in the one that came back quickly than the one which came back slowly?"

S. W. Widney: "I have samples here which bear that out. Cheap stock with cotton shoddy is slow in resilience. Wool stocks recover very quickly."

H. H. Arnold: "Suppose that test was made on a front rail punching of a certain felt today and found to have a certain reading as per record, would that same reading apply in a year hence without use?"

H. W. Jarrow: "But for a slight difference in atmospheric changes, which would put more moisture in the piece, the reading would be the same."

F. E. Morton: "What difference, if any, does a degree of humidity make in the resiliency of felt?"

H. W. Jarrow: "If you get your felt too dry you haven't as resilient a piece as you have with a certain percentage of moisture."

F. E. Morton: "Then there come atmospheric conditions under which felts are tested. You will have to have a hygrometer on your machine, Mr. Widney."

S. W. Widney: "I do not believe the atmospheric conditions would be a serious factor to be considered. Felt that has been used in the rain is abnormal, as also is felt that has been in a dry place over steam pipes. Under ordinary conditions, it would not be a factor to be considered."

F. E. Morton: "The humidity in a room or recital hall is a real factor in tone. Mr. Widney is having made for this an appliance that will take in the finished hammer. You will all recall the various opinions expressed relative to the value of reinforcement of hammers. I am looking forward with interest to an actual test of hammers, plain and reinforced, and if I have my way it is going to be done right here before this body."

R. H. Waud: "Do you think the reinforcement will help it at once? Don't you think it is a matter of time?"

F. E. Morton: "We will let the makers determine that. We can satisfy ourselves as to the value of reinforcing a hammer, which is the main thing."

H. H. Arnold: "When you come to the question of producing tone, is hardness and resiliency the main thing to be considered?"

F. E. Morton: "The ratio of hardness to resiliency, yes."

H. H. Arnold: "Is that basic?"

F. E. Morton: "The ratio is basic. The degree of hardness is a matter of individual selection."

C. H. Jackson: "You might put on an attachment to take the hammer with a loose edge on

the molding. I don't care how resilient the felt is, if the edges are loose you get a poor result. Some edges are loose in spots on the upper part of the molding. I have cut into all of them and found bad places. I should think the machine would take that."

F. E. Morton: "If the use of the hammer on the piano can show it, this resiliometer certainly should. Whether it would determine the cause of that condition remains to be seen. I believe we could take the instrument and work out a basis for all sorts of deductions."

C. H. Jackson: "I have yet to find any make of hammer immune from loose edge trouble."

F. E. Morton: "That is a fault in the glueing process. I have watched the glueing up process in a hammer shop and can understand how it can happen. It is another case of the human equation."

"C. H. Jackson brought up something which interested me very much. He said if the piano salesman would go to the extent of taking the customer into his confidence he would be well repaid. He had discussed some of these subjects with some of the ladies in Milwaukee and they came back for further information. They told it to others. It has since been made a topic for discussion there in certain Women's Clubs. That shows there is an interest evolving and that they would like to talk of these things just as men like to get together and talk of their cars. It is up to the salesman to furnish subject matter. In articles for the press, magazines, etc., if the article is signed I have a flood of correspondence afterward from the readers asking for more information and asking where they can get books on the subject. I stated at the last meeting that the terms which you use in your factory and which are used in the trade in discussing pianos should be given currency so that you can express these ideas in your own language and have them understood. If the children were taught in the schools in the language of the piano manufacturer they would ask to be shown how a piano is made. In Boston students of some schools and colleges visit piano factories in classes."

R. H. Waud: "I had four or five classes last year."

H. H. Arnold: "We had a class from the Theological Seminary."

W. S. Jenkins: "Through these meetings I have learned quite a few points and it has taught me to tell the truth in selling pianos. Now when I come to the point where I cannot tell the truth it staggers me. A party came in and asked for a player piano. I explained several things and they sounded reasonable and true. The gentleman said: 'I see you use rubber tubing. How much is that worth?' I said: 'I must say frankly that I do not know.' He replied: 'You have gained my confidence now. I am in the rubber business and I am convinced when you say you don't know how much rubber there is in there that you have been telling me the truth."

"F. E. Morton then gave a demonstration of his new electrically driven harmonic set of forks. Beginning with the first, or fundamental, he added partials up to and including the tenth, showing the effect of each on the composite tone. He said in part: "The first fork gives the same quality you get by blowing across the mouth of a bottle—no overtones. The 9th and 10th are inharmonic and give a decided roughness to the general effect. This quality is characteristic of a high tension scale or one which is overloaded. The same effect obtains from wire that is too stiff whether from composition or practice in wire drawing. Now we add the 4th partial, now the 5th, 6th. The 'horn' quality begins with the 6th.

"The more a wire is drawn after annealing, the harder it becomes. In the process of wire making it becomes harder as it progresses. At certain periods it is drawn through a hot lead bath and made soft and again drawn up to a certain degree of hardness. If the wire is not annealed at the proper point, when it reaches the required gauge it will be too soft or too hard. If it has been drawn too many times through the die after being annealed it will be too hard. The hardness expresses in sound with the 9th and 10th partials that you have just heard, caused by the breaking up of the wire into nine or more segments.

"In the composition 'Prometheus' by Scriabine, the piano is used to accentuate fury and rage of flame and to give the touch of authority to masterful assertions. The cacophonous sounds are brought into prominence by forceful blows upon the piano keys.

"If the hammer is well pointed and very hard it doesn't take a very hard blow to break the wire into a large number of segments. If the tension in your piano is particularly high, if you have overloaded your scale, if your hammers are particularly hard and pointed, you have relief in

a thick sounding board and heavy ribbing. If you were to take off the sounding board from a piano with a scale calling for heavy loading, very high tension, free action, hard pointed hammer, and put on a thin board with a light bridge, it would produce this cacophonous effect. In repairing and rebuilding this should be taken into consideration. All these things affect tone quality. Load a scale heavily, with a high tension, use a hard hammer, make the action free, the touch light and you will get this rough tone. The other extreme, which was at its best in the old three string Weber square, gave a tone consisting of the fundamental and nothing above the 4th partial. A low tension scale, this was considered a delightful instrument for voice accompaniment.

"In the piano of today—and we must talk now in terms of grand pianos—we must have the means of expressing great scope of emotions — such voicing as will give the normal seven partial tones with a light, caressing touch. Then with additional strength of touch we can bring out higher partials. The man who was raised on the little straight scale square loves it until he hears symphony orchestras, brass bands in great masses, piano recitals, great choruses and sees large numbers of people dancing to the strains of music. Then the tinkling tone of the little straight scale square does not suffice to express his emotions. The 'point of saturation' of grand pianos in America is fixed by the condition and mileage of the roads. The interest of the automobile and piano trades to this extent at least are identical."

Mining Music

From *The Music Trades*, Mar. 16, 1918

CHICAGO, ILL., March 10.—The commercial piano—the piano with nothing but price to recommend it—will soon be a thing of the past, according to Frank E. Morton, acoustic enineer of the American Steel & Wire Company, and one of the most insistent workers for the better piano.

Mr. Morton made this prediction at the meeting of the Piano Technicians, Wednesday evening, March 6, in the executive rooms of the American Steel & Wire Company. His address, delivered with compelling directness, followed the showing of the moving picture, made for his company at a cost of thousands of dollars, which depicts the many processes in the evolution of the wire which enters so importantly into the making of the piano, the pipe organ and the harp.

The large gathering of piano men, strongly impressed, through the picture, with the tremendous amount of labor and expense necessary to evolve a piano, were in fitting mood fully to appreciate a plea for better pianos and better prices and his plea for these things was direct and convincing.

He pointed out that the supply of pianos this year was certain to be inadequate to the demand, and he cautioned the manufacturers not to do anything to keep their financial men from advancing prices. In addition to the technicians there were many wholesale and retail salesmen present, and these, as after-the-meeting comment disclosed were given new ideas as to salesmanship and were strengthened in their determination to know the goods they are selling and to sell them on their merit and not on price and terms.

"When you realize that the piano represents the labor, brains and finances of thousands and thousands of your fellow-workers," said Mr. Morton, "you should never talk concessions to your customers. Instead, you should show them what the piano really represents. From the ends of the earth come the materials that enter into the making of a piano. The result is a wonderful art product, and this should be impressed upon the prospective purchaser. But instead of doing this, many salesmen make price the paramount issue. This is because they do not know what is in a piano.

"If we can give the people a proper knowledge of piano values, they will have a higher regard for pianos and will therefore be willing to pay a fitting price. There is not enough money in the piano business to-day because the people do not appreciate the value of a piano. There are people to-day who can express all their musical emotions on a tin whistle. Those are the people who buy the commercial piano. The more of them, the better the business of the pur-

veyor of cheap instruments. But their number is dwindling steadily, thanks to the educating of the people in things musical.

"So let the commercial piano have its swing. It is a good missionary. The day is coming when there won't be any money in the cheap commercial piano and then it will cease to be. For people are fast learning about pianos. They are getting interested in them just as people are interested in automobiles today. They want to know the name, the reputation, the merit of the action and of all the other parts of a piano. They want to know all about it.

"The time is ripe now for an educational campaign. I know of no manufacturer who is not at least trying to make a fairly good piano. This gives hope of much higher strivings. There is always room above; there is only the ground below.

"Some of the manufacturers tell me they are planning to bring school students to their factories to let them get a first-hand knowledge of the making of pianos. This is an excellent movement. The more people you can get to your factories to find out what you are doing, the better for the industry. The matter of price depends upon your own knowledge of values and your ability to disseminate that knowledge.

"I plead for a higher price on the present piano. You are not making anything like enough from your product. You should be able to maintain departments where research work for the betterment of your product and of the industry generally could be carried on. You cannot do this because the prices you receive for your pianos make outlay for such important purposes practically impossible. While everybody has raised the price of his pianos in the past few months, the advances in most cases have scarcely made up the difference in the cost of production.

"At no time has the manufacturer of good pianos received the price his commodity merits, and he never will receive it, until, by process of educating the public and the salesman, pianos are sold strictly on merit—as a costly art product.

"When the reconstruction period following the war sets in the piano will feel it in a pronounced way. The reaction the people will feel when great victory crowns the period of self-denial and uncertainty, will find its expression in a large degree through music, and there will be a demand for things musical such as the country has never known. The demand will be for the good piano.

"Now is the time to prepare for this development, and to do this the piano and player-piano must have greater publicity. There are many ways to gain this publicity. One good way is to call the attention of the public to the thousand and one features of the piano that to you are every-day affairs but to the average person is brand-new information.

"The National Bureau for the Advancement of Music is doing considerable work in this direction. Active work has been begun here by one who is competent, interested and can interest. Join in this movement and the piano industry will profit by it."

Mr. Morton urged the piano men to lend every support to the roll and record movement which was first launched by the Chicago Piano & Organ Association and taken up by the Chicago "Evening Post," which runs a department devoted to it.

"When I suggested to the Chicago Piano & Organ Association that we endeavor to make the movement nationwide, I did not believe it would grow anything like as rapidly as it has," he said. "It is becoming a national movement. Other cities have taken it up and rolls and records are being recruited from cabinets in all parts of the country. I do not want to see it fall down at its base—Chicago. Everybody can influence five or six persons or he would not continue to exist. Let us all get together and compel our friends to give of their old records and rolls, if for no other reason than that they will have to buy new ones to fill the empty spaces in their cabinets. If you can do a noble act and at the same time profit by it, what can be said against that? The interest in music rolls is infectious. The sale of the rolls means new music to the neighbor of the player-piano and eventually may lead to the sale of a player-piano to that neighbor.

"We had planned to give a piano orchestra demonstration in connection with the showing of the moving picture tonight, but that was postponed because of lack of time to put it on as we desired. With the two piano performances of Gabrilowitch and Bauer here last Sunday, the piano orchestra does not make quite such a Philistine of me, perhaps. The two pianos brought out the new tonal idea so strikingly that even the musical critics noticed it and made comment. The possibilities of the piano have not been discovered and we want to do what we can toward the discovery. The piano orchestra is to be a study, not a show."

In concluding his remarks, Mr. Morton said:

"From information we have received from all parts of the country the demand for pianos this year is going to be greater than the supply. Don't do anything to keep your financial men from raising the prices of pianos and player-pianos."

Instead of the long table about which the technicians usually gather for their deliberation, the big executive room of the American Steel & Wire Company was arranged theater-fashion. An operator ran the moving-picture machine and Mr. Morton explained the views as they were thrown on the screen. The picture, which is aptly captioned "Mining Music," was originally shown at the annual banquet of the National Association of Piano Merchants, during the convention in Chicago last May. Since then it has been enlarged and improved. The harp and organ sections, both intensely interesting, were shown for the first time here. The picture has been shown in New York and other cities, and it is now planned to have it exhibited in one of the large assembly halls of Chicago in order that pianists, piano teachers and piano students especially and the public generally may see and marvel at the effort the producing of a musical instrument entails.

The picture begins in the Minnesota Hills where a number of men are prospecting for iron ore. In entertaining fashion the watcher is carried through all the processes necessary from the finding of the ore until the attainment of the great task—wire—is shown doing its duty in a concert harp, a mammoth pipe organ, and a grand piano. The mining of the ore, the loading of it on the great ships that carry it to the steel plants, the Bessemer and open-hearth methods of refining it, the drawing of the wire—all these are shown in every detail. Outside of the highly instructive character of the picture there is an appalling beauty about much of the film. It carries the watcher into unaccustomed places and drives home the mightiness of the industry without which there could be no pianos.

Of especial interest were the views of the large blast furnaces, with the various operations that take place such as the cleansing and separating of the iron ore and the generation of the terrific heat required to melt the metal. There are several of these furnaces and they cost as high as a million dollars each.

The picture also showed in detail the two processes used in the smelting of iron known as the Bessemer and Open Hearth processes.

The locating of a mine was next depicted, a large army of laborers were seen at work and a drill erected, resembling in appearance an ordinary well drill. The tests to determine the depth and quality of the ore were shown.

The extensive railroad work that enters into the mining and moving of the ore was featured in detail. The building of special lines to the mine, the moving of tracks and the large trains of cars in use giving a splendid idea of the magnitude of this work.

The transportation of the raw material over miles of country to the docks, whence it is carrie by steamers to the mills, proved very interesting. As the train of cars reached its destination each car was weighed and the weight automatically registered as it passed over the scales.

The unloading of the cars to the vessels showed how modern methods have made it possible to load a large vessel in twenty-five minutes. The cars were run down over the hold, tipped and run back and followed one after another almost as close as if they were coupled to each other.

The work of unloading the ore from the vessel when it reaches the mill proved almost as speedy as the work of loading. By means of a new plan, large scoops go down into the hold and lift three tons of ore in one mouthful. By this means a vessel can be unloaded in three-quarters of an hour.

The ore is then taken from the storage pile to the blast furnace by means of skip cars, which are hoisted to the top of the furnace and dump their load into the blast furnace.

The second part of the picture showed the processes of purifying and melting the ore. How the great heat of the blast is obtained was clearly shown by a picture of the large engine that is used for blowing the blast into the furnace. By this means the waste gas is also blown into the stove.

The pictures of the molten iron being run from the furnace were particularly clear and very interesting. As soon as the furnace was tapped the iron flowed forth in a river of molten ore, throwing off a fiery spray. When all the iron required is run off, the aperture in the furnace is closed by what is known as a mud gun which shoots a large ball of clay and closes the aperture.

The molten iron is then run into cauldrons and finally molded in troughs that resemble pig troughs, hence the name of pig iron.

The process of converting the iron into steel is next portrayed. The open-hearth furnace is ingeniously charged with limestone, scrap, and the proper mixture of iron, the temperature and the cooling is closely watched as these factors are of the greatest importance in producing a proper and even tempered steel.

After eight hours of cooking the steel is tapped and poured into molds and when cool they are reheated in soaking pits. This is necessary because the steel in the first instance cools quicker on the outside and the second heating is to offset this.

The steel is now ready for the rolls and is run back and forth through various sized rolls until it is rolled down into billets. These billets are then sheared into standard sizes for convenience in handling and these are raised and carried by means of large and powerful electric magnets. The billets are then drawn into an oven for re-heating and afterward pass through numerous rolls and become rods. These rods are cleaned to prepare for wire making. The rods are converted into wire by being drawn through dies of various sizes. While this is a simple process it is a very important one, and great care is taken to see that annealing takes place at the proper time, as it is this process which gives a proper and even temper to the wire.

The manufacture of the wire having been completed, the picture then showed the process of wiring and assembling a harp, the instrument which is really the predecessor of the piano.

The Effect of Hammer and Wire Resiliency upon Tone Quality

March 20, 1918

F. E. Morton: "We have a very broad subject and a very deep one for tonight—'The Effect of Hammer and Wire Resiliency on Tone Quality.'

"Let us consider details such as shape of hammer and mass of wire, and I will demonstrate the result of a certain specific treatment. A theory has commercial value only when demonstrated. Our verdict is rendered when the theory is demonstrated and in our case the verdict of the public is an important matter. A verdict on an opinion is only an opinion. A verdict on a demonstration is a determining factor from the commercial viewpoint.

"In our conferences during the last two years we have entertained many theories, and we have given them a certain amount of consideration. Each one knows of someone who has tried out some of these theories. I have been fortunate enough to have been taken into the confidence of quite a number and know it has resulted in an attempt to demonstrate the truth or untruth of these theories. The result is just what we have all been working for—the interest of the employe in the piano as an art product, and in the tonal results of his efforts. When every employe is vitally interested in the manufacture and sale of pianos, you will have a successful business. That is what we are striving for—a successful, profitable business. A profitable business is one which in addition to a fair profit on labor, capital and skill invested leaves an amount large enough to insure research and experimental work and the employment of specialists in order that the business may be assured of continuity through progress. If the piano is made no better fifty years hence than it is today the business will not be profitable. The piano of fifty years ago will not sell—not in this country. We have devoted a little time only to matters of architecture and that only at points which had to do with utility matters, height of keyboard and bench, etc., but we have gone rather deeply into the matter of tone production.

"We have studied tone production from two angles, the analytic and the synthetic, and by the practical application of knowledge so acquired the manufacture of pianos becomes an art, removing it from the common products in proportion to the interest of the employe in tonal value.

"I may only be voicing a theory, but I feel assured that the public interest of the future largely will be centered in tone quality rather than architecture. We always will expect to find a good cover on a good book and a good canvas well framed; we will always expect a piano to have a suitable case, but architecture will not be the paramount issue, and this is evidenced in every move in the educational world.

"Three years ago I went before the National Physics' Teachers Association at Washington and argued for the use of manufactured products instead of the usual brass and glass apparatus in demonstrating the laws of physics, without fear of helping the man or firm manufacturing. I showed that the piano offered a magnificent clinic for the demonstration of acoustical principles at a lower cost than the apparatus now in use, and that it would cross reference with matters and events of daily life. It would furnish the means for educing, thus making the theory and practice of education consistent.

"I am just in receipt of a copy of a new text book, the title of which is 'Elementary General Science,' by Daniel Russell Hodgdon, A. B., B. S., M. S., Sc. D., Head of the Departments of General Science, Science Methods and Agriculture, State Normal School, Newark, New Jersey, and published by Hinds, Hayden & Eldredge, Inc. Dr. Hodgdon states in his preface that 'the proper basis for the teaching of this subject is the environment of the student, and he has utilized in text and illustrations manufactured products, including pianos, harps and pipe organs, to the practical exclusion of conventional laboratory devices.

"The influence of every member of the piano trade should be brought to bear to introduce this text book in the public schools.

"A book has been received, accompanied by a letter, from William Braid White. It is entitled: 'Modern Piano Tuning and Allied Arts,' published by Edward Lyman Bill, Incorporated.

"I will read the inscription: 'To the Conference of American Piano Technicians meeting in Chicago, whose valuable and exhaustive discussions mark an epoch in the development of American Musical Technology, this book is, by one who has the honor of membership in that Conference, respectfully and affectionately dedicated.'

"This book was sent to me with the compliments and best wishes of the author, but I understand it is to be placed in the archives of the Conference.

"We have stated repeatedly that the composition best adapted to American tonal needs is made up of the first seven partial tones, or partials, with 50 per cent of the fundamental, and the other six partial tones decreasing sequentially in intensity to a point where the seventh is very faint, a mere trace. We have also demonstrated in a single unit that a certain tension will give that tone quality under a normal touch. That tension was found by experiment during a period covering something over six months, where the wire was kept at a constant tension of 165 pounds and the wire vibrated by means of hammer, plucking and electro magnets. At the end of that time it was analyzed and micro-photographed, and no change in the molecular construction was found.

"The physical value of a reasonable tension is demonstrated every day—the tonal value of that tension has not yet been demonstrated to you. I hope we will be able to do so to your satisfaction tonight.

"I have here a small grand piano, a laboratory product. It has no friends, no name, not even a stencil. You can say anything you please about it and you will not hurt any one's feelings. It has no price tag, nor promise of a commission for sale. I am going to use it as a clinic.

"It has a uniform tension scale. The difference between a uniform tension scale and an equal tension scale is about four pounds tension either way. That is to say, an equal tension scale is one in which every string and wire on the piano has the same identical tension as every other one. A uniform tension scale made with the help of the formulae of which you have copies gives the required tension to the first key having a change of gauge, counting from the treble, the intervening lengths being determined by semi-tone proportion.

"In an equal tension scale the agraffe must be set regardless of sweep line and it does away with the bearing bar. Above the last bar break the difference is microscopic and, therefore, the bar is practicable, but below that point the agraffe is necessary, otherwise you would sacrifice your striking point to your difference of lengths, as indicated on the bridge. In a uniform tension scale you are working from the striking point and the bearing, but it only makes a difference of about four pounds. The scale of this little grand is 160 pounds tension in the treble and 170 pounds in the bass.

"My claim for the uniform tension scale at 160 pounds tension on Perfected Wire, is that it places the tone color, under the normal touch, at the point which allows greatest scope for color on both sides. Tone color changes only may be obtained by different degrees of intensity of touch

and the length of time the hammer stays on the wire after contact. I will leave the rest to Mr. Marx Oberndorfer, who will demonstrate it to you. You will observe readily that Mr. Oberndorfer is a master in the technique of tone production."

Marx Oberndorfer: "I think the greatest test for a piano, to me, has always been to be able to imitate the instruments of the orchestra, and so when Mr. Morton asked me if I would try out this 'orphan,' I decided to give it the severest test. I will now play several pieces—I am not going to play them entirely, so you need not be bored, but I have selections which are orchestral compositions and will try, if possible, to show you the different instruments which I am trying to get out of the piano.

"The first one which I will play for you is the prelude, 'The Afternoon of a Fawn,' by Debussy. It starts out with the flute and then you will hear the harp playing the accompaniment, then the horn, flute and harp. (Demonstrated.)

"My next selection is 'Marche Slave,' by Tschaikowsky. I want to say right here that I have had to do a great deal of work in illustrating the orchestral programs, and I have not always had a piano where it was possible, and I can always tell very quickly when it will be possible. I have practiced on a piano sometimes a week at a time trying to get a certain quality of tone and could not get it, and sometimes on another piano of the same make I would get it immediately. (Demonstrated.)

"I will play the 'Musical Snuff Box,' by Liadow, as I want to show you how you can imitate an old-fashioned music box. The next I will play is 'Siegfried's Horn Call.' It is a good example of the horn with the rest of the brasses in the orchestra. (Demonstrated.) The next is excerpts from Schumann's first symphony.

"I have found that the two composers who knew the least about orchestral music, Schumann and Chopin, whose orchestrations are poor compared to the rest of the composers, have gotten the finest orchestral effects out of the piano. That, in a way, proves to me that the piano is for orchestral effects, because they are the two best composers we have for the piano—their music is always satisfactory, and, as I say, it gives us the best orchestral effects. The piano we play must give us the proper touch and technique, of course.

"I have gotten so, and a great many of my colleagues have, that I cannot play anything on the piano without thinking in terms of orchestral effects. No matter what I play, when I am teaching or when I am playing, I think of the cello, violin, harp, or the horn or other brass instruments, and, of course, we have got to have the pianos which will respond.

"I will play you another of Schumann's, which is not orchestral, which is piano music, but you can hear the different tone qualities—Schumann's 'Romance in F Sharp.'" (Demonstrated.)

(Mr. Oberndorfer also played excerpts from a piano arrangement of Rimsky-Korsakoff's tone poem, "Scheherazade.")

F. E. Morton: "Are there any questions?"

James E. Jennings: "We have heard it stated that 160 pounds is the ideal tension. That tension may be secured by shorter and larger wire or by longer and thinner wire. As there is great latitude, what effect does the shorter and heavier wire have and what effect the longer and thinner wire?"

F. E. Morton: "With a longer and thinner wire, the breaks at the change of gauge will be greater. With this uniform scale the gauge is indicated if, starting at No. 13, you continue with No. 13 to such a point as will give the least difference in tension at the break. As a matter of fact, the lengths need not vary in the smallest scale nor in the largest concert grand, down to a point where the length of the scale makes it physically impossible to carry it farther. We do not have to have 26 or 27 notes in the bass; we can have 29 or 31 if we will. It is the tone we are after; and when we get that we should make the case and action conform.

"For instance, I have been asked to devise a scale which will produce certain tone qualities, using such and such a stock action. That is not always consistent."

E. H. Lapham: "In the player piano what causes strings to break? Is it defective wire or too much tension?"

F. E. Morton: "I do not know that that could be answered in a general way, although in the majority of cases it is too much tension. A very high tension may do it or using a wire of too large a gauge, or it may be too long a string. The tension on some pianos is abnormal, some running to

235, 240 and even 245 pounds. When the wire is drawn beyond its elastic limit it breaks. You take, for instance, wire that will break at 400 pounds. I cannot speak for others, but the elastic limit of our wire is about 60 per cent of its breaking weight. When 240 pounds tension has been reached the wire begins to stretch and as soon as wire begins to stretch, if the tension is maintained and the stretching continued, it will break. That perhaps answers it in a general way. I have had people say, 'I do not want to reduce the tension on my scale, because I get a distinctive quality of tone which characterizes our pianos, and I do not want to lose it.' If it is carried beyond International pitch and beyond the elastic limit of the wire the tone loses its brilliancy or 'goes dead'; therefore, you will seldom find a string really brilliant which breaks easily.

"This instrument has not been tone regulated. It is a clinic piano and not an exposition piano. We want to bring out all of the tone and it is what I hope to see some day in the manufacturing world, a uniformly good tone without the aid of the tone regulator. I found that idea on a tobacco box: 'The flavor is in it, not on it.' In the bass at the break you have always found difficulty. Every piano manufacturer has had it, so we may as well own up to it. I do not know a single piano which is absolutely satisfactory to the progressive man at that point. I like a scale blending from the double bass into the cello, viola and on into the violin tone, and forget the break."

E. H. Lapham: "I think the trade realizes and has for a number of years that the upright piano has practically seen its day and the grand piano is the piano of the future. The demand, as we all know, is here for the small grand. These are facts. The trouble with the small grand, however, as we all know, is that it has been void of tone, but this grand you have here has a wonderful tone quality, and I think that Mr. Oberndorfer will sustain me as to that, and the question which occurs to me is why manufacturers who have been in the business for years have not produced a piano of the same character before."

James F. Bowers: "You forget Lyon & Healy's, Mr. Lapham."

F. E. Morton: "I appreciate the value of that question, but I would like to have it addressed to the manufacturers rather than to me. I accept it in good faith, and think that the manufacturer will. I will answer your question by asking another. Who is the manufacturer of the piano? Is it the man who owns the factory? Is it the manager? Is it the superintendent? Can you point to the responsible manufacturer of the piano in a factory today? I cannot, and I do not know anyone who can."

James F. Bowers: "Wouldn't that be up to Mr. Waud in our case?"

F. E. Morton: "I think Mr. Waud will agree with me when I say he is at the mercy of those men whom he employs."

R. H. Waud: "Decidedly so."

F. E. Morton: "I have gone into a factory, have drawn a scale, have done my very best, have given all that I knew; all that I could drag from science; have given the manufacturer specifications, details, drawings and blue prints that any mechanic who had never seen such an instrument, but who was a good, conscientious workman, could follow and produce what I intended should be produced; I have gone with them into the factory and attempted to supervise the making of the piano and, after all that, had a piano which I could not recognize as having emanated from my plans. I could not put my finger on any one man, the president of the company, the manager, the superintendent, the foreman, the tone regulator, the tuner and on to the various workmen, and say that he was responsible. It is a collective responsibility. Each man had traditions which he maintained in spite of all the pressure brought to bear upon him.

"I am not making a protest. I am willing to play the game according to this year's rules and know positively that we are making progress in the piano trade, and you know it. I do want to call attention to this however—there is no one man who can control the making of pianos. When the piano is completed you place it in the hands of your tone regulator. If the specifications we give can be carried out and materials and parts can be tested and rejected or accepted, then the piano can be made by the man whose brain directs, but not until then. That is the real reason why I called you gentlemen together two years ago, to see if we cannot bring about co-ordination between the man who makes the materials and the man who shapes, fabricates and puts the parts together, so that the result will be what you intended. I feel strongly on this point, and when we bring about the accomplishment of this purpose, mutiny in the factory will be unknown."

E. H. Lapham: "You are doing a wonderful work in this way. Now the minute the manu-

facturer gets down to these facts there are going to be increased sales, for the reason that many people bought pianos as pieces of furniture before and not as musical instruments, but if you can accomplish your efforts sales will increase through the purchase of pianos by musical people."

F. E. Morton: "Those of you who saw the play the 'Garden of Allah' will remember the little native who wanders across the stage with a little flute-like instrument, as nearly a simple tone as is ever heard in a wind instrument. That is a pleasant tone for a little while, but it soon becomes dull and uninteresting. The old three-string square had that tone in a great measure, and it was difficult to get the children to continue practicing on it. That was the piano which was closed up, with the fleece-lined cover on it and only opened on state occasions. It was not attractive enough in tone to make people want to hear much of it. Then there came the high tension scale in the upright, a very high tension, and a hammer which in places had to be picked until it was fluffy on the surface and that had partial tones running up to the 13th, and even up to the 15th in places, and a correspondingly less amount of the fundamental or first partial. That tone was tiresome just as the reed organ was tiresome. That is the quality of tone which makes a dog howl—it affects the nerves. From observation and deduction I assume that the first seven partials are best adapted to our needs.

"We have often wondered why in certain foreign countries the desired tone is nasal, composed of a larger number of partials and a weak fundamental. You will find, however, that these people are provincial—they remain at home and they have only such ideas as may be expressed by just such an instrument. The American people travel, see great masses of people, absorb ideas, that only may be expressed by American instruments. The American piano still is open to improvement and that is your privilege. I will work with you and for you to that end."

Frank Milner: "There seems to be a general disposition now to adopt 440 instead of 435 all over the orchestral world. What effect is that going to have on your number of partials?"

F. E. Morton: "It will necessitate a different scale."

Frank Milner: "It is admitted that it is coming."

F. E. Morton: "Reluctantly admitted by some, not at all by others. It is an orchestral idea and started from the fact that the oboe player positively refuses to change his instrument."

Frank Milner: "It seems to me that would affect these seven partials."

F. E. Morton: "It would decidedly. The tension would be increased about one pound upon each wire and string with a resultant change in tone quality. If you make a piano with 440 A as your pitch you will have to take a different length of string in your use of the formulae. I am of the opinion that they may not get it over. Personally I do not see why makers of all other instruments in the world should cater to the little oboe in such an operation.

"The question of the tension of the felt over the hammer is of decided interest —that we will all admit. The question of the permanency of that tension, whatever it may be, is one of even greater interest. Various plans have been offered by the trade and some have been found impracticable, expensive or for other reasons were eliminated. Some have shown their right to exist and some have become important factors in the trade. Among the last is the reinforced hammer and we have with us tonight Mr. George A. Ruth of the Charles Pfriemer Company who will exhibit sample hammers and show the felt in the sheet."

Mr. Ruth exhibited sets of finished hammers, with the construction and appearance of which the trade is familiar. He claimed for the reinforced hammer a retention of the original resiliency of the felt on the top of the hammer and called attention to the reinforcement as being impervious to moisture. He also stated that the reinforcement added weight to the hammer to the amount of one ounce to the set. He argued strongly in favor of foreign felt, giving as a reason for its superiority the great care and attention given to rearing and caring for the sheep from which the wool is clipped, and the condition of the fibre due to the methods of cleaning and handling. He said that the felt manufactured in America was bleached and that this bleaching process broke the fibre, producing a short fibered wool, while the foreign manufacturer did not bleach his wool.

F. E. Morton: "I want to express the appreciation of the Piano Technicians for the very gracious assistance of Mr. Oberndorfer and Mr. Ruth and assure them that we are pleased with what they gave us, all of which we accept in good faith. Without differences of opinion business would be uninteresting and these conferences would not be needed. We should bring in all the ideas offered in good faith and in return ask the privilege of questioning and bringing out such

points as we consider vital. In that we have received the co-operation of practically every one who has come before us.

"I want to ask the technicians their good pleasure in a proposal that the next conference to be held the first Wednesday in April be turned over to the tuners—to let the tuners have full freedom to tell us all what they think of us and why. Particularly why. The tuner takes charge of your product after it leaves your factory and keeps in close touch with it until it comes back to be traded in, when you are asked to give at least as much as you received for it in exchange. The tuner takes your customer when you are through with him. He really has a vast fund of knowledge and we would be very much better off in the possession of that knowledge ourselves.

"If it is your pleasure I will invite the tuners to come to the next meeting and we will give them full swing."

E. H. Lapham: "You ought to arrange for a long session."

F. E. Morton: "The place is yours all night if you want it. I hear no objections, so the next subject will be 'The Finished Piano and the Tuner.' "

The Finished Piano and the Tuner

April 3, 1918

The chairman, F. E. Morton, stated that the session was dedicated to the tuners and asked them freely to express their views, confining their discussion as far as practicable to creative, constructive criticism. He assured them that their suggestions would be accepted in good faith and invited frank and honest criticism.

W. F. McClellan: "These meetings are a great help to me, and I think they are to everyone connected with the trade.

"There are three factors in the piano trade—the manufacturer, the dealer (including the salesman), and the tuner. The manufacturer makes the goods; the dealer sells them, and the tuner takes up the burden of the work from that time on until the piano is no longer a piano. The field he covers is so extensive that it is difficult to discriminate, but this I am glad to say—every tuner, consciously or unconsciously, feels elated at meetings such as this, where points relative to construction are discussed. There are two interests in the piano trade—one looks upon the piano as a musical instrument, the other assumes that the appearance of the piano sells it. To the latter it is simply a box, or a piece of furniture with strings inside.

"The other night a question arose here, and I for one became deeply interested. I thought we were about to discover the real man behind the gun in the making of pianos, but the issue was sidestepped. Mr. Morton passed it over to somebody else and you agreed that they are limited by the disposition and ability of the workmen. I believe the view that was taken is not altogether correct. The workman must respond, and if he does not respond it is within the power of the management to discharge him and get another man in his place. Therefore, it seems to me that the man who is responsible for the piano is the manager, or the superintendent. I do not believe the piano will develop beyond some one man's ideal in the factory.

"The workman may find certain discrepancies in the piano. He can do nothing but appeal to the superintendent. If the superintendent says: 'Well, that piano is ordered to go into this carload—we have not time to go over and make those changes—we will have to take a chance on it,' the workman can do nothing further, but he has done his duty and stands higher than the superintendent or the management.

"Now let us reverse the case. If the manager comes around and finds that something in the piano is not up to what it ought to be, he can raise Cain with the workman and if he still persists he can get rid of him and get a better man.

"I think, therefore, that the man responsible will be found above the workman, because the working man has responded in every case.

"In bringing this up I wanted to do so in order to illustrate my contention. It is with the furniture element that we tuners have our greatest difficulty. Let us see how this theory works out. A lady is shown a piano. The salesman runs his fingers over the ivories—it is a good looking piano—and very likely the lady orders it. The acoustics in that room are probably very good. I

have heard some very poor toned pianos and they have sounded pretty good under these conditions.

"When the piano reaches its destination the lady finds a different tone—short and brittle. It does not please her. Her friends play on it—they have time then to listen and they do not like it. The telephone rings in the store and there is a complaint. The order is shifted over to the tuning department and they are requested to send a man out.

"Now the tuner may discover that there are a number of faults in the piano, but his allegiance to the firm he is working for compels him to cover up these faults. It would not be wise for him to say the construction is wrong, the treble action is set in too close or not close enough, or that the hammer strikes a point which damps the tone. The tone regulator may have jabbed in too hard, pushed the hammers up or made the tone stringy.

"He is confronted with a hundred and one things, and while I say that we appreciate, as tuners, Mr. Morton's meetings and the influence that it is bound to have, I think I voice the sentiment of all tuners, because the tuner never talks of the piano in any other terms but tone. He seldom considers the case.

"I am somewhat in doubt as to just where we can assist. Every tuner is willing to assist the manufacturer, but there has been no mingling together as there should be. The tuner has not been taken into the council. They call a meeting of salesmen to perfect their plans and coach them as to how best to approach the customer, but the tuner gets only his orders at night and goes out in the morning. He has never been called in to council, except when the lady who has bought a piano from appearance finds that it is not what she wanted, then he is called in and sent out. Now I believe that these things can be remedied. There are thousands of tuners today mingling with the piano trade, mingling with people who are studying music, and I believe that if the trade will take the tuner into confidence, bring out his ideas, it will be mutually beneficial.

"In the factory there is the tone regulator. Mr. Morton says he is going to eliminate him in the future, but I think he is going to have a difficult time in doing so. A hammer company sells to the superintendent five hundred sets of hammers. They are altogether different from other hammers, and unless we can get all hammer makers to make the same kind of hammers, all sounding boards alike, etc., I do not think the tone regulator can be eliminated. It seems there is an impression that the tone regulator's principal object is to pick the hammers until they are all mushed up. I do not think any good tone regulator has that idea. He finds a hammer very solid and tough, having no rebound. It goes 'plump' and there it sticks and kills the tone. Now the tone regulator must get as much life, as much resiliency from the hammer as he can without destroying its contour or interfering to such a degree as to kill the tone. It looks ridiculous, but there are a number of companies today which take men from the mill room or action room and put them on tone regulating. The tone regulator is the thorn in the side of the efficiency engineer, the superintendent or the man taken from the mill room or some other part of the works, because as soon as the piano gets to him, if the tone is defective, he detects it, and consequently he is in trouble with the management. I would like to suggest to the manufacturer that instead of taking the tone regulator from the mill room or some other part of the factory, they get these men from among the tuners.

"We are going to help Mr. Morton, we are heart and soul with him, because he is fighting our fight, but how we can help him is not exactly clear to me at the present minute. If we were permitted to take one certain instrument, we could probably point out the discrepancies there, but taken from a general standpoint, it covers such a large field that I do not know how we are going to help much.

"I would not suggest that the manufacturer of a piano ought altogether to think of profit, but I do maintain, as Mr. Morton said, that the price of the piano is not sufficient to get the best tonal results.

"Some dealers think if they would reduce the price of tuning, they could probably get more business. Now there never was a greater mistake. It would not make any difference if you tuned a piano for fifty cents, if the man did not realize that the piano needed tuning he would not throw away the fifty cents, but if he is made to understand that his piano at certain intervals needs tuning, even if the price of tuning is $3.00, he will be willing to pay it. The tuning department could have been made a paying proposition if the trade had used judgment in the propaganda when the pianos were sold. There is no other business which has greater license to exist than has the tuning

business, and yet there is hardly one store in the country whose tuning business has not decreased, notwithstanding the fact that new pianos are being sold, and the old pianos have to be tuned as well. The reason is simply that the purchaser of the piano is not impressed with the necessity of the piano needing frequent tuning.

"If the superintendent and manager must qualify for their positions, it would help. When Lyon & Healy hire a tuner, they send him into a back room and give him a piano to tune and when he has finished they send someone to see how it has been done, but in the case of superintendents, they do not seem to need any special qualifications."

F. E. Morton: "You can help me by helping each other. That is the object of these meetings. By exchanging views, each goes away with as many viewpoints as there are people present. Mr. McClellan evidently is not a student of Ulysses. Ulysses said: 'I am a part of all that I have met.' The piano is a part of all it has met on its rounds through the factory, including prejudice and tradition, and all that stands in the way of perfect co-ordination in the factory is responsible for the faults in the piano; for this reason neither the superintendent, the tone regulator, the manager, the principal stockholder, the president, nor other official is personally responsible in the true sense of the word. An exchange of employees would, perhaps, be an exchange of traditions, an exchange of prejudices. When the appliances have been supplied which will enable us scientifically to test all material and finished work and gauge it to a pre-determined standard of workmanship, in such a manner that the result means the same to the workman, the superintendent, the dealer, and to the user of the piano, it will be practicable to place the responsibility for every piano. I want to ask Mr. McClellan if, according to his own argument, it would not be an excellent matter to take the purchasing agent into the councils as well."

W. F. McClellan: "Exactly. One superintendent said to his president, 'I can put any lumber you give me into this piano, but never say anything to me about it going bad on the outside.'"

F. E. Morton: "Isn't it true that the foundation upon which the tone regulator's skill and knowledge should be based is a love of music?"

W. F. McClellan: "Yes."

F. E. Morton: "Would it be of assistance to him to attend symphony recitals and concerts?"

W. F. McClellan: "Undoubtedly. If I was a superintendent and was hiring a tone regulator I would not take him if he never attended concerts. I think the first question I would ask him would be what he knew about music—not that I would expect him to play, but if he associated with that class of people, I would consider he had some idea of tone."

F. E. Morton: "You speak of the dissatisfied customer saying that her piano had sounded good in the warerooms and that now it sounds different. Would you not say that was because of too much tone regulating?"

W. F. McClellan: In some cases, yes."

F. E. Morton: "In what case is it not so?"

W. F. McClellan: "It was the same as when heard in the store, but the salesman who was selling it touched it gently and did not bring out the defects. This is particularly true of players. When they reach the home some one comes along and hammers them like a brass band, and then we get a call to come out—that the piano does not sound right. I remember one instance where the lady insisted it was not the same piano she bought. Her room was heavily hung with curtains and velvets and a very soft carpet on the floor. I discovered the trouble and remedied it. You would hardly figure that the better class of tone regulators would jab that piano too hard, but they do. The tuner on the outside ought to be something of a tone regulator himself, because he has to deal with these conditions."

F. E. Morton: "I was referring to the work of the tone regulator in the factory. I find that where the desired degree of intensity is developed by the tone regulator rather than by the hammer maker, a rasping sound is the result. It is that kind of tone regulating that I am anxious to eliminate. I remember pianos used for a long time—particularly those made over twenty years ago, when the resilience of the hammer depended entirely upon the tone regulator—and I found that after a period of time the hammer was flat on top. The softened portion had been scuffed off until it reached the underfelt. That was the day of excessive tone regulating, as every old piano man knows. The tone regulator did not have the co-operation of the hammer maker. From your point of view co-operation between the various factors is desired by the tuner. Am I right?"

W. F. McClellan: "You are right."

F. E. Morton: "I think that in itself justifies this meeting."

George Ruth: "Do you believe in bench needling?"

W. F. McClellan: "To a certain extent. I believe that the tone regulator ought to think carefully and try to discover the different qualities of tone. There are certain places where he could go into the heart of the hammer without destroying the contour or affecting the tone, and it could be so done as to give life to the hammer. My contention is that the hammer ought to have enough life to it to make it springy, and it then gives a better quality of tone. The part on top ought to be needled only to a limited extent."

George Ruth: "If a set of hammers were made suitable for a scale, is it not possible to regulate that set of hammers by needling on the side—light needling instead of deep needling?"

W. F. McClellan: "One must determine the kind of needling from the sound."

Chas. Deutschmann: "In building a piano the maker should take into consideration that there is something to be done after it leaves the factory. The poor tuner is just one man. For instance, we must take nineteen screws from a grand to get the action out. The outside tuner's time is limited. There are other pianos made which one has to turn upside down to get at the pedal action. It should be made a penitentiary offense to make an action which will not stand on the floor. If the manufacturer would take these things into consideration, they could make things more simple and the work would be better done. There are more pianos ruined by chipping than in any other way. The work usually is done by a lot of boys."

F. E. Morton: "Mr. McClellan, what is your idea of 'ironing' to even up hammers? What is the result?"

W. F. McClellan: "I do not believe that ironing ever does a particle of good. If the felt is too soft you cannot make it good with an iron."

George C. Johnston: "The statement has been made that the pubiic should be told to take care of their pianos, but we were not told who was to tell them. The dealer should tell them, but who is to tell the dealer? He does not know much more than the customer, on the average. That has been my experience from working in the country, and, of course, we get all kinds of pianos out there, principally mail order pianos, but we do have sandwiched in a good piano now and then. With good pianos we have very little trouble. The people are willing to pay for tuning if they realize the necessity for it, but many salesmen will tell a customer that once in five years is enough. A woman told me that she had her piano for five years—a very ordinary piano. She had been told that it would not need tuning for five years. When it was six years old it sounded just as good as when it was five years old and she did not then think it needed tuning. She also said that a friend of her's had her piano for eight years and never had it tuned, and that if she commenced, she would have to have it tuned every year or two.

"Now, we have those things to contend with. The manufacturers', the dealers' and the customers' interests are at stake. The majority of pianos are manufactured behind a roll top desk, and the average man behind the roll top desk does not know what is in the piano.

"In the country the tuner has to be a tuner, a tone regulator and fly finisher, and there is one thing we have to contend with which I want to bring to your notice, and that is, the bridge in the upper section where it is cut. You will find that where it is cut at the bar break that it is impossible to keep it in tune on either side. That should be a question which should revert to the manufacturer, although if you made complaint to the dealer he would say, 'That is the way the manufacturer made it—it must be right.'

"The manufacturers of these pianos should know these things, so that the people who buy these pianos with their honest money would get value received, and the people purchasing piano should be told how to take care of them and what is necessary to keep them in good condition, and that unless they do take care of them they will not give satisfaction. When this is done you will get good results, but not until then."

George Ruth: "Do you consider the hammer the heart of the piano?"

George C. Johnston: "There are good bridges, good sounding boards, good strings and good hammers and with them you have a good piano—without any one of them you have nothing."

W. F. McClellan: "If the dealer and the manufacturer fail to acquaint the purchaser with what to do with the piano we are working in the wrong direction, but I think there is a move-

ment on now, in fact, I am glad to say that a great many of the manufacturers have shown a disposition to take hold of the matter in the right way, and they have promised to give us all the assistance we want along that line. We are just beginning to realize that the man who has to look after the piano is the man who owns it."

F. E. Morton: "I would like to suggest to the Tuners' Association that the best propaganda, because the one most acceptable, is in the form of fiction. If you can find a good story writer who will put into the stories the effect of listening to pianos out of tune and who will make it part of a readable story, you will popularize well tuned pianos. The poeple do not like to be preached at. They do not like to be told their faults directly, but they rather enjoy a thrust at the other fellow, because then it is somebody else who is 'getting it.' Let me tell you that twenty-five years ago it was a difficult thing in the average commercial hotel to get a room and bath. In the ordinary home the bath room was not considered an essential. It is not many years since the Saturday night tub idea obtained. The propaganda for bath tubs and bath room equipment was carried on very largely through fiction and popularized in that manner. Other things have been brought out in like manner. Some of them by influence. For instance, the price of shoes was not satisfactory to the shoe manufacturer and dealer. Something had to be done, and by a clever arrangement with the people who set the styles, the length of skirts was shortened. The shoe became an important factor and the shoe trade has prospered accordingly. Very few changes have been brought about by preachment. There is a reaction from that sort of thing. If your association will adopt those indirect methods of popularizing well tuned pianos, I believe it will come."

W. F. McClellan: "Would you suggest that the manufacturer or dealer attach a little notice or booklet to his piano when he sells it? I believe at that time the people would be open for instructions."

F. E. Morton: "Yes, if the dealers all would do it, but you have already indicated the difficulty there. One dealer would say that the piano should be tuned twice a year and another dealer would point out that there must be something wrong with a piano requiring so much tuning. No dealer will voluntarily put a club in another dealer's hands."

W. F. McClellan: "The best little idea is that of the A. B. Chase Company. They put in a little booklet entitled 'Construction and Care of the Piano.'

"We asked one hundred average piano owners why they were having their pianos tuned. We found only one out of the hundred who gave anything like a reasonable answer. She said, 'Why the weather has an effect on the bass of the piano and makes it go out of tune.' She was asked how she knew that. She then went over and lifted up the lid of the A. B. Chase piano and said, 'I read this.'

"I believe there is something in what Mr. Morton said—'if you drive at a man he does not like it.' I believe that the trade will assist us, themselves and the advancement of music in the home, if they will do something in that line, so that the tuner has something to back him up."

F. E. Morton: "It is a question of popularizing the idea. It is not the tuning of the piano that you want to talk about, but the idea which makes necessary the tuning of the piano."

E. B. Bartlett: "Mr. McClellan objected to the elimination of the tone regulator, as though they were a part of your propaganda. My understanding is that you want to eliminate the need for a tone regulator—not to put out worse pianos than we are making now, but better pianos with less chance for change after they do get out. I could not resist applying this right here."

F. E. Morton: "Quite right. There is one thing to which I want to commit myself, and that is that the last man to touch the piano before it goes into the box at the factory should be an artist."

W. F. McClellan: "If you had a man like that most of the pianos would not get past the shipping door."

F. E. Morton: "Would we not all benefit by that?"

W. F. McClellan: "The first thing that a man would hear when he came up and said: 'That has got to go back to the sounding board room,' would be, 'That is ordered and it is the only one we have here and it must go. We will have to chance it.'"

F. E. Morton: "I fully appreciate that it is a touch of idealism, but it all goes back to one question: 'Why is the piano?' What is the purpose? We were told at the Piano Club yesterday by Madame Sturkow-Ryder, who addressed the Technicians' Conference last year, that there are

four classes of purchasers, and the one which she pointed out as being responsible for the growth of the business was the music lovers, and she said that they had not been catered to sufficiently by the trade to bring up the piano production in any marked degree. Pianos should appeal to the hearing primarily. That appeal can be made by the manufacturer, not by the dealer alone. The tuner can do little to overcome that difficulty."

George Ruth: "Don't you think the present tendency is towards better pianos?"

F. E. Morton: "Decidedly, and that tendency must be encouraged by the manufacturer."

D. A. McDonald: "It seems to me that in this question of propaganda there is one thing which should be driven deeper than any other into the purchaser of pianos. If every purchaser of a piano could understand that the child who learns to play the piano or to sing to the accompaniment of a piano which is out of tune and is allowed to continue to sing or play on that piano up to the age of, say, eighteen or twenty years, if that person lives a hundred years he will never develop a fine sense of intonation, because that wrong tone idea will stay just as long as his body remains. If the piano owner who sends for a tuner would say to him, 'Tune that piano to 435 A exactly, no matter how many strings you break—I will pay for the strings and your time,' the sense of intonation of the coming generation would be greatly improved. Personally, I can see no reason why a person should allow one string of his piano to be out of tune any more than the violinist should play on his violin with one string out of tune."

E. E. Beach: "A number of years ago a retail store made a practice of sending out a tuner when a piano was sold and every three months thereafter for one year. They had the customers so thoroughly imbued with the idea that the piano needed tuning that they usually attended it themselves afterwards.

"A lady had her little daughter go across the room, turn her back and then the mother would strike a note on the piano and ask the note she had struck and the little girl would tell her. After the piano was tuned the daughter was unable to tell. She had gone completely out of tune with the piano."

F. E. Morton: "Memory is responsiveness above normal—that is just as true of every bit of matter on this earth as it is of the organs of hearing. Take an instrument that is at all responsive, strike its key note on another instrument and it will respond. The next time it will respond with a little greater intensity and the next time a little greater, and so on—that is memory. Responsiveness comes from the practice of responding and 'tone memory' offers material for one of those stories I suggested. You get more responsiveness from a piano after it has been played upon for a length of time. The chipping and four tunings help it, but if the piano is kept in tune and played upon, the tone improves. The sounding board will respond to the same pitch from each note a little better as time goes on. The man who has a violin which he values highly should always keep it tuned and at the same pitch. Violins increase in value because of the treatment they receive as well as the original work put on them.

"The other night Mr. Milner suggested the possibility of demanding of the manufacturers of pianos and other fixed pitch instruments that the pitch be raised to 440 A. A piano at its best at a given pitch is not at its best at another pitch. That does not mean that all scales will have to be changed."

D. A. McDonald: "In regard to the change of the official pitch of the American Federation of Musicians, which was made at the annual convention last May, I will say that it was entirely unnecessary. If they wished to get the wind instruments and pianos together all they had to do was to provide that, when the piano is used in orchestra, it shall be tuned at A-437 or A-438. Then when the temperature rises the piano will sink a little and the wind instruments will rise a little, establishing between them a very playable pitch.

"Every one knows that a wind instrument rises in pitch with a rise in temperature and almost every one has a fairly good idea as to the cause thereof, but what they do not know is just how much the different instruments are affected. That is one reason why our Army and Navy departments have placed in their latest band instrument specifications a most ridiculous provision, as well as one with which no manufacturer can comply—namely, that all instruments made for army and navy bands must give A-435 at 59° F. and A-440 at 71° or 72°. If one instrument could be made to do this—and I do not consider this possible—the others could not comply with this requirement.

"Mr. D. J. Blaikley, the eminent expert and acoustician, in his lectures on acoustics in relation to wind instruments, delivered before the Royal Military School of Music, Kneller Hall, London, gives the following table of variation in pitch caused by the rise in temperature of ten degrees, from 60° F. to 70° F.:

	Vib.
Flute and Oboe	Rise 1.50
Clarinet	" 2.06
Cornet and Trumpet	" 2.45
French Horn and Trombone	" 2.88
Euphonium or Baritone	" 3.16
Bombardon or Bass	" 3.50
Mean of full wind band	" 2.60

"If therefore, a band playing at A-435 at 60° F. encounters a rise in temperature to 70' F. the instruments will then be found about as follows:

Flute and Oboe	436.50
Clarinet	437.06
Cornet and Trumpet	437.45
French Horn and Trombone	437.88
Euphonium	438.16
Bass	438.50

"From the above it will appear that the United States bands will have to get along with the variation established by nature. If the specifications had demanded that instruments should play at A-435 when the temperature is 60° F., about all that is possible in that line would have been accomplished.

"Mr. Blaikley further states that while increase of temperature may cause a rise of as much as a quarter of a tone, the difference is modified by the breath, and that the variation between summer and winter pitch of instruments, when warmed by playing, is always less than would be caused by extremes of the outer air. In other words, that the heat imparted by the breath modifies both the rise and fall of the pitch, making the variation less than would be shown by the laboratory test.

"In my position with Lyon & Healy I have had occasion within the past ten years to test thousands of instruments, both of American and foreign make, using for purpose of comparison a well tuned reed organ, and I cannot recall a single instance of an instrument made to play at A-435 which, in the hottest summer weather, could be played with a piano correctly tuned to A-440. A person with a very strong embouchure could probably force a single note that high, but it would be absolutely impossible to play the different registers of an instrument under such a strain. The saxophone, for instance, can be played very much off pitch in the second octave, but if one attempts to play the lower register sharp the instrument will 'octave'—that is will give the note fingered an octave higher than was intended. That is the reason why a 'jazzer' does not use the lower notes of his instrument to any great extent.

"There are several other reasons why the full effect of temperature is not felt in wind instruments. For instance, when the metal in an instrument is heated it expands and the instrument becomes a little longer and a trifle larger in calibre. This is so small as to be almost negligible, but it has some effect. Also, every player blows more or less moisture into his instrument. That moisture evaporates and in doing so cools the air within the tube, and thereby lowers the pitch.

"Still another cause is that in winter time only a part of the bore of any wind instrument becomes heated. In the saxophone, probably not more than one-third, or at most, one-half of the length is affected. In the case of the basses a change of twenty degrees would not, probably, mean a change of more than ten in the air within the instrument. The few inches affected at the mouthpiece would be counteracted by the coldness of the bell and other large tubing, which the breath would fail to heat.

"In the public dance halls, is probably where the greatest trouble from changes of tempera-

ture is experienced. When the orchestra begins playing the hall is often as low as 40°. Little by little the temperature goes up to 70 or 80. Then the dancers find it too warm and the windows are opened, even if the outside air is below zero. Immediately the strings go up, including the piano. The harp is affected probably more than any other instrument. . I have played on engagements where the harpist's pay for the evening was less than his expense for broken strings caused by the opening of windows. Of course, the wind instruments drop in pitch. Often they cannot be kept up to A-435. What will they do in such cases when the piano is at A-440?

"As an instance of what change of pitch is already doing, I will state that one factory which manufacturers flutes and piccolos claims to make its instruments regularly to A-440, but because they have a large government contract calling for A-435 they are using the latter pitch. Another factory making flutes, piccolos and clarinets are supplying these instruments—despite the specification—at A-440. It is not hard to imagine the result when instruments from these two factories are used in the same band.

"I believe that the verdict of the scientific men of the world is in favor of A-435, and I should like to see everybody agree to that pitch. I should also like to see the American Federation of Musicians, as representing the professional musicians of the United States and Canada, demand that the manufacturers of wind instruments get together and standardize their pitch, instead of each one following the dictates of his own sweet will, as they have been doing for the past few years.

"From experience I am inclined to think that the manufacturers of wind instruments throughout the country know less about their pitch than others do. For example, as soon as I heard about the change I called up the head of one factory and asked him what pitch he was making his saxophones. Promptly he replied 'A-440.' A short time afterward a saxophone of his make was brought in by a lady vaudeville artist to see if we could not raise its pitch, as she could not get it up to the pianos in the theaters in which she was playing. On trying the instrument I found that I could not get it up to A-435, and on measuring it I found that it was about an inch and a half longer than other instruments in the same key of three other makes. I have since had another case of the same kind and of the same make. So much for that manufacturer's knowledge of his product. In another case the general manager of one of our largest factories read my letter to the International Musician protesting against the change and immediately wrote me a very kind and sympathetic letter saying that he was sorry that I had not first posted myself on what band instrument factories were doing, as they had been making their instruments at A-440 for a long time. He seemed quite sorry that I had made such a fool of myself, but although I have been carefully trying every instrument of his make that I have seen since, no tone of them was anywhere near A-440. He also could look into what his factory is doing, to advantage. On my desk at Lyon & Healy's lies a C soprano saxophone sent in as a sample by still another factory. So that there should be no doubt as to its pitch they put a red mark on its mouthpiece cork at a point where they said the mouthpiece should be placed to make it A-440. I tested it and found that with this adjustment it was just a comfortable A-435.

"One argument which was probably used at the convention in favor of the change is that because the symphony orchestras play at A-439 or A-440 all others should do the same. They evidently did not stop to think that symphony orchestra players have their instruments built in that pitch, but that the thousands of other players throughout the country, as well as the music stores, have only instruments made at or nearly at A-435. They, also, did not take into consideration the fact that instruments built in A-440 will vary from change of temperature just as much as the others, and that when all the factories are making reed instruments at A-440 it will again be necessary to raise the pitch of the pianos and organs to A-443 or A-445."

James F. Bowers: "Suppose at the coming meeting of the Federation, Mr. McDonald, you should represent the tuners in the matter of pitch. What would you recommend, what method would you advise as to insisting upon A-435?"

D. A. McDonald: "The convention of the American Federation meets again in May, here in Chicago, and I feel sure that if the Piano Manufacturers Association and the Tuners' Association would communicate with President Jos. N. Weber and request a hearing on this subject he would gladly comply, and would probably appoint a committee for the purpose of re-hearing. Then if that committee could be made to include representatives of all parties concerned and also some well versed scientific men who are competent to present the acoustical side of the matter, I am

confident that the old and well established International Pitch, A-435, would be restored, with the added proviso, as I have before suggested, that when pianos are tuned for orchestral use they shall be tuned to A-437 or A-438."

Frank Milner: "I became interested through the pipe organ. For a number of years 435-A was considered the correct pitch. This question of pitch has been the subject of legislative enactment and also royal edict. If we have to comply with the symphony orchestra and with the theater orchestra, you will have to have two instruments if an exact pitch is desired. It was on that account that the Federation changed the pitch from 435 to 440. We cannot change the pitch of an organ after installing as you could a piano. Therefore, because the orchestra could not be used with the organ, we had to go to 440. Many of the large orchestras—that in London and our own here prefer 440. It means a great deal more to us than it does to the piano. It costs us a lot of money to make the change."

D. A. McDonald: "I may venture one little piece of information. That change of pitch did not originate with the organ. It came about through the manufacturer of orchestra bells discovering that the smaller their bells were and the higher the pitch the less the overtones would hold over. Consequently the makers of these bells have been tuning them at 439 and 440. I asked one manufacturer of orchestra bells the other day at what pitch he is tuning his bells. He said: '439-A. It makes them sound a little more brilliant to be a little higher than the orchestra.' Like the two country violinists who had occasion to play at a kitchen dance and when they got there one said to the other: 'Let us tune a little bit apart, Bill, and then they will know there are two of us playing.' As a result of this business of tuning the bells higher than the orchestra, the orchestra bells now are being thrown out of the orchestra. It is now up to the manufacturers of orchestra bells to force a 440 pitch or they will be up against the proposition of retuning thousands of bells all over the country and most of the owners will insist on their being tuned without charge."

Frank Milner of the W. W. Kimball Company then demonstrated the Deaganometer and described its uses.

Small Grand Construction

April 17, 1918

F. E. Morton, chairman, in announcing the subject "Small Grand Construction," exhibited a scale drawing (Fig. 33), a cross section drawing showing action placement (Fig. 34), and a strung plate identical with the small grand exhibited at a prior meeting. He explained that the new scale was expected to show an improvement over the first in that the tension on the bass section was graduated from 160 pounds to 170 pounds. He further stated:

"The difficulty in reconciling the last plain wire with the first string was one of volume and quality. The first attempt was made with copper wound strings throughout. We found that copper wound strings did not blend. The jump from the steel wire to the copper wound strings was very pronounced. It seemed almost impossible to continue the tone quality. Therefore, we used the steel wound strings, with what result you now know. With the same size of steel covering wire as copper prescribed in the original drafting we get a lower tension. The effect of a change in tension led me to change the bass scale. As you will see, the bass bridge is dropped quite a bit lower on the treble end, shortening the first double. We also used a smaller gauge covering wire. The last steel wire is No. 20 gauge. The first double is 18 core wire and 34 steel covering wire. On the piano exhibited last month the first double was 18 core wire and 32 covering wire.

"During the past two years I have examined a number of instruments and made a number of experiments and I feel certain that most pianos have too high a tension on the bass side of the break. On a short scale from 110 to 135 pounds is all we can get on the treble side of the break with No. 20 wire. It is an abrupt change from that to 175 or 200 pounds, and it is unthinkable that we can get the same quality of tone with two wires, one drawn to 110 pounds and another to 175 pounds tension. One wire will vibrate in one mode or in a certain number of segments, while the other will break up into smaller segments, and it is the segmental vibrations which determine the tone quality. We must have sufficient tension to lift the sounding board by means of

the staggered pins on the bridge as well as depress it by vibration of the wire. It must move both ways. I find that 150 pounds tension on a proper gauge core wire is about the limit, below which one cannot go without sacrifice of volume. The size of the core wire determines the energy, the covering wire functioning only as weight. Covering wire, if it is a good wire, does not vibrate, it only travels with the vibrating core wire, so that anything that is done to give greater depth to

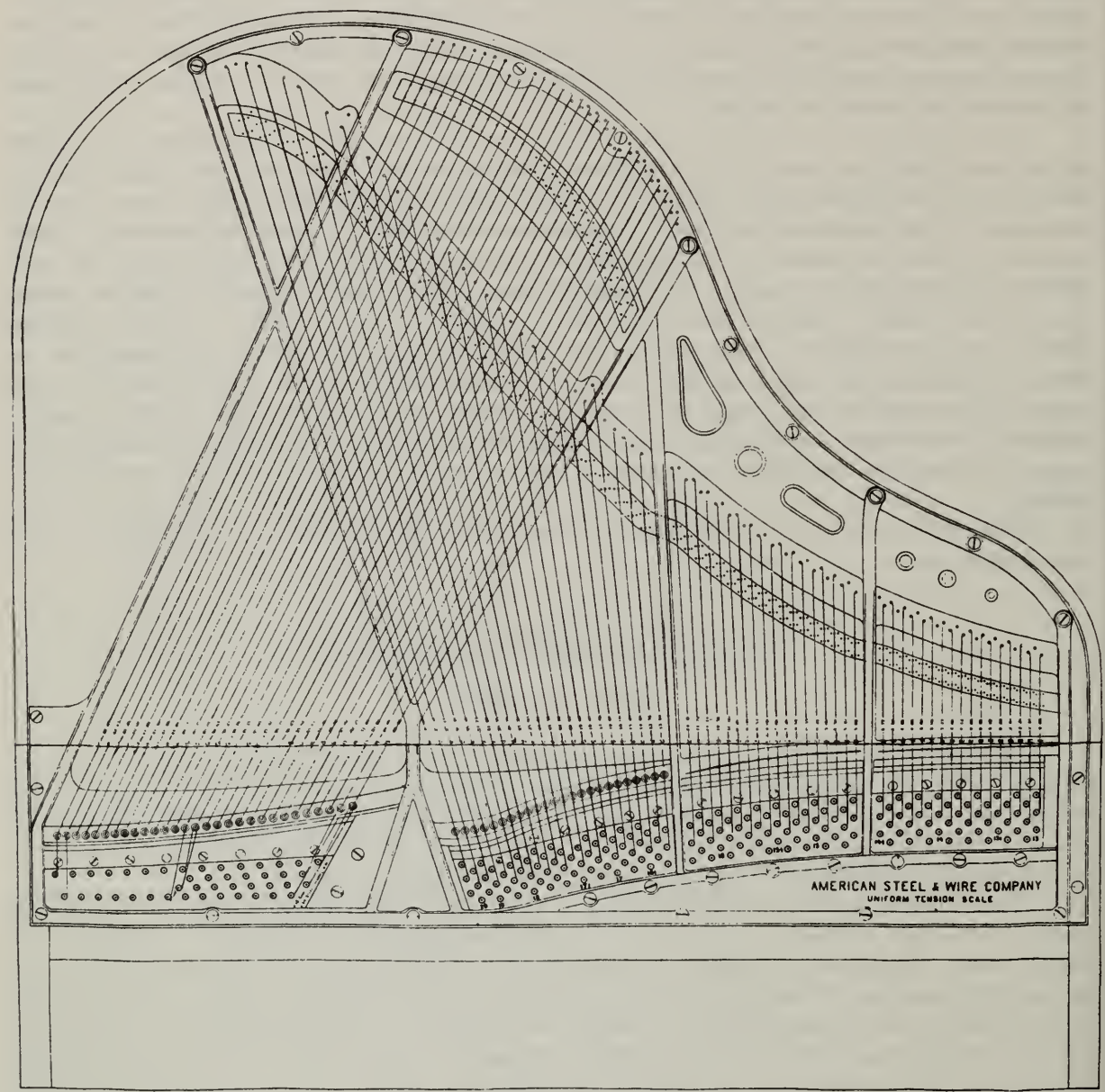


Fig. 33

the tone, greater life, greater brilliancy, involves only the core wire. A drop of two gauges between plain wire and strings gives good results—other factors being right. With No. 20 plain wire you can drop back to No. 18 core wire. If your covering wire is too small it does not hold well. No. 34 is about the smallest that you can use on the average string."

C. C. Chickering: "Don't you use frequently a tri-cord covered string in the bass? Some makers do. In a case of that kind what would be the size of the covering wire?"

F. E. Morton: "I would not like to prescribe a covering less than No. 34. I know the tri-cord is used, but I fail to see where it is an essential. So far as my observation goes the tri-cord is an afterthought and not in the original scale. Tri-cord bass was used when it was found that

the core wire was too small to supply sufficient energy, and instead of changing the action and changing the entire scale, the tri-cord was put in. The tri-cord tone must be made satisfactory by the tone regulator. You have found that to be true, haven't you?"

C. C. Chickering: "I think my own experience would lead me to say that. There is a less decided character of tone where tri-cord was used next to steel. It occurred to me that if a covered

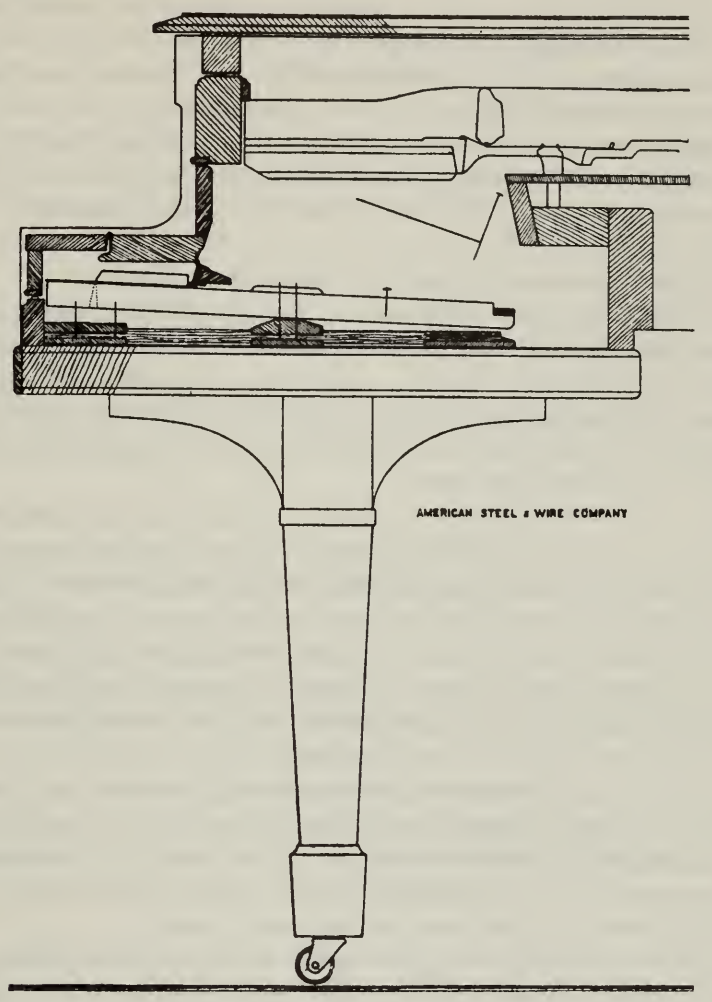


Fig. 34

string was used above the break, one or two notes at least, it might modify the general rule and carry out the question of tone character."

F. E. Morton: "It probably would. I know of one small grand in which there was a very decided improvement above the break by dropping the gauge instead of raising it—running from No. 18 to No. 19 and No. 20, then two each of No. 19 and No. 18. It was an improvement, but it was an after-thought. If the scale had been properly drawn in the first place I do not know of any reason why one should put wound strings above the break. Suppose you are down to No. 19 wire and in place of two No. 20 we put two wound strings. You cannot wind No. 20 and keep the same tension. You cannot get the same energy with smaller gauge core wire. It is a matter of intensity of vibration of the sounding board.

C. C. Chickering: "It might be possible that a No. 17 string or a No. 18 string, lightly covered, would in itself have a clearer vibration, even though the board might be tightened up on account of the closeness of the lining. Might not the lighter string vibrate more easily and freely than a thick, heavy string?"

F. E. Morton: "There is no question but that it would vibrate more freely."

H. H. Arnold: "Would the weight of the covering wire add anything to it?"

F. E. Morton: "Yes. That is why you get so little of the fundamental in a wound string. With a high tension wound string from four to six notes from the break it is hard to determine the pitch; perhaps not when you run the scale, but certainly when you strike it alone. It is because

there is so little of the fundamental. The tuners are aware of that. One reason is, as you suggest, the stiffness of the wire. Stiffness of wire is the greatest enemy of the small scale.

F. E. Morton then exhibited the small grand plate and showed the method of patterning in such a manner as to avoid residual stress and torsion.

F. E. Morton: "Suspend a plate and strike these members and you will learn very readily by the difference in sound where there is stress or torsion. It has a peculiar higher ring—a sort of inharmonic overtone, quite a bit higher than the pitch of the member. By suspending half a dozen plates and listening you may easily determine the differences due to stress and torsion.

"It pays to put your wrest plank down and be sure that every portion of it rests solidly against the plate and have sufficient screws of the proper size to hold it there absolutely rigid. That is one great big factor. I might mention that we have tried cementing the wrest plank to the plate at considerable time and expense, and while it is not a commercial possibility it demonstrates the value of rigidity."

Wm. Hehr: "What tension do you get on those copper singles?"

F. E. Morton: "Not more than 100 pounds. If you would make those of a size to give you 170 pounds the sound would be like striking a steel bar. I have heard pianists complain of the shortness of key in the small grand. There is a different feel, decidedly. Artists note it quickly. Several people whom I consider very good pianists say that their only objection to the little grand is the length of the key. I wonder just how much it means to the purchaser really, and if we can manage to give them a greater length key."

C. C. Chickering: "The distance from the back end to the front is a fixed distance. We cannot change that and I do not see how we can go back, because the minute we do that it throws the centers of the action all out of line, so it seems that we either must leave the piano as it is in spite of the criticism of the artist or else build an addition to the front of the piano which is unessential, so far as general construction is concerned, for the mere purpose of getting a longer key."

H. H. Arnold: "I do not see how you can change it unless it might be done by changing the location of the balance rail and give a little forward pitch corresponding to a longer key."

F. E. Morton: "Do you think it is worth while to change that?"

H. H. Arnold: "I do not. The artists do not buy small grands for their own work and will not play on one from choice. The small grand is for the home where they want to save space and yet have a grand piano. I would like to hear what some of the other gentlemen have to say about it—those who have charge of sales—whether they do not meet that condition of people wanting grand pianos and do not want to give them the necessary room."

E. Whelan: "There is no question about that. The average purchaser who buys a grand usually buys it more for looks. They want a grand piano—they have an idea that it lends an atmosphere of musical refinement to the home, but the criticism that we get from the musician is always one of condemnation of the small grand."

H. H. Arnold: "I do not believe the manufacturer needs to worry a great deal about the small grand."

C. C. Chickering: "I have often felt that the question of the condemnation of the small grand piano by the artist has been brought about quite largely by the unsuccessful pianos which were originally put on the market. Some of the earlier makes of small grand pianos were freakish instruments, no tone and nothing to recommend them to anyone who had the slightest musical intelligence. That is not true today. We have a number of small instruments today which may be fairly termed successful instruments from a musical standpoint. It is a condition based on an original prejudice which, I believe, will gradually work itself out. I think we can notice it in our own business. Even two or three years ago there was a decided prejudice against a piano which was less than five feet ten inches long. This was partially brought about, I believe, through the attitude and advertising of our big concerns to the effect that no piano could retain the grand qualities below the measurement of five feet ten inches."

E. Whelan: "The salesman has been to blame also. The salesman who is not selling a very small grand starts the propaganda and hammers on it very hard. He is anxious to sell a large grand."

H. H. Arnold: "Mr. Chickering, don't you think it is largely a matter of touch and not getting accustomed to it?"

C. C. Chickering: "I do not think the question of touch is very generally considered by the average purchaser, but I do think that touch enters very decidedly into the selection of a piano by an artist, even more than tone. I have seen them come into our place for a good many years and pick out an inferior piano which had the touch they liked. Many years ago a man had special pianos made for him corresponding to his touch. He was a wonderful performer and claimed it was because he did not have to go so far to get results. However, I do not believe that from my experience I would say touch was essential to the ordinary purchaser. I think the question of tone, or their idea of tone, is the only thing they consider, but the man who is a technical gymnast has to have that action so he can do all the gymnastic stunts he has in his mind, or else he does not want the piano. Tone is secondary to him. The piano on which he can perform as he wants to, he will take in preference to a better toned instrument with an action not suitable to his needs."

W. S. Jenkins: "From my experience of the last two or three years I think people have been buying small grands because they like them and I do not think the question of touch has entered into the proposition at all. I do not think we have had one in a hundred and fifty complain of the length of the keys. The small grand is more of a commercial proposition made for the public and I do not think that the manufacturer should worry about the trouble he might have if he were making concert grands for the artist."

F. E. Morton: "I felt quite confident of it myself and only raised the question because I was asked: 'Why can't we have the same length key in the small grand as we have in the concert grand?'"

C. C. Chickering: "It can be done."

F. E. Morton: "It can be done, but is it worth while?"

C. C. Chickering: "You would have a freakish looking piano. The distance out to the front of your keyboard would be at least one-third of the length of your piano, and you can imagine how that would appeal to some lady with good taste."

F. E. Morton: "One other question has come up several times in the process of working out these small grands, and that is the height of the plate above the sounding board. Some very queer ideas have been handed to me on that subject."

H. H. Arnold: "If it were not for the height of the plate above the sounding board the depth of the piano could be made a little lower and more in conformity with its size and general appearance. At present it has about the same height of case as any other grand piano. If that could be cut down from ½ to ¾ of an inch and cut down the height of the case correspondingly, it would look a little neater."

C. C. Chickering: "If I understood Mr. Morton's question, I do not think he referred to the lines of the case as much as to the effect on the tone of the piano by raising or lowering the plate, and I have had a good many discussions on that point myself."

F. E. Morton: "I think there are differences of opinion enough to make it an interesting proposition."

C. C. Chickering: "Theoretically it would seem that the plate ought to be kept away from the board and still get proper contact between the hitch pin and the bridge, but practically I do not think it makes very much difference."

F. E. Morton: "The question is: Does the height of the plate above the sounding board have anything to do with the tone of the piano?"

Wm. Hehr: "I do not believe it has."

E. E. Beach: "I do not believe that it makes any difference."

W. S. Jenkins: "Would the thickness of the bridge affect the tone?"

F. E. Morton: "You do not get the same undulations as with less mass of bridge. Bridges need not be quite as wide as we make them."

C. C. Chickering: "Some of the very finest toned pianos are heavily bridged."

F. E. Morton: "Quite true. I am referring, of course, to the little grand. Some time ago we went into the matter of cutting up bridges. I found that in certain parts of the piano a very decided improvement is made by cutting the bridge out and having it rest only on the ribbed point. On other scales there were parts in which it was decidedly not a success."

C. C. Chickering: "That is a feature of construction which I have never considered. I really do not feel competent even to express an opinion about it. Your judgment is that there are some

instruments which have been benefited by contacting only at the point where it attaches to the ribs?"

F. E. Morton: "Yes—only at the treble end of the bass bridge and both ends of the treble bridge. Now whether that would be effective on every piano I am unable to say. I have only made a couple of experiments along those lines, but it was a decided improvement, gave a much greater freedom of tone. With the lighter tension it is reasonable at least to suppose that anything which will give greater freedom of undulation will be an improvement."

C. C. Chickering: "I had a peculiar experience in that connection with the construction of the treble end of a piano in which I was once interested. We had plenty of room at the very extreme end of the piano and originally made it with the bridge cut off, and the results were not altogether satisfactory, so somebody suggested that we put a tail on the bridge. The results were very much better."

F. E. Morton: "I have done that, too, and obtained good results."

C. C. Chickering: "That would be almost contrary to the theory of too much freedom of vibration."

F. E. Morton: "That means a greater area of conduction and the tail is cut very thin."

C. C. Chickering: "We have been experimenting with the small grand and so far as overhanging the bridge in the treble is concerned we have not been successful. We find that by overhanging the bridge about half way down we got better results in tone. I only mention that to show that there can be no fixed rule. What will work out all right on one piano does not work out on another.

"I would like to open the question of solid bridge versus the glued-up type and get some expressions along that line. If the rest of the manufacturers here are having any such experience as we are now, I would like to hear about it. There is quite a bit of difficulty in getting thin maple stock for glued-up bridges at the present time. You can get them, but the manufacturers of bridges wouldjust a little bit rather not bother, because of the difficulty in getting that lumber. I am wondering whether a change from the laminated type of bridge construction to the solid bridge with a cap would be likely to be detrimental either to the piano or its tone producing qualities."

G. Thode: "Don't you think the one-piece bridge is a better tone carrier than the glued-up bridge?"

C. C. Chickering: "I think the glued-up bridge is stiffer and if stiffness is something you want to avoid, then the solid bridge would be a little more yielding, more apt to fit itself in with the vibration of the strings, but so far as the tone producing qualities of the piano are concerned, I am not prepared to answer that. I have thought sometimes that the solid bridge was better than the glued-up bridge from a tone producing standpoint, but those of us who are trying to make an expensive piano and give our salesmen something to talk about hesitate about using a solid bridge for the reason that three, four or five of the so-called old standard makers insist and stick to the usual accepted type of the glued-up bridge as being superior. I am not prepared to say which is better, but I do know from my personal experience that the glued-up type frequently gets one into trouble. If the piano is sent into the south, where there is a lot of moisture, the piano frequently is sent back to the factory. The glue has not held or the cap comes off. If you are making up your pianos from the standpoint of safety and can get first-class clear stock with the cap on it, it will stand up safer and better than the glued-up type of bridge, but I am not prepared to say which is the better bridge from the tone producing standpoint, nor which is the one best adapted to general practice. That is a point which I want to have discussed and talked about."

F. E. Morton: "Do you remember the reason for the first glued-up bridge?"

C. C. Chickering: "I do not."

F. E. Morton: "Was it not because of splitting?"

C. C. Chickering: "I presume that was the reason. That is the talk we used to have in the old factory in Boston—that the glued-up bridge was used to prevent splitting."

F. E. Morton: "In the old squares, I remember, the bridges did split. It is my recollection, and I think I am right, that that was the reason for the glued-up bridge."

C. C. Chickering: "In your opinion, then, Mr. Morton, the only excuse for the glued-up bridge

is the argument in favor of its rigidity or its ability to stand the strain of the strings, not tone results from that type of construction."

F. E. Morton: "No doubt the theory if carried into practice would go farther than that. The difference in the cut of the wood might do that as well, perhaps. I have some samples of wood here which were sent to me to test out, and the manner of testing as to splitting is rather simple. We have driven in a series of nails and have tested it out. You can look them over for results."

C. C. Chickering: "Of course, we will assume that everybody would use a quarter sawed bridge."

F. E. Morton: "That is a pretty fair test. I consider that a very good test on one-quarter. All the nails are driven in, not drilled, and it stands up very well. Personally, I do not see any reason why a first-class piece of lumber, quarter-sawed, is not 100 per cent effective for bridge work. I had end wood bridge talked to me thirty-odd years ago and spent two weeks experimenting. If I had known as much then as I learned in the experiment, I would not have spent the time. I think the theory of those who advocated end wood bridges was based on the fact that sound travels faster through the length than it does across it. As a matter of fact, there is no sound there at all; nothing but motion—so that makes it simply a foolish experiment. I have never heard an argument advanced for built-up bridges, or anything of that nature, that I could reconcile with anything I have encountered in my experimentation."

C. C. Chickering: "It comes down to this, that the glued-up bridge is merely a talking feature."

F. E. Morton: "I have always considered it so."

H. H. Arnold: "Have you not found, Mr. Chickering, that it is more difficult to keep a bridge in shape when glued up than when solid?"

C. C. Chickering: "Of course it is—it depends on circumstances. Sometimes you have to bring your bridge up, have it come to your pattern. That is the difficult part. I remember a bridge we made during the last two or three years. On the suggestion of one of our men we took a series of little pieces of maple and glued them up one on another, the idea being to get a bridge that was less stiff. We cut them out, joining them very carefully, and sawed off the two outside pieces. The grain of the wood would be running at an angle of about a quarter with the sounding board. We tried this out, particularly on a small grand which was giving us a little trouble owing to stiffness, but the results were not satisfactory.

"There is another thing which comes to my mind, although it is entirely aside from the subject in hand—that is the question of waterproof glue. In all probability the manufacturers of this country after this war is over will do a larger export business than we have done in the past, and if that should come about, the question of waterproof glue will be rather an interesting one. I have run across a concern within the last six weeks or two months in Minneapolis that is making a glue which they claim is waterproof. We have experimented with it sufficiently so that I am pretty well satisfied that they have something worth while so far as its holding qualities are concerned. We have tested it by sprinkling the joints; soaking them; put one block of veneered stock over our steam box and left it there for a day or so with the idea of loosening the glue and having it let go or blister, and it has not done so. The name of the concern is the Curtis Cold Glue Company. The only disadvantage that I know of lies in the fact that it has to be used immediately after it is mixed. Of course, after experimenting you would know just how much you would want to use, but you cannot use the old glue over again."

H. H. Arnold: "We are at the present time doing some government work and using this glue. We are also making it ourselves and it is true about the necessity of using it within a short period of time after it is mixed. It is not animal glue, but has some of those principles, and so far as holding qualities are concerned I wish to say for the benefit of those who have not looked into it very far, that we have tested it up to 2,750 pounds per square inch and then the wood broke.

"To what extent that glue will be used for commercial purposes by the manufacturers of furniture and other veneered articles remains to be seen. We had been using some for a time prior to the government demand for glued-up pieces for aeroplane work requiring waterproof glue. The original requirements were a twenty-four-hour boiling test, followed by a twenty-four-hour baking test, followed by a two weeks' submerging test in a normal room temperature. They

would have to stand all of those tests in succession, and some pieces would have to stand a separate twenty-four-hour baking test. They have changed that to an eight-hour boiling test or ten days' submerging test. It will, in my opinion, overcome the question of shrinkage of varnish. The shrinkage of varnish is not due to the varnish; it is the action of the animal glue in the pores of the wood. It is not a shrinkage, it is a rise. Of course, when you raise a part of that surface another part is sunk below the surface and, therefore, it is, in effect, a shrinkage of the sunken part.

"I do believe that on account of the moisture not having any particular effect on this glue it is very valuable. So far as having any effect on our export trade is concerned, that would be about the only part which would be affected, the appearance of the instrument. You cannot expect a sounding board maker, action maker, or hammer maker to use it."

C. C. Chickering: "Why not?"

H. H. Arnold: "We could probably get them to if there was a special interest in it. A certain time limit figures in the question where the glue is used."

C. C. Chickering: "Is it a matter of practicability or cost?"

H. H. Arnold: "The spread is greater than normal glue, but the cost is much greater at the present time."

F. E. Morton: "Are the materials from which this glue is made likely to decrease in price?"

H. H. Arnold: "The material from which the glue is produced will probably remain close to the present standard market price, but we all know where animal glue has gone."

C. C. Chickering: "Tropical pianos are usually made up in solid cases, for the reason that in those portions of the world the veneer will come off. Now if we can find a substitute for our glue by means of which we can give the market a finer figured thin wood, the same as in the atmospheric conditions under which we live, we will have a much more beautiful article to offer."

H. H. Arnold: "We are experimenting along those lines. It is quite an important matter and it seems to me that it is worth considering from that standpoint."

C. C. Chickering: "I do not know how this glue would work out on felt—whether it would hold or not. If it is absorbent it might not work so well on more absorbent materials, but as to this I am not posted."

H. H. Arnold: "We have not gone into that very deeply. We tried it a little, but I am not prepared to give any details as to its practicability."

C. C. Chickering: "It may be that in the course of the next few months I can tell you something about it. I have ordered keys and actions made with that glue, because we are having a call for export instruments, and the question of humidity is a very vital one. If I find that the glue works out satisfactorily, I will give you the benefit of our experience."

H. H. Arnold: "We took two pieces of walnut veneer, glued them down, made panels, finished them up. That panel has been kicked about for the last seven months and there is not a sign of shrinkage or veneer chipping. The action of atmospheric conditions has been eliminated. We have made the test by taking the same pieces of glued-up panel stock—taking a strip four inches long by two inches wide, quarter-inch core, and the expansion on that core was just ¼ of an inch on four-inch width. We tested it out in the usual way, baking it for twenty-four hours, and there was not a sign, either after baking or after boiling, that there was any expansion or contraction. That is one reason why water-proof glue is demanded, to prevent expansion or contraction, prevent the tearing apart of the fibers of the wood. We have to build up panels in as many as twenty-one ply —1¼-inch thick, all told. Of course if there was any expansion or contraction in building up stock of that kind the fibre of the wood would soon tear apart. We have a glue which has stood the test on holding strength far superior to any other water-proof glue on the market, Curtis included. The highest holding strength they have on it is 1300 pounds at the Madison laboratory, and some of them only 800.

"As to holding qualities no manufacturer need fear to use it. I have learned today that the Perkins people are prepared to put a water-proof glue out that is mixed with their vegetable glue, and if that would work, I think as far as the general benefits derived from the use of such a water-proof mixture are concerned, one would be just the same as the other. If you can prevent the atmospheric action, it is all that is necessary, in my opinion. It goes farther than animal glue for veneering purposes."

F. E. Morton: "Would that be effective on ribbing?"

H. H. Arnold: "Just the same as in any other part of the piano, in my opinion. You can use that even for gluing joints. Any glue which will hold 2,750 pounds to the square inch is just as good for joints as for veneer."

C. C. Chickering: "In an extremely damp climate this becomes rather a serious problem, and anything which will have a tendency to eliminate the difficulty is a step in the right direction."

H. H. Arnold: "Yes. It would not prevent the expansion of the wood in the sounding board so as to create a lap. We are going into this matter deeper and deeper, and I am glad to hear that Mr. Chickering is going to take it up with the action people, because if you are interested in that, in a short time we will be able to help you out on the other."

F. E. Morton: "One point in small grand construction is tremendously important, and that is the gluing of the sounding board to get an absolute rigidity. The use of such a glue would prove valuable. I have found and have been told of a large number of factories where the work has not been left long enough after gluing, and I have tried out some of those pianos. It was evident in the tone. One upright which was left in the press only fifteen minutes came out 'dead,' but it gradually improved."

H. H. Arnold: "I should judge that the reason would be the expansion from the water absorbed from the glue. When you first had it, it had not really dried down to a solid basis. Wherever there is a tear it will never knit again. If the board is not left in until the glue sets and hardens to that point where the expansion of the wood will not tear the fibre of the glue any more, you have something loose, and that which is loose is going to stay loose. It may afterwards dry out and not be as noticeable, but it will always be noticeable against one which had been given sufficient time to set and dry. There is a difference in glue setting and glue drying. The glue that we use will set under pressure sufficiently in a couple of hours' time so that parts can be taken out and left to dry. However, we find that we get safer results if we leave it ten to twelve hours. We know then that the water carried into the wood has been spread through the wood and a sufficient length of time given for setting and partly drying. There is one thing we must remember and that is that water carried into the wood when double veneering, is a great deal more than most people imagine. We have extracted as much as six ounces of water from a square foot of double veneered stock. That is the water carried into it with the glue."

C. C. Chickering: "Don't you think there might have been some moisture in your stock?"

H. H. Arnold: "We dried it thoroughly before using it."

C. C. Chickering: "You can say safely then that the moisture you got came from the glue?"

H. H. Arnold; "Yes."

C. C. Chickering: "One other question comes to my mind in this connection, and it bears directly on the point which we are supposed to be discussing—that is, the question of the rapidity with which you handle a board under process of construction in putting it into the piano. Is it good practice to put your ribs on and let them stand for twenty-four hours or forty-eight hours, or is it better to get them on and get your board in as quickly as you can? Some manufacturers do not hesitate to glue up, say, twenty-five, thirty, fifty or one hundred boards, get them into the piano, put the bridge on and all that sort of thing. Do you get better results with a board which is put together and glued into the piano permanently as rapidly as it can be handled?"

H. H. Arnold: "Your board is super-heated and you have an extreme contraction. You glue your ribs on that hot board. Your ribs have a normal temperature and consequently very little contraction or expansion, because the predominant percentage is end wood. By doing so you are preventing the long side of the board from expanding as freely as the other side and, therefore, it seems that the quicker the board is glued in after the ribs are on the board and sufficiently solidified the more rigid your board will be."

E. E. Beach: "We try to get our board as nearly bone dry as we can before we glue the ribs on. We also dry the ribs at the same time. Our boards are not glued in until the next day, because we do not get through with them. Before gluing on the back we put them in the hot box and warm them up again."

F. E. Morton: "Mr. Lufkin, what do you do in that case?"

Geo. Lufkin: "The boards are not glued on until the next day. It takes that long before they are finished."

C. C. Chickering: "I believe if the sound board is put into the piano the same day it is ribbed

you are going to get a better tone. If the board is left over night it gets an extreme crown, and it is a question whether that does not interfere with the vibration."

Wm. Hehr: "I just tried out a sounding board the other day, one which has been thoroughly dried, causing about 3/16" shrinkage across the board. Thirty-six hours afterwards it went back 1/8 of an inch. If it had been glued in it would have caused a checked board. We weigh the ribs down, and some boards probably lie there two or three days before they are glued in."

C. C. Chickering: "Some years ago we were manufacturing our sounding boards in another part of the city. I found that a number of the pianos were for some reason deteriorating in tone production, and we could not account for it. We examined everything, looked over the hammers and endeavored to find out where the trouble was. I finally went over to the other side of the city and found that we had about a dozen or two sounding boards standing around which had not been glued into the piano. I looked them over and found that they bellied up tremendously. I asked the man why he was doing them that way and he said they had been doing that for quite a while. He said they got to handling the work that way, found it was a little more convenient to put the ribs on and afterwards glue them all in at a time. I told him I guessed he would better handle them the other way and get his boards in as quickly as possible, and we found as soon as that was done that the pianos came out all right again."

F. E. Morton: "What is your observation on that matter, Mr. Klepac?"

Jos. F. Klepac: "I agree with Mr. Arnold and Mr. Chickering. Get your board in as soon as possible."

C. C. Chickering: "The trouble is that the board, if it is allowed to expand too much before it is glued in, will buckle in places. It will be raised in one place and hollow in another, and it just about ruins your board. If the board is expanding after it is in, it is confined to the limitations of the frame."

F. E. Morton: "The poorest sounding board is a hemisphere. That is carrying it to an absurdity, but it serves to illustrate. A talking machine diaphragm made in hemispherical form is absolutely useless. There is nothing more rigid than the arch, and rigidity is just what you do not want in that case. The board should give freely to undulations."

C. C. Chickering: "The question I was going to suggest was this: Would you, in determining the amount of bearing, give an instrument with more than a normal crown a greater bearing than a board that was comparatively flat?"

F. E. Morton: "No, I would not give it more."

C. C. Chickering: "In other words, you would give a hollow crown board the same bearing as a flat one."

F. E. Morton: "If you could assume that it would retain its position you would make the bearing the same."

C. C. Chickering: "Would not the tendency be for the hollow crown board to split more than the flat one?"

F. E. Morton: "No—not with other things being taken care of properly. It would hold its position, which is the real purpose of crowning, I take it. I do not think crowning was ever undertaken as an acoustic proposition."

Resiliency of Piano Hammers

May 1, 1918

F. E. Morton: "The series is fast drawing to a close. We usually wind up our work for the season about the last of May. The need for discussing the work we have done or tried to do and our plans for future operations seems to adapt itself to the coffee and cigar period, and so we ask you to be the guests of the American Steel & Wire Company at dinner on Wednesday evening, May 15, at 6:30 sharp.

"It may seem to those who have not attended regularly or to those who have been interested only in some one specific factor that we have rambled somewhat this year. It is a big subject and we have only 'hit the high spots.' To that extent we have rambled in search of high spots, perhaps but one point has been kept always to the front, that one thing for which we strive—a means of

substituting scientific knowledge for traditions; some way of obtaining by scientific means that elusive thing called tone; the ability to do it again and again with a full knowledge of the law of cause and effect. We may or may not have made progress—that is an individual and not a collective verdict, but that we are still working indicates a continuing interest that can but result in benefit.

"In our discussions of metals and the treatment of metal, we have taken up those points only in which we are directly interested. We have gone back to the protoplasm for an understanding of the nature of wood and the best treatment to bring desired results. In fabrication such as felt and cloth we have only touched here and there on methods, in order that we may determine our present status, the first point to be gained in changing that status. Manufacturers of pianos have told me freely that they have improved their practice and their product; that they are more proud of their work in the past two or three years than for many years preceding, all of which gives us hope that we are on the right track and that it is worth while. We have been students together and have conducted our research together and each has added just as much to his store of knowledge as he has drawn from his own store house, paradoxical as that may seem. One thing is absolutely established, and that is that we only gain as we give. A possession divided is multiplied, and so those of you who have given most have gained most.

"Among those who have become interested to the point of activity in enabling us to specify intelligently, positively and with an assurance of having our specifications made satisfactory, is Mr. S. W. Widney of The Widney Company. He has been working, as you know, for a long time to develop an instrument which will give us that much needed ratio between hardness and resiliency, particularly as applied to hammer felt. We have waited some time for the fulfillment of this promised demonstration. Let it be distinctly understood that the results are absolutely impersonal, that they are purely scientific and that anyone who is good enough freely to offer his product for this test is our good, kind friend and that any criticisms which may be made are for the purpose of mutual helpfulness. It is only reasonable to assume that the best felt which will ever be made is not made today, nor that the best piano which will ever be made is made today. All is progressive, an endless task in which we do our little bit in the time we occupy the field of action. We are backward, perhaps, compared to some other industries, in testing material before it becomes a part of the finished product. If that can be helped in the slightest degree we have received a very great assistance.

"Mr. Widney with his assistants will demonstrate the Resiliometer."

S. W. Widney: "We have been working on this instrument since last November. The instrument in its present form is practically complete with the exception of a few details, but for all intents and purposes it is the machine that we will put on the market. In our tests we have learned many things about felt and the variable conditions affecting thickness, hardness and resiliency. I wanted to make some tests on hammers of different makes and coverings of felt, but we did not have time. We have made a few tests, however—enough to show that results are positive.

"We will be glad to make demonstrations for anyone on any felt here and will answer any questions.

"With the idea that it might be possible to test wool before it was made into felt and find its resiliency in the virgin state, I went to one of the felt mills and we worked out a makeshift method. Here are two samples—one is Cape wool and the other Australian wool. I learned from the mill man that they worked up very different. One has a tendency to hardness and the other just the contrary."

F. E. Morton: "Is that due to the size or the character of the fiber?"

S. W. Widney: "I could not say positively—probably the character. These two pieces I have here he told me represented some of the wool they were using in making hammer felt at the present time. The hammer felt they are making contains a mixture of the two. It was very interesting to test the felt out in the sheet and then in the hammer and see the change which took place both in hardness and resiliency."

George Lisk: "We took Australian and Cape wool hairs and stretched them out; one would spring back very much quicker than the other. The straighter had less resiliency, less comeback."

S. W. Widney: "The mill man was very much interested and pleased. He could see after we had made a few tests the possibilities which it would offer him in getting out his product."

F. E. Morton: "Would you say then that if this instrument proves effective the mill men will use it?"

S. W. Widney: "I see no reason why they would not."

George Ruth: "Was the wool bleached or unbleached?"

S. W. Widney: "I would assume it was bleached—here it is."

George Ruth: "Australian wool in comparison to others will show a little more elasticity. If you pull it out it will spring back quicker. Was that a better quality than the other?"

S. W. Widney: "I did not ask him, but upon making the test we discovered the difference."

George Lisk: "The Resiliometer is somewhat like the Burnell instrument used in testing hardness, in that it gives the definite notes and puts the sample under compression. In using the instrument for thickness tests, you use it the same way you would the ordinary gauge. In this particular sample we get a 16-pound-per-inch pressure—that pressure concentrated on the foot provided gives 100 pounds per square inch. That reading under pressure compared to the original thickness reading gives the percentage of hardness. In testing the resiliency we release the pressure and immediately the indicator rebounds. For testing hammers we have a special appliance whereby we can set the hammer up or down. In this hammer (demonstrating) we get a reading of .460 thickness, .85 hardness and .70 resilience. That is the operation of the instrument and those figures are denifite."

George Ruth: "Mr. Widney, what is shoddy?"

S. W. Widney: "Shoddy is woolen goods made over. I think the limit is about six times, then the wool fiber becomes so short that it will not hold together. It is then ground into 'flock', a powder. There is wool shoddy and cotton mixture shoddy. An all-wool shoddy is produced by eliminating the cotton."

F. E. Morton: "If material containing shoddy has less resiliency than that made from the virgin wool, would you say that was because of the previous use of the wool or the process of re-preparing it, or both?"

S. W. Widney: "Both. The fiber is shortened from use and that naturally would take out some of its kink, which gives it resiliency."

F. E. Morton: "Then it is elasticity, or the ability to return to position immediately after being stretched, that gives resiliency to the fabric into which it goes?"

S. W. Widney: "Yes."

F. E. Morton: "Then, in effect, an instrument measuring the resiliency of a fabric is also a measure of the quality or characteristic of the wool fiber which gives it resiliency?"

S. W. Widney: "Yes, indeed."

George Lisk: "There is an analogy between the felt business today and what it will be and the steel business today and what is used to be. The steel business used to be a question of the individual absolutely. The men in charge of heat treating judged the temperatures by their eye. As a result you never got a quality of steel that you could absolutely bank on. After the installation of pyrometers, where everything was handled mechanically, individual opinion was thrown aside. From that time on the steel business began to rise. The same thing I think will be true in the felt business. Now it is a question of individual opinion. We have no working standard. Every manufacturer makes up the product according to his own opinion."

F. E. Morton: "You can carry that idea through and say that from the time steel became a dependable product the use of steel increased enormously. Would not the same thing be true of felt? If so, it justifies all the work you can put on it."

George Ruth: "That idea is very good, but an atom of iron is an atom of iron, and this is an entirely different proposition."

F. E. Morton: "It is a question of dependability. Any help in bringing that about will certainly be as valuable to the felt industry as were the pyrometer and similar instruments to the steel makers. We used to test the finished product in steel, but the steel was made, the labor invested. Now we test as the process goes on. Today we make Perfected wire having in mind the ultimate product from the furnace to the packing room, and every man who handles it is checked up by tests, with the result that we have what is required when completed. Formerly the wire was only

tested when finished and that only at the ends of each coil, it being impossible to test anything lying between. Today we predetermine whether it is to be Perfected or spring wire. This has been brought about by men working their gray matter at just the right time and bringing to the aid of the steel manufacturer, very frequently under the protest of the workmen, those appliances needed for a true test of the product during the processes of manufacture, thus insuring compliance with the original specifications. If I am right in my surmise, Mr. Widney has in mind the same thing in regard to the felt business. If this machine performs its function I think we can all agree that it is a valuable aid."

W. B. White: "If we presume that the manufacturer of felt is willing to adapt himself to fabricating a product in accordance with specifications, we will have to find a way of hooking up the piano manufacturer with the machine. At the present time the manufacturer has no standard whatever in his efforts to get the tonal quality he is after, and that is illustrated by the personal element in the tone regulator. It seems to me, therefore, that one of the things which it is the duty of such conferees as ourselves is to put up to the piano manufacturer for consideration methods by which he can make definite use of the material which is given him to work with, but the manufacturer has to learn how to use it, and until he does it will not make very much difference whether the fabricator of the felt can fill the specifications or not."

F. E. Morton: "That is quite true, but, on the other hand, I do not presume there is a piano manufacturer who occasionally does not receive a shipment of hammers with which he is more pleased than with other hammers. If I wanted to take advantage of such a means and were making pianos, I would test out every set of hammers used, identify the data and judge of the results, and when I found a set of hammers which exactly suited, I would specify to the hammer maker from that data.

"Let me tell you of one practice alone, that of micro-photography, photographing the structure of steel through a microscope, showing the layers of manganese, iron, silica, carbon, phosphorus, sulphur, and the relative positions of one substance to another. This only could be determined by a great number of micro-photographs of steel of various qualities. I do not know the number we have taken, but it has been going on for something over five years in our laboratories in Worcester, Massachusetts. We have been continuously making and checking those photographs, and it is considered one of the most effective means in its result on steel making that has ever been attempted. Now, if in the interest of a better product it is worth while to put an entire laboratory making micro-photographs continuously for five years and still continue classifying and tabulating those results for the benefit of manufacturers of steel, it would seem to me that in whatever degree such work might apply to another product it would be an equally good investment. We are not losing sight of the commercial side of the proposition. I would be the last one to advocate to the piano trade any visionary thing resulting simply in the expenditure of money, but there is an enormous amount of laboratory work which should be divided among the interests of the piano trade. I hope the time will come when the price of pianos will be raised to where they belong, and that we will cease selling on the basis of a common product. The measure of experimental work is determined by the price of the piano as compared with its cost, and the closer you bring the cost to the selling price, the more remote becomes the possibility of this work of improvement. I say that everything we can do to bring about a realization of the value of this progressive work is a help to the entire trade.

"Back in the days when the temperature and condition of steel was determined by a man who judged by shades and tints, the steel workers' wage was small, and the common laborer with the expert 'guesser' protested most strongly against the use of mechanical appliances for checking and testing, and yet with the application of those very instruments he now is raised into the expert class and is paid accordingly. The man who objected to automobiles because he was a blacksmith or owned a livery stable now has a wonderful garage and repair shop or a line of taxicabs and busses. His business has been lifted, in spite of his protests, to a plane where he may be of greater service to every man. The greater the service the greater the reward. The man who can put the felting business or any other trade on a basis where the dependableness of the product is absolutely assured, makes the worker on that line an expert workman and gives him expert's wages."

Wm. B. White: "I wish to ask Mr. Widney whether he has yet had the opportunity of examin-

ing any reasonable number of hammers in sets with a view to obtaining figures which could be used as averages."

S. W. Widney: "We have not tested a sufficient number of hammers to give any reliable data."

Wm. B. White: "I have a particular reason for wanting to know, and it is this. I have just completed work on the scale of a very small grand piano which I have arranged to be a low tension instrument—a tension running from 150 to 160 pounds. In getting the tonal results for which I am aiming, naturally, when it comes to the hammer, it would be a very important thing to obtain if possible, in advance, such knowledge based upon the analysis obtained from this machine as would make it possible for me to give orders to the fabricator of the felt and to the hammer maker according to the results obtained."

S. W. Widney: "Undoubtedly we will be able to help you out in that particular as soon as we get a sufficient number of tests made. The only test we have made so far is a superficial test to see how the different sets run as to uniformity, hardness and resiliency, and we have made rough comparisons with the hammers after they were made up and compared them with the felt in the sheet."

George Ruth: "Are the results in the sheet the same as in the hammer?"

S. W. Widney: "No. The resiliency is reduced in the hammer."

George Ruth: "How does it show as to treble and bass?"

George Lisk: "We made some tests today. A piece of felt .280 inch thick showed up 81% hard and 74% resilient. The figures may interest you: 72, 72, 70, 71; 72, 73, 73, 75, 79, 79, 81, 83, 83, 83, watch the drop, 79, 71. Here are two sheets each ¼ of an inch thick. This one shows 70% hard, together they show 73% hard, 3 points rise to each ¼ inch in thickness. That we have checked absolutely. When you are held down to a certain thickness you have to raise the quality. Where not held down to thickness, increasing the thickness would give the same resiliency."

A new hammer was then tested and turned over to Mr. White for what he considered a first-class job of voicing. It was then submitted to Mr. McClellan, who manipulated the top of the hammer, imitating as nearly as possible the practice of the itinerant tuner who 'butchers' the hammer by 'over-needling.' Mr. Deutschmann then 'ironed' the hammer back into form. The tests after each operation showed the following:

	THICKNESS	HARDNESS	RESILIENCY
As it left hammer maker	.800	.93	.73
After voicing by Mr. White	.805	.93	.76
Over-needled by Mr. McClellan	.863	.85	.50
Ironed by Mr. Deutschmann	.797	.91	.69

F. E. Morton: "The hardness was the same after voicing by Mr. White; the hardness was decreased from 93 to 85 by the over-needling process and was increased to 91 by the ironing process. In other words, the ironing brought back the hardness to within 3 points of its original status. The resiliency after voicing was increased 3 points; over-needling reduced it 23 points and it was increased by ironing to 69, or within 4 points of the original state, but note that the ironing only brought it back to within 7 points of its resiliency after the first voicing. That is, I think, an important conclusion. We have checked these figures several times to make sure we are correct.

"I want to call your attention to one thing which now assumes still greater importance. It is the resiliency of the hammer felt which determines the length of time it takes the hammer to get away from the wire, and this, as you know, determines the quality of tone by permitting or eliminating certain essential partials. The proper voicing of the hammer is, therefore, a big factor in determining the quality of tone. I have frequently heard it stated that needling a hammer simply decreases the volume. The layman usually assumes that to be the reason for voicing a hammer—that the piano is too loud and, therefore, to make it softer, have less volume, that it is voiced. Now this test has been conducted fairly and establishes the point clearly that no matter what the quality of the hammer, if the tone regulator is not an expert, the tone quality is bound to be affected. If the tone regulator attempts to reduce the volume by producing a sort of a feather bed on the head of the hammer, he changes the quality of tone of the piano. I believe if we can make that thoroughly understood by every man who touches a hammer with a needle, we will do that much to preserve the product which has been honestly and fairly put upon the market. A very inter-

esting operation would be to carry these tests to the point of destruction. After the hammer has been over-needled, that it be put on a 'thumper' and worked until the point of destruction has been reached, also after ironing it should be thumped to the point of destruction, thus determining whether ironing will give longer life to the hammer."

George Ruth: "After ironing you have adhesion on the outside and the cushion underneath. The reverse of what you are after."

F. E. Morton: "The hammer gets away from the wire quicker."

George Ruth: "Don't you think the way the hammer is made is as essential as the material?"

F. E. Morton: "We are prepared to learn the effect of tension on the top of the felt. What effect does tension have on the felt?"

S. W. Widney: "We have quite a few tabulations of figures here on that. In so far as we have gone we have noted without question that the hammer felt after it is drawn over the hammer is appreciably reduced in resiliency."

George Lisk: "I have some figures here on a set of hammers. From one treble hammer we get in the sheet a hardness reading of .81 and in the hammer a hardness reading of .86. Resiliency in the sheet is .74 and the hammer resiliency .72. Take another sheet—it reads .86 resiliency in the sheet against .73 in the hammer."

F. E. Morton: "Referring to reinforcement of hammers, without regard to the manner of reinforcing, here is a set of hammers which should give a reasonable test. In this case some have been reinforced and others have not been reinforced, alternating frequently throughout the set."

George Lisk: "Here are two adjoining—the reinforced hammer shows .93 hard and .75 in resiliency and the other shows .92 hard and .77 in resiliency."

F. E. Morton: "So reinforcement in this case increased the hardness one point and reduced the resiliency two points."

George Ruth: "I have a couple of sets of reinforced hammers here and, we being pioneers, I think you ought to test one of our sets."

F. E. Morton: "We are quite willing to do so."

George Lisk: "Here is one: Reinforced hammer .89 hard and unreinforced .89 hard. Reinforced showing .79 resiliency and unreinforced .80 resiliency. Well up in the bass it shows the same hardness and one point less in resiliency by reinforcement.

"Here are two about the middle of the register which show one point increase in hardness by reinforcement and four points less in resiliency. In the upper register we have two hammers showing one point drop in hardness and one point drop in resiliency."

F. E. Morton: "Let me suggest, if I may, to the manufacturers of hammers, whether reinforced or treated in some manner for which a special claim is made, that all tests be carried to destruction. It is the only way that anything can be accurately determined to the satisfaction of the man who wants to know the underlying principle. The piano manufacturers have given us a wonderful product. Now let us ask the hammer maker in good faith to go further with us and show us as he goes why and how he does things. We will enter into a partnership for mutual benefit and make it well worth his while.

"We are fortunate to have as a guest this evening, Mr. Charles M. Courboin, the famous Belgian organist and one of the greatest tone builders of our time."

Charles M. Courboin: "I do not think it is very fair to take advantage of a poor Belgian so far from home. The talk here this evening has been a revelation to me in more ways than one. I have had my own ideas about tone quality and have always been rather skeptical about piano tone quality, but this talk has made me very much more appreciative of the possibilities of the piano than I have ever been before. I thank you."

An informal discussion of the relative merits of domestic and imported wools and felts followed, and piano hammers of numerous makes and styles were submitted and examined by those present.

Dinner and General Review

May 15, 1918

F. E. Morton: "Conditions are changing so rapidly in these days when great events are following each other in such rapid sequence, that it is inexpedient to determine now just what we will do. If I am in a position to do so, and I do not now know of any reason why I should not be, I want this work or some branch of this work which has developed during the last year, to go on, and I want to do all that I can for it. I want to feel that the piano industry is established on a scientific basis; that the final result of every operation from the production of the raw material to the finished product has been predetermined; that every move is made with full knowledge of cause and effect; that there will be no more accidents. On the merchandising side I want to feel that it is as dignified, reputable and ethical as the sale of any art product. When I go into an art gallery, I always feel that I would better put on my 'Sunday best' and make a function of it. There is an atmosphere of dignity, of refinement and culture inconsistent with the idea of barter and trade and which precludes the possibility of considering pictures in terms of price. I want to see the day when all will have the same reverence when they step inside a piano wareroom. It is not a shopping proposition fundamentally—we have made it so. The time is propitious for a readjustment. Respectability, honesty of purpose and scientific achievement can be expressed in the product instead of words to impress or mentally coerce the customer. In fact, we should not think of them in the future as customers, but as participants with us.

"You are going to have a sellers' market, a condition we were discussing some time ago, but which seemed afar off. In a sellers' market you will determine your own future condition. This condition must be backed up at the factory and we must not under any circumstances, because of the agressiveness of the buyer, be led into commercializing our products. Now is the time to lay the foundation for that long period after the war. You can look forward without fear to a good business. The latent resources of this country are enormous. Its racial activity is about 20 per cent to 25 per cent capacity. This is no time for pessimism, it is a time for hard work, producing a little more tomorrow than you have today. In Canada the people are very much in earnest. Everyone is purposeful in his work. I saw no young men on the street whom I thought should be in service, and those who were on the street were very obviously making it safe for those who had gone over to the other side. Under those conditions the demand for pianos is very much greater than any one ever imagined it could be under the most favorable circumstances, and we are less than one year from those conditions."

Mr. Morton then called on Mr. James F. Bowers, President of the Chicago Piano and Organ Association, stating that speeches were not in order around a family table.

James F. Bowers: "I feel very much honored in being asked to be present at an affair of this kind given under such auspices. Speaking for the association which the Chairman has given honorable mention, the Chicago Piano and Organ Association, I believe I speak for them, as I certainly do for myself, when I say that the series of meetings carried on under the direction of the worthy Chairman have been helpful, beneficial and constructive, to say nothing of being entertaining in the highest degree.

"Now and again, in fact as a general thing, I have found myself, together with Gene Whelan who usually sits with me, coming up for air frequently, the matters being so far over our heads. We have sometimes found ourselves going down for the third time, while listening to the fulminations of Brother Arnold, Brother Waud, to say nothing of the Cicero of the trade, William Braid White.

"I am firmly of the opinion that if conditions make it possible these meetings should be continued indefinitely for years to come, as they have been wonderfully beneficial. Every man who has left this room after these meetings has left it richer than when he came in, if he had a mind capable of absorbing important and useful facts. The diversity of interesting subjects, the manner of their presentation, the comment about the table, the after-meeting discussions, all bearing upon matters cogent, eminently fitting and appropriate to conditions, have been worth their weight in gold, and I am glad to be here tonight to express my belief in them.

"I desire to testify to the goodness and usefulness, the benefit and wisdom of this undertaking.

Our host of the evening and his company need no honorable mention at our hands. They speak for themselves. We are the beneficiaries. I hope we will be able to go on with this work and that the health and strength and prosperity of our host and his aids will continue, and that in the house of Morton and in that of the American Steel & Wire Company may there always be found forty lakes and seventy palm trees."

Eugene Whelan, President of the Piano Club of Chicago: "I am very glad of an opportunity to express myself regarding the meetings of 'us technicians.' I, personally, have derived much that has proven helpful and I wish it were possible for every sales manager and salesman to become acquainted with your viewpoint, and then I think many of them would undergo the same change that I have. I can recollect not such a great while ago, if while waiting on a customer, they mentioned that they were looking at the Hobart M. Cable piano I was there with a great sledge hammer and started to tell them what a bad piano it was, but during these meetings a change has come over me, and now when some one mentions the Hobart M. Cable piano to me I see the genial face of Mr. Fishbaugh confronting me and I change my tune. If one speaks of the Bush & Gerts piano, up comes the picture of Mr. Gerts or the ruddy countenance of our friend Mr. Arnold, and I hesitate again and say nice things about their piano and wish them well, and then tell the customer other things about our piano. I, therefore, wish it were possible for all salesmen to attend these meetings. I thank you all for the privilege of mingling with you and learning about your pianos."

H. H. Arnold: "I thank the Chairman for his comment and for the privilege of attending these meetings. I am sorry to say that I missed two during this season; last year I did not miss any. Every evening I have been here I have had a very interesting time and have always learned something. I hope that if I have differed with any one at any time it has left no ill-feeling. Any one who has differed with me can feel assured that it has left no feeling on my part. We are not here to criticise, we are here to learn, and the only way we can learn is by word of mouth and hearing. The Chairman has been kind enough, with his company, to give us these opportunities of getting together, and I certainly hope this opportunity will be granted again the coming season. As far as our piano is concerned, I hope everybody will like it, especially those who buy in large quantities. I am sorry to say we are not even now able to keep up with the demand. I thank the Chairman and all you gentlemen for the assistance which you have given me from time to time."

F. E. Morton: "The Bush & Gerts grand piano here is made on the American Equal Tension Scale. It will be demonstrated by Mr. Harold Triggs who will play for us."

Mr. Triggs played Stacatto Caprice by Bogrich and responded to an encore with Lotus Land by Cyril Scott, after which Chairman Morton paid a high tribute to the Trade Press and expressed the appreciation of the members for the excellent treatment accorded. He then called upon Mr. Roy E. Waite, Editor of the Piano Trade Magazine.

Roy E. Waite: "Referring to the matter touched by Mr. Morton; I think it has been the experience of all the trade papers; in fact, we have been very much surprised at the great amount of interest throughout the country in the reports of the technicians' meetings. It only goes to show that the men out on the firing line, the salesmen and dealers, are very much interested in what you, gentlemen, do here; more than that, they are interested to know how pianos are made, and, if in knowing something of them they become better merchandisers, it is well worth while. I also think it has been the experience of all the trade papers that these meetings help our circulation—something that we are always able to use to advantage. The matter of deleting certain parts of the reports is, I believe, left to Mr. Morton, and I will say that he is a censor par excellence. I have been present at some of the meetings and while, as he says, nothing has been said that anybody need be ashamed of, there are things said and discussed which it would not be politic to spread before the entire trade, because unfortunately we have not yet arrived at that ideal state where the trade is entirely free from misunderstanding.

"This movement is a good deal bigger than simply a matter of piano manufacturing technique. It works in very harmoniously with other movements in the trade, particularly the work for the advancement of music, the movement for distributing music rolls and talking machine records throughout the army camps. All these movements really aim at a single bull's eye which is greater efficiency in manufacturing and greater efficiency in merchandising, and in these times it is very essential that we eliminate all waste in the factory to the end that we may release man power

and materials for the big job we have on hand across the water. Although some of us may not be able to work directly for the government we all can help by promoting efficiency, making every move count, making every dollar count, and every piece of material count for all it is worth. I think that I can speak for all the trade papers when I say that we have learned a great deal from these meetings. Very few, if any of us, are piano manufacturers, although we sometimes may write as though we were, but that is more or less camouflage. We have learned a great deal here not only about the production of pianos from a technical phase, but have learned how important these things are as they permeate out into the trade all over the country. The trade is interested in these meetings not only in this country but abroad. We have found that out.

"I think the entire trade owes a great deal to Mr. Morton and the company which is back of this movement, and I hope that conditions will be such in the fall that these meetings may be continued and the work go on."

Raymond Bill (Music Trade Review): "The Chicago Technicians' Conference is one of the greatest innovations of the industry during the past few years. It is not a debating society, but an institution for scientific achievement. There are many reasons why we should have this kind of achievement and I think the last few months have brought about a new angle which is really significant, and it is this: A certain element is pessimistic and a certain other element is not pessimistic. You will find that the man who is not pessimistic and who never gets pessimistic is the man who is thinking ahead, is still learning, still studying and still progressing. You will find that is also true of institutions. There is always a way to meet every situation, every new condition which may arise, and frankly I am sorry to see the Chicago Technicians' conferences discontinued during the summer, because we are at a time which is critical nationally and industrially, and it is a time when we want everybody steady and everybody interested in the progress of the industry."

Thomas J. Mercer (Music Trade Indicator): "We not only have been glad to give space to a full report of these meetings, but we have derived a great deal of benefit through a perusal of the reports which have had an educational value, and we have felt the benefit in a way which pleases all newspaper men, through increased circulation. I recall numerous instances of special interest on the part of our Canadian friends who were desirous of securing the paper regularly on account of the reports of these meetings. You gentlemen who are reported every time no doubt are glad to know that you are becoming internationally famous in the technical side of piano making.

"I hope these meetings will go on and while the trade paper men are denied the privilege of attendance I know that so far as we are concerned, we will be glad to continue giving a full report of the meetings and be glad of the opportunity given us to educate ourselves along technical lines."

F. E. Morton: "Mr. Arnold tried to pose as the infant of the trade, but there is a man here tonight who is the youngest in the industry, although you would not think it, because, I believe, he made the first talk before you at your first conference. Within the last month there has been born into the industrial world a new piano company whose product, a Trench piano, is closely related to war activities. Mr. C. H. Jackson, of The Jackson Piano Company, Milwaukee, Wisconsin."

C. H. Jackson: "I firmly believe that these meetings are worth while. In the factory with which I have been connected in the past I have been getting some real ideas from the men who have read the reports of the Technicians' meetings. Prior to these meetings if there was anything new I had to go out and pick it up myself, but these men have been coming to me with real ideas which have been the means of bettering the piano, and I surely hope that they will go on next season."

E. H. Lapham: "In the life of W. W. Kimball I always considered, as have many others, that he was one of the wisest men ever connected with the music trade. Mr. Kimball, it was said, made the statement that nine-tenths of the people knew nothing about pianos. Whether he said it or not, it was true, and it is really true today. It also may have been said prior to that time that nine-tenths of the piano men knew nothing about pianos, but it is not true today, and that it is not is largely through the influence of Mr. Frank E. Morton. I honestly believe that there has never been a man connected with the music trade in Chicago, — I may say in the United States—and I am absolutely sincere in this, who has been such an inspiration to the trade as Mr. Morton. It is a wonderful thing and the whole music industry is benefited by it. With men like Mr. George W. Pound in the East and Mr. Morton in Chicago, I think the music trade can well be congratulated."

F. E. Morton: "A manufacturer taking me through his factory in Canada introduced me to his superintendent and tone regulator, and they began talking about these meetings. One of them said: 'Mr. Morton, who are Mr. Fishbaugh, Mr. Arnold and Mr. Waud? We have always wanted to know.' I questioned them and learned that those three men had said the things they wanted to hear; had talked to them in their own language and told them what they wanted to know."

R. H. Waud: "I am only one of a great many who have attended these meetings and learned more than they expected to learn. These meetings have helped me immensely. I have enjoyed them very much and certainly took away more than I ever brought. I surely hope that the meetings will be continued. I presume everybody has done the same as I have—taken these ideas to the factory and tested them out, retaining such as prove useful. We cannot use everything we hear or practice everything we are told, but we can do some of the things, and it certainly has been of great benefit to me in my work."

E. B. Bartlett (W. W. Kimball Company): "I have been greatly interested in these meetings, and I am sure they have been of great benefit to the trade. I should say that the benefit was in direct ratio to the absorbing qualities of the minds attending. Certainly there has been a great amount of valuable information. The results of scientific investigations, the practical experiments and the following out to logical conclusions of theories which have been carried on under Mr. Morton's direction certainly have been a great help to those who would take advantage of it, and I feel, therefore, that we are greatly indebted to the American Steel & Wire Company and particularly to Mr. Morton who has helped us. Those of us who have enjoyed this hospitality before, of course, knew what to expect tonight. It may not be out of place to recognize the quality of the dinner—it could not be surpassed anywhere.

"Something has been said about the trials and tribulations the piano trade is passing through at this time. It occurred to me at the time that we only grow and gain strength by overcoming obstacles. It is a favorite theory of mine that the man who looks for the easy way, who works along the line of least resistance travels slowly and rarely arrives. An athlete trains vigorously for a considerable period before engaging in any athletic event. He does not coddle himself; he does not take the easy way. He works and he works hard and practices daily for a long period of time before the event. His whole thought is to win the event in which he expects to take part. The same thing applies whether manufacturing pianos, selling pianos, looking after the management or whatever the line of activity may be. It is the obstacles we meet, the work we do before we come right up to the sticking point that helps us to win.

"I have sometimes said to the salesmen: 'After you have done all you can, do a little bit more and that will get the business.' It is true, I believe, in every line of activity.

"As has been suggested, we will soon have a sellers' market. Now you should be fair with that market, so that when our days of prosperity come, as they are bound to come, we will not have anything to apologize for or be ashamed of. I am proud of the piano business and at a meeting in Washington, something over a year ago, I got a new inspiration. Facts which are well known to most of us were presented in a new light. I realized then as I never had before that the piano is an educational institution, a very valuable and important factor for the youth of the country. That being so its future is assured and so we do not need to worry about the future. Today is the only time that is ours, and if we do well our task today, the future will take care of itself."

E. J. Fishbaugh: "The majority of us are trying to walk across the gang plank of difficulties loaded down with weights. The Chinese, as I understand, are ancestor worshipers, and I think that 99 per cent of us are ancestor worshipers. We want to carry ancestral traditions across the gang plank of the present difficulties and if we do so we will break the plank."

William Braid White: "No word that I could say would deepen the sense of appreciation I am certain all of us have for the privilege of attendance at the Technicians' conferences during the last two years. I may express my own feelings best in the words of that great man who said to the charming woman who afterwards became his wife: 'To have known you has been a liberal education.'

"It is perhaps more than a coincidence that the inception of these conferences coincided almost with the beginning of the great world drama of which we are now a very considerable part, and in which I am thankful to say we are as one with our allies to the last man and to the last dol-

lar. It was perhaps more than a coincidence that Mr. Morton clearly foresaw that the war which would come after the war would be one which would require the utmost of energy, the utmost of systemization, the utmost of organization.

"In that war which comes after the war the United States will find itself in a condition quite unique. Before the war broke out about nine out of ten pianos manufactured in the world for oversea trade were produced within the German Empire.

"We make the best pianos in the world. We are the only people who, in the modern sense of the word, can be said to make pianos. No piano made in the world today can be compared for one moment with our ordinary, reasonably good, second-rate instruments. It would be very remarkable if in the war after the war we did not get a large share of that oversea trade. It would seem that Mr. Morton must have been gifted with something like prophetic insight when he suggested bringing together men interested in the scientific side of piano making, men determined to do something which everybody said could not be done. We have gotten round this table and have done the things which could not be done. We have learned remarkable things. There is one thing in particular, and without wishing to be personal, for something like ten years I have been talking an equal tension scale. Nobody paid any attention to me, and really I do not know that I particularly expected it. We have one here tonight and there are others. Mr. Morton has exhibited one. They mark a revolution in piano making, because it shows that we have at least realized that tradition has nothing to do with it and that science has everything.

"For my part I can say that to have had the opportunity of being one of the board to sit around this table and take part in discussions which had to do with production and other questions of piano making has been a tremendous privilege, a privilege for which I cannot too sincerely thank my other member friends, Mr. Morton himself, and the great company which has stood back of him. I do not think that any of us as yet quite understand how much we are indebted to these gentlemen. I do not think that any of us have considered how really important the work is in which we have been engaged. When the Peace Conference has dictated its terms we shall be ready to derive the benefit from what we have done around this table, to take our place in this industry, not only as the makers of the best pianos, but the makers of scientifically made pianos. With what we have we are going to be able to take the oversea proposition and put it on a scientific basis, and when the war after the war begins we shall be able to restore the trade to a basis where we shall not only dominate domestic production, but the production of the world. We make the best instruments which have ever been made, but during the next fifty years we are going to make pianos which will amaze every one.

"Mr. Morton, you have given us not only entertainment, not only pleasure, not only opportunities for discussion, but you have been to us a liberal education, and I thank you."

F. E. Morton: "I truly appreciate all that has been said, but I do not feel that I can accept it for my own part. I have had the full support of the company I have the honor to serve.

"As I sat here looking at our service flag representing 1800 young men in the service, two of them sons of Mr. Baackes whose companionship he is now enjoying during the short time he may, I thought of the good, solid and loyal support he has given us and which has made this work possible. I think he is treating us as he is treating his country, giving us the best he has. I do not want to let that sense of appreciation lodge with me when it should go back to where it rightfully belongs."

E. H. Lapham: "Gentlemen, I think this is a suitable time for all of us to make known our appreciation of what has been done for us. I move a rising vote of appreciation of what the American Steel & Wire Company and its representatives have done. I would like to see you all upon your feet as a token of appreciation for their work. Now three cheers for Frank E. Morton. Hip, Hip, Hooray."

Piano Tone Building

PROCEEDINGS OF THE
PIANO TECHNICIANS'
CONFERENCE
NEW YORK
1919

Accoustic Department
American Steel & Wire
Company

Members of New York Piano Technician Conference

A

Abendschein, F. H., The Staib-Abendschein Company.

Adessa, G., Milton Piano Company.

Aldcroftt, Richard B., President, De Rivas & Harris Manufacturing Company.

Allen, E. H., President, Boston Piano Supply Company, Norwood, Mass.

Allen, George W., Milton Piano Company.

Amico, S., Brambach Piano Company.

Anderson, A. D., De Rivas & Harris Manufacturing Company.

Arnette, Dr. Lilly, Pianist.

B

Bacon, W. P. H., President, The Bacon Piano Company, Inc.

Bacon, E. F., Hardman, Peck & Company.

Bartel, F., Kohler & Campbell, Inc.

Bauer, H. R., Secretary, The Bogart Piano Company.

Behning, Albert, Secretary, New York Piano Manufacturers Association.

Behr, William J., President, Behr Bros. & Company.

Bilhuber, Paul, Steinway & Sons.

Bjur, William L., President, Bjur Bros.

Bogart, E. B., President, The Bogart Piano Company.

Bradner, H. W., Kohler & Campbell, Inc.

Brambach, Oscar, Weser Brothers.

Brown, A. P., Steinway, Long Island.

Brownson, H. C., Parker Young Company.

Buell, F. C., Kindler & Collins, Inc.

Burleigh, W. F., Murphy Varnish Company

C

Cameron, C. E. Jr., Lauter Piano Company.

Campbell, Mark P., President, Brambach Piano Company.

Campbell, Gordon, Brambach Piano Company.

Cassebeer, Theodore, Steinway & Sons.

Conklin, R. B., Flood & Conklin, Newark, New Jersey.

Conkling, Prof. R. P., College of Technology (Mathematical Department) Newark, New Jersey.

Connor, Francis.

Coryell, F. G., The Laffargue Company.

Croce, A., Kohler & Campbell, Inc.

D

de Rochemont, Max J., Vice-President, The Laffargue Company.

Dlouhy, William, Lauter Piano Company.

Dragner, H., De Rivas & Harris Manufacturing Company.

E

Edgar, Frank E., Vice-President, The Autopiano Company.

Elliott, Katherine, Pianist.

Eyring, L. J., Pratt, Read & Company, Deep River, Conn.

F

Fekete, John, Brambach Piano Company.

G

Gastia, T., Estey Piano Company.

Gittins, H. E., Estey Piano Company.

Gorsuch, L., Wickham Piano Plate Company, Springfield, Ohio.

Gould, W. M., Lyons, N. Y.

Greco, Tony, B. H. Janssen.

Gregory, H., Frederick Loeser & Company, Brooklyn, New York.

Grinnell, A. A., Vice-Pres. Grinnell Bros. Detroit, Michigan.

Grinnell, C. A., President, Music Industries Chamber of Commerce, Detroit, Michigan.

H

Hagenhauer, C., Kohler & Campbell, Inc.

Hammond, C. S., Scruggs, Vandervoort & Barney, St Louis, Mo.

Harsnett, R., The Autopiano Company.

Harvey, R. J., New York Music School for the Blind.

Hazelton, Halsey, President, Hazelton Bros. Inc.

Henns, J., Ludwig & Company.

Hepperla, Walter C., Secretary, Brambach Piano Company.

Hodgdon, Dr. D. R., College of Technology, Newark, New Jersey.

Hoerer, R., Brambach Piano Company.

Hohn, H., Kohler & Campbell, Inc.

Holz, George, Mapes Piano String Company.

Hovey, C. F., President, Braumuller Piano Company.

J

Jones, Nelson, Frederick Loeser & Company, Brooklyn, New York.

K

Kahl, George H., Armour Glue Works.
Kamm, H. Hardman, Peck & Company.
Kauling, L., Brambach Piano Company.
Kennedy, P. S., Murphy Varnish Company.
Klein, A., W. P. Haines & Company, Inc.
Klugh, Paul B., President, The Autopiano Company.
Kneiste, John, The Autopiano Company.
Kraus, Francis, Milton Piano Company.
Kubelka, G., Kohler & Campbell, Inc.

L

LaJoie, Hubert J., Superintendent, The Autopiano Company.
Lang, J. R. A., Estey Piano Company.
Lauve, L. L., Armour Glue Works.
Lawless, J. T., American Felt Company, Dorchester, N. Y.
Lawrence, H. E. Standard Pneumatic Action Company.
Lindeman, Gillis R., Secretary, Melodigrand Company of New York.
Lisk, George, The Widney Company, Chicago, Illinois.
LoBoves, M. C., The Autopiano Company.
Lohr, Fr d W., Hardman, Peck & Company.
Lohr, Robert, Lauter Piano Company.

M

Martini, Henry, Milton Piano Company.
Mauer, Henry, The Autopiano Company.
McIntyre, G. L., Kohler & Campbell, Inc.
Mella, C., Wegman Piano Company, Newark, New Jersey.
Moyer, H. A., Kindler & Collins, Inc.
Muckey, Dr. Floyd S.

N

Newcomber, G. M., Soloelle Company.
Newton, H., Kohler & Campbell, Inc.
Niepke, G. W., Ludwig & Company.
Nixon, J., Kohler & Campbell, Inc

O

Oktavec, Joseph, President, The Laffargue Company.
Osthagen, William, Superintendent, Milton Piano Company.
Ostrander, A. J., Lyons, New York.

P

Padrone, Ralph, Milton Piano Company.
Perrott, Thomas A., Hazelton Bros. Inc.
Perry, L. D., Treasurer, Ludwig & Company.
Peterson, F., Hardman, Peck & Company.
Pfannstiehl, Fred, Superintendent, Kohler & Campbell, Inc.
Phelps, F. P., Lyons, New York.
Piliero, Sal, Milton Piano Company.
Plaisted, William M., Vice-President, Hazelton Bros. Inc
Pokorney, Frank, The Autopiano Company.
Pound, George W., General Counsel, Music Industries Chamber of Commerce.

R

Ramacciotti, F., F. Ramacciotti, Inc.
Rammelkamp, W. E., Secretary, Import Felt Company.
Rettinger, Joseph, George Steck & Company.
Richter, August, Horace Waters & Company.
Rogers, L. O., The Autopiano Company.
Rossi, John, United Piano String Company.
Ruhenbeck, William, Arlington, N. J.

S

Sargent, C. L., Murphy Varnish Company.
Schaff, William G., John A. Schaff Company, Chicago, Illinois.
Schaffler, Louis, Milton Piano Company.
Scheele, William, J. & C. Fischer, Inc.
Scheihing, George J., Horace Waters & Company.
Schreiner, A., Standard Scientific Company.
Schwab, John J., Mgr. Francis Connor.
Sciannimonico, M., Brambach Piano Company.
Shore, Justin O., Hardman, Peck & Company.
Sibley, Beeman P., The Autopiano Company.
Simpson, Herbert, Vice-President, Kohler & Campbell, Inc.
Sleeper, J. E., Wickham Piano Plate Company, Springfield, Ohio.
Staib, William E., The Bogart Piano Company.
Strauch, Albert T., Sr., Strauch Bros. Inc.
Strauch, Albert T., Jr., Strauch Bros. Inc.
Swanberg, Carl F., Mansfield Piano Company.
Swanson, W., Kohler & Campbell, Inc.
Sylvester, Seymour, Bass Brothers.

T

Taylor, S. D., Perkins Glue Company, South Bend, Ind.
Terry, W. E., American Felt Company.
Tiscornia, John, F. Ramacciotti, Inc.
Traver, H W., The Autopiano Company.

TREMAINE, C. M., Director, National Bureau for the Advancement of Music.

TRIOLA, F., Brambach Piano Company.

U

URQUHART, UBERT, Soloelle Company

V

VAIL, EDWARD F., The Autopiano Company.

VERGE, A. L., Peter Cooper Glue Company.

VILIM, VINCENT, President and General Manager, Import Felt Company.

VON SCHUCKMAN, F., Peter Cooper Glue Company.

W

WEIL, MILTON, Krakauer Brothers.

WEIR, W. J., Superintendent, The Weber Piano Company.

WICKHAM, J. C., Wickham Piano Plate Company, Springfield, Ohio.

WICKHAM, H. G. Wickham Piano Plate Company, Matawan, N. J.

WIDNEY, STANLEY, The Widney Company, Chicago, Illinois.

WILLIAMS, O. W., The Packard Piano Company.

WILLIAMS, W. B., Haddorf Piano Company.

WISNER, J. F., Kohler & Campbell, Inc.

WODRASKA, WALTER, R. S. Howard Company.

WOOD, CHARLES H., Wood & Brooks Company, Buffalo, New York.

WUERTZ, O. W., President, O. W. Wuertz Company.

First Meeting of New York Piano Technicians

February 19, 1919.—The first conference of the New York Piano Technicians was held in the assembly room of the United States Steel Corporation at 71 Broadway. The meeting was called to order by the chairman, Frank E. Morton, acoustic engineer of the American Steel & Wire Company, and the purpose and methods submitted to those present. The purpose, as stated by Mr. Morton, is the discussion of all technical questions bearing on the building of pianos, by superintendents, sales managers and executives of piano manufactories, having in view the predetermining of results obtained.

It was unanimously agreed that only such reports as were edited by the chairman should be given to the trade press, thus permitting free and unrestricted discussion of all subjects without injury to the interests of any.

Mr. Morton then called upon Mr. George W. Pound, general counsel and manager of the Music Industries Chamber of Commerce, who said in part:

"Mr. Morton and Gentlemen of the Industries: It seems to me that we should take a constructive part in this work in New York which has been so splendidly done in Chicago. I had the privilege, in the course of my duties, to attend some of the Chicago meetings and in some little way participate in the proceedings.

"A regiment went to France with the inscription on its banner, 'Deeds, Not Words.' It is the actuality of performance, rather than the ideals of tradition, which must be cultivated by you. This country has preserved its industries through the war. No other country in the world has done that. In France and Germany the industries were all ruined. In England only 5,000 pianos were rationed and manufactured during each quarter, 16½ per cent of normal, and 60 per cent was required to be exported. Repairs on not to exceed 1,000 instruments per quarter were allowed.

"The English manufacturers cannot supply their own trade. Germany and France are also out of the running. It seems to me your problem is not only to bring your capacity to 400,000 pianos this year, but you should make for greater efficiency and more profit than before. You should now reach out to the markets of the world. We have the brains and the genius in America to accomplish this thing. These meetings will help us to progress in piano construction.

"The value of the export business is not only in the units of commodity that may be sold or maintenance of exchange in times of war, but that you may always have an outlet for that overproduction at home which surely will come from expanded production.

"It has been a problem to some of our free-trade friends why, for instance, under the beneficent rule of protection certain products were sold cheaper in London than at home. Two marked examples are the sewing machine and the typewriter."

Mr. Pound referred to the German propaganda in South America against buying pianos made in America, as Germany could make better and cheaper pianos. He stated that Spanish banks are controlled by German capital and England is unable to care for trade in South America, New Zealand and Australia, all of which are open to America. He continued:

"We cannot take advantage of this great opportunity that confronts us by following in the footsteps of the past. The day of destruction has gone. War did much for manhood and womanhood and sounded the knell of the destructive man. The world has no place for a man who drags things down. With this thought and splendid opportunity afforded by these meetings, conducted by a man of brains, the biggest man in his line in this country, let us grasp this wonderful opportunity. I am going to try and tell the people, on my forthcoming coast to coast trip, your hopes, my vision, of music."

F. E. Morton: "The president of the National Piano Manufacturers Association is also chairman of the committee of arrangements of the New York Piano Manufacturers Association. We would like a few words from Mr. Klugh."

Paul B. Klugh: "I think, Mr. Chairman, you want to get to the subject matter of the meeting here as soon as possible, as I see many anxious faces who want to know more about building pianos. I heartily agree with you in this constructive work, allowing freedom of speech but not of press. I talked with some of the men in Chicago who attended the meetings held there last year and was told some of the humorous sides of the talks, unpublished, and afterwards read the report of the meeting, after being edited, and I can see the justice of the position Mr. Morton takes. If you are going to have open meetings and ask questions which might in cold print reflect upon the members, you do not want to embarrass those men by publishing their questions and answers. Every man here should assume the duty of spreading the gospel of these meetings. Every man in the business should attend these meetings. It is a wonderful opportunity, costs us nothing; the American Steel & Wire Company pays the bill and all we have to do is to come and learn all we can. The advancement of the piano is worthy of our attention, for nothing under the sun has reached perfection. I, for one, want to be present at all the meetings and learn something about making pianos."

F. E. Morton: "One point in which we are all interested has brought no definite action. Where are we going to get our expert workmen five, ten or twenty years from now? Is your factory an attractive place for a young man who wants a career? Is the young man going to come in there and work from bench to bench as in the past? Is the man who has worked in the trade five or ten years and has become expert going to find someone stepping in ahead of him prepared only by an academic knowledge? I think that possibility affects every man here. I want to give about five minutes to a man who has anticipated all this and has effected a plan to cope with this situation. I want you to know him and get such knowledge of his plans as will enable you to assist him and he to assist you. You should have just such an institution in New York as he has established in New Jersey. I have the honor to introduce the president of the College of Technology of Newark, New Jersey, Dr. Daniel R. Hodgdon."

Dr. D. R. Hodgdon: "The institution which we are directing in New Jersey is being built up by the industrial men who have seen by consequences of the war that men have not been educated on right lines. There has been too much theory and not enough actual practice in his education to make him of value to commercial institutions. It is a co-operative plan between the educational man and the industries. In relation to your line of industry, why is it not possible to train men to become acoustic engineers in a school of that kind? The subject of physics and the subject of mechanics can be combined for practical use. We hear a great deal about Pascal's law but seldom applied in a common sense way. We are also not only developing the engineer there but trying to find some kind of work or industry in which the wounded sailor or soldier can be trained. The thought has come to me that it is an excellent place in which to train men who have become injured while working, who are already a burden upon the manufacturer. You know the rigid laws regarding the responsibility of the manufacturer in our state applying to the workman and sometimes the men become careless on that account."

F. E. Morton: "There is no 'cure all' idea extant. I have no particular hobby but I do cultivate the man who has one. If we can get enough men together with enough hobbies, we will secure information which will benefit us all. No particular subje t is to be followed to the exclusion of others. Men of brains and intellect have devoted their lives to this work. It is our privilege to know what they have achieved. Tradition plays a great part in our work and it is very difficult to uproot by radical treatment any of the practices which have obtained in years past, and yet that must be done. Progress demands that we throw aside our prejudices and alleged factory secrets and, so far as possible, learn what the most advanced have done in our particular line, begin where the last man left off, and go forward.

"We must first define our present position. I will define mine. The welfare of the piano trade is of importance to our company. We cannot make a dollar from the piano trade until you have made it, therefore, we want you to be successful. We want to go further in our salesmanship and assist you in using material as intelligently as may be. If we have not the experts ourselves we will bring them to you if possible. I think it is agreed there is no such thing as an ideal piano. What we propose to do in the future must be plotted, planned and designed and we must know that we are going in the right direction. The piano of fifty years ago had a tone composed of a very light first partial or fundamental and what might be described as a nasal

tone. That tone satisfied for a time, as did the reed organ. If we listen to someone playing an accordeon, mouth organ or reed organ, it does not take long to tire us. It is physiological; it tires the nerves. We want to progress from that tone. It is an open question whether we are progressing when we go from the tinkling sound of the straight scale square to the broad, deep tone of the concert grand. I have heard good arguments on both sides. Popular taste, however, tends that way, as shown by the increased sale of instruments. We must, therefore, secure in our pianos a greater fundamental or first partial. When that prospective customer says, 'I don't care for that,' it may mean the fundamental is not strong enough, or if flute-like in quality without much spice or character, it has not much besides the fundamental. The flute is composed almost exclusively of the fundamental, hence the old adage, 'The only thing worse than a flute concerto is a concert of flutes.' I will have at a future meeting a series of harmonic forks by means of which I will be enabled to demonstrate these partials and in what proportion they obtain. The application of these principles is your business and I do not want to encroach. The individuality of the instrument should be retained by all means.

"Given the physical possibility of an instrument, the longest string of which is twenty-eight feet, a scale could be drawn that would give a theoretically true scale. We have brought that theory down to a very small scale; a very short bass string; a very short steel wire at the break. The problem has been to get a satisfactory tone, without breaks, throughout the instrument. In the solution of this problem certain possibilities have developed, some of which have been accepted and ingenious devices have been brought to bear, but the fact remains that we must have a good, live, responsive sounding board and we must give to that sounding board the vibrations we want that sounding board to give out. While the board will only give out such forms of energy as are given it, it will not always give out all that is given it, so it may be necessary to make certain allowances. Our first problem, therefore, will be the vibrator; later we will take up resonance.

"Let us consider a base for our vibrator. The area of the sounding board for a house piano is not a vital factor. That sounds iconoclastic to some, but not so much so as it did five years ago. A four-foot eight-inch grand has been developed with a sounding board about as big as that of a bass guitar. The thing most important is the rigid retention of that board. First comes the composition, then the treatment of the board. If you will take a little piece of lath and hold in you hand so (demonstrating) and snap it, it will give one or two movements and stop. What becomes of that energy? It is conveyed to the flesh of the hand and through friction of the molecular tissue passes off as heat. In other words, the energy is expressing as heat. This is what happens in the sounding board which is not rigidly retained.

"The form and treatment of the bridge will provide a topic for discussion for an entire evening. Proper weight, length and tension of the wires become important factors, and will merit our attention.

"Now, as to the mechanism by which the string is set in motion. Considered only as a machine, the piano is an instrument wherein the energy applied at the end of key expresses as vibration in the sounding board.

"Mediums for conducting energy with a minimum loss, striking point, resiliency of hammer felt covering, treatment of the hammer in the making and in the instrument, all become interesting factors and will be taken up in due time.

"When your work is done in the factory to your satisfaction and the instrument is shipped, what will happen to it then? Who will be as much interested as you in its preservation, and who then will have the keeping of your reputation? We are privileged to witness the first presentation of a device for keeping the piano in tune—'once tuned, always tuned'—the principle of which is not difficult to understand or explain. It is the invention of Mr. A. J. Ostrander, of Lyons, N. Y., and will be demonstrated by the inventor and Mr. Gould."

A J. Ostrander: "Three conditions govern the pitch of a vibrating string: (1) length, (2) weight per unit of length and (3) tension. In the piano as now constructed the first two of the above conditions remain virtually constant. It therefore, is necessary only to remedy the variation in the third condition, the change in tension due to the contraction and expansion of the wires under atmospheric conditions or change in tension due to any other causes.

"This is accomplished, in this device, through the operation of what is known as Pascal's

law of internal pressure of fluids (or semi-fluids), which states that the pressure in all parts of a chamber containing such fluid under pressure is equal.

"It, therefore, follows that a freely-moving piston having a given cross-section area will always exert an amount of pressure directly proportional to the pressure in the chamber. By means of a simple lever of the second class, this pressure is stepped up and applied directly to the string, the necessary amount of pull being accurately obtained by adjusting a movable fulcrum to give the proper ratio between the two members of the lever. Once this adjustment is made, with a given piston pressure, a given pull on the string is maintained, regardless of its contraction or expansion, thus meeting the third condition mentioned.

"Another law of pitch in vibrating strings is this: That to raise any string a half tone in pitch, an increase of 12 35/100 per cent in the pull already exerted must be applied. Thus, a string having 100 pounds pull would, in going up half a tone, require a pull of 112 35/100 pounds, while one having 200 pounds would require 224 7/10 pounds.

"An illustration of the working of the device under normal conditions may be given as follows: Suppose 100 strings to be tuned to middle C, and that one string contracts (or is drawn up) enough to raise the pitch one-half tone, all the other strings remaining the same in length. The increased pull of the contracted string immediately transmits, through the lever, increased pressure to the piston controlling this string. But by the law of internal pressure, this increase of pressure on one piston is immediately transmitted to the entire compression chamber, affecting all the other pistons. The result, then, is that, instead of the one string going up half a tone and all the others remaining constant, all the strings go up 1/100 of a half tone, thus maintaining a musical instrument, though at a slightly different pitch.

"To maintain a given pitch in all strings it is only necessary to provide a master piston controlled by a weight or spring.

"As the pressure of any piston is directly proportional to the pressure in the chamber, and as the amount of pressure by one member of a lever is directly proportional to the amount of pressure applied to the other member, it follows that with this device it is possible, by merely changing the amount of pressure in the chamber, to raise or lower the pitch of the entire instrument at a moment's notice.

"The small increase in the cost of construction that may result will be offset by the reduction in selling cost, elimination of gratuitous tuning after the sale and changes in construction such as doing away with the wrest plank and pins. Other important items can be mentioned.

"In closing it is only fair to say that the present model was intended merely for experimental and research work. It is made entirely by hand and is necessarily crude and inaccurate. Also it is the first model of its kind and it is obvious that it is open to great improvement in mechanical refinement, both as to material and in design and arrangement of parts. But we believe it is entirely conclusive in its demonstration of the principles involved and their applicability toward the desired result."

F. E. Morton: "It may not be popular with tuners. The most important thing in making a radical change or in the installation of labor-saving machinery is first to sell it to the workman. If this is not done your product meets with antagonism and your sales propaganda is handicapped from the start. The best sales argument I know for improved machinery is found in the automobile. When it first came on the market it was opposed by every man who had a livery stable or blacksmith shop. It would have taken some time to have sold the automobile idea to these people. The man who had a livery stable has now a garage, and the blacksmith has a repair shop or service station and apparently makes more money than before."

J. J. Schwab: "Can you change the pitch right here?"

A. J. Ostrander: "Yes, sir. It is now below pitch. I will demonstrate putting it in tune (raising pitch one-half tone). You can raise the piano to the pitch desired by singer or orchestra. Once the tuning is done it is self-compensating after that."

H. J. La Joie: "What would it cost to incorporate the device in a piano?"

W. M. Gould: "It is not on a selling basis as yet. It is only here for your consideration."

B. P. Sibley: "Will it do away with tuning pins?"

W. M. Gould: "Yes, and the pin block."

August Richter: "This instrument has to be tuned originally perfectly?"

W .M. Gould: "Yes."

Dr. D. R. Hodgdon: "How do you maintain that pressure?"

W .M. Gould: "By a master piston."

Dr. D. R. Hodgdon: "Do you use mercury?"

W .M. Gould: "No. Wax and oil."

W. B. Williams. "How do you get and keep these pistons tight?"

A. J. Ostrander: "There is where I had a fight. There are several ways of doing it. This is a tubular diaphragm."

F. Pfannstiehl: "In this construction is it necessary to put an eye in each end of the wire?"

W. M. Gould: "Not necessarily an eye."

Dr. F. S. Muckey: "It seems to me we can think of this as a three-horse evener. The fulcrum gives the same advantage you give one horse or one team over another."

F. E. Morton: "Does it strike you as being practical, Dr. Muckey?"

Dr. F. S. Muckey: "The only thing which might interfere is the condition of the fluid or wax. If that can be controlled I should think it would not get out of tune."

W. M. Gould: "The comparison of the three-horse evener strikes me at home. I am in the nursery business and use horses.

"I have been very much interested in the remarks made regarding co-operation, because in our line of business we spend a great deal of time in these co-operative meetings. They have lasted with us for twenty years and we have always had good results. I want to thank the piano manufacturers for the very courteous treatment Mr. Ostrander and I have been accorded. I also want to thank Mr. Morton for the privilege of exhibiting our apparatus this evening. We did not come with the idea of marketing anything but to find out how a proposition of this kind would be received by the trade. We have worked so far without the assistance of experts in the trade."

F. E. Morton: "I want at our next meeting to demonstrate to the man who makes pianos of what tone is composed. Let me suggest to everyone here the value of selective listening. Our environment is such that we select what we receive. I imagine the shepherd on the plains hears and notes every sound. It is also true of all wild animals. I hope with the aid of apparatus to direct your attention to the things for which you should listen. When a man tunes an instrument he listens for beats. It is equally simple in listening to a sound for quality. We are greatly concerned with tone quality. If you will listen to one key for a long time you will be surprised to learn what you have missed.

"I stated at a recent meeting of the New York Piano Manufacturers' Association that the manufacture of pianos is an engineering proposition, beginning with the plate. None of us maintains that it has reached perfection. Long ago when we wanted great strength we used a lot of material. Now we use a smaller amount of material better distributed. There is lots of room for advancement along this line in pianos.

"Now will someone give a problem in piano manufacture they want discussed? What is your pet peeve?"

Edw. F. Vail: "The varnish problem."

F. E. Morton: "I will bring in an expert on that."

Dr. F. S. Muckey: "I think you suggested a few moments ago tone quality. What it is and how to get it."

F. E. Morton: "That subject will take up an entire evening and I will provide an apparatus."

L. D. Perry: "The method of making the sounding board rigid."

Fred Pfannstiehl: "Uniformity of the casting and drilling of plates."

J. J. Schwab: "Relation of the back to the piano."

H. J. La Joie: "Glue problem as relating to veneers."

Justin O. Shore: "Are there any experts on wood drying? Tests determining whether woods are actually dry?"

F. E. Morton: "If the lumberman takes care of his end of it, you need have no trouble. I spent a good part of a year's work on lumber and found results that were interesting only to the lumberman. Now they have established laboratories and corps of experts. The chances are in favor of your getting satisfactory treatment from the responsible lumbermen."

Dr. D. R. Hodgdon: "Is there not a chemical test to determine the amount of water in wood?"

F. E. Morton: "Yes. Let me offer a few suggestions for your consideration. In a violin we have a confined body of air, a small vent on each side, a sounding board of spruce and a back of hard wood, we have a sound post and base bar and the confined body of air is measurable. By blowing over the F hole you will find its keynote. It is usually F or F♯. It responds fairly well all through the scale, although in some parts better than in others. The point of greatest response may be affected by moving the sounding post. Now what have you as a resonance box in the piano? You might say the space between the wires and the front panel. This space usually is filled with shock absorbers.

"Try a player-piano manually before and after putting in the player action and note the difference. See if you cannot find some way of compensating for the loss of resonance.

"Think of the back of the piano. What is the function of the back posts? If a bridge consisting of two timbers covered with planks is put across a stream and to strengthen it steel girders are added, which carries the load, the timbers, the steel, or both? These questions apply directly to the piano.

"I put that problem to the chief engineer of a bridge company. He said there could be only one instant in eternity when both the wood and steel would maintain the load. That would be when either the steel or wood was giving way and the load was being transferred to the other. Apply this principle to your back and plate. Think of a flange around your plate making it self-sustaining and sufficient to sustain its load. Think of your wrest plank being made a part of your plate by being very firmly attached to the plate instead of the frame. Think of the plate as carrying the load. How about the necessity for back posts? These posts cost money and make expensive freight.

"Another point to think about. It is a positive crime to cut out the bridge for the bar brace. You can make up for it to some extent by putting a block on the board behind it, but why do it in the first place? The foundryman says he needs that room. It is not true. It is not necessary to have a plate one-fourth or three-eighths of an inch thick over the wrest plank. Bring it down to one-eighth and do away with tuning pin bushing. You must cut out great masses of metal in the plate. We will bring in the foundryman and let him explain why."

"Make a note of your troubles; bring them in and let us discuss them together."

"On the subject of felt, if we can predetermine the quality why should we depend, as we do, for resiliency on the individual judgment for the proper tightening of the clamps?"

C. Arthur Brown: "There is no reason why a machine should not be made that would do it. It is hard to give a felt man that viewpoint. He has his factory arranged on a certain basis and on traditions and it is exceedingly difficult to bring a felt man to the point where he will acknowledge that it is possible to make a felt that can be handled on a machine. A hammer maker said to me that the presses had to be handled by hand, each screw treated separately and a certain amount of pressure exerted on the hammers as formed. The amount of pressure thus depends entirely upon the personal equation—the 'feel' of the man handling the clamp. When he is feeling strong he may put on more pressure than late in the day when he is tired. He may put more pressure on it after having a drink. A thousand things can influence the pressure the man puts on the hammers. All of those things can be much better done by machinery but to date we have been unable to induce the felt man to see that. We have partially completed or designed a machine that will do the work."

F. E. Morton: "Referring to felt: In Germany, a number of years ago, I took up with a felt maker their felt as compared with our domestic felt. The statement was made to me then that we never would be able to make as good felt in the United States as was made in Germany because we did not have the water. Practically the same statement was made in England. We took that matter up with certain felt companies here and assured them that synthetic water is a practical, commercial undertaking."

Dr. D. R. Hodgdon: "How does water affect the felt?"

C. Arthur Brown: "The resiliency of the felt depends upon the quality of fibre and water is called 'hard' because of the fact that it contains a proportion of lime and magnesia, each fibre gets a coat and it kills the resiliency. Elimination of hardening qualities in water is necessary to bring about the proper quality of felt."

Albert T. Strauch: "To what extent has the machine for hammer felts been perfected?

Automatic machines have been devised distributing pressure on felts in different sections. Have they not been failures?"

C. Arthur Brown: "I believe that was carried out but the designs, from all we could learn, were not such as to insure success. The fact that it failed shows the execution, not necessarily the idea, was wrong."

After an informal discussion, the conference adjourned.

Tone Building

Feb. 26, 1919

F. E. Morton: "The poverty of terms in which to express tone quality must be apparent to anyone here who has ever attempted to describe his own product. We have used the technical terms of the painter in speaking of 'tone color'; we go into the chemist's domain and speak of 'dry' tone and 'liquid' tone and have borrowed words from other trades and professions to such an extent that we feel the man who will write an acoustical dictionary will accomplish more than one who writes an elaborate treatise on acoustics. We all flounder when struggling for terms to express our tonal ideas. But we have a few expressions in common use in piano factories and they are very expressive, some of them too expressive for common use. The terms used in the factory, however, should be used by the dealer and by the customer, otherwise your ideas cannot be expressed to the prospective buyer. Talk in shop terms on every occasion. I have a friend in the Middle West who tried it for two days with the result that several people came to his warerooms to get ideas for papers to be read as a basis for discussions in their clubs. It became, in effect, a propaganda. Take the public into your confidence. I know of no better illustration of its benefits than the automobile trade. Every time a change is made in a car it becomes a news item. The daily press publishes a page of automobile news every day. If the public had not been taken into the confidence of the manufacturers, and interested technically, the press would not devote the space to the subject. The motor terminology is known to all.

"Vibration is an expression of energy. Vibration is the first expression of life; the first expression of all energy. Your interest need not be confined to vibrations in numbers that appeal only to the sense of hearing; from zero to quintillions per second, up that ascending scale of number and power through sound, electricity, heat, light and the X-ray to the great antarctic beyond, all is of interest. The law of vibration is of vital interest to every industry. I was talking to a Manufacturers' Association convention on vibration and its application to their respective needs. I thought I had included every industry represented. After the meeting, a man came to me and said, 'I came to get some points and am disappointed. I am a manufacturer of refrigerators.' I told him to reverse the instructions I gave to the men who make heating apparatus. To you, however, vibration means pitch and quality, with a limitation to a range from about 27 to something over 4,000 per second. You must first have a vibrator and the nature of that vibrator must be predetermined. The mechanism of vibration has been evolved during the last two centuries and yet action makers will now tell you that very few basic changes have been made during that time. Your object, mechanically speaking, in making pianos is the devising and making of a machine in which a given energy when exerted on a key will express as vibration in the wire, conducted through the bridge to the sounding board, retaining so much of mode and intensity as will satisfactorily affect the organs of hearing. Fortunately for the piano trade, hearing is not affected alike or there would be only one kind of piano desired.

"Don't think that the individuality of your product will be interfered with by acceptance and use of such knowledge of these laws as may be given you. These points I am giving you are only sign posts. Whatever vehicle you may choose is your own, but the sign post is a constant. Science is only the accumulation and compilation of facts that have largely been deduced at the work bench. I venture to state that the greatest scientists in our universities would be proud and glad to have your knowledge of mechanics as additional scientific information. So when we speak of a scientific way of doing things, we mean this is the best practice observed up to date.

"It will be sufficient for our present purpose if we define noise as a disturbance in the

atmosphere producing a sound too brief or too irregular to have an assignable pitch, and tone as a sound continuing uniformly for an appreciable time and having an assignable pitch.

"Tonight we want to consider tone quality and to what it is attributable, as far as your practice is concerned. Many years ago, when I wanted to draw and was unable to express myself properly through that means, I asked the instructor what I lacked. The artist told me that the first essential is to see things as they really are. I found by putting on neutral blue glasses I could eliminate color and see things very differently. Before we can consider tone quality, it is necessary to eliminate some accompanying sounds from consideration, and then direct our entire attention to certain component parts of tone. We then recognize that tone is composite—made up of other tones and the effect of the dominance or diminution of any one or more of these partial tones. A simple tone is not composite and is produced when wire vibrates as a whole and not in segments."

Mr. Morton then demonstrated simple and pendular vibration and segmental vibration by means of his Spiral Wave Demonstrator. "Wire vibrates as a whole, producing the first partial or fundamental. It also vibrates in two segments, producing the second partial, and so on up through the fifth, sixth, seventh and eighth. What really happens is the breaking up of that wire into segments according to tension and composition (demonstrating Mehlde's experiment). With a very fine wire of fair length partials can be obtained and made audible (with a resonator) up to forty-two or forty-three.

"This is a simple tone (demonstrating with electrically driven fork) like the tone produced by blowing over the mouth of a bottle or like the Bourdon stop in a pipe organ. It is the same sound you get in certain parts of the flute. The seventh partial adds 'crispness' to the tone. The eighth gives pointed brilliancy like adding a piccolo to a band."

Dr. F. S. Muckey: "I made some tests this afternoon and got the ninth and twelfth."

F. E. Morton: "As soon as the seventh is increased we get the ninth, and that is inharmonic, it sounds out of tune. So to keep the ninth and eleventh out, we must be satisfied with a suggestion only of the seventh. Where a cacophonous tone, as used in some compositions to express dissonance, passion or anger is desired, a very hard blow on a full sized concert grand, about in the middle of the piano, will develop the partials well up into the thirties, because a great force or energy applied will break the medium into many segments. A perfectly round wire will break into segments sequentially from one into two, into three, etc. You get your greatest fundamental at the time of impact of the hammer on the wire, but the sequence of partials developed is determined by the roundness of the wire, because a flat body vibrates in odd numbered segments beginning with the third. We need the even numbered segments: (demonstrating with forks) the third, sixth and seventh are the ones which give timber and richness to the tone. They are the spices or seasoning and you should do nothing to your piano that will throw in too many of these odd numbered segments. A plate vibrating at certain points is inimical to the tone you require. The old three-stringed square at a point near the bar break produced a tonal combination that drove the tuner mad. Every note was wild; every one a howl. This was overcome to a large extent by reducing the amount of metal at that point. When you find that howl in a string you will generally find too much metal; it may be in the wire or in the plate.

"These tones do not interfere in a manner that is unpleasant to the ear (demonstrating with seven forks). We used to want to hear the simple tone alone. Now we want something added to that tone. I take it we have reached a point today where the general public responds well to seven partials in piano tone. How you shall distribute them is left to your judgment and the result constitutes that something known as individuality. However, it is safe to say that you cannot have too much fundamental; that should be strongly dominant. You are catering to the needs and tastes of millions of people.

"Do not get the impression that this proportion of seven partials alone will determine tone quality. A stiff wire, from whatever cause, will bring out inharmonics, higher partials above the seventh. They will be very clear and very dominant because you cannot get a full fundamental. The wire may be too stiff for several reasons. Take a steel rod and strike it and you get the same effect you get from too high tension, too heavy a gauge for length of wire, or if the wire is too hard from composition or practice. In any of these cases, the resultant sound is the same; just as when I strike this fork with a piece of metal (demonstrating).

"Another thing affecting tone is the point at which the wire is struck by the hammer. It is an established fact that the striking point within certain well-defined limits determines the quality of tone. If you strike at one-half you get a hollow sound. That hollowness leaves as you move back toward the agraffe. As you approach the agraffe closely you produce a 'nasal' quality, a thinner tone with weak fundamental and many overtones. Strike middle C at one-twelfth and you will throw in higher partials which you will hear plainly above the weakened fundamental. Take a piano on which you can change the hammer line and listen as you go toward the agraffe to the thin 'nasal' quality and toward the middle for 'hollowness.' The striking point is determined by your desire for a tendency to 'hollow' or 'nasal' tone. You are not striking a single point on the wire. That only could be struck with a metal hammer having a sharp edge. A hammer which has been over-needled demonstrates the other extreme. These points are nodes, meaning quiet points (illustrating with fork and thread). If you were to strike here (indicating) it would cease to be a node. In striking a nodal point you make of it a crest. On a short wire the node of the seventh is close to the eighth and a flat hammer will strike both. Suppose your wire is four inches, and the striking point is one-eighth,—it is so close to the seventh and ninth that if the hammer stays on the wire any length of time you destroy the nodes and crests that would form there (demonstrating). Note the wave formed by the stroke of the hammer. Your agraffe and plate bearing are supposed to reflect the waves back and forth.

"Not only the resiliency of the hammer but that of the wire is a factor. One or the other must be used as a constant,—which one should be determined by wire and felt men. If we have 100 pounds tension on one string and 185 pounds tension on another string, is it reasonable to suppose with the same felt, the same hammer, that we can get the same quality of tone? Can we expect the tone regulator to correct these gross errors which should be solved by the scale draftsman? Certain parts of the piano require certain characteristic tones but they should blend with other parts as in a string quartet.

"I have talked with string makers who have found it impossible to follow the specifications of the manufacturer where the tension of the wire goes beyond the elastic limit; they substituted a heavier and coarser wire which would stand the strain but sacrificed all acoustic value. The fault lies with the man who draws the scale. When materials are of the very best, they must be accorded proper treatment. One can abuse a truck horse, but not a thoroughbred.

"I have seen alleged artists strike a key on a piano and give a shake on the key afterwards, thinking they got tremando effect by so doing. To one who knows, that is foolish. There are many such theories which, if true, would argue against the possible efficiency of player-pianos. The only influence which the performer can wield is the degree of energy applied and the order in which the respective keys are struck. Intensity of tonal energy is accounted for in the performance of the wire as amplitude; the order in which keys are struck is accounted for as reinforced partials.

"Piano wire is at its best at a tension practicable, with a maximum amplitude of vibration and a minimum of segmental vibration."

W. C. Hepperla: "What is the difference between European and American tone?"

F. E. Morton: "The European tone is more 'nasal,' has a weaker fundamental."

F. E. Edgar: "Don't you think that their liking for pianos having a 'tinkling' sound may be the result of using the mandolin and other like instruments?"

F. E. Morton: "Yes, an association of ideas, possibly. In America we want a big, broad tone. The people demand it. You can well remember the first pipe organs used in moving picture houses, two or three reedy stops and a tremolo; now they cannot get an organ big enough to express their ideas. We want increased fundamentals, possibly 50 per cent fundamental."

Dr. F. S. Muckey: "On what do you base your statement when you say 50 per cent fundamental?"

F. E. Morton: "That may be an ideal tone—one toward which we strive. I have some experiments along that line—records taken direct from the sounding board."

Dr. F. S. Muckey: "Do you think you get that from any sounding board as now manufactured?"

F. E. Morton: "No, but it is being approached."

Dr. F. S. Muckey: "Don't you think that it can be done? Don't you think the sounding board could be so constructed? At present the ribs on the back of the sounding board interfere. We get

most of our tone from the sounding board itself. Anything which interferes with the larger segmentations cuts down the fundamental more than the overtones."

F. E. Morton: "The undulation of the board is, of course, to be considered."

W. B. Williams: "Does greater amplitude of vibration mean more body of tone?"

F. E. Morton: "That means concentration of energy. Whether it is conveyed through the bridge to the sounding board depends upon efficiency of construction.

"The amplitude of the wire's vibration is indicative of the amount of energy for the energy is directly as the square of the amplitude."

Francis Connor: "Don't you think it would be an immense help if we had a piano here for demonstration purposes?"

F. E. Morton: "This was suggested at one of our Chicago conferences and the first question raised was, 'Whose piano?' After several months of experiments on piano materials, I assembled them into an orphan piano and everyone had a 'whack' at it."

Dr. F. S. Muckey: "You touched upon one point, Mr. Morton, which I think can be elaborated—terminology. If a term doesn't mean the same to all of us we cannot understand one another. The meaning must be based on the things we are describing. Now the things which determine quality are the number and relative intensity of partial tones. When we speak of a 'nasal' tone, we mean one that has a weak fundamental and high partials. This term, however is not applicable and the sound is not produced in the nose. That peculiar quality that we have referred to as 'nasal' is simply a lack of fundamental and too much overtone. I think it is of the utmost importance that we find the proper terminology."

F. E. Morton: "I agree with you fully, Doctor, and for that reason am at a great loss for terms with which clearly to express myself. Salesmen, particularly, need proper terminology, as the old method of condemning other products no longer is popular, and he needs proper words with which he may express his claims to patronage."

Dr. F. S. Muckey. "In all the pianos I have examined I have yet to find one with a well sustained tone. It is constantly interrupted. We get what seems like a sustained tone, but when heard through resonators we find it is intermittent."

F. E. Morton: "That shows a lack of synchronization of partials caused by faulty construction. Take a wire with lumps in it; tonal interruptions follow. The rigid retention of the board also is a very important factor."

Dr. F. S. Muckey: "Referring to salesmanship, I am convinced if I had an instrument with the ideal sustained tone and a set of resonators, that I could sell the instrument. It would only take a few moments for the prospective purchaser to hear the partials in the composite tone through use of the resonators. All tone I have listened to so far in pianos has been intermittent, a tone and then absolute silence. This alternation continues for a time and then dies out."

Dr. D. R. Hodgdon: "What is the relation between that intermittance and beats? You get silence anyway. How can the tone be sustained?"

Dr. F. S. Muckey: "Two ways, I think. By greater responsiveness to segmentation in the sounding board and more resonance. I have experimented along this line and it almost entirely eliminates those periods of silence. The fundamental can be heard all the time with a slight impulse in the tone. The overtones continue, but the fundamental holds the longest."

Dr. D. R. Hodgdon: "How do you reconcile the theory that the rapidity of the break or beat is part of the thing needed for harmony?"

Dr. F. S. Muckey: "I don't believe it is true."

Dr. D. R. Hodgdon: "This work was recently published."

Dr. F. S. Muckey: "I don't take much stock in authorities."

Dr. D. R. Hodgdon: "Your questioning of authorities is what prompted my question."

Dr. F. S. Muckey: "To illustrate what I mean. I was working in the college laboratory one day and a man came in to see what I was doing there. The professor of physics came in and suggested that he might be interested in hearing 'vowel forks.' They were simply a series of forks which could only give fundamental tones. The forks were passed around and the professor asked if he could hear the vowel 'oo' sound and the man said he could. The professor asked me what I heard and I replied, 'only the fundamental tone.' After passing the forks around again, no one heard the 'oo' sound."

After general and group discussions the conference was adjourned.

Bass Strings—Their Manufacture and Proper Use

Mar. 5, 1919

F. E. Morton: "The original bass string which, by the way, was not A-27, was made from brass and wound with brass wire its full length. That was followed by steel wire wound with brass; steel wire wound with iron; a steel wound and copper wound. The core wire was swaged and the winding began and ended inside the vibrating length. The pitch is inversely as the square root of the weight, inversely as the length, and directly as the square root of the tension, so, as we have not sufficient length—a physical impossibility—we take a wire of sufficient gauge to energize the sounding board at a reasonable vibrating tension, and compensate for length by added weight. The sole function, therefore, of the covering wire is weight.

"The function of the core wire is to act as the vibrator and conduct its energy through the bridge to the sounding board. If the board is not sufficiently energized, it may be due to a small core wire, providing length, bearing and distance from bridge pin to hitch pin are correct. The effect of the core wire of too small gauge is lack of sounding board energy and corresponding lack of tonal intensity.

"Now we will take the first bass string from the break on a 44 set—Key No. 27, B. If plain wire No. 20 were used at a tension of 170 lbs. a length would be required of about 49⅝ inches. The same key given a No. 18 core wire and a No. 28 copper covering wire requires a length for the same pitch at the same tension of about 32½ inches. Now that same key with that same length and a No. 19 core wire and a No. 28 copper covering wire gives a tension of 196 lbs. Note the difference—26 lbs. by a change of one gauge in core wire. The same key with No. 18 core wire and No. 28 steel covering wire at a tension of 170 lbs. requires a length of about 33¼ inches; that is about 1¼ inches more than with copper covering wire.

"Suppose you have figured on a length of 40 inches, for instance, for your first string from the break, sent your pattern to the string maker and expect him to use No. 18 core wire and No. 28 copper covering wire. The string breaks at that tension because it is pulling about 256 pounds. If you don't change your pattern and he does the wise thing from his viewpoint he will use No. 19 instead of No. 18, because tensile strength increases faster than the resultant tension. This may be perfectly proper mechanically, but the increase of tension of 42 lbs. results in a bass drum tone. The string maker is not at fault; this difficulty should be met by your scale draftsman. By using No. 16 core and No. 34 copper covering the tension will be reduced to 204 lbs. You are going from a No. 20 plain wire to a No. 16 core wire, and you are attempting to work a heavy bass bridge on a part of the board which requires great energizing. With a reasonable tension and a reasonable loading you can drop from No. 20 plain wire to No. 18 core wire and be able to blend bass and treble. As a result of experimenting, I have found that 175 lbs. tension on a bass scale is the maximum that should be used for good tone production. Mechanically you can bring it close to its elastic limit, and it will stand. Observation of the work of the string makers of this country shows their practice is excellent. But if the first bass string length from the break is too long you are putting the string maker to a test in which, if he succeeds, you fail.

"We have with us tonight several string makers, and I ask them to treat us in good faith. We want to get together on these points and straighten out matters. William G. Schaff, of the John A. Schaff Company."

W. G. Schaff: "Mr. Morton, permit me to express my appreciation for your work in conducting these meetings. I think they are of great value and should prove a stimulus and inspiration to the trade.

"We want more light and a greater understanding regarding piano construction and such meetings as these will help the piano man to crawl out of his shell and emerge from the medieval night and take his place in the sun. He will then automatically slough off the skin of jealousy and suspicion. Experience has taught us, gentlemen, that we cannot 'go it alone.' Life is a co-operative proposition and each must contibute something to the common good.

"The string maker has had a great many difficulties with which to contend. He meets

varying situations. Here are some little matters which occur to me relating to the handling of the product:

"Don't oil the tuning pins in the bass section or the steel core of the bass strings with a view to counteracting the moisture of the stringer's bare hands. Oiling the strings is an evil and it is surprising how many practical piano men take issue with me on that point. Stringers should wear gloves. They should take a chance on the string getting rusty and not on the tone, because a rusty string will last a good many years and produce a satisfactory tone, whereas one that has been oiled may not last long enough to get by the tone regulator.

"Then we have the strong armed chipper to contend with, the husky chap who yanks the very devil out of the wires and injures the tonal quality and durability of the instrument. He should be restrained.

"These all may seem very simple and obvious things, Mr. Chairman, but I find they are common practice.

"You also allow strings to lie around on the floor and some one comes along and spits tobacco juice over them. You should chain the office cat that goes to sleep on the trap board and key bed of the piano. When your dealer writes in that a complete set has gone dead and he had to send a tuner into the country at an expense of $10, don't conclude that the string maker or your tone regulator has put one over on you; maybe there are one or two faulty strings in the set which could be had from the string maker for the asking.

"When the plate man sends his plate with so many varying pin positions that when you pin a set of strings the winding will run through the agraffe and bridge pins, you curse the string maker and make him drag his weary body all over town, when Ramaciotti and myself might well be playing golf, to set you right when if you would only use your God-given ingenuity you could have measured the distance between bridge and bearing and found out who was at fault.

"Then we come to the question of operating freak scales. You hand us string lengths—you suggest wire sizes and you ask for results that are impossible and foredoomed to failure. Many a troublesome scale may originally have been satisfactory, but there have been so many changes, so much copying and you have gotten so far from the basic plan that it stands there as an abortion. You need a scientific man to take hold of this, and Mr. Morton is the man with the practical knowledge and science to do it.

"Now the string man is inclined to be helpful. He will talk in a sort of a wise way about changing the string length or shifting the bridge or something like that, but really gentlemen, it is not wise to take his advice because he would only get himself in bad as well as yourself."

J. Rossi: "Mr. Schaff has given you his experience. We find a lot of trouble on the first C sharp from the break. We get 'tubby' and overtones. We find tensions on some pianos of 250 to 285 lbs. The first note from the break gives the most trouble in pianos throughout the country. The longer strings give more trouble than the shorter ones.

"The tubby string is a question of high tension."

Geo. Holz. "Mr. Schaff has voiced my sentiments but if I can give any information, I will be glad to co-operate in every way."

F. Ramacciotti: "I am afraid Mr. Schaff has taken the wind out of my sails. However, I would like to inquire what produces the 'bell' tone. I was called upon many years ago to find out what caused an overtone or bell tone. I went to Boston and interviewed two superintendents of factories and both gave me different reasons. I wrote a piano man who gave me seven or eight reasons and many suggestions as to how to overcome it."

F. E. Morton: "What data does the customer give in his specifications?"

Geo. Holz: "He usually sends on his pattern for measurements. Sometimes they shape up excellently and when there is a doubt in my mind I make suggestions. If a man wants 50 or 75 sets, I tell him to try out one or more sets first. I find usually that if a set does not come out satisfactorily the customer is open to suggestions. We can co-operate and get together and get good results."

F. E. Morton: "Have you noticed a difference in the vowel sound of copper and steel-covered strings?"

Geo. Holz: "We get better results from a set of strings where the singles are wound with copper and the rest with iron. Our business has revolutionized itself in the last ten years, running

90 per cent copper wire. Copper has greater specific gravity; gives more weight, but there is such a thing as overloading the string. I should say there was a difference in the quality of tone. Copper is softer and gives a more mellow tone."

F. E. Morton: "Anyone noticed the difference in quality of copper and 'iron' covered strings?"

F. Ramacciotti: "The difference I find between copper and iron is that the iron gives a more brilliant tone; the copper gives a duller tone, often a tubby tone. Some people want tubby tones; we give them the copper. Some want brilliant tones, especially those for export."

F. E. Morton: "There is a decided difference, and if any care to experiment along that line I suggest you alternate with copper and steel wound strings on the same scale. Considering it as a vowel sound you will find a decided difference between the two. An experiment of that nature on any scale is very well worth while. Alternate keys are better than unisons, as you will have to damp one and the conditions are not as favorable.

"The difference between copper and steel is as great as that of o-o and e-e. Thinking of it as a vowel sound perhaps will tend to direct your attention to quality. It is true, as has been stated, that the first ten singles in the ordinary 44 string sets should be of copper in the average scale. It does not require as large a covering wire, therefore the string is not so stiff when wound with copper as with the same weight of steel. On doubles, with the tone which the trade seems to be striving for at present, I think you will find better results with the iron string. The possibility of getting a 'crispness,' a little of the 'cello effect, perhaps, makes possible a blend between the treble and extreme bass. The tone regulator's work also will be lessened.

"The copper wound string was brought into common use very largely by the piano salesman. It never was an acoustical measure in the first place. Some hold that at that time it was impossible to make a steel covering wire soft enough, and there is truth in that. Steel covering wire now is drawn softer than copper. The situation is much like the use of varicolored felts in actions, where we sacrifice a perfectly good piece of woolen felt to the destructive action of the dye in order to have green, red or purple felt, and then shut it up where it is rarely seen afterwards. The excuse is 'we have always done it.'

"The effect which has been referred to as producing overtones, as 'bell' tone, as a bass drum effect, is due to the stiffness of the wire. It may be due to composition of core or covering wire or the wire may be overdrawn. If the covering wire is too hard or the core wire is too hard, or if it is wound too heavily, you have a stiff string. The same effect results from high tension. You cannot improve the tone by increasing the tension. The string maker is right in the practice of winding and you can well consult him. Whenever you have that bar effect, that tone with a 'ping' which is the bane of the tuner and tone regulator, it is stiffness of the wire. The simplest method of getting away from it is a change to a reasonable tension.

"The breaking weight of No. 20 bass string wire is about 480 lbs. No. 18 is something like 420 lbs.

Four hundred and eighty pounds breaking weight would give an elastic limit on our wire of about 288 lbs. When you approach 280 lbs. on No. 20, you are getting so close to the elastic limit that it gives you no leeway for the first tuning. That is unnecessarily high. Later on we will take up sounding boards, ribbing and bridges, consideration of which will show how to bring down the tension. When I say bring down the tension of your bass strings, I don't mean on the same board that you use on high tension. It requires changing. One hundred and seventy-five pounds with proper handling of bridge and sounding board will give a clean and clear tone, and a greater factor of safety for working. At 175 lbs. tension, strings will last for years, and when taken off and micro-photographed it is found that the molecular structure of the wire has not changed. Anything that is done to meet your demand for a higher tension, such as increasing the breaking weight, is done at the expense of acoustic value. The number of replacements which you demand from the string maker adds to the expense of your operation. Reduce the tension on those high tension scales and it will give you a much better instrument and a more saleable one. If you have a heavy sounding board, well crowned, with solid bridge and hitch pin close to your bridge pin, you are adding very materially to the expense of piano manufacture."

C. F. Hovey: "If we had a bearing of wood instead of plate, would it not bring a lower tension?"

F. E. Morton: "You mean the plate bearing at the tuning pin end? Not necessarily.

The function of the bearing is the return of the energy and the more rigid the material the more energy it will return. A very heavy metal presser bar is a great help. Particularly if the presser bar is lugged to the plate."

Dr. F. S. Muckey: "What is meant by 'tubby' strings?"

F. E. Morton: "In a bass string, almost the same as 'nasal' in the treble. In the tubby string the prime amplitude is very slight."

Dr. F. S. Muckey: "It is not strong fundamentally?"

F. E. Morton: "No, and the tone is very short lived. It fades away almost immediately after contact of the hammer with the wire."

Dr. F. S. Muckey: "The reverse of the sustained tone?"

F. E. Morton: "Yes, because there is very little to sustain. The energy is lost."

Dr. F. S. Muckey: "And that is due to what?"

F. E. Morton: "Very generally to the fact that the wire has been drawn beyond its elastic limit and no longer piano wire. You get the same effect as from iron."

Dr. F. S. Muckey: "It is not resilient?"

F. E. Morton: "Not at all."

Dr. F. S. Muckey: "What is the 'bell' tone?"

F. E. Morton: "The same effect as striking a steel bar. Lacking in fundamental but with stronger high partials than the tubby tone. It is also difficult to determine the pitch. Tuners have told me that where the 'bell' tone is in evidence they can only tune by partials or harmonics."

Dr. F. S. Muckey: "It seems to me it would be of great value to translate these terms into terms of partial tones."

F. E. Morton: "It would be of great help, but these are 'shop' terms and closely associated with the odor of glue, varnish and sawdust. I was raised on them, like every other piano man, and it is most unfortunate that we are so limited in our mediums of expression.

"Another remedy for that which has been referred to as 'bell' tone is the tone regulator."

Dr. F. S. Muckey: "What does he do to change it?"

F. E. Morton: "He picks up the felt on the hammer—the effect being the same as if you said to every person who played on it, 'Touch that key lightly.' This, in effect, is reducing the intensity of partials in order to hear the fundamental."

A. Ostrander: "How much is the tension increased by the hammer blow?"

F. E. Morton: "Different tension on every point of the arc. We strike a blow on the end of a key, of say, 10 ounces. Of that two or 2½ ounces are taken up in overcoming weight and friction, so only about seven ounces, if we may refer to it that way, is applied energy. Then take the leverage into consideration and you will find it is not a great deal. There are seven points of leverage to take into consideration and the computation of stress at right angles. It makes a complicated problem."

Dr. F. S. Muckey: "One more question about that 'bell' tone. Does softening the hammer make more fundamental?"

F. E. Morton: "No. It reduces the volume of higher partials. The tone regulator has not an easy task. He must bring the whole piano to one standard if he makes a uniform scale. He can bring a good, clean, clear, resonant tone down to the level of the dead tone of the 'tubby' string, but he cannot bring the standard of the lower to the higher quality."

Dr. F. S. Muckey: "What effect has the picking of the felt on the hammers?"

F. E. Morton: "Decreases the resiliency and durability of the hammer. The evidence of life in the hammer is resiliency. Mr. Ramaciotti, do your customers specify tension or give you information relative to tension?"

F. Ramacciotti: "Only in one case."

F. E. Morton: "How about you, Mr. Schaff?"

W. G. Schaff: "Very rarely do I come in contact with a real scientific piano man. I think the tribe is dying out."

F. E. Morton: "Mr. Holz, you have numbers of sets of strings established. If a new scale is brought in don't you have one on hand with about the same lengths and take that one and move it up or down to the right point?"

George Holz: "As a rule I do."

F. E. Morton: "Mr. Schaff, if you were given lengths and weights you would work from such specifications gladly?"

W. G. Schaff: "In a few instances we have. We sometimes give the customer our experience to arrive at a satisfactory break, and in most cases the customer has deferred to our suggestions. I can truthfully say there are very few who give us specifications as to wire, weights and tensions."

F. E. Morton: "The sole object here is commercial. What I want to get at is this: Suppose a piano manufacturer would bring to you a specification and pattern with the weights and lengths. Assuming they were scientifically computed and accurately designed, would the manufacturer conduct his business at less expense?"

W. G. Schaff: "He would. I think the disposition among piano men, Mr. Morton, is to produce the maximum tone. They like the treble very clear, and when they get to the bass they don't plan to have that bass blend with the rest particularly. The piano man would rather point out to his dealer what a wonderful bass it has. Now I believe that in a piano scientifically laid out, acoustically correct, the bass, compared with pianos not laid out correctly, will not show up so well or so big. Take the Steinway, for instance, their bass is not particularly a big bass, but it is well balanced. Now the majority of piano men are not looking for that balance but are looking for a big tone without regard to the ensemble. If they would reduce that bass a little the string maker's job would be simple."

F. E. Morton: "Would it mean less expense to the piano man?"

W. G. Schaff: "It certainly would. I find, Mr. Morton, that in the majority of instruments shipped, instead of being around 175 lb. tension, are more nearly 190 and 210; there is greater brilliancy, but the margin of safety is much reduced."

Dr. F. S. Muckey: "How about this effect of brilliancy, does it lack fundamental?"

F. E. Morton: "A wire which will produce a good fundamental and one which will produce little fundamental in proportion to harmonics may both be made brilliant. There is such a thing as a brilliant saxaphone tone."

Dr. F. S. Muckey: "Your tone, all fundamental, would not be termed 'brilliant'?"

F. E. Morton: "I would say the term 'brilliant' might be used here in a comparative sense. The piccolo is brilliant as compared with the flute. The high pitch required in the last octave of the piano is given a test for brilliancy. In that last octave they do get a strong fundamental, not much elsé—a piccolo tone."

Dr. F. S. Muckey: "In the very high piano tones I think there are no overtones."

L. D. Perry: "Do you know of any piano constructed scientifically with 175 lb. tension in the bass that will stand the pounding an artist will give it?"

F. E. Morton: "Yes, sir, at 170 lb. even."

Dr. F. S. Muckey: "How do you determine the proper degree of stiffness to give best results?"

F. E. Morton: "The degree which will permit of a good amplitude of fundamental vibration and yet sufficient tension to energize the bridge."

Dr. F. S. Muckey: "How do you determine it?"

F. E. Morton: "The types of construction differ materially. Rarely do you find two makers who use the same caliper of sounding board in different parts of the instrument or the same bridge and rib work on crowning."

Dr. F. S. Muckey: "Any way of determining the pressure on the bridge for bass bearing?"

F. E. Morton: "That is directly as the crowning and the ribbing. If very heavily ribbed it requires greater bearing. When highly crowned it requires a greater bearing."

Dr. F. S. Muckey: "Any standard measures?"

F. E. Morton: "None that I have ever heard of; only the results of individual experimentation. None have been published to my knowledge."

Dr. F. S. Muckey: "Any definite rule as to the height of bridge, from the level a string would take if there were no bridge?"

F. E. Morton: "That difference is the bearing."

Dr. F. S. Muckey: "Would the higher bridge have greater pressure?"

F. E. Morton: "As relating to the bearing it is a great factor. It should be determined by ribbing, thickness of board and crowning of board."

Dr. F. S. Muckey: "In other words, the amount of resistance you have in your board?"

F. E. Morton: "Yes. There is a demand for copperized strings. Do you use the same weights, same loading in copperized as you do in steel?"

F. Ramacciotti: "Same as in the steel. At the break they hold up much better than with real copper. I cannot understand it."

F. E. Morton: "The copper wash or copperizing, as it is called, is not a factor in that. But do you find any difference in the covering wire—in its handling?"

F. Ramacciotti: "No. The hardness is about equal. Easier to wind than with real copper."

F. E. Morton: "Replacements about the same as in steel?"

F. Ramacciotti: "Less than that with copper."

F. E. Morton: "Do your customers attempt to hold you responsible for its discoloration?"

F. Ramacciotti: "No. It tarnishes but holds pretty well."

(Samples of copper and copperized wire passed around for inspection.)

F. E. Morton: "Mr. Schaff, in which direction do you twist in eyeing a string and why?"

W. G. Schaff: "We twist to the left for no particular mechanical reason."

F. E. Morton: "Do you ever take into consideration the practice in some factories of giving the string a few twists in putting it on?"

W. G. Schaff: "We instruct our men to twist the string to the left in the direction of the winding. Sometimes they may get it twisted the other way."

F. E. Morton: "Would it be of any benefit in that case to make your loop twist to the left?"

W. G. Schaff: "We twist to the left, but have no mechanical reason; just as good a loop results if twisted to the right."

F. E. Morton: "Watch your stringers. You will find the stringer gives three or four twists to the string before setting the pin. It has been learned that it helps on high tension scales for the same reason we twist a rod for concrete reinforcement. It increases the tensile strength. Sometimes a few twists will be just enough to take it above the high tension required, but this is always at the expense of acoustic value. It seems like a minor point, yet in a factory where such scales obtain it becomes an important matter.

"Mr. Ramacciotti, what do you consider a reasonable number of turns on a good loop?"

F. Ramacciotti: "The size of the wire determines that. Seven to nine, with anchor of two to three turns."

F. E. Morton: "In a scale where the distance from the hitch pin to the bridge pin is too short for that many turns, do you have trouble?"

F. Ramacciotti: "That would only happen in the first string—the heavy string. Seldom does it happen beyond that."

F. E. Morton: "There is one other point I want to bring out for record, and that is the question of distance from hitch pin to bridge pin. The minimum up to the last octave and a half should be three inches. If you get less than three inches the result is a down pressure, a gripping or binding of the sounding board. Then it requires a higher tension and considerable manipulation of ribs, sounding board, etc., to get away from the effects. If the sounding board cannot move up as freely as it should there is one reason for your 'tubby' tone. While you cannot get anything from the sounding board that is not given it by the string, there are modes of vibration in the string not expressed by the sounding board. While three inches is the minimum up to the last octave, from there you gradually reduce to two inches."

Dr. F. S. Muckey: "What is the maximum?"

F. E. Morton: "Determined by the length of the string on the other side of the bridge. It must not be so far that it will require an extreme bellying of the board."

Dr. F. S. Muckey: "What would you say was a good medium?"

F. E. Morton: "A fair medium for the bass strings would be from five to five and a half inches. Excellent results may be obtained at that length."

J. J. Schwab: "Don't many manufacturers claim the tonal life is sustained longer by use of copper-wound strings, say after twenty years? You have a different tone in the copper than in the iron."

F. E. Morton: "I have in my possession a little old straight-scale square with the original steel-wound strings, about sixty-five years old. There is not a buzzing string or dead string in the piano."

J. J. Schwab: "Was the composition different?"

F. E. Morton: "The composition was the same by analysis as used today. The practice of wire drawing is slightly different now. We draw a softer covering wire than we did at that time."

J. J. Schwab: "In that old piano, you had the same hardness of covering wire?"

F. E. Morton: "It is not too hard, because it doesn't show it in tone. If covering wire is too hard it will throw in its own key note, usually an inharmonic, and this also is true of copper. It is difficult to draw copper soft enough for covering wire for those who are very discriminating."

J. J. Schwab: "Take iron covering wire fifteen and forty years old and you will find two different strings."

F. E. Morton: "I don't know that from experience. I have taken off covering wire from a piano after it has been in use twenty-five or thirty years and found that the molecular structure of the covering wire has not changed. There is no fatigue."

J. J. Schwab: "Isn't covering wire made softer today?"

F. E. Morton: "Yes, softer than it has ever been made before."

Wm. Ruhenbeck: "Iron covering wire is more sonorous. Copper will outlast iron by thirty years. When an iron-covered string goes into a damp climate, in less than ten years you will find dead strings."

F. E. Morton: "In a high tension scale that always obtained. Given a wire, we will say of an elastic limit of 240 pounds, bring that wire up to 225 pounds' tension, the wire begins to stretch and then it is no longer steel. The molecular structure changes when the wire begins to stretch. I have found bass strings in natural gas regions covered as with a gum. It has the same effect as oiling the bass strings. There are numerous reasons why strings go dead besides the covering material."

Wm. Ruhenbeck: "Iron strings go dead almost immediately. Copper retains its life."

F. E. Morton: "It is not the covering wire that goes dead; it is the core wire. Is the striking point ever given you in specifications?"

W. G. Schaff: "We never get it."

J. Rossi: "It is never specified."

F. Ramacciotti: "No."

F. E. Morton: "What is your experience with core wire? Is it too highly polished?"

W. G. Schaff: "We prefer a highly polished wire. It seems to be less likely to rust."

F. E. Morton: "You don't find any particular difference in the winding or in its holding?"

W. G. Schaff: "No."

F. Ramacciotti: "We find that the highly polished wire does not grip so well."

Geo. Holz: "From a selling standpoint, it makes a better appearance, but I believe a highly polished steel wire loop and eye when pulled to pitch will have a tendency to slip."

F. E. Morton: "No difference in the holding or gripping at the swage?"

Geo. Holz: "No."

W. G. Schaff: "Mr. Morton, has your company ever made a wire hexagonal in shape?"

F. E. Morton: "Only as an experimental product."

W. G. Schaff: "We have a connection that uses that kind of wire for bass strings, and they prefer it. These pianos are for export."

F. E. Morton: "For export pianos the hexagonal wire will give a peculiar tone which the Europeans prefer. It is the only thing which will match up with that peculiar tonal characteristic required in what is known as the European product. You can get that 'klang' that is wanted in some parts of South America in the treble by loading your scale, by tension and by bearing. The booming bass of an American piano does not match that tone. Hexagonal wires having a flat surface vibrate segmentally. They want high odd-numbered partials.

"Which is better, a tinned or bright under-covering wire?"

F. Ramacciotti: "I think there is no difference. Results seem to be the same as far I know."

W. G. Schaff: "I find the tinned under-covering wire decidedly better."

J. Rossi: "I find the bright corrodes more quickly than the tinned."

F. E. Morton: "Have any one of you ever noted any difference in specifications for the distance from wrapping to bearing in the bass strings? Anything over or under the usual three-fourths inch?"

W. G. Schaff: "I have in mind one customer who wants a winding a half inch from either bridge point."

F. E. Morton: "Did he give a reason?"

W. G. Schaff: "Well, no. He wanted a longer wrapping."

Wm. Ruhenbeck: "It should be from three-fourths to one and one-fourth inches."

J. Rossi: "Three-fourths inch is too much from the pin to the wrapping, about one-fourth inch if dimensions were always alike. Plates usually shrink and we have to make this allowance."

F. E. Morton: "One fourth inch would be the best? Doctor, how do you account for that?"

Dr. F. S. Muckey: "I have not worked on that as yet."

F. E. Morton: "The function of the core wire evidently is being usurped by the covering wire."

J. Rossi: "If the covering were only one-fourth inch from the bearing, the vibration would go direct and stronger into the bridge."

F. E. Morton: "You don't mean to say that vibration stops at the point of wrapping?"

J. Rossi: "No; but if the covering is closer to the bridge the vibration is better."

F. E. Morton: "What pitch is the usual factory practice for chipper and first tuner?"

F. Kraus: "Concert pitch in chipping."

J. O. Shore: "Concert pitch. If you have it too high, you exceed the elastic limit."

F. E. Morton: "If concert pitch is used by the chipper and first tuner, the tension on the wire and strings must be computed on that basis, and if you want to know exactly what your strings are going to be called upon to stand then instead of figuring on international pitch, figure on concert pitch, for there is a decided difference."

J. J. Schwab: "Some chippers, when they get to the middle of the bass, feel of the string for tension. They tune by feeling."

F. E. Morton: "I have heard of some who pulled until the string was straight. This might be called tuning by sight."

Wm. Ruhenbeck: "Bass strings should never be pulled beyond the pitch of their own key."

F. E. Morton: "How do you define the point at which double covering should begin?"

W. G. Schaff: "There again they are governed somewhat by the tonal result they are trying to get. Some scales are laid out without double covering. The piano maker should have a balanced tone in his piano. You can get excellent tone with single covering, but if you compare that with a double-wound string it would not show up favorably alone, so we are governed entirely by the customer. I don't know how durable that string will be, but it gives a big tone."

W. C. Hepperla: "Do I understand it is the opinion of the string maker that it is a fault on the part of the piano man to want too heavy a bass?"

F. E. Morton: "Yes."

Geo. Holz: "We have scales where the first four or five strings and some scales where the first fifteen strings are double wound. I quite agree with Mr. Schaff. We have had scales submitted to us in which the strings were more like cables than piano strings."

Dr. F. S. Muckey: "Is the quality of tone the same in the single and double wound?"

F. E. Morton: "No."

Geo. Holz: "You can strike a happy medium between the two."

J. O. Shore: "Is a single-wound string more stiff than a double-wound?"

W. G. Schaff: "It certainly is. A double-wound string is more flexible."

Mark P. Campbell: "Is there any marked difference in so-called volume of two pianos where one has single-wound strings and the other double-wound?"

F. E. Morton: "Yes. Yet the carrying power is greater in the single than in the double."

Wm. Ruhenbeck: "Double-covering wire was only adopted when upright pianos were made."

J. O. Shore: "In double wrapping, do you get more overtones?"

F. E. Morton: "Yes, on short scale instruments; it is stiff with a tone almost like a bar."

J. O. Shore: "But the string is considered as a whole; not the wrappings separately?"

F. E. Morton: "Wrappings only function as weight. Mr. Campbell, what is your idea of the sales value of copper-covered strings?"

Mark P. Campbell: "It was brought about in the first place by the manufacturer who

wanted a better finished article. It was quickly taken up by the salesman and pointed out as a more durable piece of mechanism. The advantage of copper over iron is dwelt upon on account of its not rusting. How quickly it loses its value or its effect on the tonal quality is not comprehended by the buyer who, as you know, has little or no knowledge of tone. It is certainly a good sales point."

F. E. Morton: "Is that argument still potent?"

Mark P. Campbell. "Yes, indeed."

F. E. Morton: "I want to point out a few things that seem to be natural deductions from the discussion of the evening. In the first place, string trouble is expensive. Someone must bear the expense. The string maker has his recourse in the dealer and the dealer in the customer. Progress in piano manufacture should bring with it efficiency. Anything that will obviate string trouble undoubtedly is of interest to all concerned. The mechanical and acoustical value of core and covering wire is not always the same, and to reconcile them requires change in design and practice. The result, however, is a factor of safety and you can make good use of it. When that is accomplished, matters of tone will be found very largely to follow. That which will give most favorable treatment to the materials used will give the best results tonally. Points brought out by the makers of strings are in line with acoustical value. Therefore, the function of the core and function of the covering wire should be your guide in determining the use of each or the specifying of both. Keep in mind that the function of the covering wire is only weight. If you require on your piano that your bass strings be brought to a tension of 200 pounds or more, it is because of defects elsewhere which should be remedied, and the expense of such change will be less than the added expense in the time of chipper and tuner. When a string is found to be faulty, you have used the string maker's time, your employer's time.

"The effect of using hard covering wire, which is up to the string maker largely, is the producing of a tone which decreases the audibility of the fundamental by increasing the odd partials. Hard covering wire forces into the general composite tone it own vibration, and I am not sure you don't get the longitudinal vibration as well. The stiffening of the wire through high tension or hardness or through other causes is all done at the expense of the fundamental. Any of you who have listened to pianos played in concert, four or six played together, noted that the entire performance is sadly lacking in fundamentals and that the lack is shown up by a greater volume in the treble. I have tried on one or two occasions double basses with four pianos. The fundamental was exceedingly grateful. We might just as well have this in the piano itself and make it more satisfying. It could be used as a great selling point.

"Remember, gentlemen, that a buzzing string is quite likely to become a dead one. It indicates a stretching of the core wire which will result in a dead string. Look to your tension when you have buzzing strings."

William Scheele: "Why is it a dead string, 16 or 18 years old, may be used again after being sandpapered?"

Dr. D. R. Hodgdon: "Electro magnetic forces may have been generated."

F. E. Morton: "Unless it was a faulty wrapping in the first place, it would be caused by fatigue of the core wire. How that may be resuscitated by the rubbing of another wire, I can hardly understand.

"Note in your scale, gentlemen, particularly the difference between elastic limit and breaking weight, and don't figure over 60 per cent. That is high for elastic limit."

J. J. Schwab: "What is your idea of bringing the string up to concert pitch and then rubbing it with a hardwood stick?"

F. E. Morton: "Rubbing the string down used to be considered better practice than drawing up to higher tension, and was supposed to give the effect of a couple of tunings. I don't think the tension on the wire would be as great as drawing it up to pitches used now for stretching purposes. Of two evils, choose the lesser.

"When the pattern goes to the foundry and an iron pattern is made, we look upon it as settled that we always will have the same plate, but, unfortunately, we don't. You accuse the string maker of changing your scale when as a matter of fact your plate has been changed. Originally every scale is pretty fair that gets to a point where it is manufactured in quantity. But watch your foundry—watch your templets for marking. I have found the templet used by the belly-

man which was minus one screw, which had increased the treble string lengths and decreased the bass string lengths materially. Check up your patterns. By a little initial expense in the factory things can be changed which will save money from now on."

Varnish

Mar. 12, 1919

The conference was called to order by the Chairman, Mr. F. E. Morton, who said:

"Tonight we will discuss varnish, its use, its possibilities and its limitations. Give us the benefit of your experience and queries. Questions are valuable in that they make the one to whom the question is addressed think."

Mr. Morton then called on C. L. Sargent, of the Murphy Varnish Company, who after assuring the trade of the desire of his company to co-operate with the manufacturers, introduced P. S. Kennedy, of the piano varnish department of the same company.

P. S. Kennedy: "The ordinary piano finish usually is put on wood of open grain which requires filling, and the first operation, as you all know, is to stain the wood, fill it, and then follow with varnish until the work is bodied up; then it is rubbed off to a level finish and finally polished.

"As to the stain, I think practically everybody is agreed that the water stains are the most practical, both from the standpoint of their fastness under the influence of light and ease of application. Once a water stain is on there is no 'trickiness' left. In an oil stain you always have to contend, more or less, with greases from anilines which go in oil stains. Perhaps some of the bigger varnish manufacturers have anilines to the point where they are practically grease proof, still there is always danger of getting some with grease which will make the filler and varnish dry slow, causing lots of trouble. The only objection to the water stain is that it raises the grain of the wood. The good points, however, compensate for the bad. There are many who believe, after water staining, in putting on a coat of shellac to seal the wood and more or less prevent shrinkage. There is a very strong prejudice against shellac, and with good reason, for there is no question but that shellac improperly used will make varnish extremely sensitive to cracking. On the other hand, it has been demonstrated that when properly used in a very thin wash of about ten parts alcohol to one part of the ordinary shellac varnish as it is sold, it is practical.

"The filler, of course, is the manufacturer's composition. Everyone who makes it has his own ideas. Most of the fillers are made of finely bolted silex, raw oil with a little good drying Japan in it; it varies according to the manufacture and causes a great deal of trouble on account of the foreign greases either in the oil or aniline colors.

"In bringing up the varnished case there is a wide difference of opinion as to how the varnish should be applied. I think most finishers believe in laying down varnish with turpentine up to the point of the last or last two coats and making the last coat particularly thin, the idea being that as the filler is somewhat porous the thin varnish sinks in the tiny pores and really acts as a sealer. The first coat of varnish is the most effective when it becomes a sealing coat instead of a bodying coat. Attempting to make the first a body coat is rather dangerous, as it develops in over coating and sweating trouble when rubbed. The bodying up and polishing are shop matters. Everybody has his own ideas as to the amount of pumice, rottonstone and polishing oil to be used.

"As to the application of the varnish, sprays have come into use to a great extent and there is more or less difference of opinion on its practicability. Production governs the use of sprays to some extent. Some shops are very successful and others are not. The kiln for the drying of varnish has come into extensive use. I think a great majority, if not all the piano manufacturers having a large production, use the kiln. While this also has its problems, if used scientifically it gives satisfaction. It gives a uniformity of results which could not be obtained formerly on account of varying conditions of the weather."

H. J. La Joie: "What temperature do you advocate for kiln drying of varnish?"

P. S. Kennedy: "Anywhere from 104° to 114° is the most practical."

H. J. La Joie: "What is the result of temperature greater than 114°?"

P. S. Kennedy: "There is not any serious result until the glue and veneer are affected except

you will have to be more strict in the treatment of the varnish. If you put the varnish in the kiln an hour later at 125° instead of 114°, you have sweating troubles when you rub and when you start to coat, glue trouble, which is serious."

F. E. Morton: "Would you specify different varnish for thinner veneer? Does the thickness of the veneer have anything to do with the kind of varnish used?"

P. S. Kennedy: "No, I would not say it did."

F. E. Morton: On a very thin veneer the glue works up through the wood, so you are in effect putting varnish over glue."

P. S. Kennedy: "Yes, much more elastic varnish should be used over the thinner veneer; with that elastic varnish you would not get as full a polish, but it would be much safer to use in that case."

F. E. Morton: "Is elasticity determined by the kind of oil used?"

P. S. Kennedy: "Yes. But while that holds in a general way you still must consider the polishing power of your varnish."

F. E. Morton: "I have an idea that when men who use varnish have a clearer idea of what component part of the varnish is responsible for certain characteristics, they will be better able to diagnose their troubles. As I understand it the lustre and durability is due largely to the gum used; the elasticy, and to a less extent the durability, to the drying oils; the metallic dryers are oxygen carriers, and the volatile solvents act as spreaders.

"I have seen very poor cases which upon examination were found to have resulted from a very thin veneer. The glue had soaked up to the surface. The varnish man was blamed. When the limitations of varnish are known, more intelligent use of it can be had."

Theodore Cassebeer: "Confined to the use of shaved veneer, as most of the trade now is, one has no choice as to thickness. As few use sawed veneer, the trade is held to 1–28 inch."

F. E. Morton: "Do you think the glue which works through may have an effect upon the varnish?"

Theo. Cassebeer: "Many manufacturers put paper on the outside before they put it in the press. The adhering paper must be taken off by scraper or sanding machine."

F. E. Morton: "The scraping and sanding produce a thinner veneer."

Edw. F. Vail: "What is your experience with a patent filler and the advantage gained by its use?"

P. S. Kennedy: "By the patent filler I suppose you refer to combined stain and filler. That is a question that goes back to the product and therefore is difficult to talk about. They are further governed by the nature of the color which is used; if it is a color which is grease free, it is a very good proposition, but there is an element of risk in it.

"*All oil colors will fade*—a mahogany quite rapidly. I think the principal objection to it is the chance taken in color. It works easily and polishes very quickly."

A. T. Strauch, Jr.: "Do you advocate using a different varnish for bodying and polishing; a more elastic for bodying?"

P. S. Kennedy: "There really would be nothing gained by that, if I understand the question properly. I think probably a comparison with automobiles would be the best example. After you get your stain and filler on you bring it up with rubbing varnish which is rubbed to a surface and flowed with a finishing varnish of very long oil, a durable varnish, but one which never really dries hard. No advantage is gained by following such a system in piano varnish, because it does not have to have outside exposure, so there is no reason for an extremely elastic varnish over it. If you put on a more elastic coat than the one underneath you are getting a better polish because of less oil in under coats and it is the gum which makes possible the polishing."

A. T. Strauch: "My idea was the reverse—you should have the oil elastic varnish under it to counteract the glue work."

P. S. Kennedy: "Glue works everything over it and in working the elastic varnish it would be working under the varnish, which is more brittle, and it would not be long before cracks would appear. An exception would be where you use a cheaper varnish to bring up the work and a higher grade for the final coat. If the composition of the two varnishes were the same there would be no difference in elasticity."

F. E. Morton: "What gum is used in that cheaper varnish?"

P. S. Kennedy: "The difference in price is governed by the grade of the gum, or in other words the softness of the gum. The softer the grade the poorer the polish. Color enters into it because pale gum is more valuable, other things being equal."

F. E. Morton: "Are gum and shellac of the same kingdom?"

P. S. Kennedy: "Shellac has resin and a wax in it and is an animal product; it is not a vegetable. Gum is the sap of a tree fossilized."

F. E. Morton. "When products of the vegetable and animal kingdom are brought together there is a lack of synchronization. For instance, a mixture of cotton and wool is not as durable as either all cotton or all wool. The cotton is of a lower rate of vibration than the wool and the wool wears out the cotton. This is true of any two products from different kingdoms. The objection to the use of shellac with varnish is scientific."

Joseph Rettinger: "Is not China wood oil used instead of linseed oil?"

P. S. Kennedy: "Linseed and china wood oils are both very excellent and one has, perhaps, what the other has not. The most satisfactory results are secured by a blend of the two. China wood oil used alone is very difficult to handle in a shop where the ventilation is not of the best. Many of you have had a flat or frosted 'alligator' finish. The linseed does not have the waterproofing or elastic qualities but has working qualities and safety the other has not. The two combined give very fine results.

"The gummy waterproof nature of the China wood oil would be shown up by the rubbing and be complained of by the workman. It is a question whether it is gum or oil. When dry it is quite comparable to rubber."

Edw. F. Vail: "What is the proper time between coating?"

P. S. Kennedy: "It varies entirely with the varnish. It is not well to wait too long between because you get scale."

G. Kubelka: "What is the cause of pin holes in varnish and how can they be overcome?"

P. S. Kennedy: "A good deal of pin hole trouble goes back to case work. My experience is that the belt sander has a lot to do with pin holes. In running over the work little particles of glass come off and get tucked into the pores and when you fill your work those little particles have stuck; when you coat up your work you lift out the little particles in the holes. The next coat you put on gets into the holes and carries all the way up. I think this is one of the most common causes. The successful way to overcome this is to run your belt sanders in both directions over the wood."

F. E. Morton: "Didn't they show up before we had belt sanders?"

P. S. Kennedy: "There are other causes, of course, and usually have to do with the pores of the wood, and it will show up most frequently on highly figured veneers. The pores run at such an angle it is difficult to get the filler down into them. It leaves an air space underneath and a suction is created which pulls the varnish down. The best way to overcome that is to use a thin coat of filler and then double fill with the first thin coat of the regular body."

G. Kubelka: "How about cracks in pilasters?"

P. S. Kennedy: "I think really to put that proposition up fairly you would have to exhibit the cracks. There are different kinds of cracks and you can distinguish the difference in appearance. Cold cracks would come in a pilaster directly across the grain. If the cracks are of exactly the same nature over the glue and over the pilaster it is safe to put it up to the varnish."

Theo. Cassebeer: "Is it not a fact that varnish manufacturers claim that the oils are supposed to check less now for that very reason? They are longer in oil and we have more shrinkage. Old time varnishes which had the same gum checked easier than the modern varnish. Modern varnish has more shrinkage."

P. S. Kennedy: "There are just as short varnishes today as there were fifteen or twenty years ago."

Theo. Cassebeer: "I mean the usual type varnish not requiring as high polish."

P. S. Kennedy: "There is a general tendency that way, because, while you cannot get the polishing power which is known as the old time, you do get an elasticity which is a pretty good, safe guaranty against cold checking."

F. E. Morton: "What causes sweating?"

P. S. Kennedy: "The varnish film is improperly dried in the center, or top dried."

Theo Cassebeer: "It is very similar to the treatment of lumber—surface drying, caused by insufficient moisture and too much heat."

F. E. Morton: "What humidity is the best?"

P. S. Kennedy: ".40 to.45 gives a good, healthy normal condition."

Edw. F. Vail: "We find 24 to .30 best from our experience."

P. S. Kennedy: "Do you put the work in the kiln as soon as varnished or let it stand over night?"

Edw. F. Vail: "Perhaps an hour after a dozen have been finished."

Theo. Cassebeer: "If you had 84 and 104 you have a relative humidity of .40."

P. S. Kennedy: "When you run with too great humidity you get soft rubbing."

Fred W. Lohr: "There are very few workmen who understand 'relative humidity.' Give them degrees on the thermometer."

P. S. Kennedy: "Your point is well taken."

G. Kubelka: "Getting back to pin holes, I don't think you explained what the real cause is. You blame the sanding machine."

P. S. Kennedy: "Not as the entire cause."

G. Kubelka: "What would you recommend?"

P. S. Kennedy: "When you stain, sand paper with very fine quality, about 00, and graze over to knock off little fibers, but not enough pressure to force the glass or garnets into the wood. When you come across a condition caused by little particles in the pores and you find you are getting pin holes from sanding, use steel wool and make correction on your next."

Mark P. Campbell: "Do you find pin holes in better grades of varnish?"

P. S. Kennedy: "Yes, sir. You get them with all grades. There is a condition which develops sometimes known as 'pits' often confused with pin holes. Pitting, if in the varnish, is caused by imperfectly made varnish."

Mark P. Cambell: "You could not confine it entirely to sanding? Might it not also be caused by improper drying of veneer work?"

P. S. Kennedy: "That will come up where dried in a kiln. When you put your work in the kiln the moisture forces itself out and causes pin holes."

Mark P. Campbell: "Where veneer work is dried in a kiln before staining or filling, do you find this condition?"

P. S. Kennedy: "I would not say it was more general than in air dried."

F. E. Morton: "Is there anything in the composition of varnish which, if not thoroughly macerated or digested, could cause that separation at points which would produce that effect?"

P. S. Kennedy: "It could occur with oils which were not properly mixed."

F. E. Morton: "What oil?"

P. S. Kennedy: "Linseed oil."

F. E. Morton: "A portion of a drop not thoroughly mixed with the rest would cause the varnish to leave that point?"

P. S. Kennedy: "No, sir. You could not get that condition with linseed oil."

Oscar Brambach: "While in charge of a large plant, a young man was sent to me who was anxious to know what the use of varnish and wood was against that used out West. He was scientific in his methods and had magnifying glasses of various powers. While he was in the factory we had some of this pin hole trouble and we examined several cases where the pores of the wood were large, magnifying these pores thirty and some one hundred diameters. We followed this batch of cases through the varnish room. We could see by aid of the glass a fine powder of the wood itself in the pores underneath the varnish. We observed some more cases and followed them through the factory, but before they came to fillers we blew these pores out thoroughly from top to bottom and gave them a fine wash of water; then to the stain room. These cases had no pin holes. Most people use brushes. You will not find pin holes in cases where the pores are very tight. But you will where the pores are large enough to contain this powder. You cannot wipe or brush it out; you must blow it out."

Theo. Cassebeer: "I think Mr. Brambach is absolutely on the right track. You start in with a sander first one way and then the other, and you actually press this fine powder into the

pores of the wood. Sucking off sawdust does not take it all off. The blowing method strikes me as a very sensible and thorough practice."

Oscar Brambach: "Pin holes are also due to defective fillers."

J. R. Lang: "I have found pin holes before varnish was put on, with a glass such as Mr. Brambach used. I think you can find pores in wood where it has been treated with fillers twice, thin and thick. I have used a coat of alcohol before staining, successfully. The alcohol seems to make the sap, or sugar, in the wood impervious to water. Some of those holes in the dry veneer contain a little shell of gum, like glass, and the filler will not stick to it."

L. D. Perry: "I would like to say we have had a lot of varnish trouble, but we do not know what pin holes are today. I think if anybody in this line of business will use a thin filler, rub it in properly and use thin varnish they will not have pin holes. You must *fill* the pore, and it cannot be done with a thick filler. That can be illustrated by trying to shove a cork in a greasy mouthed bottle. We use what is known as the immersion system of varnishing. We have about thirty-five barrels of varnish in the tank and put in six cases at a time, in fact everything which belongs to the case. After you shove them down there is a pressure and the varnish is forced into the pores. Naturally, on account of using this immersion system we use a thinner body of varnish. We do not know what sweating is any more. Our cases are smooth, even and level. If you will use a thin filler and rub it in properly and use thin varnish you will have no more pin hole troubles."

G. Kubelka: "What consistency would you use?"

L. D. Perry: "Use your judgment. Do not allow the filler to be gummy; have sufficient turpentine so when you rub them in you force the air out. You must get the air out of the pores."

H. Kamm: "My experience has been the same. I do not have pin holes and have been in the business a long time. I use very thin filler and very thin varnish."

F. E. Morton: "What is used in place of linseed oil?"

P. S. Kennedy: "Several known drying oils and mineral oils."

L. D. Perry: "One of the best mediums is China nut oil for thinning down. It dries much more quickly and you can rub it off in a very short time, and it is hard and ready for varnish."

G. Kubelka: "Why is it you do not find pin holes in oak veneer? Neither have I found them in walnut veneer. We do not clean them out any better than mahogany."

Oscar Brambach: "The pores are probably large and you take the sawdust out with the brush."

G. Kubelka: "Suppose in your mahogany veneer you blew out the pores and still found pin holes?"

Oscar Brambach: "You have not filled properly."

Theo. Cassebeer: "People didn't use fillers fifteen years ago. Do you think you had less complaints of pin holes?"

Joseph Rettinger: "We used English varnish. We looked more closely to higher finish. In the old system of scraping we had pin holes. The proper filler will overcome it, as Mr. Perry stated, if you go at it systematically. In the old days before fillers were manufactured we made our fillers of sawdust and oil. I have had pin holes and don't deny it. The kiln and the spray have brought their problems. However, pin holes are not so serious as checking and cracking. I look for the day to come when we will get away from varnish itself. I think there will be a substitute and not in the far future."

L. D. Perry: "When it comes to a dull finish you must use outside varnish. You will get more shrinkage, but it will not scale as much. The dull finish if done with outside varnish will stand up against dampness much better than the hard finish. If you have a dull finish that is smooth, the people will be pleased."

Joseph Rettinger: "The outside varnish does not check?"

L. D. Perry: "The idea I want to convey is if you want a dull finish it must be done with outside varnish."

F. E. Morton: "What would you say of temperature in spraying, Mr. Kennedy?"

P. S. Kennedy: "I think the best results are secured by heating both the varnish and the air. It is very much like running a kiln. Everybody has a little different idea as to temperature,

but the limit will usually run between 110° and 140°, and I think the average temperature used is about 120°."

F. E. Morton: "Should the air and the varnish be at the same temperature?"

P. S. Kennedy: "Practically the same. The reason for heating the varnish and the air is that when the compressed air is released it is in a condition that can probably be best compared with the freezing of water by ammonia. When the air expands it takes heat from everything around it. The varnish which is in closest proximity is chilled and goes on cold, and as the varnish warms up with the temperature of the room it expands and gives a condition of overcoating and enameling. When you heat the air and varnish you relieve that condition so that when the pressure is released you get the varnish on the work at approximately 70 degrees and the varnish stays where it is put. You will have difficulty sometimes in heating the varnish too high."

John Kneiste: "How much temperature? There is a big difference between summer and winter weather. If you have 70 degrees in your room you have considerable heat. Heat varnish in a cold room and it will not flow out."

P. S. Kennedy: "It will flow out fairly well. Your volatiles are your spreading medium and will evaporate slowly. The cooler it is the longer the volatile will remain on the work."

Jno. Kneiste: "Will it go in the borders as easily? The wood not being as warm as the varnish, the varnish will get cold. The temperature of the varnish should be about 70 degrees or 80 degrees."

P. S. Kennedy: "The factor of safety is the most important matter. Put the varnish on at the temperature you would brush it on and do away with over coating. If you have adverse room conditions you cannot expect results."

Jno. Kneiste: "Just the same as if you brushed it?"

P. S. Kennedy: "The varnish actually doesn't go on the work thin. When the varnish goes out of the atomizer a great deal of the volatile is out before it meets the work. It goes on heavy."

Jno. Kneiste: "We want it to go on thin to fill those pin holes."

P. S. Kennedy: "That is a matter of coating, particularly your first. Reduce your varnish with considerable turpentine."

Paul Bilhuber: "In the spraying of aeroplane wings almost one hundred per cent of thinner must be added to be sure it will reach the work. There would be no chance of the wood chilling the spray if both were heated. That varnish will strike at about 70°."

P. S. Kennedy: "I made some tests in spraying—collecting the excess flowing down in dishes. It averaged from 60° to 70°."

J. R. Lang: "Does it make any difference how far the air brush is from the work?"

P. S. Kennedy: "I really think that is a matter of local conditions, because I have seen good work at eighteen inches and good work at eight inches."

J. R. Lang: "With the same consistency of varnish?"

P. S. Kennedy: "No, not with the same varnish. It must be adjusted by the workman, according to the varnish."

J. R. Lang: "I think there is a vast difference in the escape of the volatiles."

Paul B. Klugh: "I would like to ask about China wood oil, where it comes from; what is it?"

P. S. Kennedy: "It comes from China. It is pressed from a nut that grows on a tree. It has been used for thousands of years by the Chinese on their ship bottoms and decks."

Paul B. Klugh: "How long has it been used commercially in varnish?"

P. S. Kennedy: "About twenty years. Its greatest point is its wonderful waterproofing quality."

Paul B. Klugh: "Used in spar varnishes more than in interior? Is that the way they get that outside varnish?"

P. S. Kennedy: "Yes."

Paul B. Klugh: "Does it ever dry in the form it comes originally?"

P. S. Kennedy: "It dries flat and 'cheesy.' It does not dry with the film as linseed oil does."

Paul B. Klugh: "It does not become brittle?"

P. S. Kennedy: "No."

Paul B. Klugh: "I have a piece of rubber tubing treated with China wood oil ten years ago, and it is flexible; it seems as though it is a good deal like the rubber itself. It is not only preserving the rubber, but it is about as flexible as the rubber and of the same consistency."

F. E. Morton: "Was it treated both outside and in?"

Paul B. Klugh: "Outside. When that is put in varnish what makes it hard, or does it stay in the same gelatinous state?"

P. S. Kennedy: "By mixing of linseed oil. The purpose of any oil is to expand the gum."

Paul B. Klugh: "Do you get elasticity from China wood oil?"

P. S. Kennedy: "Yes."

Paul B. Klugh: "How do you determine what the contents should be of China wood oil in piano varnish? I mean roughly."

P. S. Kennedy: "I couldn't tell you. For different cases and conditions it would vary all over the board. You could not fix a proportion."

Paul B. Klugh: "Would you use a larger percentage of China wood oil in flowing varnish?"

P. S. Kennedy: "For working qualities, no. Linseed oil has the working quality—it gives proper flowing powers."

J. R. Lang: "Can you make synthetic rubber from China wood oil?"

P. S. Kennedy: "Yes, it is a very good substitute."

Jno. Kneiste: "I would like to ask whether those who use spraying machines find it better to coat over edges with a brush."

J. R. Lang: "It is unnecessary."

Jno. Kneiste: "My experience has been that it is necessary to go over with the brush if you want to get something on the moulding."

F. E. Morton: "I have watched that process considerably. Perhaps it is up to the man who uses the spray."

Mark P. Campbell: "Will an oil varnish overcome checking?"

P. S. Kennedy: "Except where it is a case of grease underneath. Cold checking is overcome by elasticity.

"As to sounding boards: It is a question whether you want an elastic varnish or a very short varnish. I think the general opinion is that it makes a decided difference whether you use a short varnish or an elastic one and one of the principal factors is its color, which must be very pale."

Theo. Cassebeer: "We would like to break away from short varnish and get an elastic one. We have not experimented very much on it."

F. E. Morton: "From an acoustic standpoint, actual experiment shows a much better result obtained by simply rubbing linseed oil in with a cloth. The board will be much improved and will stay put. It is not as finished a looking board, but it certainly does give you every bit of sounding board value. You have not put a jacket on the board; have not interfered with the undulation."

J. R. Lang: "You would have to keep it in a glass case."

F. E. Morton: "I only refer to acoustic value. Varnish should be of the elastic type, but if very elastic the varnish would act as a shock absorber, the very opposite of the requirement.

"Regarding the use of sandrack on the board, I find that anything used other than linseed oil is a compromise and the degree of compromise is determined by the individual. We are not permitted to make pianos just as we would like to; the conventions dictate architecture, etc., so it is largely a matter of compromising tonal value to these conventions. Anything on the board which will produce either an elastic, or, as it was expressed, 'cheesy' effect, is injurious."

L. D. Perry: "The old violin makers never were satisfied until they got the varnish on the instrument. The violin without any varnish has a peculiar quality of tone that you don't care to hear, and when varnished it is entirely different."

F. E. Morton: "A violin in the first place is made with the idea of varnishing. It is true that a violin belly unvarnished and not intended to be varnished can be made to be very

responsive. Shellac on the sounding board is one of the poorest substitutes that could be used. It does not respond in the same degree as the wood itself.

L. D. Perry: "Very hard varnish will have a better effect than anything soft or elastic if it is thin."

F. E. Morton: "Yes, if it is thin. The compromise should lie in the thickness of the varnish."

Theo. Cassebeer: "When I used the word 'elastic' I did not mean anything elastic enough to be soft. I meant a varnish just a little longer than what we call 'short varnish.' "

F. E. Morton: "I want to express for the Flood & Conklin Varnish Company of Newark, N. J., their regret at not being able to have their representative here. They wish to be heard at another time.

"I want also to express to the representatives of the Murphy Varnish Company our appreciation of their courtesy and consideration in giving us of their store of knowledge. We accept it in good faith."

Piano Sounding Boards

Mar. 19, 1919

The conference was called to order by F. E. Morton, chairman, who said:

"The subject tonight is Piano Sounding Boards, which naturally will include resonance and responsiveness. That we may distinguish responsiveness from resonance before discussing sounding boards and their treatment, we will have an explanation of resonance. When we come to the board question just bear in mind the prime factor,—for what are we striving? Why is a sounding board? Older men will look back upon attempts to add things to the instrument inconsistent with its purpose. Let us keep to the one line of argument—what is the function of the board, its limitations, and are there possibilities not yet developed?

Fig. 1

Photograph of the motion of the flames while singing the vowel *ä* as in father.

The lower line is the fundamental, and the others are the 1st, 2nd, 3rd, etc., overtones in the order of their pitch. One wave of the fundamental corresponds to two in the first overtone, three in the second, four in the third, and so on.

"I have heard it said by scientists and laymen that a satisfactory definition of resonance has not been given. I have encountered alleged definitions, the nearest approach to a true statement being that it is 'a production of a second sound by a stimulation of a first.' Whether this is satisfactory to you after discussion remains to be determined. If it means anything else to you, let us have the benefit of your views. These questions have not been settled for all time. The textbooks largely have failed to meet the issue. We will now hear from one whom I know is not satisfied with the definition up to date—Dr. Floyd S. Muckey."

Dr. F. S. Muckey: "As Mr. Morton has said, we ought to know just what the function of resonance is; just where, in the matter of tone production, this matter of resonance applies; how to effect tone production in the piano as well as in other musical instruments.

"We might go over the whole matter of tone production, briefly, as it will show exactly where this matter of resonance comes in, if it does. I doubt whether we are getting much, if any, in our pianos as constructed today. The first step is a definition. Tone production is air wave production and I have here an analysis of a tone (exhibiting chart showing fundamental and overtones). (See Fig. 1, page 35.) I have the original photograph from which this analysis was drawn and will pass this around. It is a natural representation of air waves in a string tone. Now the first thing that we need in tone production is something to start these air waves. This is called a vibrator. In the piano we have a string that originates the waves transmitted through the bridge to the sounding board, the sounding board dividing into segments according to the pitch to be produced. We have a great many segments for every series of air waves produced and therefore the sounding board itself starts a great many air waves at the same time and we get a louder sound from the sounding board than from the string. If it were only the string we could not hear it very far. We, therefore, amplify the sound by means of the sounding board.

"There are three things to consider in tone, or, if we translate tones as air waves, three things we must study in air waves. The length of wave, or number of waves produced in a certain time which determines pitch; the height of the wave from the crest to the hollow, which determines volume; the number and relative intensity of partial tones, which determine quality. Resonance has to do with volume and quality. The first question then is—do we get a proper vibration of the string—proper length, weight and tension of string, for best volume and quality? We cannot do anything until we get vibration of the string itself and then the sounding board reproduces as accurately as possible the string vibrations. If a string is vibrating *naturally* this (C_1), which

Fig. 2

represents the fundamental, will always be strongest. The fundamental tones should always be the strongest and overtones should gradually decrease. That combination of partial tones gives tone of good volume and quality. However, the fundamental must be the important one in the group; the tone with good fundamental always has good volume and good quality. If

the fundamental is weak and overtones too strong, you get a disagreeable tone. The reason is that the higher pitches are never as agreeable as the lower pitches. The rapid vibration of the ear drum produces a disagreeable tone, while a slow wave motion produces an agreeable sensation. The fundamental or lowest pitch, therefore, should be the strongest. This does not obtain in pianos as built at the present time. The fundamental in most pianos is not as strong as the second and third overtones. The fundamental and first overtone are always weaker than the second or third overtones. It took several years to build an apparatus to analyze tone.

"What is the cause of the weak fundamental and first overtone? When we first strike the string, for an instant you will get a disturbed vibration of the string but a moment later it will assume its natural action. We don't get out of the sounding board the most desirable combination of these partial tones. Now after we have started the air waves by this dual vibrator, the string and the sounding board, the function of resonance comes in. The question now is, do we do anything to the air waves after they have been started by the string and sounding board? As far as I know, there is no piano built at the present time that is making use of what I term resonance Most of the men I have met in the business of making pianos seem to think they have resonance in the sounding board. That is not my idea of resonance. The sounding board is a vibrator and not a resonator. It is used to start air waves, but a resonator cannot start waves. The resonator picks up air waves already started. I have here a tuning fork and resonator. (Striking the tuning fork.) (See Fig. 2, page 36). You can hardly hear it. Now I will strike it in the same manner and you note the great difference in tone with a resonator (using resonator with fork). The explanation is this: When I place the vibrator close to the mouth of the resonator these air waves are entering the resonator in different directions; some go straight back and others reflect at different angles. Finally we get a lot together near the outlet of the resonator and they are discharged in one big wave. The definition I would give is: **Resonance is a condensation of the air waves started by the vibrator, in the resonator near the outlet by means of reflection in the cavity.** I have another resonator and a tuning fork; the resonator has a larger opening and I can put the tuning fork directly inside the cavity. When it is about so far in I get no tone at all, but when I put it farther in or out, I get tone. There is one position where no tone is produced. The point of condensation is just inside the outlet of this resonator. Resonance is the most important thing in volume and quality of tone. (Demonstrating.) Note that I am using no more energy in one instance than I am in the other. The same blow is given to the fork, but you cannot hear it without the resonator. With this resonator this tone can be heard 900 feet in the open; not in a noisy city, but in the country. You can only hear it about three feet without a resonator. You can judge what an important factor resonance is in the matter of tone production and the question for you gentlemen to determine is whether you are using it in the manufacture of pianos. Another thing, the more effective your vibrator, the more effective your resonator cavity. The matter of the string action and the sounding board action is very important to this factor, resonance. If we haven't the right kind of air waves, then the resonance factor will not act as well as if we send the proper air waves into the resonance cavity. I don't believe you have a sounding board that will reproduce accurately wave motion from the string. To make this matter of resonance a little clearer: That fork when vibrating is sending out air waves. The second air wave will never catch up with the first, as they travel at the same rate, unless you have means of holding back the first, and the only possible way to do that is through reflection, and that is what we do in this cavity."

Paul B. Klugh: "Is this resonator made to match that fork or can it be of any size?"

Dr. F. S. Muckey: "This particular resonator will only resonate well at this pitch. This spherical resonator is a very simply shaped cavity—one of the most simple shapes. Therefore, the pitch is practically limited to this fork. The finest mechanism we have, the vocal organs, having a cavity about six inches long, about three wide and three inches high, will reinforce well four octaves. We must have a complex cavity to enforce a wide range of pitch."

Paul B. Klugh: "This is an A fork. If you place in front of that orifice a C fork, would it resound?"

Dr. F. S. Muckey: "Only a little."

Paul B. Klugh: "How does that result differ from what you would get if you struck the fork and stuck the handle on the surface of the resonator?"

Dr. F. S. Muckey: "You get a better result on a board. (Demonstrating.) Any fork you put on there would respond."

Paul B. Klugh: "In this latter case the vibration of the fork is transmitted directly to the surface of the sounding box, whereas in your example there is no conducting medium. What is the difference in those two demonstrations?"

Dr. F. S. Muckey (striking fork and resting handle on table): "This is a sounding board effect . This board is so thick and heavy you get only a little segmentation, which immediately dies out, and the fundamental is not sustained. Now if I put it on this (placing fork on spruce top of sounding box), which is much thinner, it segments in a better way to sustain the fundamental tone."

L. D. Perry: "The trumpet and other reed pipes in a pipe organ will not sound unless you have vibrators and resonators synchronized."

Dr. F. S. Muckey: "In the pipe organ the pitch is determined by the resonator. The pitch in this combination is determined by the fork, not the resonator."

L. D. Perry: "If the resonator did not correspond to the fork you would not get anything?"

F. E. Morton: "No. In other words, it is a selective resonator."

L. D. Perry: "In building pianos we cannot build a resonator for each tone of the instrument."

Dr. F. S. Muckey: "You can build a complex cavity. The vocal cavity is very complex, no larger than six inches long and three inches wide and high, and yet we can reinforce every possible pitch in a range of at least two octaves. You vary the volume, the pitch and the quality in the voice mechanism without a sounding board. In the piano we can use both sounding board and resonance effect."

U. Urquhart: "Does the tone continue from the resonator?"

Dr. F. S. Muckey: "It stops immediately."

F. E. Morton: "Perhaps he refers to the persistence in the resonator itself, which can be heard for a few seconds afterwards."

Dr. F. S. Muckey: "If I stop the fork the only continuation is the tone in the resonator after vibration is stopped. Air waves travel 1,000 feet a second, so your tone would not stand long in the resonator."

F. E. Morton: "I think Dr. Muckey has drawn a nice distinction between the driver and the driven, and in our work on sounding boards if we will substitute the word 'responsiveness' for resonance until we have defined the latter, I think the incentive to do better work in the factory will increase. With a fork set upon a sounding board, with the volume of air contained between the top, sides and bottom of a pitch identical with that of the fork, we have a combination of sounding board and resonator. I take it that the Doctor does not intend to do away with the sounding board.

"Here is an example which may interest you, of a combination of resonance and responsiveness. This is a Koenig fork and resonance case, made in 1870 or 1871. Look at the material from which this top is made. I had it cleaned so you can see the grain of the spruce. This is the material selected by one of the greatest acoustical experts for a resonance box sounding board."

Mr. Morton then sounded the Koenig fork on its resonance box and passed another fork and resonance box of the same pitch to the members, asking them to note the vibration of the second fork and also that of the top of the resonance box.

Dr. F. S. Muckey: "Touch it on the base and see if you get a sounding board effect."

F. E. Morton: "Scarcely feel any vibration in the base. You have here nothing but resonance. Here is another fork and resonator, made by Chas. F. Pleumacher about twenty-five years ago in Philadelphia, also sounding board the grain of which may be seen. The sides of this seem to be of oak veneer and the bottom is of spruce the same as top. You will note that while the top responds slightly to the Koenig fork, the fork does not respond at all."

Dr. F. S. Muckey: "Are they tuned to the same pitch?"

F. E. Morton: "This is C-256; the other A-435."

"Now, the only point which, so far as I know, is applicable to the shop, to the work bench, is the matter of responsiveness, and let me say that there are possibilities in responsiveness of which no advantage yet has been taken. In a church built of heavy timbers about seventy-five years

before, a pipe organ was placed and for the first year no disagreement arose between organ and building. But after a while a responsiveness developed resulting in the reinforcement of one of sixteen-foot pedal pipes. It first became disturbing to the organist and then, when the plaster started to fall, to others and from that time on the effect increased very rapidly. I was called in to see if I could solve the problem and found a wonderful old red pine timber running across the ceiling; that timber was three feet square and beautifully seasoned. (Any violin makers looking for a good wood will find it when that church is torn down.) When that pipe was sounded the timber vibrated. As usual, the diagosis was 99 per cent and the treatment 1 per cent, the treatment in this case consisting of changing the pitch of the timber.

"The highest efficiency in responsiveness is reached through repeated responding and the more a body responds the more responsive it becomes. People are the same way; it is what we call 'habit.' It is true of all substances—rocks, stones, trees, everything in nature. Once it has responded it becomes memory and the response will be more prompt and energetic the next time. We are not taking advantage of that principle. I don't think it would be drawing too fine a point to say that if you placed your sounding board stock where pianos were being tuned daily, you would get those boards in the habit of responding. I believe you would find a decided improvement in your stock. We all know the piano improves after it is tuned a few times. We require board which is capable of responding not only to one key, but to energy, to any frequency, and we find spruce is more satisfactory for that purpose and far more durable than any other wood used. It is possible to use cedar, certain types of fir, etc., but there are serious objections. In cedar the volatile oil evaporates and then the wood shreds easily. In spruce, properly handled, the final result is a collection of millions of little sounding boards, little diaphragms, and there is no question but that there is a certain amount of cell resonance when properly prepared. By micro-photograph we have been able to visualize the diaphragms and the result is a more responsive wood and, while minute, a certain amount of resonance."

Dr. F. S. Muckey: "Do you mean by resonance the same as I have explained?"

F. E. Morton: "Yes, as I will show you. There is a picture of this little diaphragm and the air space around it. That little sounding board has a minute chamber on either side of it. This is magnified 650,000 times. Just to what extent that enters into the function of the sounding board, I don't know whether any one has determined. But the fact remains, where a board is treated in such a manner as to rupture the diaphragm it is not as satisfactory a board." (Fig. 3.)

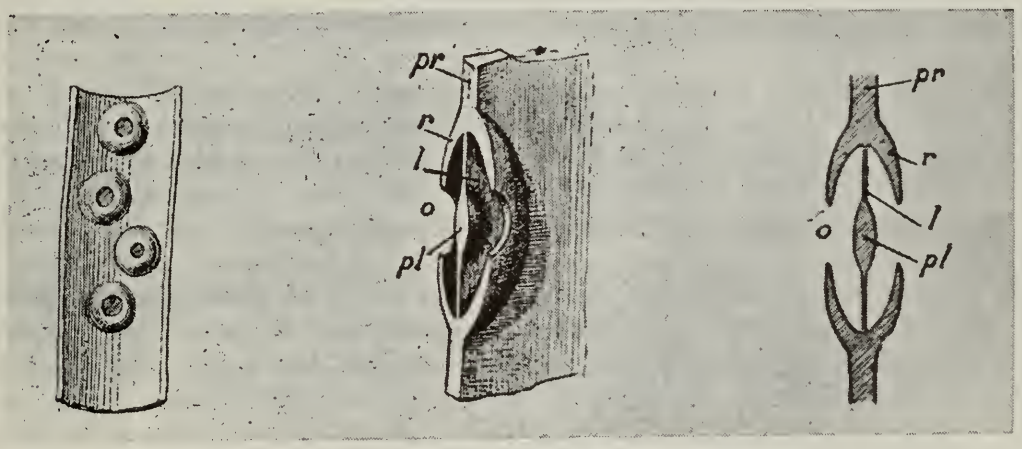


Fig. 3
The disc with the vibrating membrane in flat, perspective, and plan view. Every sound board of spruce contains millions of these resonators.

Mr. Morton then read extracts from an article which he prepared and which was published in several lumber trade journals, giving detailed instructions for the cutting, sawing and seasoning of spruce for sounding boards.

"What I want to emphasize most strongly is that the function of the sounding board is to respond to the energy conducted to it. You want the board to express the same frequencies as are given to it by the wire. As for resonance, the piano tuner goes into a home and finds an upright against the wall. He suggests they put it across the corner and they do get a little resonance

perhaps by so doing. The only resonance cavity in the piano itself worth speaking of is the space between the board and panels, a large part of which is taken up by the action, in which also is placed felt and other soft materials, thus spoiling the resonator. The question of working out, in any way, tone production by means of a resonator is wide open—an antarctic in the piano trade. I am very glad to have Dr. Muckey's experience, and the trade will be much enriched by his efforts if he is as successful as he has been in the vocal field.

"I know factories, and so do you, where the purchase of sounding board stock is purely commercial, and where boards are sent into the stock room to be used in the manufacture of pianos which would cause anyone not brought up in the piano business to give up his job. This practice is becoming less, especially among those who discriminate. We want to improve the piano tone by utilizing what we have to the fullest extent. Get your board as responsive as it is possible, but remember a vibrating body will not persist in its vibrating until the energy is reflected back and forth—kept there. The sole purpose of an agraffe is to reflect the energy of the wire back again. The sole purpose of the plate bearing is the same. To carry out that idea in the sounding board, have the edges of your board retained as rigidly as you can. In a grand piano, and to a lesser extent an upright, on the extreme treble end the temptation is great for a narrow board bearing. You should have at least one inch bearing on your board at the extreme treble and one and one-half inches the balance of the way. If it is not gripped firmly the energy is conducted into the lining or into the case, resulting in heat. In other words, you are not using the energy you have to energize the board—to make it dance.

"Speaking of the shape of the interior of a spherical resonator. The reflection of energy inside the resonator is a very interesting study to a man who plays billiards. Imagine a round billiard table having one pocket. You shoot a cue ball from a point close in front of the pocket to every point on the cushion. How many of those balls shot at the same time would arrive at the pocket entrance at the same time? This is a question of angles and the reinforcement is by addition. It does not consume a bit more oil in a lamp if you put a big reflector behind the light. Resonance requires no added energy. Those of you who have visited the Mormon Tabernacle at Salt Lake City are familiar with the usual dropping of a pin on the floor and hearing the sound of its fall in any part of the building. The Tabernacle is pretty nearly half egg-shaped and if you were to look into it very closely you would find exactly what Dr. Muckey has described as a complex resonator, and not very complex at that. If you want good results in an auditorium, avoid angles. The Tabernacle, acoustically, is good because there are no angles. Whether it was built with that idea in view or not, it brought about a wonderful reinforcement and it is not a selective resonator.

"Think of this spherical resonator combining these waves and passing them out in a smaller number of greater waves where they can be heard at a distance of nine hundred feet and then note that dissipation is as the square of the distance. The only point in selective resonators that need interest you is that there is very little dissipation. It is reinforcement by addition."

F. Pfannstiehl: "Regarding the treatment of the sounding board, what is the best medium for preservation?"

F. E. Morton: "I stated in the last meeting that, from an acoustic standpoint only, the best treatment for a piece of spruce for efficiency and for durability is linseed oil rubbed on with a cloth. As the sounding board would become dusty and dirty, especially in grand pianos, this is not a commercial possibility. Anything else that is done is a compromise. Short varnish is acoustically better than long varnish for a sounding board."

F. Pfannstiehl: "For given area of sounding board, is there a scientific way of determining the area which should be covered by the ribs?"

F. E. Morton: "What do you understand to be the function of ribbing?"

F. Pfannstiehl: "Necessary evil."

F. E. Morton: "The best definition I have heard yet.

"The rib is placed there to keep the board from caving in. When you have sufficient to hold it in the position desired, the rib has performed its full function. The bridge, however, should never end between ribs. Another function of the rib is the conduction of energy from one segment of the board to another.

"Here are three strips of spruce. Suppose on this center section I place a bridge and on each

side of it glue the other two pieces. This is common practice in sound board making. If instead I separate them so, I get as good results if they are ribbed. Glue and wood not do synchronize—do not respond in the same manner."

F. Pfannstiehl: "Is there some way of figuring out just the weight of the ribs and amount to give a certain area of sounding board?"

F. E. Morton: "Ribbing is not as the area. It is directly as the bearing, as the crowning and also as the thickness of the board. I have seen a very responsive board, very thin, low tension scale with very little ribbing. The board when drawn up had scarcely any crowning visible; down pretty nearly level. It had just bearing enough so the strings gripped the bridge pins, and the result was wonderful; it made a very responsive sounding board. A light touch on the key produced a tone equivalent in quality to a much heavier stroke on another piano. I take it that the artist wants such a responsiveness there that the slightest touch will bring a full characteristic quality of tone. You want responsiveness in your board, but very rigid retention."

Mark P. Campbell: "Have you made tests of spruce from different sections of the country? From what sections has the spruce given best results?"

F. E. Morton: "I have not found it a matter of locality, but a matter of selection. There is magnificent spruce in Idaho and Washington; fine sounding board stock, but you have not always been getting it."

Mark P. Campbell: "Do you find it a finer spruce than that found in the Adirondacks?"

F. E. Morton: "No, but if the western spruce were properly prepared and selected, the resulting stock would prove very satisfactory. They have not yet fully acquainted themselves with your needs."

Mark P. Campbell: "Do you find in Washington that the spruce is much larger timber?"

F. E. Morton: "Generally speaking, yes. But there is very fine, slow-growing spruce in the Adirondacks."

Mark P. Campbell: "Do they have slow-growing spruce in Washington?"

F. E. Morton: "On the north or west side of the hill slopes."

Mark P. Campbell: "If we don't get it, what is it used for?"

F. E. Morton: "For other commercial purposes."

Mark P. Campbell: "Just what is this so-called spruce of reddish color and soft in texture that they sometimes make boards of?"

F. E. Morton: "Here is a piece of that spruce, evidently put in as one strip of a sounding board. It is sap wood and never should have been used. Bend it up so (demonstrating), rub your finger across the grain and you will find it has roughed. That wood will not stand the compression on one side and tension on the other which is necessary if you crown your board. It is good material for split sounding boards. The distance from the ground to the first cut to be used as sounding board stock is about six feet, and it should stop before reaching the first limbs. In resawing all sap wood should be cut off.

"I want to repeat that there is lots of good spruce in the country and of that spruce a very great deal of it is good for sounding boards. It has not been delivered to you. Sounding boards have been a mixture of strips such as the sample represents—an otherwise perfectly good board with a strip of slash grain and a strip of sap wood running through it. In other words, the strips were not properly selected and matched. I think if you will give them back to your sounding board salesmen you will get better boards. In their treatment of spruce the lumbermen have improved very much in the last two years. You should check up with these people. They have the goods."

Dr. F. S. Muckey: "It seems to me the general opinion is that a good sounding board for sympathetic vibration must have a certain degree of thickness or thinness and homogenity of texture. We have the second qualification in the laminated sounding board and one with no ribs on the back. We have a board at present one-fourth inch thick in one place and, depending on the rib, three-fourths inch or an inch in another place, and it will not be as responsive as a board having the same thickness throughout. The question is whether the rib is necessary. I do not believe it is. I think it is an evil because the different partial tones, as in the phonograph, are produced by different sized segmentations of the board itself. The second from the fundamental is much larger than for the first overtone. If we in some way can get rid of the rib so the large seg-

ments will act as well as the smaller ones we will strengthen our fundamental. I think the removal of those ribs is important and I think they can be removed."

F. E. Morton: "There is one factor in sounding board construction which modifies an application of that principle, which principle is absolutely correct. That is glue. With a layer of glue between the strips the rib performs a function in conducting energy from one strip to another."

Dr. F. S. Muckey: "Cannot you perform the same function without the rib?"

F. E. Morton: "It is not unlikely that a glue may be made to overcome this. If we can get glue that will conduct well, as well as the wood, the objection to the removal of ribs is gone. The ideal board, as I have said, would be made of one piece. A homogeneous board is exactly what the bellyman means by well selected stock."

Dr. F. S. Muckey: "Can we not laminate the boards?"

F. E. Morton: "That has been done in three-ply boards with very unsatisfactory results."

Dr. F. S. Muckey: "I think we can get this by laminating if the boards are not too thick. I tested out one, but the board was too thick and it will not segment properly for fundamental and lower overtones. You must have enough resistance to hold up the pressure of the strings."

F. E. Morton: "You must get into high tension if you have too thick a board."

Dr. F. S. Muckey: "Not over one-fourth inch thick."

F. E. Morton: "As a commercial proposition in the factory, is it possible to select from the stock of shipped boards those which are wrong in principle, such as I have shown you and ship them back?"

Mark P. Campbell: "We do it."

F. E. Morton: "I think that practice, if made general, would bring the board people to your way of thinking."

W. J. Behr: "If glue between the strips in the sounding board is a non-conductor, how about the strips in the sounding board and rib?"

F. E. Morton: "You are losing efficiency by using a glue between board and ribs. I don't say it does not conduct energy, but that the form of energy is distorted. Glue is not good sounding board material."

Mark P. Campbell: "Is that because it is animal glue?"

F. E. Morton: "It is not resonant material. The value of vegetable glue has not yet been demonstrated."

Mark P. Campbell: "Any experiments been made with vegetable glue?"

F. E. Morton: "Yes, sir. But as full demonstration requires special presses and special treatment, the progress of these experiments has been slow. The glue promises well."

C. F. Hovey: "I would like to ask if you have experimented with the direction of the grain and the results obtained."

F. E. Morton: "Yes, and the grain running the same way as the bridge has proved most satisfactory."

F. Pfannstiehl: "Have sounding boards ever been made for pianos of any other material than wood that you know of?"

F. E. Morton: "Yes, of aluminum, of steel and of rock maple. Those are extremes in hardness and those boards had a selective responsiveness. A board, for instance, the key note of which was G, responded beautifully to the key of G; very much better than the spruce sounding board. It was good in all G's and fair in D. In other words, it responded to its key note and harmonics, but the others were absolutely impossible. A bass bridge made of aluminum, stiffened with four units of vanadium, was tested out on six upright pianos in which these metal bridges were installed, together with six pianos with regular wood bridges; the sustaining power of the pianos having metal bridges was much greater than those with wood, but the quality of tone was not as satisfactory. The higher partials were very dominant."

Dr. F. S. Muckey: "Are these metal boards made of the same thickness—no ribbing?"

F. E. Morton: "Uniform thickness, and no ribbing."

U. Urquhart: "I believe the Doctor here has started with a wrong assumption—that air waves come from the string. I have made a few experiments as a matter of curiosity. I am not a piano builder. I believe when the string is set in vibration and numerous segments start in the

string, a rhythmic movement of the particles composing the string results. The crest of the string stretches, while at the node it compresses, and this starts a molecular disturbance. You hear the motion of the string, which is a tone in itself. It is a molecular disturbance of the board which causes air waves we call tone.

"I made a resonator very roughly and I discovered that, taking any means of setting up a vibration like a tuning fork, string or phonograph record, I could conduct molecular disturbances into the resonator or amplifier by means of a string which had very little tension and produce that tone and carry it across the room.

"I think the old idea of sounding boards in pianos is wrong. I take a tuning fork and you can hear it and by touching the resonator you hear a tone. It is better if on something solid. As a matter of curiosity I put a fork on the handle of this umbrella—you don't hear anything. I now conduct that tone through the umbrella handle and stick to this box and you hear it plainly."

F. E. Morton: "Is not what you mean by conducted molecular disturbances in the wire fully accounted for in longitudinal vibration?"

U. Urquhart: "I am not a technical man and therefore do not know. I experimented also with a strip of sounding board material four feet long and did the same thing and got excellent results. By just touching the fork to this end of the spruce, three-quarters of an inch wide and one-quarter of an inch thick, and attaching it to the box I get good resonance. The flexing of that piece of spruce would destroy freedom of tone. I took the resonator and screwed it on maple flooring thirteen feet long and secured it solidly. If I lifted up the end of the strip of flooring, so, the weight of the material would bend it and destroy the tone. I took a piece of hard pine one foot square and got the same results. I believe if we had a quiet room we could put the tuning fork on one end of the table and resonator on the other end and get the same results."

Dr. F. S. Muckey: "If we put a string across the mouth of this resonator cavity with the same pitch without any connection and put that string into vibration, would we not get a response from the cavity?"

U. Urquhart: "Yes."

Dr. F. S. Muckey: "Did you get conduction of sound?"

U. Urquhart: "When you set the sounding board in vibration it is a different vibration than when you set a volume of air vibrating. I am not a scientist, but I took a few of these experiments to the head of a technical college and asked for the law governing this. He was unable to throw any light on the matter."

Dr. F. S. Muckey: "I don't think the air waves themselves have any effect on the sounding board. It is the vibration of the string which is conducted to the sounding board itself which amplified the air waves started by the string. You can take a log one hundred feet long and you can hear a scratch made at the other end."

Paul B. Klugh: "I don't see that Mr. Urquhart has brought out anything new. I go back to the first question I asked Dr. Muckey, one relating to the amplification of the sound through his resonator, and then I requested him to put that tuning fork upon the sounding board. In one case you transmit directly, and in the other case you have the principle first given by Dr. Muckey as the gathering of these sound waves and amplifying them. Now the mere fact that you put an umbrella between does not affect the sounding board."

Dr. F. S. Muckey: "The efficiency of the medium for transmitting the vibrations under Mr. Urquhart's demonstration will diminish according to the size, length, etc."

F. E. Morton: "The reason why the conducting member did not conduct after having been bended was that it was made elastic, which is an argument against a rubber bridge. A piece of wood or lath will only conduct as long as the pressure is directly in the line of rigidity. If you could take a piece of wood and stretch it, it would become elastic. The structure is the same in weight as before, but you have separated its molecules, making the body elastic."

Dr. F. S. Muckey: "I think Mr. Urquhart said he thought it was due to the molecular disturbance. Passing a current of electricity through a wire produces a molecular disturbance. If we hold the wire there, not physically connected, would it produce sound?"

F. E. Morton: "An electric current is of a higher rate of vibration than sound. If it were possible to hear electrical vibration it would manifest as longitudinal vibration of the medium."

U. Urquhart: "Have you gentlemen ever seen a piano without any bridge? I have seen one and played on it. It had a wonderful tone. This is another explanation of tone coming from the sounding board which came some other way. It did not come through the bridge. The plate was brought up to the bridge line. The molecular disturbance went through the plate into the board in another fashion. I do not claim I have discovered anything new. I simply believe we have been fooled in the function of the sounding board."

F. E. Morton: "If you could be shown the actual movement of a sounding board at any given point and knew the movement was transverse and rhythmic, would it alter your opinion of this theory?"

U. Urquhart: "It might."

Mr. Morton stated that he already had visualized this movement and hoped to perfect a permanent instrument for this purpose.

After an informal discussion of vibration responsiveness and resonance as applied to specific cases, the conference adjourned.

Glue

Mar. 26, 1919

F. E. Morton: "It is the general opinion of the men who use glue, the men who make glue and those making apparatus for the preparation of glue, that an understanding between the parties concerned would benefit all."

Mr. Morton then introduced L. L. Lauve of the Armour Company.

L. L. Lauve: "I am perhaps better qualified to talk about the handling rather than the manufacture of glue, as I have been interested as a salesman. The actual manufacture of glue is handed down from father to son. There is a knack in judging the raw materials from which glue is made.

"I can tell you briefly that glue is divided into bone and hide glue. The raw material of the hide glue consists of hide trimmings. When a hide is taken from a steer it is usually sent to the tanner and he trims it, because as a leather man he can trim better than the packer, leather being more valuable than glue. These trimmings consist of corners and edges; the inside of the hide also has a skin valuable for hide glue. Another source is the sinews of the animal, obtained direct from the packing house from cattle that are used as 'canners.' These raw materials are sent to the glue house from the packing house. The primary treatment is the removal of all blood and grease, and this is usually done by liming. The practice is similar to that of sugar making in skill. If you have seen sugar in the process of making you know it is put into a big kettle and the sugar maker knows, by testing, just when it is right for a strike—when the syrup will crystallize into sugar.

"The bones for glue are obtained daily from canners. The fresh meat is not boned, so it is only the canner of beef who can supply the bone stock for our business. There is a quality known as 'old bones' collected from the city, which gives a certain type of glue, dark in color. We get about 250,000 pounds of bones a day. Proper handling applies to raw materials as well as to the use of glue in your factory. These materials are dead cattle and will putrify if not handled carefully. Ours is handled daily, and we get a much higher test on the stock, and no putrefaction takes place. In going through a modern glue factory you will get very little repugnant odor. If you have odors in your factory it means inferior materials or poor management by your glue man. You are also losing money, as you are not getting the value from your glue. Whenever a batch of raw material is put in the glue kettle for manufacture, some small part of this material may begin to putrify and it will lower the test of the whole batch two or three points. If you have a kettle of glue that is getting bad and you add fresh, it is like putting a bad apple into a barrel of good apples—it spoils the whole. I find a good deal of abuse of glue because people take it for granted that they know all about it and how to handle it. In the manufacture the material is put into the vats and water is added and it is made into a very light broth with a superfluous amount of water. In order to get this liquid to such a state that it will jelly and cut in slices, the superfluous water must be removed. This evaporation is accomplished in vacuum at 120 degrees,

avoiding excess heat as far as possible, and this applies as well to your business. Superheating is a common abuse of glue and causes it to lose its adhesive and spreading values.

"I was called into a big factory one time; the odor around the factory was terrible, and the man said the salesman who sold him the glue told him to use a little citronelle to overcome the odor. This happened in a business rated AAA1 for sixty years. They were using a gasoline drum with one end cut out and a steam pipe running into it and losing about 5 cents per pound on their glue. They melted their glue, poured it into pans and made cakes and the cakes were covered with 'whiskers.' This is also a common practice among glue users. Look into your own factory and if you find drippings all over the floor and a dirty mess around the kettles, your people are handling glue wrong.

"One firm I have in mind handles 3,000 pounds of glue per day, making containers for shrapnel, waterproof containers with metal ends. They handle it in a space not larger than 15 feet square and you could eat off the floor.

"A common fault is measuring water and glue without reference to weight. In a flake glue the conditions in weight contained in standard barrels will vary on account of thickness of glue. A man is accustomed to filling a pail with glue, not taking into consideration the variation in weight. A thin-cut glue of the same grade made in one month will vary from a glue made a month previous in weight, and one pail of glue will weigh fourteen pounds, while another pail of the same grade made in a different batch will weigh seventeen pounds. If the same amount of water is used for both, the man complains he is not getting the same quality. Nine times out of ten it goes back to the measuring. You manufacturers do not give enough attention to your glue room—why put a porter in charge when it will pay you well to put a good man in your glue room?"

A. L. Verge: "There is a difference between the dry and the green glue stock. Glue stock which has been taken from the hide, if used when first taken from the hide and limed right then, makes an entirely different glue than the same stock taken dry and limed. The bone taken right from the animal makes a different glue than the same bone dried. The fresh bone makes a light green glue and the dry makes a darker colored product. For silk it is used in the green state. For strength in joining you should use a dry glue stock."

F. Von Schuckman: "My particular experience has been in selling glue. We can tell you many things, you men in the office, but we would really like to get hold of your practical man who is not governed by dollars and cents. There has been a great upheaval in glue—from the flake to the ground form. One factory I was in used only the flake form. The man in charge prepared in the course of a day, I should judge, twenty great big forty-gallon tanks of glue. I asked him how he prepared his glue and he invited me to watch his process. He put in his glue and then poured on water. There were a lot of lumps floating around on the top. I had explained that in ground glue the practice should be reversed. The ground glue should be stirred in prepared like a cereal and made without lumps. I demonstrated to the man and the proprietor by taking a lump out of his kettle and showing them the dry glue inside of this lump. He said he would change his practice. I called again at the expiration of a month, but they were making the glue the same old way, and they were using a half million pounds a year. They could have prepared that glue in one-quarter of the time. I convinced the office man, but he could not influence the practical man.

"The war has done a great deal in educating people to get the full value out of glue. I have it on good authority that one concern in the past two years has gotten twenty-five per cent more out of the glue than they ever had before because it was more expensive and they had to economize. When it was cheap, it was 'just glue' and no account was taken of the waste. But recently, with high prices obtaining, it becomes a factor, and even chemists are employed to see how much more can be gotten out of glue. The glue that cost ten and twelve cents now costs them fifty cents, and the glue must go farther.

"One big point to be taken into consideration is cleanliness of the vessels and the amount of heat applied. It is safe to say that few users look at it from that standpoint. The glue is heated and allowed to cool off and heated again. If you have an actual test to determine your grades you will find that just by the application of too much heat you have lost at least one full grade of value. When you use one grade which costs only a half cent more a pound, it does not mean

much, but when it makes a difference of eight or ten cents a pound it means a great deal. The glue is put on in the morning and the man is not ready when the glue is right and you still have the heat under the glue. When you heat glue beyond 160 degrees, or even 150 degrees, the entire day, you have lost two grades of glue in value, if not more. The installation of a modern glue kettle will save money for the manufacturer—it will pay for itself in a very short time.

"When putrefaction takes place in glue animalculae form which feed at certain degrees of heat. If you heat above the boiling point you could destroy them, but you would also destroy your glue. When there is an odor in your glue room there is something wrong. If the glue cools down and not much purtefaction has set in you will have the odor, but if you heat it up again these animalculae come back to life, so if you put fresh material in the putrefied batch you sacrifice your fresh glue. You must throw this bad glue away; it has lost its adhesive power.

"Grading of glues has been the specialty of the Peter Cooper Glue Company and it is one of the oldest concerns in the business. Most firms grade their glue along their own lines, but the best advertising our competitors give us is when a salesman says, 'This is equal to 1¼ Peter Cooper glue.' We have thirteen grades of glue, from the low bone glue up to the highest grade."

F. E. Morton: "Do you give out publicly the viscosity and crushing tests you make of this glue in the factory?"

F. Von Shuckman: "That is done in the factory. The viscosity test, as I have understood it, is allowing the glue liquor to run through an aperture like a sand glass. It takes so long at a given temperature. If it runs through more quickly, it has a lighter body. Six to one is the proper proportion for testing for viscosity; always compared on the basis of known quantity and proper temperature. After it is heated we allow it to jelly and the jelly with greatest resistance is the best."

F. E. Morton: "A very simple way, instead of depending on the touch, is to put it into a receptacle on the scales and, with a flat surface of a known diameter, note the pressure at which it breaks. I would recommend that users of glue interest themselves in the viscosity and tensile strength in the jelly if only to interest those who are working with it.

"Has any movement in the past few years been made to remove the human equation in glue manufacture?"

L. L. Lauve: "The selection of raw material is absolutely dependent upon the human equation. The chemical analysis of, say, four grades would show no difference in the ash residue, etc. You are dealing with perishable products in the making of glue, and the glue maker must be able to judge of the raw materials. When the glue is made, a hydrometer is used to determine moisture. It is a general fallacy that the hydrometer determines the strength of glue. People will take a good glue and an inferior glue and make a solution and judge the value by a hydrometer. It gives you density only; it will tell you nothing about the strength. It indicates only how much foreign matter other than water is contained in the glue. After the glue is made, your chemical laboratory can help you out. Acid is used and you must neutralize the acid. Most bone glues have a slight acid reaction. It becomes interesting in veneer work. If you had a mixture of hide and bone glue for veneer work and this bone glue was very acid, it would be rather dangerous, as it is apt to crystallize if it is there to any extent. An easy way to test for acid is to use litmus paper. If it is super-acid the litmus paper will show a red color."

F. E. Morton: "It is then too late to do anything after that test with the glue?"

L. L. Lauve: "If it is too acid it is better to reject it. Some of you are troubled with foam when spreading. A foam test is given on each boiling in the laboratory. If your glue foams there is no grease in it. It takes a very little grease to hold that down. If there is much grease it turns rancid. If your glue foams, ask your glue man to give you a glue with a very little grease in it."

Mr. Seymour Sylvester, representing Bass Bros., manufacturers of glue heaters, advocated the use of modern, up-to-date equipment for factories, stating that the investment would bring large returns. He cited one firm using twenty-four pounds of glue to seventeen pounds of water which benefited by the use of his apparatus. They are now making the same mixture with one pound of glue to three pounds of water—the installation paying for itself in six weeks. He also recommended a central source of supply in each factory, with a responsible man in charge. Mr. Sylvester

suggested a simple test for glue as follows: Put an ounce of glue in an ordinary tobacco sack; soak it in water and then let it drip over night. If it then weighs four ounces, the absorbing ratio is three to one.

Paul Bilhuber: "We use the hydrometer solely to check up on foreign matter. We always keep samples of our different glue stock for comparison. Possibly fifty per cent will run fairly uniform and the balance will vary. It is advisable to take samples from four or five barrels out of fifty. We make a water test which indicates the spreading power of the glue. There is no absolute test, only comparative. We have a basis for comparative samples as far back as 1895. These are not always used, but we do compare one season's shipment with another. There is a slight deterioration in glue after four or five years. We also use the viscosity test. It is the ability of the liquid to run out through a little glass tube with standard opening in a given period of time. We use a pipette, and while the given column of water will run out in fifteen seconds, glues, of, say, 1¼ or 1½ to 1⅜ vary from seventeen to nineteen to twenty-one seconds, timed with a stop watch. We make the jelly test with a little machine perfected by a man named Smith, called glueometer. A little tube with a film or skin over the end is put into the jelly, air pressure is put on it and the pressure necessary to break the jelly is registered by the column of water in the tube, on the scale. This is a comparative test. Viscosity and jelly tests are most accurate. Another test is by breaking the glue apart or rubbing pieces together—this for tensile strength. We tested for foam with a small egg beater. This is important in veneer work where you have blisters, as there is no glue where there is a bubble. We also test for grease. (Showing pictures.) The color will not take on grease and they show up as eyes. If you have too much grease, the glue will have no adhesive value and the strength of the glue is lowered. We have made many experiments in deterioration of glue through heating, but not necessarily through excessive heat. We do not allow our glue to go above 155. If more glue is made up than is used during the day, and the glue man keeps adding fresh glue, if glue stands around more than a day, or if it stands over night with the heat on, a deterioration of from nine per cent the first day to twelve per cent the second and thirty per cent on the third day results. Glue is very much like meat. It is fibrous and if overheated the fiber will not hold together, and the application of excessive heat destroys the fibers."

F. E. Morton: "It is analogous to fatigue in steel?"

Paul Bilhuber: "It is a fatigue strain. Even heat that is not excessive—and you would not call 155 degrees excessive—is destructive. It is advisable always to use glue that is absolutely fresh. The acid in the glue is not so important except with certain woods."

A. L. Verge: "Speaking of the use of formaldehyde: Use sulphate of zinc or carbolic acid instead of formaldehyde, as it rubberizes the product."

Paul Bilhuber: "In what particular circumstances would a piano manufacturer use any preservative in his glue?"

A. L. Verge: "Never, if he uses fresh glue all the time."

F. E. Morton: "Does not the use of a preservative indicate poor treatment of the glue?"

A. L. Verge: "Yes, it is better to do away with it than to treat it."

F. Von Schuckman: "There is a preservative added in the making of glue. Don't get gelatine confounded with glue. They are entirely different. In a broad sense, a chemical analysis of pure glue and gelatine might be the same, but no chemist is able to tell the difference in the molecular composition."

Dr. D. R. Hodgdon: "The chemist does know. He has recently found out and he can give you the chemical analysis. Mr. Hughes, secretary of the National Confectioners' Association, has had this threshed out very thoroughly. Glue is a kind of gelatine, but gelatine is not glue. The only animal that can digest glue is a goat."

L. L. Lauve: "Gelatine is really a pure food glue. It must contain no arsenic or bacteria causing typhoid fever. No ordinary glue will stand that test."

Dr. D. R. Hodgdon: "Gelatine will convert to glucose, but glue will not convert to gelatine."

L. L. Lauve: "Gelatine is made from the calf's pate."

F. E. Morton: "One matter which was touched upon was the acid and alkali in glues. This should be of interest to the manufacturer of player actions. The use of brass in conjunction with

glue induces electrolytic action and corrodes the brass. I have found the same to be true of felts and leathers. Two or three years ago the matter of felts and leathers in player actions came up when there was trouble with valves. The guide pins and springs would corrode. Most of this was traceable directly to felt, leather or glue. If glue shows an acid reaction then the copper, zinc and acid form a battery, producing electrolysis. In felts and leathers used in piano construction the reaction frequently is acid, running from .08 to .12 per cent acid. It is not a bad plan to test your felts and leathers as well as glue for acid reaction for player valve work.

"The warning of Mr. Bilhuber not to subject glue to too great heat, nor to a normal heat for a protracted period is reasonable. The result is accounted for as in the case of metals—fatigue caused by a continuous vibration at a rate higher than normal. Continuous vibration is the cause of fatigue. The moral is very obvious—don't make up more glue than you can use in a day. Some very successful woodworkers claim it is very profitable to soak glue over night in cold water for use the next day, and the quality of their work, if attributable to that, would make it seem a very excellent practice. Never put glue in hot water under any circumstances. In one piano factory for a year they have put the glue to soak in cold water every night, and they do not seem to find it difficult to determine the amount needed for a day's use. In this way the efficiency of the glue is maintained. The glue that is furnished by standard glue manufacturers is good, it is excellent. They do their work very much better than those who handle glue in the factories. My sympathy is with the glue manufacturer. The tradition is what stands in the way. When the piano manufacturers get away from tradition and act upon reasoning and understanding they will turn out more and better work.

"Considering the composition and decomposition of glue, would not the conditions described as obtaining in some factories of floor drippings and glue-pot overflow be a menace to the health of the men working in the same room?"

Dr. F. S. Muckey: "It certainly would."

F. E. Morton: "The very fact that disease-producing bacteria are present makes it as objectionable as any other kind of filth. It would be a good idea to beat the health authorities to this discovery. In making the workroom sanitary, glue and money will be saved."

F. Pfannstiehl: "How is the adhesive quality affected in joints when put in the dry kiln as contrasted with outside drying? Does shortening the time of operation affect the adhesive quality?"

Paul Bilhuber: "We have experimented with test samples on joint work. Veneer cannot be subjected to strain. We find the strength is not jeopardized by putting this work in the kiln. But we have found it advisable to give it an initial air drying—veneer work about ten days, a few weeks is even better; minimum time six days for joint work. We take it easy and never subject glue to any strain we can avoid. A kiln with the proper moisture does not deteriorate the work."

L. D. Perry: "What are the relative merits of flake and ground? I think the ground much superior. You can get the water to it better and have less chance for trouble."

F. E. Morton: "My understanding is that the glue is ground to facilitate blending."

L. L. Lauve: "If you are going to make a blend it is impossible to blend two flake glues. It is rare to find two different boilings of glue of the same grade. The flakes are not of the same size or the same thickness. If we made the mixture of two flake glues, mixing them thoroughly, the jogging of the truck would shake the heavier flakes to the bottom. If you are going to blend, use a granulated."

F. E. Morton: "Is there any difference at all in the respective values of flake and ground glue?"

L. L. Lauve: "Some maintain there is. It has not been shown. In a sandpaper factory which we have we use a lot of our glue. Our man has some traditions on the flake and ground glue. He has never been able to demonstrate the difference. He makes the sandpaper satisfactorily and he buys the flake glue."

L. D. Perry: "About fifteen years ago we were using the flake glue. I looked after it for a while and I got tired of it and we have used ground glue for at least ten years and nothing else. We get a very even grade of glue and we can make it in an hour's time.

"In reference to heat, you can add more water if you do not use so much heat. More water

is necessary than most people believe, because you must get it into the pores of the wood. In veneering we find we can save 25 per cent in glue by adding more water and using cauls barely warm to the hand. It flows out easier when lots of water is in it."

S. D. Taylor: "Mr. Morton very kindly invited me to attend this meeting and I gladly accepted the invitation. The majority of you, possibly all of you, know something about vegetable glue. No doubt many of you are familiar with the use of it. It is made from starch. Many of the rules in the manufacture of animal glue apply to the manufacture of vegetable glue. The first thing is to select the proper kind of starch to make vegetable glue. We test all of our raw material; we give it a viscosity test and after we have the proper mixture it is put through quite a lengthy process; the material passes through a series of tanks and then through a series of dryers before it is ready for shipment. As each batch of glue comes through our factory we make viscosity and strength tests of the finished glue. We use the pulling test entirely. We take maple blocks about one inch square, glue them up and pull them apart with a testing machine which registers the strength they will stand. I am glad to state that in a great big majority of the blocks we pull apart the wood gives way first. Our average test on a pull strength on one-inch maple blocks runs from, I should say, 850 to 1,200 pounds per square inch.

"No doubt some of you know that in the making of high-grade veneer work we like to use 2⅛ parts of water to one of glue, used in conjunction with a solvent of caustic soda. Put so many pounds of water and so many pounds of dry glue into your kettle. Add a certain percentage of solvent, about three pounds of solvent to one hundred of glue. After it is thoroughly dissolved, turn on the steam and apply the heat up to about 150 degrees and when the mixture is converted to a nice amber color and transparent, the conversion is completed. We then cool it and when it is quite cool it is ready for use. We can also prepare this cold. We can cook it with the solvent alone, but that mixture cannot be used on all kinds of work. For some lines of veneer doors, where heavy face veneer is used, we can prepare it without the use of heat at all. The stain occasioned depends upon the amount of solvent. If the veneer used is of a proper grade, stains very seldom will appear with that amount of solvent. If you increase the solvent, stains might show."

F. E. Morton: "Can this be used for joint work?"

S. D. Taylor: "Some people are using it for joint work every day. I think before taking up the use of glue there are other points which need to be considered—the proper preparation of the stock you are going to glue; the proper moisture contained, and whether it is in the right condition as to dryness. In the making of piano tops or ends, where a thick core is used, it is necessary that it be machined properly. I hardly suppose you will admit that your planers get off, but I have seen them with one side thinner. You may have a loose edge and you wonder what caused it. In making five-ply work, use the proper kind of crossband. I don't think I can agree with a good many in the use of very thin crossbands. I don't see where it gives the desired results. I know lots of it is used and I don't mean to say my opinion is authority, but I believe more manufacturers, every day, are coming to the use of a thicker crossband."

F. E. Morton: "In the use of vegetable glue in the factory is it necessary to have special apparatus?"

S. D. Taylor: "Yes, sir. We make our own equipment. There is other equipment made that will handle the vegetable glue, but we feel our equipment handles it better because it is constructed specially for vegetable glue, while the other equipment is not."

F. E. Morton: "Is vegetable glue waterproof?"

S. D. Taylor: "No, sir. It is more resistant to moisture in the air, but I don't believe that it would stand any better than animal glue if subjected to water. In some climatic conditions the vegetable glue stands up better than the animal glue; at least some of our customers have told us so."

Dr. F. S. Muckey: "What is the comparative cost?"

S. D. Taylor: "It is hard at the present time to give a comparative cost, on account of unusual conditions forcing prices up. In normal times we were able to sell vegetable glue for eight and eight and a half cents where a good grade of animal glue sold from ten to thirteen cents."

F. E. Morton: "Is material from which vegetable glue is made likely to advance in price with increased use, or is it a common product?"

S. D. Taylor: "I hardly think so. So many unusual things have happened, it is pretty hard to predict what will come up next, but I cannot see where there is any cause for it. We use Cassava beet mostly. In the past year, due to our Government restricting the importation of it, we used something else, but we are now back to our old practice of Cassava beet."

A. L. Verge: "Is any deterioration caused by caustic soda after a joint has been glued up?"

S. D. Taylor: "We have not found any place yet where we can say it has. Our glue has only been on the market about eleven years. We have different samples at our factory made at the time Mr. Perkins was first experimenting."

A. L. Verge: "Would they split in the wood or in the glue?"

S. D. Taylor: "It would depend on the texture of the wood. The joint on those samples shows up as strong today as the day they were made."

A. L. Verge: "The caustic soda does not deteriorate the glue?"

S. D. Taylor: "I cannot go back of the eleven years we have been in the business."

Paul Bilhuber: "Is there a physical test the manufacturer can make to insure the quality being kept up? That we may know that we are getting what we specified?"

S. D. Taylor: "My way of testing any kind of glue is by gluing two pieces of wood together. There is no doubt that you can get certain knowledge of animal glue by making laboratory tests, but from the experience I have had in the glue business, if I were a user of glue today I would want to glue two pieces of wood. I don't know that there is a laboratory test."

H. W. Bradner: "How long do you have to leave that under clamp?"

S. D. Taylor: "Some using it for joint work leave it under pressure two hours and machine it the next day."

H. W. Bradner: "Don't you get a stain from vegetable glue on thin oak veneer?"

S. D. Taylor: "I have seen that tried and the caustic soda on oak has a tendency to make a greenish kind of a line."

H. W. Bradner: "How do you spread that glue on a joint? Do you brush it?"

S. D. Taylor: "It is too heavy to brush. We make a spreader. Some spreaders take as many as four boards at a time."

H. W. Bradner: "What footage do you get on your veneer work?"

S. D. Taylor: "With a 2⅛ to 1 mixture, forty-five to fifty to the pound."

H. W. Bradner: "The Singer Sewing Machine Company get about sixty. They have some 86,000 feet coming through their stock room daily."

Dr. D. R. Hodgdon: "Will protozoa live in this vegetable glue as it does in the animal glue?"

S. D. Taylor: "I don't know that I could tell you that. I am not familiar enough with the medical part of it."

L. D. Perry: "Is this glue absolutely sweet and clean all the time?"

S. D. Taylor: "I have seen our glue which has stood three weeks and was then used up. It is odorless; however, if you get quite close to it you can detect a little caustic odor, but nothing objectionable. The workmen like to handle it pretty well."

F. Pfannstiehl: "We had trouble with veneer work at certain seasons of the year. We started some years ago with vegetable glue and sent out a number of pianos to the sea coast, from Long Island to the Gulf. We got reports every three months on these pianos. We still get reports on those original shipments, and they are giving excellent satisfaction."

S. D. Taylor: "We installed an equipment for the Hobart M. Cable Company and glued up a great many cases for testing purposes. They shipped those cases out to all parts of the United States and kept track of them. It was at least a year after that before they started the use of our glue. The way those cases stood up convinced them it could be used for piano work. I was up against a stone wall in trying to sell the piano man new glue. We let the piano trade alone for quite a while."

Dr. F. S. Muckey: "Are they beginning to use it now?"

S. D. Taylor: "Quite a few, and I think the majority of them will say it has given satisfaction."

H. W. Bradner: "Absolutely."

F. E. Morton: "The men report satisfactory results on the use of vegetable glue in the Hobart M. Cable Company."

F. Pfannstiehl: "They make their own piano back and use vegetable glue exclusively, and that has the greatest glue strain of anything in the piano."

F. E. Morton: "In the report of the Piano Technicians in Chicago, the experience of Mr. Fishbaugh, superintendent of that factory, is decidedly interesting."

A. T. Strauch, Jr.: "Any tests being made in gluing felts or cloth?"

S. D. Taylor: "I think the caustic soda would attack the felt. I think the use of vegetable glue can be applied to a lot of things that it is not used for at the present time. It is still in its infancy as far as development is concerned. Three or four of our customers are using it in fiber furniture."

Dr. F. S. Muckey: "Could piano men use it to glue ribs?"

F. E. Morton: "It has been used, but it is a little early to tell the effect of it. The real result would show in vibration."

H. W. Bradner: "After a board is glued with Perkins' glue, how much water do you take out?"

S. D. Taylor: "Before the stock is machined at all I would say it was to be brought down to the same moisture content that it had before it was glued. Of course, as to whether you could do that and hold it there would depend upon the amount of humidity in the factory. The stock will take on that moisture."

H. W. Bradner: "The reason I asked is that some people will only take out 50 per cent. I maintain it should come out to at least 70 per cent."

S. D. Taylor: "I would not say that I think it would be safe to machine stock with 50 per cent of moisture where you work to a close measurement."

H. W. Bradner: "What is your experience on warping veneer with animal glue and vegetable?"

S. D. Taylor: "I don't think a panel made with vegetable glue will warp as quickly as with animal glue. I do not say the vegetable glue will not warp at all because a good deal depends on the wood. You make a three-ply panel and the back veneer runs straight, face veneer curves out to the side; that is likely to warp. It is the wood, not the glue. Vegetable glue does not draw as it dries, therefore I think a straighter panel can be made than with animal glue. Vegetable glue requires more uniform pressure than animal glue. Animal glue warps more."

Mr. Morton then read portions of a letter from Mr. H. H. Arnold, of Bush & Gerts, relating to their experience with casein glue.

Mr. Morton then said:

"It seems to me there need be no unknown quantities in vegetable or casein glue. I am firmly of the conviction that the reason there is any mystery in anyone's mind is because the man who uses the glue has not been sufficiently interested in the proposition. It is true in every line, and I honestly think the answer to the glue question in the piano trade will come when the man at the glue kettle is interested in glue. It is up to the superintendent and foreman to interest him in the proposition. Interest is the basis of all efficiency. We can compel any maker of piano supplies to deliver the goods we want only after we have learned intelligently to specify those materials, but we cannot do this until every man has a knowledge of conditions. It is making a constant of every variable that must take our attention in this and other equations."

Felt

April 2, 1919

The conference was called to order by the chairman, Frank E. Morton, who stated that the aim of the members should be to specify their needs in substance and terms intelligible alike to all having to do with the execution of their orders. He called attention to the vast army of workmen not on the factory pay roll as such, but whose debits and credits were entered on the books as "material," and the difficulties encountered in issuing intelligible orders to these workmen, or in recognizing a faithful response thereto. He continued:

"Nearly every product which goes into a piano represents the highest refinement of the raw material. Piano wire is the highest refinement of steel. You use the choicest varnishes; piano hammer felt is the highest refinement to which wool can be brought. This vast army of workmen

is producing these things, but you are unable to tell them exactly what you want. It is through such conferences as these that an understanding may be obtained.

"This industry shall be Americanized. Pianos going from this country shall be American pianos and not merely an assembly of foreign products. Everyone manufacturing these supplies must use every means possible to bring the standard up, not only to equal but to excel that produced in any other country."

Mr. Morton then introduced Mr. W. E. Terry, New York manager of the American Felt Company, requesting an accounting for the opportunities of the past two years.

W. E. Terry: "In view of the fact that there are others from my company better qualified to give you this information, I will defer to them. I might say in a general way that our product, unquestionably, has been brought up to higher standards. We are using the finest wool, and our method of manufacture is more painstaking than ever. We find we are getting the finest products up to this time."

J. T. Lawless: "Perhaps you want the story of how felt is made. It is generally accepted that a shorter wool than that used for any of the clothing wool has to be used. The American wools best for hammer felts are obtained from California and Texas. They seem to have more resiliency. The wool is prepared by scouring, and there still is necessity for removing the specks caused by tar, which has to be done by hand. As yet there is no chemical process that will eliminate the tar without injury to the fiber. The wool is carded in the usual way with cards similar to clothing cards. The hardening is an important factor; fulling is perhaps the most important process of all. The fulling is the knitting of the fiber and therefore more important than in any other product. The finishing is similar to the finishing of other felts, except that it is quite essential that no artificial firmness be given it, as by pressing. The 'setting up' of the felt is done according to specifications. Orders come to the felt mill with particular specifications, and the felt is laid up. Each sheet is made according to the particular requirements of the respective user."

F. E. Morton: "You have specifications from your users in the mill?"

J. T. Lawless: "We are supplied with a measure or taper stick."

F. E. Morton: "Aside from the taper of the felt, are degrees of softness and hardness specified?"

J. T. Lawless: "Some like a firm bass."

F. E. Morton: "The degree of hardness and softness in the various sections rests with you?"

J. T. Lawless: "Yes, I would say that."

Paul Bilhuber: "I would like to ask how the carding is done. We have recently had trouble which we trace to the carding machine. We have found broken bits of wire in our felt."

J. T. Lawless: "A carder is a machine made with a wooden cylinder 48 inches in diameter, and about as wide, clothed with wire. It is quite like a curry comb. These wires are set loose in canvas or in leather. Contacting this cylinder are small rolls covered with wire, and the stock feeds on the cylinders, and each of these small rolls picks up the lumps and lets the fiber that is straight pass on. A little comb combs it off. If a card gets rusty, the wire breaks off. The fiber coming from the card is like a thin film or kind of a web. It is hard to understand how wire can stay in it, but occasionally it does."

Paul Bilhuber: "Can you remove them?"

J. T. Lawless: "If the 'clothing' starts to break, it is a case of reclothing the card."

Paul Bilhuber: "We find it in piano hammer felt. Is there any way of removing the wire from the material?"

J. T. Lawless: "It can be picked out. If near the surface, there will be a rust spot which will indicate the presence of wire."

F. E. Morton: "After it has passed the card, could it be passed over a magnet?"

J. T. Lawless: "It does not happen often enough for that, if proper attention is given to the clothing of the machine."

F. E. Morton: "Do you use Australian wool as a blend?"

J. T. Lawless: "We have used it."

F. E. Morton: "Have hammer felt makers, either here or anywhere else, used other than American and Australian wools?"

J. T. Lawless: "The Cape wool. It is softer than the Texas or California native wools."

F. E. Morton: "Doubtless you have heard it stated that the country in which sheep grow and the care given them influence the quality of wool. Has anything of that nature come to your notice that is reasonable?"

J. T. Lawless: "The coarse wools used for carpets come principally from China and India."

F. E. Morton: "Is that a different breed of sheep?"

J. T. Lawless: "Yes, it is; but other sheep grown in that country would have wool of like nature. Wool from China is more nearly like hair."

F. E. Morton: "Is there any wool market open to any other country which is not open to the buyer of the United States on the same basis, in normal times?"

J. T. Lawless: "I think not. I don't know of any, Mr. Morton."

C. Arthur Brown: "What is the typical characteristic of the individual fiber that is best adapted for making felt?"

J. T. Lawless: "A fiber of a staple, perhaps 1½ inches in length, crinkly, a fine fiber and alive."

C. Arthur Brown: "The crinkly feature is a very important factor?"

J. T. Lawless: "Yes."

F. E. Morton: "Is it due to the fact it is crinkly or because the crinkly condition indicates life in the fiber?"

J. T. Lawless: "I think it is because the crinkly condition indicates live fiber. This, in my judgment, is brought about to some extent by the scales on the fiber."

G. M. Newcomer: "Is the tensile strength of the fiber indicative of its quality?"

J. T. Lawless: "Yes, but fiber that is sufficiently strong can be spoiled by improper treatment."

C. Arthur Brown: "Is there any notable difference in the serrations on a good felting fiber and a non-felting fiber and, if so, what is that difference?"

J. T. Lawless: "A fiber with the greater number of serrations to the inch is supposed to be and is generally accepted as a better felting fiber. Wools without many serrations, however, will felt."

C. Arthur Brown: "Will they make as firm a felt?"

J. T. Lawless: "Yes."

C. Arthur Brown: "Wherein lies the difference for piano use?"

J. T. Lawless: "I was not speaking with regard to piano hammers. They will felt in a hard way."

Paul Bilhuber: "What is the meaning of the term 'alive'?"

J. T. Lawless: "The elasticity of the wool and the crinkly feature indicating the life of the sheep."

E. F. Bacon: "What is 'pulled' wool?"

J. T. Lawless: "Pulled wool is that taken from the pelt after it is removed from the sheep. Serrations or scales close as the sheep dies. Some authorities say a pulled wool will felt as well or better than a fleeced wool, but it is not so."

C. F. Hovey: "Is the same length of staple used all through the sheet?"

J. T. Lawless: "The same staple."

F. Pfannstiehl: "Is wool used from all parts of the sheep?"

J. T. Lawless: "Certain parts only. The wool is sorted and different parts are graded."

F. Pfannstiehl: "From what part of the sheep do they get best quality for piano purposes?"

J. T. Lawless: "I cannot really say."

F. E. Morton: "That is the wool sorter's job. It is matter of 'touch.'"

J. T. Lawless: "For the most part, the wool from the flanks will be coarse."

F. E. Morton: "That wool really all comes in one bag and is sorted?"

J. T. Lawless: "Well, a fleece is usually tied up by itself, but handled in such a way that it is pretty well mixed."

F. E. Morton: "The sorting is a matter of personal judgment?"

J. T. Lawless: "Yes."

F. Pfannstiehl: "I should think, if they used the wool from certain parts of the body, that it

would vary in springiness and wearing qualities. Take parts of the sheep which never come in contact with anything, that is, protected, and the part coming in contact with stone, fences, etc., would be tougher—have more or less resiliency."

F. E. Morton: "Piano hammer felt is a blend of wools, is it not?"

J. T. Lawless: "Yes."

Paul Bilhuber: "What is the most desirable characteristic of water used for felt; what is the best water?"

J. T. Lawless: "In fulling, soap is used; soap, heat and water liven the fiber. It opens the serrations and helps join the fiber. As far as water is concerned, any water that is neutral or can be made neutral will give the proper agent to the fulling."

Paul Bilhuber: "What do you mean by neutral?"

J. T. Lawless: "Water that will not precipitate."

C. Arthur Brown: "Where do you find such water?"

J. T. Lawless: "We make our felt in Connecticut. We have a river there without pollution, and we have the only mill on the river. It is water that is reasonably soft."

C. Arthur Brown: "Any measure of softness?"

J. T. Lawless: "We had analyses made of the water, but I cannot tell you offhand what they are."

C. Arthur Brown: "I might answer your question by saying that I don't think there is any water anywhere on earth that cannot be duplicated, with the possible exception of some radio impregnated waters, in this country. Less than two weeks ago I found a water absolutely neutral —a surface water—no mineral salts, no alkali, no acidity. It is the only one I know of that comes up to that standard. That water is found just north of Mobile, Alabama. In some sections of the South they get artesian water which is not only neutral but of negative hardness; containing just a little bit of soda which turns it the other way and makes it softer than a neutral water."

F. E. Morton: "Take any mineral content of salts of lime and magnesia in comparison with pure water, H_2O, can you give us a statement as to the saving in soap in the felting operation?"

C. Arthur Brown: "I think that was gone into several years ago at one of the mills and they saved better than two-thirds of the soap, about 70 per cent. As has been stated before, the felting qualities of the wool depend largely upon its crinkliness and number of serrations. Where a water containing lime and magnesia is used after the fulling, there is deposited on each fiber a thin coating of lime and magnesia. That has a tendency to even up the wool fiber; to cover over these serrations. If you will take those fibers and section them with a very fine microtone and put them under the microscope, you will find that between the serrations there is a greater tendency for the lime and magnesia salts to accumulate, partially eliminating the effect of the serrations. The experiments made a few years ago seem to indicate that that was disastrous to the wool. It had a tendency to deteriorate its resiliency, to load it up. The more load, the less resiliency. This is logical from every scientific viewpoint we can get of the matter. We have before us an instrument tonight that we will hear about later, that is intended to give certain data as to resiliency and hardness of felts. I rather think that the results obtained by this instrument can be very nicely supplemented by chemical analysis of the ash, and taken in conjunction with the data from the resiliometer will give you a better basis for your specifications than we have yet obtained."

A. T. Strauch, Jr.: "Is there any particular advantage in bleaching the wool?"

J. T. Lawless: "I don't know that I am prepared to answer that. There is such a difference of opinion."

C. Arthur Brown: "There is a material difference in the several methods of bleaching, is there not?"

J. T. Lawless: "Yes, there is a sulphur bleach; a sun bleach; a peroxide bleach and a sulphuric acid bleach which is really not a bleach at all.

C. Arthur Brown: "All of those would tend, at least the sulphur, to put mineral matter in the wool?"

J. T. Lawless: "I should suppose so and the sulphuric bleach leaves the felt with a harsher feeling than the other bleaches."

A. T. Strauch: "Why is the wool bleached?"

J. T. Lawless: "Ours is not."

Vincent Vilim: "What causes water marks in the felt? It is a center stain and cannot be seen on the surface but shows when cut and is of a greenish color."

J. T. Lawless: "It might be that the soap in the fulling is not thoroughly washed out. If not thoroughly washed out it is forced to the center and lodges there."

Paul Bilhuber: "Are hammer felts ever sized?"

J. T. Lawless: "I have heard of it being done but have never seen it."

Paul Bilhuber: "Is it beneficial?"

J. T. Lawless: "It is detrimental."

Paul Bilhuber: "Why is it done—is it to increase the weight of the felt?"

J. T. Lawless: "To make it harder."

Paul Bilhuber: "Will the addition of any size or foreign material aid the elasticity of felt?"

J. T. Lawless: "It is a detriment—same as pressing—an artificial stiffening, and should not be put in as far as resiliency is concerned. Sometimes the treble end is covered with sizing material; not on top but in contact with the molding."

Geo. Lisk: "Would you go so far as to say that it would injure instead of benefit?"

J. T. Lawless: "I don't know of any chemical that would help it."

C. Arthur Brown: "My opinion is that anything of an inorganic nature must of necessity be very injurious. I don't know of anything of an organic nature other than wool that can possibly be beneficial. The wool itself contains certain mineral matter, not as dirt, but as an inherent part of the wool; that is, matter which has been abstracted from the food of the animal and by its life processes carried into the wool. There is a doubt, but I don't believe a very reasonable one, that that mineral matter is anything more than carried. I think it is not, itself, alive. The fibre is probably, as Mr. Morton and I arrived at it, of a higher rate of vibration than the mineral matter. I believe that (this is theory only, so far) by means of suitable solvents and following with microscopic examination you can differentiate between the mineral matter that has been carried into the wool in its growth and that which is found on the outside of the wool as a result of rinsing, or washing out of the fulling matter. I think it would be quite possible to determine whether that matter was an inert substance put into the wool in the course of manufacture or whether it was mineral matter in the wool of itself, natural or unnatural."

Paul Bilhuber: "Has anything been tried to reduce that native mineral in the wool?"

C. Arthur Brown: "I think not. I am afraid the results would be injurious rather than beneficial. I think it would be possible, however, to keep lots of mineral out of the felt that now goes into it."

F. E. Morton: "Let us go back to the discussion on wound strings. The wound string is not as resilient as the core wire. Added weight reduces the resiliency. Take a single fibre of wool, load it with salts of magnesia and lime, and, treating it as a wire, figure its resiliency. It has too much weight for length. There is no doubt in my mind that the fault which has been found with certain hammer felts could largely be attributed to that cause. I recall a number of years ago a very cheap hammer felt and by some used for commercial products. I have seen new hammers put on those pianos, a key struck and the lime and magnesia dust would fly from the hammer. If there was ever any resiliency in those hammers it never was discovered. The time it took the hammer to get away from the wire showed its quality. That is an extreme case, and I have not seen it for a number of years. But is it a matter of degree or total elimination? I think it is worth while to determine that. If it is true, there still remains something to be done to make American felt what it should be. It is true that the mixture of organic and inorganic is detrimental to the organic. There is in all matter a vibration natural to itself. The rate of vibration of the inorganic is low; that of vegetable higher; that of animal, still higher. The process of organization requires energy; in the case of the animal, food; in the vegetable kingdom, nourishment from soil, and this added energy expresses as a higher frequency of vibration. It is common knowledge that a mixture of wool and cotton is undesirable. The vibration rate of the wool is greater than that of cotton and therefore the cotton wears out the wool. The mixture is not as durable as either wool or cotton. The same is true of every product. In the automobile business alloys for points of bearing and contact have been a problem. One metal bearing on another of a different rate of vibration reduces the durability of both. The difference in the rate of vibration of inorganic

elements is less than that between organic and inorganic. The rate of wool fiber with inorganic matter is lower because of its presence, and that of the inorganic is higher because of its contiguity to organized matter. Whether from a vibration viewpoint or general observation of textile fabrics, it all comes to the same thing. The ideal material is live, active wool that is all organic.

"Progress in the past five years in felt making has been tremendous and I am not prepared to say today that any country in the world can make better felt than is made in America. If it can be done once or twice or three times, it can be done continuously. The industry must have your active interest and support and the resultant product your commendation.

"As to the making of felt into hammers—I would like to hear from those making hammers."

Paul Bilhuber: "We are not custom hammer makers, but we have made some. We have sought the best materials on the market. We have all steel equipment for that reason. The better the hammer, the less work there is for the tone regulator. There are lots of ways to make hammers. Some makers reinforce their hammers. Our reinforced hammers are not absolutely waterproof but moisture resistant, made so by our process of introducing a chemical which rubberizes the felt and makes it impervious to water. It is much like the action of formaldehyde in glue as mentioned at the last meeting. We use a gelatine in conjunction with a chemical producing a rubberlike re-inforcement."

A. T. Strauch, Jr.: "I am not qualified to talk on hammers, as I have not had much experience in that line yet. I am as yet just breaking into the business and what I know is just from what I have observed. Frequently, when I approach piano men in regard to the purchase of hammers, they take a hammer, look at it and say, 'That looks like a small hammer' (comparing with some other hammer), or, 'This has more felt on it', and invariably these hammers they show me have more felt on the sides and about the same amount of felt on top, and their hammers will have larger molding. The important part is the felt on the top of the hammer. The molding is there just to hold the hammer firmly and allow the hammer felt to be stretched over it. The molding we use is only large enough to bear the pressure. We have tried to find a glue which is waterproof. We have an extensive repair business. The hammers are sent in to be reglued because moisture has loosened the hammer felt. We wanted to make some experiments with casein. We tried it on some other action parts and found that the glue did not soak into the felt, but just caught the nap."

F. E. Morton: "The casein glue does not rise?"

A. T. Strauch, Jr.: "No. The important part is stretching the felt over the molding. It pulls when the pressure is put on there and helps to increase the tension and unless the glue soaks into the felt sufficiently, you will not get a right tension on the hammer."

F. E. Morton: "What material do you use for your hammer molds?"

A. T. Strauch, Jr.: "The caul is partly wood and partly metal."

F. E. Morton: "Which comes in contact with the hammer?"

A. T. Strauch, Jr.: "Around the sides it is metal and on the tip it is wood."

Vincent Vilim: "I am going to give you a line on top felt only. Hammer making depends greatly on felt cutting. I am probably the only man in the United States that handles all kinds of felts. I find that by using all kinds of felts I have found the secret of cutting. Felt with a back on will not make a good hammer. If you want good results and resiliency the felt must be cut to a point. A stumpy piece of felt that is high will double up when forced into the mold."

F. E. Morton: "If you could specify in such a manner that the maker of felt would give you exactly what you want, would you adopt such a method or device?"

Vincent Vilim: "I have thousands of sheets of felt and I have to pick them out and give them to the manufacturer who wants that sort of a hammer."

F. E. Morton: "Assuming you could specify to the felt makers in the terms meaning the same to you both and did not have to sort over and cut, would it not reduce your costs?"

Vincent Vilim: "Surely it would save money if any specifications could be given in such a manner that it could be checked up."

F. E. Morton: "Referring to these softer felts, if you had an instrument, for instance, by which you could test it out in an easy way, would you use and depend upon it?"

Vincent Vilim: "I would want to cut a half dozen anyway."

F. E. Morton: "But if the instrument was correct, you would not have to cut to test."

Vincent Vilim: "I think I would keep on doing it."

F. Pfannstiehl: "Is there any method known whereby the hammer maker can give specifications to the felt maker so we can get uniformity in hammers?"

F. E. Morton: "I think if there is none now there will be before we get through."

W. C. Hepperla: "How is American felt compared with foreign? Is there as much uniformity in the American hammer made today as in the imported?"

Vincent Vilim: "The product of the American Felt Company is better. It is as good as any imported felt we have ever had, especially during the last two years."

E. H. Allen: "The manufacturer and the felt maker have not gotten together because the requirements of the various piano men are so different. The piano hammer coverer stands between the felt manufacturer and the piano man. He has to get the best felt he can from felt manufacturers; with it he tries to meet the particular requirement of each piano man. One piano man wants a hammer with a very soft bass; another a firm bass; one will spend a lot of time on his hammers and another doesn't want to give that much time. Much depends on the way the felt is handled by the hammer coverer. He cannot take any kind of felt and get good results. He should have the proper felt in the first place. Probably the quality of the felt as a whole has more to do with results than what the hammer coverer may do to the felt. We would like to feel we are an important factor, but I do not believe any hammer coverer can take poor felt and make a hammer which will give good tone results. We can take a piece of felt that is not what it ought to be and tinker with it and get fair results. The hammer coverer can take a mighty good piece of hammer felt and in his operation of covering the hammer, spoil it. The piano man can take a fine set of hammers and his tone regulator can very easily spoil them if he doesn't handle them right. To illustrate, one piano concern that we made hammers for for a number of years made no complaints. Suddenly a complaint came that our hammers were too hard in the bass; couldn't do anything with them. We had to change our specifications, even going back to the felt manufacturer. We found that the old tone regulator had gotten drunk and had been fired, and the new man wanted something entirely different.

"The American Felt Company has no suggestions to force on the piano man as to the making of hammers. It is purely custom business. We try to find out what each man wants and the result he wants to obtain. The results we have to obtain depend not only on the felt itself but also upon its handling. As Mr. Vilim stated, even the cutting has a great deal to do with it. I think Mr. Vilim is right, you cannot force down into the mold much more felt than is directly under the point of your molding. All other felt will bulge out and go to the side. One gentleman has spoken of the size of the molding. The place for the hammer felt is on top. On the other hand, the piano man likes to give the impression he is using a large, heavy hammer while he is only using a light weight felt. If he wishes to make his hammer appear to be 14 pounds, he says to the hammer man, make it so and so. A heavy looking hammer can be made with a comparatively light felt. If he wants a better quality of hammer he can get that. It depends on what the piano man wants and what he is willing to pay. We welcome any suggestions from the piano man which will improve our product. We feel that our hammer felts manufactured in America are very much better than they were a year or two ago. We have improved greatly during the war and the American made felt today is probably better in every way than it ever was before and I certainly feel that it at least compares favorably with any foreign make that ever was used to any extent in this country."

W. E. Rammelkamp: "Is there any advantage in using hammers without underfelt? We have many calls from abroad for hammers without any underfelt."

F. E. Morton: "If you will just postpone that question a few minutes,* I think we will give you some real data.

Paul B. Klugh: "Referring to the pathetic case of the tone regulator that Mr. Allen spoke of who was discharged, would it be out of place to suggest that after July 1st there will be no more trouble of that nature?"

---

*Note: Tests with resiliometer after the session showed a higher resiliency in hammers without underfelt.

E. H. Allen: "I would merely like to say that while that may remove that particular trouble of the hammer coverer, I am not at all sure it is going to be worth while."

F. E. Morton: "Perhaps the price of equipment may be deemed excessive.

"Mr. Allen brought out a point which is vital—the difference in actual requirements. There is a point which has been overlooked, to some extent by the trade. I think the hammer makers all will agree that one vital point is the resiliency of the hammer, the time it takes the hammer to get away from the wire after it has struck. Certainly the hammer that gets away the quickest is the most effective hammer. The degree of hardness and softness depends on the judgment of the tone regulator. The all important factor to take into consideration, therefore, is the resiliency of the wire—two bodies come together, the required resiliency of one depending largely upon the resiliency of the other. The time of get-away is just as dependent upon the resiliency of the wire it strikes as that of the hammer. A synchronization of the two will give the desired result.

"The reason the tone regulator requires different degrees of hardness and softness in the same scale is because he has different wire tensions. The reason why you have to have a softer hammer in one part than in another is because you have a higher tension in those parts. You must have a very soft hammer in the bass, beginning with the first double, because your tension is abnormally high at that point as compared with the plain wire adjoining it. Assuming the same wire is used, a uniform tension throughout the scale would demand a uniform degree of hardness or softness. That is the vital factor. It is true and has been demonstrated that uniform tension does away with a very large part of the tone regulator's work, even without special instructions to the hammer maker. Most of the research work on that line has been done by a very difficult process. If applied to an ordinary engineering plan it would have been considered utterly impossible. The whole problem all the way through has been presented without a single constant upon which to base a calculation. No man, up to a short time ago, manufacturing pianos (and I except so few as to be considered negligible), knows the tension of his entire scale and therefore cannot draw up specifications for hammers based on the tension of his scale, but I do know that when the tension is uniform no complex specifications are needed for hammers. For a piano of uniform tension, maximum variation about four pounds, a set of hammers was ordered from Mr. Vilim. No special orders were given as to the relative hardness or softness of the bass, tenor or treble. That set of hammers was put on the piano, has never been touched with a needle up to this date, and I will defy anyone to run over that scale and find the miscellaneous vowel sounds incident to the average piano prior to tone regulation. You can save time of your tone regulator by starting back a little farther, and the extra cost of change in the scale to make this possible, will be absorbed in your saving in a very short time.

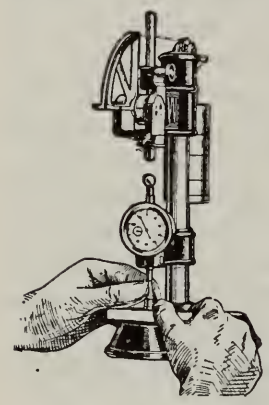


Fig. 4.

"These ideas are practical and if carried out would standardize specifications to the hammer maker and eliminate this 'custom trade' business with its attendant expense to that extent. Drawing your scale to a uniform tension gives a variation, if ½ numbered wire is used, of not to exceed four pounds. The first string in the extreme treble should be of a length that will give the required tension. Suppose you have four keys of number 13 wire and then begin on 13½, the first 13½ also should be of a length to give the required tension. The difference in length of those notes lying between may be determined by semi-tone proportion. You will find the formulae in the *American Piano & Pipe Organ News*, a copy of which will be forwarded to you from any of our offices. Begin your first number 14 wire at a length giving required tension, and figure the semitone proportion between the 13½ and 14. Proceed throughout the scale in like manner using half number to and including No. 16½. The tension on the strings will not vary over four pounds from the set tension of the first one of each number. It is entirely practicable to take the scale you are already using and change it. You will have to make a slight change in your plate. You will absorb that added cost in a very short time in labor. On next Wednesday evening I will have a uniform tension scale here to show you. I will also have an equal tension scale, both grands, and I want you to be absolutely fearless in

your denunciations if you have them—they have no friends, and you are perfectly free to criticise.

"Further hammer making points will be brought out by the demonstration of the Resiliometer invented by Mr. Stanley Widney, president of the Widney Company." (See Fig. 4, page 58.)

Stanley Widney: "I simply want to say we have perfected the instrument that will measure values in felt. First comes the thickness. I have handled a good many hammers, and I know there has never been any definite means of measuring hammer thickness because the edges curl up on the treble. The next value is relative hardness and we have always relied on the human touch, which is a variable. No two men have the same touch, nor one man the same at different times of the day. The same applies to resiliency. It is a case of the human element—always a variable. In getting out this instrument, we have been working about two years with the best engineering talent that we could find. Mr. Brown has given us a great deal of help, and so has Mr. Morton, as also have numerous engineers in war work and munitions. Mr. Bilhuber was one of the first to develop the instrument and might now rightfully call it his 'baby.' He made one statement here that leads me to believe that he has forgotten some of the tests he has made with this machine—that drawing felt over the hammer makes it more resilient. He discovered it was just the opposite. Those are the things we have run into, but when we got an instrument which would really measure, we found we were wrong on many points. The chart Mr. Morton has gotten out will simplify the matter all the way down the line.* It puts the whole matter into figures that you can transmit and the other man can understand. There won't be any guesswork. Of course it is always up to the felt manufacturer whether he wants to check himself up. If he wants to he has the means. Most of the felt manufacturers are anxious to have this instrument."

Geo. Lisk: "The function of the instrument, in short, is to establish a series of standards, an intelligible language between the maker of felt, hammer maker and piano manufacturer. A standard of thickness, hardness and resiliency will enable the felt man to produce a felt that can be put into a hammer which in turn can be put into the piano with very little work on the part of the tone regulator. In determining hardness the pressure we use is 100 lbs. to the square inch. Some times we use as high as 3,000 lbs. to the square inch to determine the hardness of wood fibre. We have weights representing ten, fifteen, twenty and thirty pounds. First we determine the normal thickness of the material and note it (demonstrating); then apply the 10 lbs. weight, noting the depression it makes, then the 15 lbs., then the 20, each time noting the amount of depression. Now the full load of 100 lbs. is on. The normal thickness of this material is .279 in.; under pressure it is .201 in. thick. Difference .078 in. In engineering terms we have measured the amount of energy we have applied."

Mr. Lisk then tested felts and hammers and explained in detail the method of making readings. He also made and explained a graph of these readings, saying that while the graph is a most convenient and comprehensive form of record, it is not essential.

F. E. Morton: "Everything in this work shows that error lies back of the tone regulator. He is supposed to cover all the errors made before the piano comes to him. To stop that expense and prolong the life of the instrument we must go back to the original cause. First, in the laying of a scale that does not require a lot of tone regulating; second, that the type and quality of hammer be such as will give you the desired results without added work. If you pay more for your hammer, don't forget the labor account you are not charged with on your pay roll."

F. Pfannstiehl: "Too much is left to the human element. You have mentioned there are no constants. Let us get them. Let us start somewhere, from either end. Let us standardize conditions. We are all after the best tone. If it is a fact, as has been stated here, that hammers are mutilated, let us do away with it. Let us do away with the human element by more modern methods, and get the exact tension or whatever specifications may be necessary and then the hammer maker can give exact specifications to the felt maker."

F. E. Morton: "Would you not say, in your judgment, that the superintendents of factories would be interested to a point of activity?"

---

*Note: Tone regulator's chart, furnished complimentary by American Steel & Wire Company upon application.

F. Pfannstiehl: "They ought to be."

Geo. Lisk then spoke of the automobile industry—how they got together in just such an informal conferences as this with the end in view of standardizing automobile parts, and gave some interesting figures showing the economies effected.

F. E. Morton: "In all of the ideas of standardization that have been recommended or suggested not one will result in a standardization of tone. Making scales of equal or uniform tension, establishing standardization for hammers; standardization of measures for bearing, crowning, etc., through the entire piano, give even greater scope for individual expression of tone ideals than now obtains. In player-pianos a tremendous amount of expense has been and will be saved by analogous practices. Player actions with parts made special at added expense are unnecessary because, with slight changes not affecting the instrument, they can be made standard. This is only one part of a campaign we are waging, all to one purpose, the making of a better product at a lower cost.

Piano Plates

April 9, 1919

F. E. Morton: "The subject for discussion this evening is plates, and this will take us, more or less, into foundry practice. This is not the first time I have had the pleasure of a discussion on plates, as it was a matter of daily occurrence in my office. This brought me in contact with the methods and motives of the foundry man, and I believe that any failure to meet your needs has been due to lack of understanding. The foundry man is willing to meet the manufacturer half way. There also has been a failure on the part of the manufacturer to understand the possibilities and limitations of foundry practice.

"One great enemy of the completed plate is internal stress, and if we can find means of acquainting the foundry man with the needs of the trade and the manufacturers of pianos with the cause and effect of internal stress, much will be accomplished for the good of both. Very little change has been wrought in design, and few of the difficulties met by the foundry have been remedied. While we don't look for a radical change beginning tomorrow morning we hope a discussion will set us to thinking. Our progress should be evolutionary, not revolutionary."

Mr. Morton then introduced Mr. J. C. Wickham of the Wickham United Industries who said: "I want to start by asking if any of you gentlemen have ever been tried for murder. I feel that way now. This is the first opportunity I have ever had of meeting the piano technicians and I want to express my appreciation. Mr. Morton said: 'Go as far as possible without offending your customers.' For the time being, we have no customers in this room, but tomorrow morning when you get out your order book don't forget the Wickham Company. This is a wonderful opportunity for you men to know each other, and one of the best things for the progress of the piano industry. Knowing your fellow man is one of the real big things of life. Co-operation in plate making means everything, just as it does in every other line of industry. If this meeting will result in you gentlemen taking up with your plate makers, whoever they may be, your problems, I will guarantee they will be able to overcome for you seventy-five per cent of your present difficulties.

"Our customers have trouble with their plates. I have never yet heard of absolute perfection in the works of mankind. Co-operation is necessary, but when you send a pattern of wood to the foundry man and occasionally give reports. this is not co-operation. This is the only industry I know in which the manufacturer, buying a special casting to be fitted to his product, does not own and maintain his patterns.

"Our methods today are considered right only because they have existed for years; tomorrow we will not tolerate them. I wish to sow a thought seed—individually come to us and we will help you solve your plate problems. Let me tell you something of the general practice in our commercial casting business. By commercial castings, I mean such as are used in automobiles, tractors, electrical motors and bread making machines. In every one of those lines, the manufacturer owns and pays for the maintenance of his castings. The manufacturer carefully works out with his engineers just what he wants and has it sketched. His corps of engineers figures the stress and considers the uses and abuses to which it is put. After testing it out he adopts

it as a standard. At a great expense to himself he rigs up that job to make it fool-proof. Later someone may suggest a change. That change means real money and he must pay for the change. Sometimes it means discarding entirely the old equipment at a great expense to himself. Compare this practice with your own.

"During the past four or five years there has been a wonderful improvement in plate making. Today we are just 'going over the top.' However, a perfect plate means proper equipment and proper equipment costs money. The piano man has never paid or contributed his share toward that proper equipment by paying for the producing and maintenance of patterns. The plate maker has always been forced to pay for that equipment and he has been spending his own money for the benefit of the piano manufacturer. Now what can the foundry man do but expend the least possible money for that equipment which will enable him to get by and hold your business? I only express this as constructive criticism. The piano manufacturer is not entirely to blame for these conditions, because I don't believe it has ever been put up to him in the right manner; when it is, he is going to give the plate maker full co-operation. It may appear that we are talking for ourselves, but we are talking for the whole industry. We have a wide-awake concern, men who want to do things in a modern way; it hurts us to be compelled to do things as they were done twenty years ago, and with your assistance we will make plates differently.

"A pattern is now sent to us from which we make an iron casting. If it does not come straight, we have to file and change it—we footing the bill; then we sink it in the sand, make a plate and send it to you. It is again returned to you after templet treating. That costs money. Every hole drilled in the plate—the steel bushings for the templet—those bushings alone cost on an average of five cents a piece. The pattern as sent to us is merely an idea that has not been thoroughly tested out—has not been adjudged a scientific proposition that will produce results. We make this plate without any assurance that this pattern will be adopted. We ask how many plates you will take from this pattern. You do not know, as you must consider what the merchant is going to demand also.

"Gentlemen, if the piano manufacturer cannot tell us how many castings he will take from that pattern or whether or not it will be adopted as standard, how can the plate maker do other than chance the least amount of money on your gamble? If a definite number of castings were guaranteed from that pattern, we could make it in a different manner altogether. You may draw a pattern by all the rules of science and we won't get exactly what you figure on. By drawing it carefully you may get close to what you want. We make a plate according to design and in order to get that plate with just the proper crown and no internal stress, it will take, on an average, no less than six castings from the wood. Seven times out of ten, patterns that are made are not correct. Another thing, the factory management and the purchasing department should co-operate. As long as the club of price is held over the head of any supply man, he is influenced by the thought that he may lose that business tomorrow on account of ten or twenty-five cents. What we want and what you want as manufacturers, is confidence and co-operation. This we stand ready to give."

F. E. Morton: "Before questions are asked, I would like to get something specific before you. I have advocated a uniform tension scale which is rather a compromise with the ultimate equal tension, because it permits of changes in existing plates without much added expense, and I thought perhaps you would like to have then visualized. This (indicating) is a uniform tension scale— this (indicating) is an equal tension scale. The tension on the uniform tension scale is 160 lbs., carried through the treble as far as physical conditions permit, leaving the last plain wire of a length which gives only 140 lbs. tension. The bass is 170 lbs. throughout. The change in the design of that scale is shown in this blue print. In this last scale the tension on the first bass double is the same as on the last plain wire and the tension graduates from the break up to 160 lbs. The object of the change is this—when that first uniform tension scale was put into a piano the jump of thirty pounds in the tension required tone regulation. In this latter case no tone regulation was necessary. The result was such a blending as results from the cello to the double bass; it is gradual—does away with the 'break' and requires almost no tone regulating. I had a set of hammers made with the same pressure throughout and practically no tone regulating was necessary. These plates will be left here for your criticism and inspection. The casting of this

plate (uniform tension) was reported by the foundry as being a very satisfactory plate to cast; only one casting pattern was made. There are still some points which I think can be improved upon, and I have asked Mr. C. Arthur Brown to make an analysis of this plate for your benefit."

C. Arthur Brown: "The number of strings in the extreme treble in the Uniform Tension Scale, up to the first bar break, is 51, with a combined pull of 8,160 lbs.

"There are 54 strings in the treble section, between the first and second bars, exerting a combined pull of 8,640 lbs.

"In the tenor section, between the second bar and the break, there are 72 strings with a combined pull of 11,520 lbs. The combined pull of these 177 strings in the extreme treble, treble and tenor sections is 28,320 lbs.

"Based on the hammer line the angles of pull of these various strings vary slightly from one another, but the general direction is approximately the same, not varying more than seven and one-half degrees from the mean angle from the base line of the hammers. Not to clutter up the records with too fine distinctions, we can regard the pull as in one direction. In figuring the pull of the strings we have assumed an equal tension of 160 lbs. per string. This is more than really exists but we need not take the lower tensions into consideration.

"In the bass section there are 17 doubles and 12 singles, all exerting their pull in a general direction common to themselves; but this general direction varies about 50 degrees from the mean of the extreme tenor section. The combined pull of the 34 strings in the double section amounts to 5,440 lbs. and that of the 12 singles to 1,920 lbs. or a combined pull in the bass section of 7,360 lbs., assuming the same tension as in the treble and tenor sections, which will be sufficiently accurate for our purpose.

"The combined pull of all strings would therefore be approximately 35,680 lbs. If all these strings exerted their pull in exactly the same direction, the total crushing force would be readily carried by a short member having *one square inch of cross section.* (Fig. 5.)

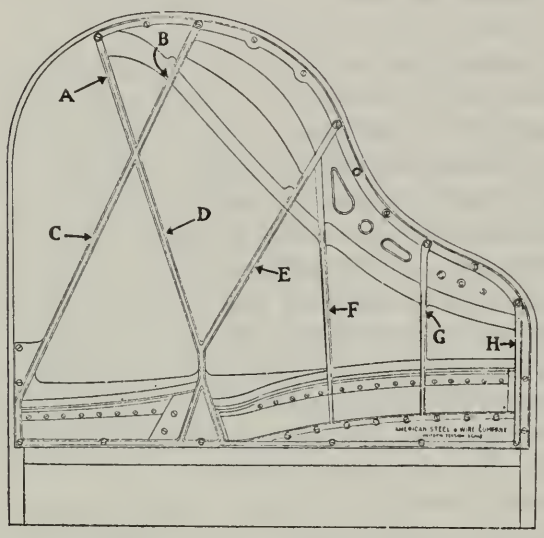


Fig. 5.

"The cross section of metal in A is 1.64 sq. inches; B—1.09 sq. in.; C—1.64 sq. in.; D—0.93 sq. in.; E—1.09 sq. in.; F—1.40 sq. in.; G—1.25 sq. in., and H—1.56 sq. in., total 10.60 sq. in.

"While these bars or struts act largely as compression members, they also act in torsion and bending. From a strict engineering viewpoint they, as found in this plate, are not of the most economical form. A lesser quantity of metal, properly placed, would make a plate equally strong and more rigid; a modified T or L shaped strut would give greater strength and rigidity with less metal.

"The struts not only serve to keep the hitch pin end from moving towards the tuning pin end in a direct line, but also to keep the plate as a whole from buckling inwardly toward the sounding board.

"This tendency to buckle is not so pronounced at the hitch pin end as at the tuning pin end as the angle of pull away from the horizontal at the tuning pin end is as high as 28 degrees in the tenor section while the angle acting over the bridge is relatively much smaller, being only about five degrees.

"The largest turning movement is on the fulcrum point at the plate bearing, the force exerted on the agraffe, exerting itself upwardly, is the largest force acting upwardly and the bars must be so designed as not only to care for this but also keep the hitch pin and tuning pin ends rigid in their positions.

"Thus these bars must resist not only an upward but a longitudinal thrust. Due to the various angles of pull, they must also resist a torsional or twisting movement, created partially all through the scale but particularly by the overlay.

"This torsional thrust is cared for by the members D and E more particularly but to a smaller extent also by A and to a still smaller and largely negligible extent by F.

"While this plate is of excellent design, generally speaking, a better placement of metal unquestionably would give equal strength and rigidity with a considerably smaller weight of iron, materially reducing the cost of the plate. I do not consider myself qualified to say what the effect of the lighter plate would be on the tonal quality, but as far as my knowledge goes it should not interfere with the tone quality, but improve it.

"All of the struts could be reduced in height and thickness and a smaller amount in the web at the bottom. One thing particularly noticeable in this plate and also the equal tension plate, is that you have an absolutely clear bridge which needs no cutting. The bars all clear the bridge nicely."

F. E. Morton: "On the member marked D, is there a torsion or other than direct stress and, if so, what direction does it take?"

C. Arthur Brown: "That would come from the strings in the tenor section traveling to the hitch pin and these two forces acting across one another."

F. E. Morton: "In general plate casting I find that the member D has such a torsion as when broken to give a positive twist, and this detracts from its tonal value. At what point in the plate would action be taken to remedy that?"

C. Arthur Brown: "The probabilities are that this being a lighter member than these others it cools more rapidly and when this has set firmly, these members have not set, therefore when the plate is cooled an internal stress obtains, the effect of which is expressed in the member D."

F. E. Morton: "Is there a mass of metal at any other point which by elimination would make that torsion less?"

C. Arthur Brown: "If all these members were constructed with less metal it would have a tendency to take the strain off of that."

F. E. Morton: "Please note the nose bolt in the second treble bar. In your judgment, is that necessary?"

C. Arthur Brown: "I do not think so."

F. E. Morton: "If that nose bolt were necessary, would it not argue a bad design of plate?"

C. Arthur Brown: "Yes, sir."

Mark P. Campbell: "Would nose bolts strengthen it in any place, based on figures you present, of stress and strain?"

C. Arthur Brown: "If improperly designed they are necessary. I don't think in this particular case they are needed. If this member were heavier or the other members lighter, I think the nose bolt could be taken out."

F. E. Morton: "I made a piano from a plate just like it and did not put in nose bolts. It was checked up very carefully, position of strings, board and plate noted and no buckling was found."

Mark P. Campbell: "From an engineering standpoint, would you say a plate of different dimensions could be made of sufficient strength to carry the strain without any artificial assistance?"

C. Arthur Brown: "I think possibly the holding down on the rim of the plate may be assisted slightly by the wood. I never investigated sufficiently to say."

Mark P. Campbell: "Where rupture occurs, would you add more metal?"

C. Arthur Brown: "Adding or taking away an internal stress may be brought about by too much mass at one point and may be responsible for rupture of the plate."

Mark P. Campbell: "How are those internal stresses caused?"

C. Arthur Brown: "By unequal cooling."

Mark P. Campbell: "How can that be overcome?"

C. Arthur Brown: "By heat risers—retarding the cooling of some portions."

Mark P. Campbell: "Would that be called artificial?"

C. Arthur Brown: "It is foundry practice."

F. Pfannstiehl: "Would it be better to use heat risers or would it be better practice to reconstruct the design of the plate?"

C. Arthur Brown: "Reconstruct your plate and save money."

F. Pfannstiehl: "The piano manufacturer is not so experienced in matters pertaining to plates as the foundry man. Could he give us known factors or proper proportions?"

C. Arthur Brown: "I should think very close co-operation between the plate foundry man and piano man would bring about a decidedly better practice by both."

F. Pfannstiehl: "Is anything known to the scientific man that will better determine the uniform shrinkage of plates?"

C. Arthur Brown: "I think I should defer to the plate maker on that. It can be controlled by analysis. It is impossible for any man to put a casting into sand of such a size and have a hundred come out uniform. They are not poured into just the same sand at the same temperature. There are a number of factors besides the composition of metal, which would exert an influence."

F. E. Morton: "The general shrinkage is known."

C. Arthur Brown: "Yes, and there are variations which cannot be accounted for. I would like to ask in relation to the metal which you use in your plate work—is there any secret in its composition or is it a fine quality of gray iron?"

J. C. Wickham: "There are no secrets in our business. We use the best iron we can get by chemical analysis."

Mark P. Campbell: "Do you make or would you make wooden patterns?"

J. C. Wickham: "We have never been called upon to make wooden patterns; however, it would be a pleasure to take your drawing, construct a wooden pattern, from that an iron pattern, give it all the tests and furnish you with a casting from the casting pattern. That involves an expenditure of money and we would want some guaranty of business from that expenditure."

Mark P. Campbell: "In making that pattern from a drawing—you first measure the tension of the strings—what would be your practice?"

J. C. Wickham: "We know the strength of the iron. We would make a pattern from the drawing—then a casting."

Mark P. Campbell: "Would you figure on the resistance necessary for the combined strain of the strings that come directly on the plate at angles—lines of resistance?"

J. C. Wickham: "We would be glad to do that. We have often changed patterns to overcome difficulties where we had the necessary things to do it with."

C. Arthur Brown: "There are a large number of changes made in plates, are there not, that are sent to you for manufacture, from time to time?"

J. C. Wickham: "We make changes."

J. R. Lang: "When you look over a wooden pattern, and you see too much iron, do you make a change in the wooden pattern before making the casting?"

J. C. Wickham: "Occasionally."

Mark P. Campbell: "Do you recommend to your piano manufacturers changes that you see or do you analyze it from a scientific standpoint with a view to making a plate satisfactory?"

J. C. Wickham: "Generally speaking, we have not found that our trade has been in a mood to receive such suggestions."

Mark P. Campbell: "Did you find that out by making suggestions?"

J. C. Wickham: "We have. We sometimes make a change and say nothing about it."

Mark P. Campbell: "Is that based on the spirit of co-operation?"

J. C. Wickham: "Based on the desire to protect ourselves."

Mark P. Campbell: "Do you think if the trade were more receptive you would be in position to make suggestions for changes beneficial to the plate?"

J. C. Wickham: "We would work hand in glove with the piano manufacturer whenever a new scale came out."

Mark P. Campbell: "Is the cause analyzed when plates break?"

J. C. Wickham: "Yes."

Mark P. Campbell: "Sometimes factory defects and sometimes pattern defects?"

J. C. Wickham: "Plenty of faults in the foundry practice; sometimes the buck is passed."

Mark P. Campbell: "You spoke of co-operation being of importance, but do you mean it would be a better practice for you to make all the wooden patterns?"

J. C. Wickham: "It has never been tried out. Personally, I am for breaking away from the things that have ruled and ruined us for years, but they must come about gradually. A better method cannot be decided offhand; it takes time, but I think that wonderful results could be

accomplished by starting now with a little co-operation. If you make a pattern, call in the foundry man and talk over things with him."

Mark P. Campbell: "Is the average foundry man in position to show him scientifically the stresses that are necessary on an even tension scale from point to point?"

J. C. Wickham: "If he is not it is because he has never been called upon to do it before. He would quickly put himself in shape to do these things and with proper encouragement he would get up a department that would take care of it."

Mark P. Campbell: "You would be willing to inaugurate an engineering department if your business would warrant it in volume?"

J. C. Wickham: "It would be our dream realized."

F. E. Morton: "If you organized a Service Department, in your judgment would the financial cost of the plate to the purchaser be increased or decreased?"

J. C. Wickham: "It would be hard to say. What the piano manufacturer wants to do is to make a better instrument at the same price or the same instrument at a lower price. Offhand I would say they would be no higher in price."

F. E. Morton: "In other lines the cost has been reduced both to the manufacturer and customer."

C. Arthur Brown: "If the ordinary plate is too heavy now and if a better placement of metal is made, would there not be a saving there?"

J. C. Wickham: "There would be a saving. I was speaking of the cost of manufacture, not of material."

F. E. Morton: "You could get greater production yourself working on correct lines with the same labor."

J. C. Wickham: "We have increased production but there is always the human equation. We make a practice of sharing our saving."

F. E. Morton: "With good sane practice resulting in a lesser quantity of rejections for any reason, a possibility of organizing because of known conditions—could you not with the same force of men turn out a greater amount of product?"

J. C. Wickham: "Yes, I would think that that would be the case, but it is impossible to say absolutely, as we have not been able to try it."

F. E. Morton: "If the conditions are right the benefits are mutual. It is this mutual benefit I am trying to bring to your attention. If the manufacturer turns over the making of patterns and plates to you, it relieves him of a certain amount of experimenting and work and if done in quantity by you, and you have a big enough clientele to warrant it, would it not be of advantage to the manufacturer? On the other hand, having the practice well defined in your own foundry, I believe your own organization could turn out more work. If this is the case and both stand to profit, the division of the cost would be fair. I have made a dozen or so patterns in my shop and I know the cost. I know that a pattern turned over to a foundry without a thorough understanding. makes you unnecessary expense; if an understanding obtained that expense would be eliminated."

C. Arthur Brown: "What is the relative difference in quality of the plate made by hand molding and that by machine molding as regards uniformity?"

J. C. Wickham: "To my positive knowledge no plates have been made by machine molding and put up for such criticism as the customer would put who does not manufacture his own plate."

F. E. Morton: "You want to be sure of your plate before machine molding?"

J. C. Wickham: "You can throw back on the plate maker today plates you would accept if you were conducting your own foundry. Plate makers have never had the pleasure of producing plates by machine."

F. E. Morton: "What is a fair factor of safety? Given a ten tons pull, what should the resistance be for a general practice?"

J. C. Wickham: "I would say in a piano plate the factor of fifty per cent by estimate."

F. E. Morton: "In general foundry practice on castings of like nature, what is the factor of safety?"

C. Arthur Brown: "It depends altogether on what use the casting is put to. It would run as high as three, maybe two for general work."

Mark P. Campbell: "As you study the piano plate, what would you say?"

C. Arthur Brown: "I would say three on that, on account of the vibration to which the plate is subjected in action."

F. E. Morton: "Given an upright plate in the factory under greater tension than the final requisite. In transportation a jolt breaks a bar. Could you not say that was caused by internal stress?"

C. Arthur Brown: "Certainly, it is internal stress."

F. E. Morton: "I have found it true in all cases of transportation breakage. Whenever you find a member broken you will find that one side of that member has departed from the other, whether it is turned, pulled away or has dropped below the other. It had tension before it had a load—almost as great as the factor of safety. In making a plate, should not the factor of safety take into account the internal stress of the plate?"

C. Arthur Brown: "It should. I believe Mr. Campbell asked me a question a while ago. Maybe I answered more loosely than I should. In regard to a member breaking, whether it would not be wise to add additional metal to that member? I think that that one thing ought to be emphasized strongly. It is not the lightness that ordinarily causes it to break, it is caused by an undue tension on another member."

F. E. Morton: "Two or three points have come up that have a bearing on this question. In the old three string square piano, up in the treble was a light piece of plate or web at the curve. We used to call it the 'harp' of the plate. It was considered weak because it did not have as much metal as other points. One experience I recall was of the manufacturer of a large three string square. While no breakage had taken place in several years, he decided there should be more metal there, so he had an additional amount put there and immediately there developed a 'howl' in the strings opposite that point. It made smooth tuning impossible. They therefore added more metal; the 'howl' was just as disturbing and a half dozen plates broke. More metal was put in and I know personally that in the first three pianos sent out the plates broke at that point. I have since seen the same thing done to uprights and grands. Increasing the mass of metal and using heat risers is not sufficient to overcome unequal cooling. In a plate where breakage occurs, the chances are the member that breaks is not the offending member. The problem is to locate excess of metal. There are numerous places in this plate which can be improved. Every rise in this plate is followed correspondingly on the back. This rise is hollow underneath.

"On this scale (equal tension scale) made for a manufacturer, some of his ideas were embodied. There is more metal in this plate than in the other. A great deal of this could be taken out with benefit. As to the effect tonally, I have been told by manufacturers that the taking out of metal from plates injured the tone. I have never heard a satisfactory explanation of this. The only function of the bearing of the string on the plate bearing is the return of energy. If the plate is not elastic, if it is rigid and does not give, it cannot interfere with tonal value. Putting felt here (indicating strings bearing between bridge and hitch pins) indicates that something is wrong. If made right the bearing would be on the plate and not on a felt bearing. Disturbance of the felt results, so part of the energy put on the key is expressed in heat instead of sound. Taping strings is covering a fault which exists in design. Anything you do that contacts elastic material with strings or sounding board takes just that much from the tonal value of the instrument. There can be no exception to that rule.

"Now in uprights of today there is one great error and I think every manufacturer knows it. The treble bar comes down in such a line as requires cutting away part of the bridge. This is absolutely unnecessary, as the bar can be carried across to clear the bridge and still not come out far enough to interfere with the action. There is a point where the foundry and piano men should get together. When you cut your bridge at that point you are affecting everything on a line of sounding board grain with that down to about middle C."

F. Pfannstiehl: "As to removing metal, where would you add the metal removed from the bottom of the brace—to the sides?"

F. E. Morton: "I made a different line of resistance. I don't mean to say that you could take your present pattern and follow that out. I would say that the bar could be carried in the same line as at present and on the bottom form an inverted T, carry it above the string line and not interfere with the strings or the bridge.

"Now that the export business becomes attractive, there are upright scales I know that can dispense with back posts to a point which will increase profits in transportation as well as material. Consult your plate maker as to the possibility of such strengthening of the plate by flanges to make it sufficient for the work. Make the wrest plank practically part of the plate and you will have a point from which to work, resulting in the removal of back posts if the plate is right. In a 4 ft. 8 in. upright it was desired to place some mechanism in the back of the instrument and I was asked what could be done to give room and whether it would be possible to use certain space without injury to the instrument. I found a well flanged plate, lines of direction good, and ordered the back posts out; after considerable argument one was made without back posts. Every man that touched it stood off, apparently in fear of an explosion. That was five years ago. No plate has broken and no change was made in the plate. No trouble of any kind developed, due to the lines of stress on the plate and flanges.

"No matter how large your scale, even if a 10-foot grand, you can carry out the uniform or equal tension, and the strings will be of the same length down to the compromising point, as in the scale of a five-foot grand. I don't know of a reason why any piano should have a limited bass—why it should not be 27, 29, 31 or 33 notes, if necessary to bring about proper lengths in the plain wire at the break, nor in a larger instrument why you should not have 12 or 13 notes in the bass. I know from experiments that excellent results can be had in small grands and uprights by extending the bass to 31, if necessary. Extend it to a point to get sufficient tension on your last plain wire. The break always has been the point of sacrifice, but there is no necessity for having the location of that break emperical.

"In order to have one constant for securing proper hammer resilience, we must first know the resilience of the wire. In making a uniform tension scale, I took our Perfected and Crown wire, made tests extending over several months and found that at 165 lbs. no change had occurred in the molecular structure of the wire after a test equal to six years' wear. This was determined by micro-photography. A slight change was observed at 175 lbs. From 160 to 170 lbs. gives the best acoustical and mechanical results and the mechanical results alone will pay well. Bring down the tension, particularly the first four wound strings. There is a difference in the treatment of plain wire and a wound string because only the core wire can energize the bridge."

Mark P. Campbell: "May I ask what you consider the relation of the rim to the plate, from a standpoint of resistance?"

C. Arthur Brown: "Added rigidity."

Mark P. Campbell: "Could that be measured by thickness through?"

C. Arthur Brown: "I hardly know. I should say that it could. That is a question I have not gone into."

Mark P. Campbell: "It has been customary to make rims for grands about as that one appears there. I am wondering if because of custom or because of scientific measurement."

C. Arthur Brown: "I would not feel qualified to answer without further study."

Mark P. Campbell: "It forms an anchor for the plate—on what basis, if not tradition, is it made that way?"

Dr. F. S. Muckey: "What effect would the flange have? Suppose you had a flange on an upright, would it affect the strain on that particular cross piece which has torsion?"

F. E. Morton: "I took it off, not because of the metal but because of a different direction of bracing."

Wm. Ruhenbeck: "I think it was custom. I have seen grands made where the rim was three-quarters of an inch thick, three ply."

F. E. Morton: "I have known cases where they went farther than that and built up a very heavy case as well.

"The sounding board requires a broad enough bearing to give it absolute rigidity. If attached to something elastic you would have a force working counter to that on the bridge. Personally I know of no reason for a thick heavy rim."

Mark P. Campbell: "I was speaking of the depth.

"Would you say, Mr. Brown, that in a small grand, properly strung to international pitch, it would change position, buckle?"

F. E. Morton: "Having watched that very carefully, I can say that all the changes in position were accounted for by the sounding board."

Mark P. Campbell: "How did you arrive at your decision?"

F. E. Morton: "By micrometer measurements; position of plate; position of the bar and of certain set wires throughout, over a constant."

Mark. P. Campbell: "As a result of your experimenting, you would say there is a waste in our laminated structure?"

F. E. Morton: "I should say so, if that is a fair representative of the idea."

Mark P. Campbell: "It would be a fair one if made as nearly alike as it is possible to make plates.

"We have made some very interesting experiments in our factory on the rim. We drew strings up to such a degree that they became worthless, to get the exact resistance of plate and rim and found that there is a great waste, and that practice has been followed for years in making of backs; from a selling point it could be pointed out as a great weakness."

F. E. Morton: "One other point I want to get an opinion on is the relation of the flange on the back of the upright plate under the wrest plank. Have you found it necessary?"

F. Pfannstiehl: "I made a plate pattern and instead of having the flange run clear across, I had three bearing points of one inch each. I couldn't see any difference."

F. E. Morton: "Is there any reason why you should not take those three points out?

"If the wrest plank were made part of the plate by rigid bolting the flange could not function, could it?"

F. Pfannstiehl: "No, if the wrest plank were bolted to the plate as one member."

Wm. Ruhenbeck: "There would be danger of bolt shrinkage. The flange would hold it."

F. Pfannstiehl: "With the elimination of the flange on the plate, could more uniform castings be made?"

J. C. Wickham: "Why not determine whether the flange is necessary? Yes, it would be more uniform. You could locate your points to set your plate more quickly. Suppose you got that back flange in proper relation to tuning pins, etc., would your wrest plank be absolutely accurate?"

F. Pfannstiehl: "We would fit it to make it so."

Wm. Ruhenbeck: "It can be done, but it takes about a half day."

J. C. Wickham: "If you take the back flange off the plate you can set your wood bearings by a templet with relation to your wrest plank with sufficient accuracy, put a large templet on your plate, marking end holes for tuning pins and hitch pins; then you could take any plate without back flange and you could throw that on the back. You could line up your pins for wood bearings and locate the position of your plate by locating those tuning pin and hitch pin holes and every one be the same. Now the back flange on your plate is not accurate unless machined. If you fit the back with absolute accuracy, that is an extra expense."

Wm. Ruhenbeck: "The piano can stand just as well without a flange."

F. E. Morton: "Would you say it was useless?"

Wm. Ruhenbeck: "If a piano goes to the tropics, it is better to have the flange."

F. E. Morton: "That would indicate a fault somewhere else."

J. C. Wickham: "Why is the back flange of use?"

Wm. Ruhenbeck: "An insurance against plate shrinking in extreme climatic conditions."

F. E. Morton: "Having found three points were sufficient, would not the result of cutting out more metal be a profitable move?"

F. Pfannstiehl: "I do it. If three are not enough, you might want five. It is a question of experimenting whether an inch is enough. I put my contact right behind the bars, figuring that the bars are carrying a big percentage of the strain."

J. C. Wickham: "Does the back flange carry any strain?"

F. Pfannstiehl: "I am sure it does."

Small Grands

April 16, 1919

Mr. Morton introduced the subject as follows:

"We have taken up the principal materials entering into piano building and brought out such ›ints as are supposed to give us a knowledge of their possibilities and limitations. Having had mind the assembling of these materials, the relation of one material to another largely has :en covered.

"You will recall a statement made by Mr. Wickham at the last meeting. 'We have not al- ıys found that the members of the trade have been in a mood to receive such suggestions.' ıis he gave as a reason for not having offered assistance or co-operation on certain lines. In a easure that has been true in my experience. Very reputable firms here in New York have re- nted my statement of a Natural Law. I am willing to go before a notary and swear that neither e company I serve nor myself had anything to do with the making of that Law. The trade ing built upon traditions, we apparently resent having such traditions placed in jeopardy by a ıtement of Natural Law.

"When a man says, 'I am going to have my first bass string, 27 B, 50 inches long and I am ing to use No. 18 core wire, covered with No. 34 covering wire, and I know it is right, there is thing left other than to point out the law that tension is directly as the square of the length and rectly as the weight, and therefore if he draws it up to 300 lbs. he must find steel wire No. 18 uge, having an elastic limit above 300 lbs. So far that has not been made. And I will say rther that when it is made, no matter of what material, and drawn to 300 lbs. tension, a stiffness ll result which will cause that string when struck to break into small segments, for it cannot ›rate as a whole.

"The trade interest today centers largely in the small grand piano. The difficulty has been e limitations affecting length of string. If, however, I have only twenty-seven notes in the bass, ey must be of such a length as will give a rational and reasonable tension at which a wire will vi- ate naturally as a whole, producing a full fundamental. This is in accordance with Natural Law, d we cannot violate this law without getting poor tone quality. There is nothing to prevent us ving an overstrung bass of more than 27 notes. It is not essential that we hold to 27 notes and en try to compel the supply trades to meet the demands necessitated by this error. Keep in mind at the greatest difficulty has been found at the break, and that it is the shortness of the last plain re, rather than any part of the overstrung bass which has caused this difficulty. In my opinion, e first doubles of the small grand have proved better in short than in larger grands. The posi- ›n of the bridge has necessitated shortening these strings in the small grand, lessened the tension d forced the maker to give a better tone. That does not help the last plain wire very much. e must have a given length there in order to utilize a proper gauge of wire. It takes much more ergy to set this board in vibration when acted upon at the rim than farther toward the center, us requiring a larger gauge wire. The reason we use a larger gauge of wire as we approach the bass because of the greater energy required. Don't, under any circumstances, conclude that with a ıger string we can justify by the use of a smaller core wire. Note this bridge, remembering that e purpose is to energize the board from this point. (Indicating point near rim.) ıppose I were to put a No. 14 core wire in there to reduce my tension. I will have sufficient energy, and the tone regulator, to make it uniform, must harden the hammer. ›u can induce a mode of vibration on a small wire with a hard hammer and increased energy actically the same as by striking a larger gauge stiff wire with a softer hammer and a lighter ›w—or by the aid of the tone regulator. Seven out of eight queries coming to me from men gaged in designing new scales or reconstructing old ones are based on that one point.

"The grand piano prior to, we will say, four or five years ago was a 'specialty.' Prior to that ne I never heard a piano manufacturer admit that he made money on grand pianos. The an- er is quantity production. It is much cheaper to pass the work down the line to the workmen, r instance, than to bring the workmen to the job. I know makers who are building grand pianos

complete practically on one spot. Going to the other extreme we find the endless chain system c assembling, similar to the Ford method."

J. R. Lang: "What is the value of the agraffe over that of the suspension bridge bearing?

F. E. Morton: "A rigid retention of the string at one point. The distance from one bearing t the other is the issue. For instance, we will say here is a rate of vibration of 200 per second. Th hammer strikes the wire forcing it to the bar; it flies back 200 times per second. A measur of the intensity of that sound will show a variation in intensity every 1-200 of a second unt the vibrations have decreased in amplitude very materially. With the agraffe it is not so ap parent."

W. C. Hepperla: "Will a grand piano, with the same length of string as an uprigh with same sounding board area, have an increased tone over an upright?"

F. E. Morton: "If you mean volume, no."

W. C. Hepperla: "How big a factor is the sounding board area?"

F. E. Morton: "Not so great as is usually considered. I think your company has demonstr ted that fully. In this uniform tension scale the working sounding board would not compa unfavorably in size with that of a bass guitar. I can go still further and say that prob ably 225 square inches could be taken from that board and not affect its volume one partic provided the space vacated were used for the obtaining of a greater rigidity. The vital facto is the rigidity with which the sounding board is retained in its position."

Dr. F. S. Muckey: "Is it not the sensitiveness of the board itself rather than the size whic determines the volume?"

F. E. Morton: "Responsiveness depends on several factors—the principal one being rigidit of retention."

Dr. F. S. Muckey: "Your string starts the vibrations, and the sounding board merely rein forces those by responding sympathetically to the vibration of the string. The better the r sponse the greater the volume and the better the quality."

F. E. Morton: "How would you value the sounding board of a harp as compared with th piano?"

Dr. F. S. Muckey: "I have not studied the harp and do not understand much about it."

F. E. Morton: "In the piano the board is depressed by the bearing and in the harp it is raise by the tension of the strings."

Dr. F. S. Muckey: "I don't know that that would make much difference so long as the prop relation of the strings to the board is observed."

F. E. Morton: "I have never had the pleasure of working that out on the harp. think it would be interesting and might demonstrate that the longitudinal vibration of the strin in the harp enters into sounding board responsiveness."

Dr. F. S. Muckey: "Responsiveness depends upon its particular position. You must hav tension on any vibrator but that tension should not be greater in one direction than another. Th vibrator itself should not be pushed in one direction more than in another."

F. E. Morton: "Responsiveness of the board in the piano is changed by the bearing."

Dr. F. S. Muckey; "Bearing has much to do with it, but numerous other facto also enter into that. The down pressure against the board caused by contact of the strin through tension should not overcome the responsiveness of the board."

F. E. Morton: "I have in my office a model of a bridge with what is practically an agraffe in stead of staggered bridge pins; the application of which would not require a crowned board.

Dr. F. S. Muckey: "I do not believe the crowned board is absolutely essential."

F. E. Morton: "It is not necessary to crown it more than one way.

"The model I refer to worked beautifully. I think if the agraffe did not have as much met as the regular agraffe it might afford interesting results. If an up and down bearing could be ha crowning would be unnecessary. I am not prepared to state it will work, but think the exper ment is well worth trying."

Mark P. Campbell: "That was common practice years ago with one manufacturer."

F. E. Morton: "Did they also crown?"

J. R. Lang: "They did."

F. E. Morton: "That would spoil it."

Mark P. Campbell: "Is it not a fact that the trade as a whole regarded the grand piano up within a few years ago only from a certain standpoint, that of length? Beyond that it was impossible in the mind of the trade."

F. E. Morton: "Yes sir. The grand was not popularized by advertising. I recall an advertisement a few years ago picturing a grand piano, played upon by a great and well known artist. In little cloud scene above was a vision of angels. That would convey to the person who saw it the impression that perhaps once in a generation some person would be born who could play on a grand piano. This would in no way tend to popularize the grand with the great buying public. When I see such ads as yours—and I have also seen others—of a grand piano in a living room with the children playing on it, it became at once in my mind a home proposition. I look upon the small grand piano as the forerunner of a big business in grands. The market for concert grands, six foot grands and larger, is going to be increased tremendously by the popularizing of the five foot grand."

Dr. F. S. Muckey: "What is the relative demand at present of grands and ordinary uprights?"

Mark P. Campbell: "Well, Doctor, I might answer that question by giving you a little history. I think it will be in order. Up to six years ago the grand piano product in our industry was about 9,000; relatively speaking, that is a very small percentage compared with about 100,000 players and uprights. The trade has used the grand piano ever since the first one was overrung, in 1856, as a prestige builder. Manufacturers have not specially cared to build grands, cabinet makers disliked to build cases because of the uncertainty of the size of scale. A few cases could be made and then the maker would change the model. It has always seemed to me that in the natural evolution of piano building the small grand would have followed the square but the manufacturers brought the upright in and continued to use the grand as a prestige builder, presenting it as a superior instrument. Hundreds of thousands of dollars have been spent by manufacturers and dealers presenting it as the superior piano. We look for it on the concert stage; in the best homes; we find them in the studios, but there it has stopped. Reducing the size has had something to do with popularizing the small grand, bringing it into a position where it could become a home piano. The dealer in the past has not shown the grand piano. A customer coming into the warerooms had to ask to see grand pianos, if he wanted to see one; he was always shown the uprights. The grand pianos that were in use up to a few years ago have been bought—not sold. It is only within the past few years that the small grand has come into the field, come in large, and taken its proper place. The public has looked upon the purchase of a grand as an outlay of from $700 to $1,000. Purchasing uprights, in each case the lady would say when shown grand pianos: 'Are they not beautiful? Some day I hope to own one; we have not room for it.' Size as well as price held it back. Now that the smaller grand has been proved, they want the grand and the future for the grand is going to be very large. We see it, and dealers say, 'Our territory is not a grand territory.' As a matter of fact New York was not a grand piano market, nor many other large cities I could mention. How could they be when less than 9,000 were distributed over the country? The manufacturers have been to blame for it, not the public. The dealers when they said, 'Our territory is not a grand territory,' also said the same with regard to the player piano and it was only through the persistent efforts of the manufacturers that the player got in. The dealers resisted the upright. It is a fact that if some of the leaders in manufacturing pianos had had their way there never would have been an upright built to sell for less than $500. But there came into the field pianos that could be sold for much less and we found a new market in the families and homes of people who wanted pianos for various reasons.

"It was an education, and so we increased our business tremendously; the same condition is facing us in the small grand, and I venture to say that the smaller grand is going to supersede upright pianos— not by evolution but on the basis of careful study and canvass of the buying public. I had this opportunity while directing manager of a large retail business and part of our system demanded that I should meet every customer. I studied them and spoke about grands and was sure, when we started this business, that the small grand piano, if it could be built at a price that would meet the buying public, would be a big seller, and we talked 3,000 grands a year, a third of all built; we were looked upon with some suspicion as to our sanity. Now we talk about 10,000 grands, but on the right basis. Our first pianos were not built any cheaper than any other grands. But we established a price based on labor and material on an output of 2,000 grands. One large

concern I know of at that time was building 100 or 150 grands a year, and didn't want to increas their business; it was a nuisance in the factory because they did not get up to the point where the could use proper machinery to build in quantities and organize their labor for such productior There must be a standardization and a quantity output must be reached before one can appl those rules of manufacture. We found in our industry a dreadful waste. Take an action factor where they have a hundred customers and you will find at least 90 different actions in that factory none of which differences have a bearing on tone; no added selling value but only a tremendou waste.

"In supplies, we are, as a rule, an independent business. We take the raw material and pro duce the finished product and are not dependent on supplies like many other manufacturers With that independence lies the great importance of production. Our wholesale price was no based on the cost when we began; if we had we would not have sold. We had to base the price t meet the public demand.

"I remember asking a key maker to figure on 2,000 sets and he said, 'You will have to wai a day or so because I have never figured on more than two dozen sets at a time.' That cannot b an economical basis on which to manufacture. We are referred to as 'specialists' on grands. W are, as our factories are devoted solely to their manufacture, and we are in a position to study th market for grands. We are merchandizing an art product—selling it to the public. We ar making it to stand and to wear, and it is durable. We are constantly minimizing the cost of pro duction and applying new methods. Every one is welcome to come to our factory. A grea many manufacturers are using our methods. It is a better method and more economical to appl the board. Then comes the selling proposition and we come to the real meat in the cocoanut— the buying public. What is the market? How can it be presented through creative advertising Creating a desire, that is the advertising man's great forte and the best advertising men are abl to put in printer's ink things that create interest followed by a desire and consumated by a sale That is the grand piano business today and its future is tremendous. The sooner manufacturer get bigger production (we think we are about five years ahead) the better we will like it—w welcome them and want the competition. We had to make our own at first; in a gingerly way th dealers asked us to send one, now these same dealers are sending for them in car lots. The allowed this business to go to the nearest big cities for years. We must necessarily put into ou construction all the thought and all the science of proper piano building and also put into it th practice of selling a completed article."

F. E. Morton: "I may say that the optimism which was expressed by Mr. Campbell is share by me and caused me to devote considerable time to the small grand. I think the grand is th piano of the future. It has many points that appeal to the homemaker. That is one reaso the public has responded so well. I have talked with people who are interested in interior deco ration and they tell me it is easier to furnish a room up to a grand than to an upright."

Mark P. Campbell: "The placing of a grand where an upright has stood changes the whol room. A young man came to our place not long ago and asked permission to go through the fac tory to see how our grands were made. He stated he was a buyer and I personally conducted him After he had looked things over he said, 'I am going to get married and shall buy a grand piano t put in my home, not because I can afford it, but because it will almost furnish a room; it wil save me $200 or $300 in that one room.' "

J. R. Lang: "Did you experiment with the height of the bridge relative to the line from th agraffe to hitch pin?"

F. E. Morton: "Yes."

J. R. Lang: "Did you try a low bridge?"

F. E. Morton: "One factor which determines largely the height of the bridge is the crow of the board, the thickness of the ribbing and the weight of the board. The thickness o the board may be considered less of a factor now, as most manufacturers are using the same thick ness.

"There is one point, however, which justifies the reduction in the height of the bridge withou changing bearing. What is your idea of the necessity, if any, of keeping the plate at its presen distance from the sounding board? Why not lower the plate?"

J. R. Lang: "Would it not necessarily lower the bridge?"

F. E. Morton: "Does it make a difference whether it is 1 inch or ¼ inch from the web to the board?"

J. R. Lang: "Not a bit. But you have to raise the plate to get height of bridge."

F. E. Morton: "Perhaps that may have been the original reason."

J. R. Lang: "Would a lower bridge give a clearer tone?"

F. E. Morton: "Yes. If that could be brought about in a grand piano, a saving in height could be effected sufficient to bring the very small piano down to a depth more nearly in proportion to its length. Architecturally it would be an improvement."

Dr. F. S. Muckey: "I cannot see any objection to lowering the plate and lessening the height of the bridge. I should think it would be an advantage. What is the usual height, above the level of the string?"

F. E. Morton: "The necessary bearing determines that."

Dr. F. S. Muckey: "Is there some limitation to that?"

F. E. Morton: "The tension cuts quite a figure. The higher tension requires a greater bearing also."

Mark P. Campbell: "I think the unevenness of the plate necessitates raising the board."

F. E. Morton: "That unevenness would largely be overcome."

Mark P. Campbell: "It is very difficult for plate makers to overcome. I don't mean direct thickness but unevenness of edges, perhaps improper casting."

F. E. Morton: "It might require a greater margin of safety at the foundry."

J. R. Lang: "Suppose you lowered the hitch pin line one half inch?"

F. E. Morton: "It would lower the bridge that much."

J. R. Lang: "What would the result be?"

F. E. Morton: "Less resistance to overcome in setting the sounding board in motion—a more responsive board. I have found it is not necessary to use as wide a bridge as is found in general practice, also that bringing the bridge pins closer together not only is practicable but brings better results; naturally all this decreases the weight on the sounding board."

J. R. Lang: "Why did you not carry that out in this scale?"

F. E. Morton: "It is quite a bit narrower than that which the party for whom I made this had been accustomed."

J. R. Lang: "If you were to draw a scale, would you try to center the bridge in the board, an equal amount of board on each side of the bridge?"

F. E. Morton: "Not necessarily. The farther toward the center your bridge is placed the more responsive the board becomes. If you go close to the rim you have a smaller factor of safety. Away from the rim, to a reasonable distance I see no reason for calculating for a dead center. As far as the bridge is concerned, I approve of this plan very generally because of two great benefits:

"First, this position of the bridge gives an equal tension on all strings. In this scale every string is pulling 160 lbs. It is the required position of the bridge to give those lengths and the first benefit from that is the standing in tune of the instrument. This has been demonstrated.

"Second, with that tension no special treatment of hammers is necessary; the same resilience of hammer throughout will break the string into the required segmental vibration. That means less tone regulating, no special instructions to the hammer maker. If you can get a uniform quality (not the same quality) by equal tension as a basis, and a known basis, hardness of hammers and resilience of felt, you have a line from which to work—a standard. I think it is quite worth while from those two points alone. Certain it is the piano will stand in tune better than another; this has a value in the eyes of the purchaser. It will drop together in a year without use. There are no high points in it, and after being played upon two or three hours the condition is the same, showing it was not taken up by friction at bearing points. There is also less waste in strings, wires and tuning pins. No high tension points at which tuning pins, strings and wires break or buzzing strings develop; a less number of replacements throughout. It makes for real economy in the factory. **It costs less to make a thing right than it does to make it wrong.** This comes to light in quantity production. Mr. Campbell based his work on quantity production which was right and proper. If the conditions had not been right quantity production would not have squared with his original calculations. You can apply that to manufacturing practice generally."

Mark P. Campbell: "Are you in any way familiar with the percentage of troubles with the board in the grand as compared with the upright, commonly known as a split?"

F. E. Morton: "About three years ago a large number of firms had trouble of that sort. It has been largely overcome in the practice of today which seems to be conducive to clean board stock and the sounding boards are holding very well."

Mark P. Campbell: "In the case of larger grands, to hold boards rigid, is it more prevalent for that reason?"

F. E. Morton: "Yes, sir. One way of meeting that which was considered successful at the time was the making up of quite a number, permitting them to stand for some time in a room kept at a stated temperature conducive to splitting and those that did split were shimmed, finished up and varnished after this had taken place. That is unnecessary, if the crowning is properly attended and the board and ribs properly treated before being assembled."

Mark P. Campbell: "You mean by that, factory drying?"

F. E. Morton: "Yes, and that the boards be put on the backs of uprights as soon as ribs are put on. If put on later, even twenty-four to thirty-six hours, it makes a vast difference."

Mark. P. Campbell: "What you say applies particularly to uprights?"

F. E. Morton: "It is just as true of grands, but seems more common to uprights on account of quantity production."

Gordon Campbell: "You spoke of the lath vibrating longer when held in a vise than when held in the hand. When you strike a note and the energy goes from the rim back over the board, which is desirable, the waste energy passes through the rim. Is it desirable to have the rim vibrate?"

F. E. Morton: "The desirable condition would be found in a rim that would reflect all that vibration. The reason the lath vibrates a greater length of time when placed in the vise is because the vise not being elastic does not vibrate."

Gordon Campbell: "You hold your board to the back rim. Suppose that is sufficiently heavy to retain the energy?"

F. E. Morton: "It is not elastic material. If you put it in contact with soft material you do conduct that energy away. 100 per cent efficiency would obtain where all the energy was returned to the board."

Gordon Campbell: "A certain amount of that must get away. If that can be sent out in vibration of the outer rim, is it not better than not to have the rim vibrate?"

F. E. Morton: "It is better than having the board contact anything elastic. In other words, it is better that all energy be expressed as motion rather than as heat."

Gordon Campbell: "You mean if the rim vibrates it is bad for the tone of the piano?"

F. E. Morton: "If an elastic substance contacts your sounding board at any point a part of the energy which is supposed to express as motion of the board itself goes into this elastic substance and expresses as heat."

Dr. F. S. Muckey: "The difficulty is that you have not the responsive material in your rim for vibration that you have in your sounding board. Heat there is going to be an inevitable loss."

F. E. Morton: "You have an analogous case in the triplex—wire between the agraffe and plate bearing of a proportionate length to the whole to secure a vibration between the pin and the agraffe. Once the energy has passed the agraffe it is well to permit its use. If I strike this wire with a hammer and put my finger on the triplex, it dulls the sound. Removing the finger adds to the brilliancy of the whole, but permitting energy to pass the agraffe has to that extent defeated the purpose, which was to return that energy to the bridge—use it, to energize the board. I would say to one who had built up such a scale to demonstrate its value now that you have it you would better allow it to express than to felt it but if it were not there at all, the energy would express through the board instead.'"

Gordon Campbell: "Would it be there? Would there not still be waste?"

F. E. Morton: "If less than 100 per cent agraffe effectiveness obtains there is waste."

Dr. F. S. Muckey: "Even if you did get any added energy there, it is in the wrong place. What you want is a strong fundamental. The duplex or triplex sale would not reinforce the fundamental tone unless the string were as long on one side as on the other. Whether added energy obtains or not, that energy is misplaced and produces a bad effect."

F. E. Morton: "Brilliancy in the treble is a desirable factor. Through the general scale I uite agree with Doctor Muckey, the energy is misplaced. The sole purpose is the movement of ıe sounding board in certain modes, and the modes most desirable, requiring the greatest reıforcements, are the first and second partials, particularly the first."

Dr. D. R. Hodgdon: "If you are trying to transfer energy to the board, what excuse is there ›r putting felt on?"

F. E. Morton: "The excuse given by others is the possibility of the wires barely touching, ıe vibration causing them to jingle."

Dr. D. R. Hodgdon: "Why do you have it between agraffe and tuning pins?"

F. E. Morton: "For the same reason. It would be much better to have a half round bearıg here giving a positive bearing for the wire."

Paul B. Klugh: "I recall at one time hiring a high priced designer to design some cases, being issatisfied with some of the criticisms of architects, artists and experts of that type and after ıose cases were designed and the tremendous bill paid, those cases never sold, but the cases that ·e brought through the factory by the men who are accustomed to making and designing cases ›r the public, although they may not please the technical eye, seem to please the public and that after l is the important thing. The old idea that a piano must have a 13½ inch side has disappeared. oday you have thousands of player pianos made three or four inches wider than that and no one ·er thinks of it. It is also interesting to record that my present company was the first one to reıce the size of the back of the piano so the enlargement of the side of the case would be as little as ›ssible. Now every company has adopted the thin or small back. I remember when we used double truss, running from under the key bed to the toe block. We ran out of back trusses, ıipped the pianos without them and found nobody noticed it. The truss costs money and from ıat day no double truss had been put on.

"I would like to ask you a question about the harp and its sounding board. I have observed hen a harp is used in an orchestra that the tone of the harp travels better than that of the piano. mean by 'better' that you can distinguish the harp from the entire orchestra, yet with a piano is difficult to do so."

F. E. Morton: "It is because the string is plucked. The violin carries much further when the ring is plucked than when bowed."

Paul B. Klugh: "Why is it?"

Dr. F. S. Muckey: "You get high over tones and they are not covered up by a mass of tones / the orchestra. They are different from the rest of the tones. Different in pitch, particurly."

Paul B. Klugh: "I have heard harpists state that you can hear a harp at a greater distance an the piano."

Dr. F. S. Muckey: "I don't think that is true."

F. E. Morton: "It might be true of a good harp. The tone of a plucked string carries emendously.

"Volume and carrying power are two different characteristics. One would think the volume a lower pitch of the same instrument would be greater than that of a higher. Strike the C ·low middle C on the piano and then strike the first C below the extreme C in the treble. The gher pitch carries farther, yet if you stand beside the piano, the volume of the lower will appear be greater."

C. M. Tremaine: "Has the sounding board anything to do with it?"

F. E. Morton: "I don't know the work of the harp sounding board. I do know that the ıund of a plucked string will carry farther than that same string bowed or struck with a ımmer. A very excellent violin may not sound as loud to the player as a modern 'commercial ıdle,' but it will carry above a full orchestra where the cheap 'fiddle' will be lost."

Paul B. Klugh: "As I understand you, the higher the tone the farther it carries? Would you y the tenor voice could be heard farther than a bass? Can a quartette be heard farther than a ngle voice?"

F. E. Morton: "Not farther than the first tenor."

Paul B. Klugh: "Why is it you can hear the cheering of a baseball mob a mile and a half vay and not hear one voice alone that distance?"

F. E. Morton: "One would not be heard because he would not have the advantage of a grand stand, fence or whatever forms the resonator. Given, if it were possible, one hundred voices of the same quality, same timbre, same volume and pitch and shouting the same vowel sound at the same time, in the open, they could not be heard any father than one."

Paul B. Klugh: "You mean to say 30,000 tenors could not be heard farther than one tenor?"

F. E. Morton: "No, sir, they could not."

W. M. Plaisted: "Why do you use three treble strings rather than one?"

F. E. Morton: "To convey energy through three mediums to the sounding board."

Dr. F. S. Muckey: "I think if we had one hundred voices absolutely the same pitch, possibly that tone would carry farther than one voice."

F. E. Morton: "Not unless reinforced."

Paul B. Klugh: "I remember one time when there was a national convention of bands numbering three hundred. The big feature of that convention was that all the bands were to go into one park and play the "Star Spangled Banner" and it was thought that it would be heard several miles away. No one heard it except those in the natural zone where one band would have been heard. I drew the conclusion that one voice would carry as far as hundreds until this baseball incident came up and I heard 30,000 voices cheering where one could not possibly have been heard at such a great distance."

Dr. D. R. Hodgdon: "You could hear if any one man yelled as loudly."

F. E. Morton: "There is no question as to the principle. The only possibility of a large number of voices carrying farther than one would be where such conditions obtained as would bring about a reinforcement of tones. Such condition would be analogous to that of a resonator."

W. C. Hepperla: "Is it not true that a grand piano with the same length of string as an upright has a greater carrying power? Would that scale standing over there carry tone as far as if lying horizontally?"

F. E. Morton: "Position of strings has nothing do to with it. The best carrying violin I ever had the privilege of hearing was played by an artist who held it in a horizontal position."

W. C. Hepperla: "If the upright had the panels out and was not stood against the wall would it have the same volume as a grand with same length of string?"

F. E. Morton: "Yes."

Katherine Elliott: "If you have two large pianos in a small room it 'eats up' the tone. If I open the windows of my studio it alters the tone of my piano."

F. E. Morton: "Opening and closing a resonator changes the intensity."

Katherine Elliott: "Would the answer in part be that one voice carries straight and the others 'eat' on themselves?"

Dr. F. S. Muckey: "I don't think there is any possibility of that. There might be an interference caused by the reflection of the air waves."

F. E. Morton: "That would account for it."

C. F. Hovey: "In constructing a room, what would be the form for best tone?"

F. E. Morton: "One without any angles. The only demonstration I am familiar with in this country is the Tabernacle at Salt Lake City. It accounts for the ease with which you can hear sounds. There are no angles. An ideal music room would be constructed like a half egg shell."

Dr. F. S. Muckey: "I have met a number of people within the last year, since interested in investigating the piano, who are in position to judge of tone quality, artists and musicians who consider the piano as now constructed anything but a musical instrument. Also players of various instruments have expressed themselves in the same manner. Now from my study of the piano and analysis of tones, I believe there is some ground for these statements. I have been listening to all the tones of the pianos of every make, and in analyzing the tone I have not yet found a piano which produced a sustained tone. The complex tone sounds like a sustained tone. If you pick out the different partial tones not a single one is sustained. It will go on and stop, and again and stop—an interruption in tone. The interruptions do not come at the same time but at different times, so the tone as a whole goes on. Now according to Helmhotz, a musi-

cal tone is one in which the particles of air move to and fro uniformly, regularly, that motion continued. Under those circumstances you have sustained tone, but the particles of air disturbed by the piano are not uniform in their measurement, not technically musical tones."

Katherine Elliott: "I think one difficulty is the lack of co-operation between the music dealer, the manufacturer and the music teacher. Retail dealers offer us very desirable commission for putting their pianos out. It is exceedingly attractive to any teacher, because we cannot always get the price we should obtain for lessons and because we have not a stated income, so the teacher will go to this firm, whether good, bad or indifferent, and select a piano for her pupil, although knowing better. The average teacher falls for the dollar."

F. E. Morton: "Thinking of tones in dollars and cents is not confined to teachers alone."

Katherine Elliott: "In my classes, I have had tuners lecture to my pupils."

F. E. Morton:" Is it your opinion that if children were taught to listen for the partials they would be able to understand tone quality as well as the child today understands that certain tints are made up of certain primary colors?"

Katherine Elliott: "Yes. They should be taught to the pupil at an early stage."

Mark P. Campbell: "Compare the cheaper pianos of today with the high grade uprights years ago and note the change. Our cheaper pianos today are better than the expensive ones of thirty-five years ago."

Dr. F. S. Muckey: "The piano has been greatly improved. The reason for that improvement might help us to go farther. There is still a lack, because we do not get sustained quality. The tone is changing all the time and will as long as we get the interruptions. The tone quality is not the same at any two intervals of time because we have changing partial tones all the time."

Mark P. Campbell: "Is that not so of other string instruments?"

Dr. F. S. Muckey: "It is not so with the violin. The notes are sustained by means of the bow."

F. E. Morton: "Energy is continuously applied in other instruments."

Dr. F. S. Muckey: "Our fundamental tone should be absolutely uninterrupted and the same tone quality sustained as long as the tone can be heard. If a musician has a certain sentiment to express, he must have the same quality of tone. It cannot be done at the present time."

F. E. Morton: "That could be illustrated in this way. The hammer strikes the wire and about 1-120 of a second afterwards the fundamental is at its highest peak point or greatest amplitude; then it diminishes very rapidly. Some of the partial tones, the odd numbered higher partials particularly, are at their peak before the fundamental, and sustain much longer. The relative partials are not alike in their sustaining power. The more responsive board will better sustain the fundamental. I made a test and found that uniform sustaining could be had for fifteen seconds on a very responsive board. This also admitted of greater scope of expression than one having a great crown, heavy load and high tension but which gave more of a 'boom' tone.

"I think that difficulty may be overcome. Up to date experiments have been made without any assurance that back of the experimental point things had properly been taken care of. As long as factors are unknown they remain unknown in the final solution. Taking into consideration the factors covered first by natural law,—length, weight, pitch and tension, and the necessity of conserving every bit of energy to produce motion—if all these are taken care of the treatment of the sounding board is on a known basis. A more responsive board is possible but we must let go of some pet theories in order to get it."

Mark P. Campbell: "Your engineer told us that in your small plate there was 36,000 lbs. strain on the strings. What is your idea of the pressure on the board as a result of that strain passing over the board?"

F. E. Morton: "I could not tell you that because I don't know the bearing of each string."

Mark P. Campbell: "Is there any way of obtaining that?"

F. E. Morton: "Yes, by measurement."

Mark P. Campbell: "It would change, however, with the different lengths of bar of pianos, would it not?"

F. E. Morton: "It would change with the distance between bridge and hitch pin also."

Dr. D. R. Hodgdon: "There goes your law of angle of forces."

F. E. Morton: "The bearing is not the same on both."

Mark P. Campbell: "Because that is a continuous bridge, would it not carry that weight through to the end of the bridge or have an influence on the board as a whole?"

F. E. Morton: "The greater the tension the greater the bearing."

J. O. Shore: "There is more flexibility in the larger board."

Mark P. Campbell: "If possible to measure, would we not find practically the tension the same on the small as large?"

J. O. Shore: "If the bearings are the same I think you would have a greater tension in a small grand because your strings would be a little shorter. I mean the tension of the strings. I think you would have a downward strain."

Dr. D. R. Hodgdon: "I am wondering if the demand has not grown greater in the world for music on account of the psychological effect in our schools. I overheard a teacher the other day giving a lesson. All she did was to play a little piece and turning to the children, asked them, 'What does that make you want to do?' Each child acted out the emotion. I am not a musician but it seems to me people are reaching out for something because they are not satisfied. The musical world is demanding more."

F. E. Morton: "I have made the experiment of having a new composition played to students and then asking each one to write on a piece of paper the name he would suggest for the composition. I have been astonished at the interpretations."

General Piano Construction

April 23, 1919

Chairman F. E. Morton stated that numerous queries and comments addressed to him indicated a desire on the part of many for information relative to specific operations which, while diverse in character, might be classified under general construction. He therefore announced the meeting open for discussion of any and all subjects relating to piano building not clarified by past conferences.

The first subject taken up was that of bearing, and Dr. D. R. Hodgdon, president of the College of Technology of Newark, N. J., was called upon to give formulæ for the correct solution of problems relating to bearing of piano strings upon the sounding board through the bridge.

Dr. Hodgdon gave the following formulæ and solutions upon the blackboard, explaining each step. While using trigonometrical functions he explained fully the principles underlying all the operations.

Dr. D. R. Hodgdon: "The object is to determine the pressure which a single string exerts on the sounding board of a piano. This pressure is communicated to the sounding board through the bridge over which the string passes. There has been no opportunity to determine the relative tensions in the string on the opposite sides of the bridge and therefore, for this discussion, it has been assumed that the string adjusts itself so that the tension is the same on both sides. Since the bridge is constructed so that there is a minimum of friction where the string passes over it and since the height of the bridge is very small, it seems that this assumption is not very far from correct. The fact that a piano in which the bridge is not treated to minimize this friction will very soon be found out of tune, while one so treated remains in tune for a long period, seems also to strengthen this assumption. With this assumption the pressure on the bridge works out in a very simple way, as follows:

"Calling the tension in pounds on the string T, the length of the string in inches from the agraffe to the bridge B, the height of the bridge in fractions of an inch above the level of the agraffe and the hitch pin C, the length of the string in inches from the bridge to the hitch pin A, the pressure of the string in pounds on the bridge P, and the angles as indicated in the drawing, the following relations are evident. The downward force which the A side of the string exerts on the bridge is T sin M. The corresponding force due to side B is T sin N. Therefore the total downward pressure is T sin M + T sin N (their sum). From the figure we

have $\sin M = \frac{C}{A}$ and $\sin N = \frac{C}{B}$

Therefore
$$P = T\frac{C}{A} + T\frac{C}{B}$$
$$= T\left(\frac{C}{A} + \frac{C}{B}\right)$$
$$= TC\left(\frac{1}{A} + \frac{1}{B}\right)$$
$$= TC\left(\frac{A+B}{AB}\right)$$

"In words, the force which the string exerts on the bridge is found by adding the lengths of the parts of the string and dividing this sum by the product of their lengths, and finally multiplying this result by the height of the bridge and then by the tension in the string.

"A practical example would work as follows: Suppose the length of the string from the agraffe to the bridge to be 8 inches and on the other side of the bridge to be 3 inches, the rise of the bridge to be $\frac{1}{16}$ inch and the tension 160 pounds. Then, using the formulæ above, we obtain

$$P = TC\left(\frac{A+B}{AB}\right)$$
$$= 160 \times 1/16 \times \frac{8+3}{8 \times 3}$$
$$= 160 \times 1/16 \times \frac{11}{24}$$
$$= \frac{110}{24}$$
$$= 4\ 7/12$$

therefore the pressure is 4-7/12 pounds.

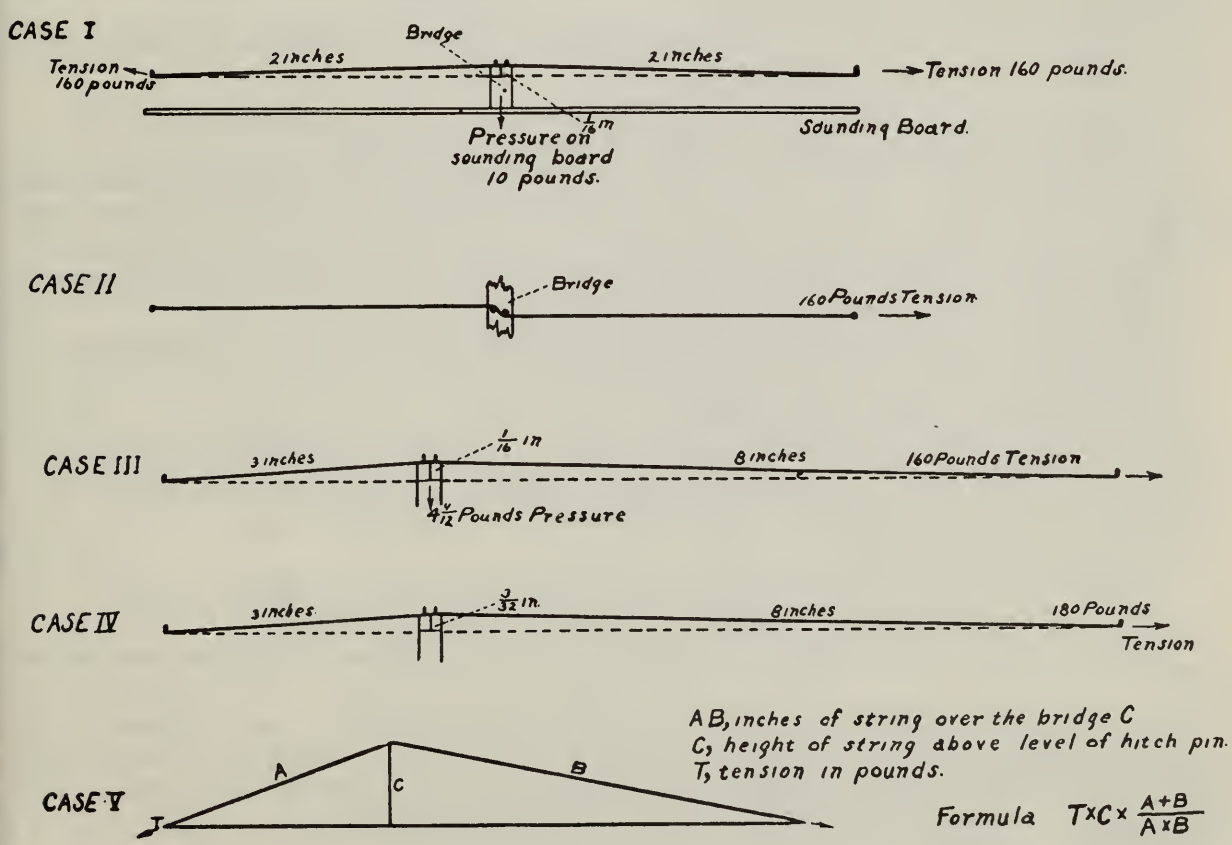


Fig. 6

Case 1 represents a string 2 inches long on both sides of the bridge. The height of the string above the level is $\frac{1}{16}$ of an inch. The string has a tension of 160 pounds.

Case 3 represents a string 3 inches long on one side of the bridge and 8 inches long on the other side with a tension of 160 pounds.

Case 4 represents a string 3 inches long on one side of the bridge and 8 inches long on the other side, with a tension of 180 pounds.

Case 5 is a diagram showing the different parts which must be taken into consideration in obtaining a formula for this work, and finding the tension on the sounding board for each string. A and B represent inches of string over the bridge at C. C represents height of string above the level of the hitch pin. T represents the number of pounds of tension on the string."

Paul B. Klugh: "What, then, is the total pressure on the board?"

F. E. Morton: "We arrive at that total by multiplying the average bearing of each wire by the total number of strings."

Dr. D. R. Hodgdon: "This gives an approximate total of 1,725 lbs."

Dr. Hodgdon then illustrated the increase and decrease of bearing caused by raising or lowering the bridge. He attached spring scales to each end of a string, lifting the string at various points by means of another pair of scales and noting the relative weights recorded on the three scales.

F. E. Morton: "As the tension increases, the ribbing also is increased in weight; the crowning of the board and the bearing is increased. With high tension a near approach of the bridge to the edge of the board necessitates a shortening of the distance from hitch pin to bridge, thus the bearing is increased proportionately greater than the tension, giving a drum effect to the tone. There is a point in the tension beyond which, first, the wire does not vibrate naturally; second, the sounding board is overloaded and therefore does not respond freely; third, it is impossible to secure a uniform quality of tone throughout."

Mr. Morton then demonstrated the use of his formulæ in finding length, weight or tension, working out several examples propounded by those present, upon the blackboard. He advocated the use of logarithms, stating that any one who could add, subtract, multiply and divide could learn their use in a few hours. He recommended Bruhns' New Manual of Logarithms to seven places of decimals for this purpose.

F. Pfannstiehl: "What is the tension on a No. 20 gauge wire 38 inches long at C, the 28th note? This is usually the first plain wire from the break."

F. E. Morton (after calculations): "112 lbs."

F. Pfannstiehl: "In this case would it be well to use a larger wire?"

F. E. Morton: "Not necessarily. A poor quality of tone as often results from wire of too large gauge as from too low tension. In short scales loaded to D, the third note from the break, with No. 20 wire better tonal results frequently obtain by using a No. 19 on the last two notes."

Paul B. Klugh: "About how many scales have been worked out mathematically that way?"

F. E. Morton: "I can account for about twenty-four."

Paul B. Klugh: "How many are manufactured, that have been worked out mathematically?'

F. E. Morton: "I think there are close to twenty."

Paul B. Klugh: "Uprights and Grands?"

F. E. Morton: "Yes. In a number of those cases concessions were made resulting in a com promise, and only such changes were made as did not require a change in actions, cases, etc."

Dr. F. S. Muckey: "Was there a great difference in tone quality?"

F. E. Morton: "Yes, sir."

Dr. D. R. Hodgdon: "How do they get scales without mathematical computations?"

F. E. Morton: "Frequently by copying with a few changes introduced."

Dr. F. S. Muckey: "In working out this scale (indicating), did you use uniform or equal tension?"

F. E. Morton: "Same tension on each string. It is only practicable where agraffes are used. (Showing on scale the graduation of wire in half sizes.) The hammer line is the constant. Uniform tension is obtained by a formula for semi-tone proportion published in the Piano Wire News, page 16. The use of half numbers gives a decided advantage."

F. Pfannstiehl: "Given a string of a certain length, what factor is used to determine the triking point?"

F. E. Morton: "The striking point is determined by the quality desired. When anyone ys that making piano building an exact science, building intelligently and on a known basis, taking away the individuality of the piano, he is mistaken. Predetermining results does not ean sacrificing the individuality of the instrument. You can predetermine the quality of tone y hammer line; shape, size and weight of hammer or even in the setting of the action."

Dr. F. S. Muckey: "Would not the hammer line depend on the load and tension?"

F. E. Morton: "It is only to secure the desired quality that the hammer line is set."

Dr. F. S. Muckey: "If you had a very large gauge string and a great deal of tension you ould have to strike it at another point?"

F. E. Morton: "Usually those who load their scales heavily and get high tension do so get a quality which could have been duplicated by changing the hammer line. Many a an has spent good money and lots of time increasing the loading of scale, increasing the aring, the weight of the board and the crowning, when he could have obtained the same result y changing the hammer line."

Dr. D. R. Hodgdon: "Is there any reason why the bridge is not made of metal and secured in ace or made a part of the plate?"

F. E. Morton: "I have a bass bridge which is the most successful of any I have seen, made aluminum, with a few units of vanadium. It is effective, and the sustaining power is increased ut the tone is not so satisfactory. The bearing is given in order that the board may partake of e motion of the string, hence the staggered pins on the bridge."

The conference then entered into a general discussion of factory practice, machine work, ssibilities of further co-operation between the makers of pianos and the supply trade, and inti- ate and interesting argument ensued relative to methods of advancing workmen and means of ving men showing proficiency and interest such advantages as would enable them to become perintendents and managers.

Piano Actions

April 30, 1919

Mr. Morton introduced the theme of the evening as follows:

"The subject tonight is piano actions, with a view to the possible standardizing of parts. Ir. Klein of the Haines Piano Company has submitted an upright action model without bridles r your examination, criticism and queries.

"One point which seemed to stand out at the last meeting was the interest taken in the prob- ms of the piano manufacturers by Dr. D. R. Hodgdon, president of the College of Technology of ewark, N. J. The formulae and diagrams presented were worked out by the students of that llege as part of their regular work. This marks an epoch in the trade. When our colleges and chnological institutions work out problems as part of their regular work, we are experiencing real o-operation. Dr. Hodgdon at any time will receive engineering problems from any manufacturer nd will put them through the same course. He wants live material for the students. With at precedent established, we may look to the future with optimism.

"Mr. Strauch, in your action factory, have you two manufacturers using the same action rackets?"

A. T. Strauch: "Yes."

F. E. Morton: "Is this merely a happening or a common condition?"

A. T. Strauch: "An accident."

F. H. Abendschein: "That is our experience, also."

C. H. Wood: "Our experience is the same."

F. E. Morton: "Practically the main part of action hardware, then, is special."

"I want to preface anything that may be said for or against, by repeating what I have aid before, that the standardizing of methods and the basic parts of pianos will in no sense

standardize tone. I think every manufacturer has all he can do to standardize tone in hi own product. As to the benefits to be derived, we will hear from the action makers an manufacturers of pianos.

"Mr. Strauch, are you in favor of standardization?"

A. T. Strauch: "We most surely are. I presume it is permissible to ask questions. Wh do a dozen manufacturers making twelve four-foot-eight pianos have twelve different height for their actions? Such a variation in brackets is costly. Twelve different piano makers wil set their top bolts in twelve different positions, making a difference in length of the neck of th bracket. These things we have been unable to control, and it has necessitated our having al these different patterns."

F. E. Morton: "Have you taken it up with manufacturers and suggested those changes?"

A. T. Strauch: "No."

F. H. Abendschein: "We have not taken up the matter on account of the great expense It would mean changing of all gates for casting. We have in our factory over 200 kinds of actio brackets in use."

F. E. Morton: "From your viewpoint, would the standardization to a very small numbe give you a benefit commensurate with the cost of the change?"

F. H. Abendschein: "Naturally it would. It's a hard pill to swallow until you reach tha point, however. It would mean discarding all these patterns, in which capital has been invested It is about as expensive to reconstruct old patterns as making new ones. Gates cost about $2 each."

F. E. Morton: "Are you in favor, as far as practicable, of standardizing action brackets Mr. Wood?"

C. H. Wood: "That involves a great many problems which must be met. There ar probably in active service today 2,000 different action brackets. Those gates cost about $2 apiece. That means about $55,000 invested, which at the present time represents the bracket required for various makes of pianos. The minute you change you must throw away $55,000 None of the action manufacturers are able to give a reasonable explanation for these variations Before you can do much with the action makers, you piano manufacturers must get together Another thing, no two actions are made in the United States with the same center."

F. E. Morton: "Mr. Pfannstiehl, what is your opinion?"

F. Pfannstiehl: "You will have to go as far back as the plate maker. However, I thin it can be done. I have carried out the thing to this extent—we do away with the top bolt altogether. I don't see why we all can't."

A. T. Strauch: "It will depend on the height of action. A lot of manufacturers makin four-foot-eight pianos will vary a quarter of an inch, therefore your brackets must be long enoug to cover that difference."

F. Pfannstiehl: "I have used the same bracket for a four-foot-six and a four-foot eight."

A. T. Strauch: "The Starr Piano Company has done that for years. They never use bracket bolt; they fasten it against the plate with a screw."

F. Pfannstiehl: "If there are so many long brackets, you could cover the distance with tw brackets; I don't think anything is made out of the range of four foot to four foot ten inches Get the factory superintendents interested and go back to the plate maker to change castings i necessary."

A. T. Strauch: "Every manufacturer of pianos has his own idea. He may want a doubl rack or a single rack. We have 238 patterns, which involve quite an investment. If we coul get down to one pattern, it would compensate very quickly. In grands, it is different—onl about two patterns. The height is governed by the opening of the front of the case. Thos two patterns will cover any height to which a grand is built today."

F. E. Morton: "From the piano manufacturer's viewpoint, what would be the relativ expense in standardization, assuming that his particular patterns were not used?"

A. T. Strauch: "The standardization between action makers would hardly become general thing, because of the variation in centers to which Mr. Wood referred. If the actio maker could standardize his own actions it would make a great saving."

F. E. Morton: "Mr. Pfannstiehl, assuming you had to change your brackets to conform to a standard agreed upon, would the expense of that change amount to enough to be considered by you?"

F. Pfannstiehl: "I don't think so."

Joseph Oktavec: "I hardly think it would need consideration."

Mark P. Campbell: "I should say it could be very easily done from the piano manufacturer's end."

C. H. Wood: "There would be a large initial cost to be distributed."

F. E. Morton: "Would there be a recourse for that added expense?"

C. H. Wood: "The action manufacturer cannot make a move until the piano manufacturers get together and adopt a standard for the action makers to follow. It would then be an easy matter for us to conform to their ideas."

F. E. Morton: "Let us get to dimensions. What would be the first point to be discussed?"

C. H. Wood: "Standard dimensions above the main action rail rest."

A. T. Strauch: "Better take it from the striking point."

C. H. Wood: "The trouble is that the phrase 'striking point' is rarely used. We would be working with a doubtful element."

A. T. Strauch: "I think it would be the most reliable from a piano man's viewpoint."

C. H. Wood: "Fully 95 per cent are devoid of that information."

A. T. Strauch: "We prefer the striking point, as we can get something from that."

C. H. Wood: "Perhaps in theory, but few specifications come in that way, in our experience. I am trying to avoid any unnecessary reforms."

E. B. Bogart: "The 'striking point' does not give us just the idea that we can figure on, but it seems to me that the bracket can be standardized if the length of neck from the center of butt flange to the bracket bolt is designated in units of one-half inch."

J. O. Shore: "The move proposed would mean a saving to the action maker which would probably come back to the piano manufacturer and if they could devise a standard bracket that we could use, we would like to adopt it. There would be two points which would have to be determined—the overstrung bass and the treble bar."

William J. Behr: "I can't see any reason why it should not be standardized above the rail. Every manufacturer has a different striking point and the bracket must be regulated according to that."

F. H. Abendschein: "We have been groping in the dark. A number of years ago I made a drawing which I have with me. It is my belief that the bracket can be made standard above the action rail. The action must be set always the same distance from the strings. This drawing shows the set-up of an action. (Fig. 7.)

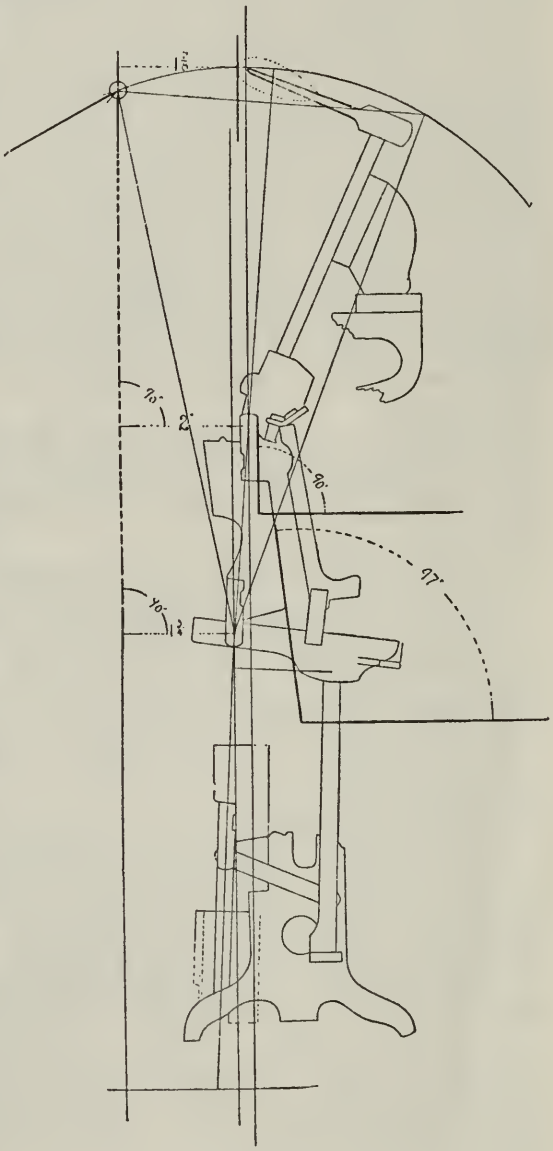


Fig. 7

"The three most important centers of the action are the butt, wip and fly. The distance between the butt and wip is 3¼ inches; that covers at least twenty-five actions of different makes and ages. It has always been 3½ inches in well built actions. This drawing shows that the

wip is ½ inch nearer the strings than the butt center. The velocity diagram automatically works out that distance. When the action is set so that the wip center is ¼ inch to the rear of the butt center, this permits the front of the action rail to assume an angle of 97 degrees. This insures a maximum efficiency of the action movement. With this setting, the face of the butt flange stands at an angle of 90 degrees. All these angles are reckoned from the bed, which is assumed to be horizontal. The blow distance of 1⅞ inches seems to be adopted by all manufacturers—the correct distance is 2 inches, butt an allowance of ⅛ inch is made for the wear on the face of the hammer. The distance between the butt center and striking point should be 5⅝ inches. This has been used in grands right along, but no manufacturer has ever given a reason for that. The distance between the butt center and steel strings should be approximately 2⅛ inches. If you set an action with those measurements, you will always get it right, regardless of length of shank, providing the boring of the hammer is 2½ inches in the treble, from center of shank boring to the face of the hammer. Like many other things, many piano makers do this not knowing why.

"The front of the rail assuming an angle of 97 degrees when the butt center is 2⅛ inches from the string, the wip center is ¼ inch closer to the string than butt center. The position of the action rail lug, the hammer rest and spring rail rest should be standardized. Assuming that we did standardize these three points, they would be of no avail unless the action is set 2⅛ inches from the string. If the butt center is 3 inches from the steel string and we still have a blow of 1⅞ inches, the contact point on the butt is higher than when set at the proper distance. You must raise your hammer rail to meet your shank—more blow felt is required under the hammer rail and a loss of power ensues. Many houses use the same bracket but continually get different thicknesses of felt under the hammer rail, because they don't get the proper distance from the butt center to the string,—setting the action as they do from the front of the case. If they were to gauge their cases when received, the distance from the front of case to a line dropped perpendicular from the striking point,—they could always set their actions the same. If your piano manufacturers are willing to do this, it will be one of the biggest steps to help along standardization. Unless you will do this, all talk of standardization is of no avail."

G. Adessa: "How about making hooks shorter or longer in the rail?"

F. H. Abendschein: "You should not make your hooks shorter or longer. 2½ inches is the proper length. The boring in the bracket on which the hammer rail hook pivots should always be in the same place."

A. T. Strauch: "We have standardized our borings."

F. H. Abendschein: "Many manufacturers insist on its being in a particular position and we have been unable to get them to change."

A. T. Strauch: "The proper place for the rail to be centered on the brackets is from the center of the butt; then there will be no travel on the rail."

C. H. Wood: "Do you consider it possible to standardize brackets with present methods of setting actions?"

F. H. Abendschein: "Utterly impossible."

A. T. Strauch: "They cannot make them alike so long as they set the action to the keys."

C. H. Wood: "Don't you find very great variety of opinions as to how it should be set?"

F. H. Abendschein: "It has been my experience that they try to build the action to the case instead of the case around the action."

F. E. Morton: "If those points mentioned are constants and results can be obtained from them, would not a gain be had by the manufacturer in adopting them?"

F. H. Abendschein: "There would be."

F. E. Morton: "Would it permit of finishing up an action before it is put in?"

F. H. Abendschein: "No. Not with an upright action. With a grand they regulate on the bench."

F. E. Morton: "Mr. Pfannstiehl, do you think it is practicable so to co-operate with the action maker and effect such changes as will make possible the finishing of an upright action before it is put in?"

F. Pfannstiehl: "Absolutely. Get yout plate right, then you can do it."

F. E. Morton: "Everything in the way of standardization goes back to plate construction, as far as you have tried it?"

F. Pfannstiehl: "Yes, sir, that is my experience."

F. E. Morton: "What would be the attitude of the manufacturers of pianos in effecting changes going back to the plate?"

J. O. Shore: "If we can make changes in the plates not too involved, we would be very glad to do anything to help standardization."

F. E. Morton: "What would you consider involved?"

J. O. Shore: "If we would have to shift our bass strings, bolt holes—changes of that kind."

F. E. Morton: "Assuming standardization was considered seriously by the trade, Mr. Abendschein, would these points be affected, would the construction at the break and bar prove a handicap? Is that a factor?"

F. H. Abendschein: "I don't think so. For argument's sake let us assume we had twelve plates where we wanted to standardize the position of the top bolt. Suppose we had a blueprint of each of these. The right way to arrive at a conclusion would be to lay one blueprint over another but have the blow lines, one exactly over the other and then through the center of the bolt holes in the top blueprint drive a needle through the whole twelve; then examine each blue print individually and see where the positions of the holes are. Imagine the wide discrepancies shown. Who is going to act as a judge as to which position is correct—who is competent?"

F. E. Morton: "I appreciate getting at this from the right angle as well as any one and I would like it distinctly understood that I have no pet theories to air and don't think it should be a one man job, but I do think getting together and discussing these points will uncover possibilities that were not known to exist, and this makes for progress. You piano manufacturers must do your share. Each is interested, but it is your ideas which are going to count. As far as my experience with piano action makers goes they have shown their willingness to come halfway in co-operation. If, when we have discussed this sufficiently it is your pleasure that a committee be appointed to investigate the matter on a scientific basis and report at some future time, it is your privilege. I would be very glad to put such a motion and have a committee appointed from the floor."

C. H. Wood: "Will any manufacturer explain why the brackets of the same sticker length should vary two and one-fourth pounds in weight? We have cases where they vary in weight from six to eight and a quarter pounds. Quite a difference in view of required strength of materials, especially at the market price of cast iron."

Mark P. Campbell: "Why should these differences exist? Why these various lengths and ideas of brackets, their form, their pattern and their weight?"

Paul B. Klugh: "I don't think we will get anywhere by talking details of standardization. I think action makers have occupied the attitude of a custom tailor. They made actions to order instead of ready to use. It looks to me as though standardization must come from the action makers, not from piano manufacturers. Every piano manufacturer has a different idea as to what he wants. If I were making actions and a customer came in, I would tell him that I would make him what he wanted for so much money, but that if he would take standard actions I could sell them at a less price. If the action manufacturer would consider it possible to offer a price differential on what he calls his standardized action, I believe it would be possible within a reasonable length of time to get a large proportion of the piano manufacturers to adopt that standard to save that price even if as small as twenty-five cents, or as fair as fifty cents, or if it were as attractive as a dollar an action. If a manufacturer can use 500 or 1,000 or 10,000 actions with a saving, which is a profit, he would himself gravitate toward that standardization."

C. H. Wood: "How can we attempt standardization of actions without standardizing the setting of the action? I think an action maker would be extremely foolish to standardize brackets. Shall we say, you must set your action so and so? Every one of us would go right after it if you would tell us what you want, but I should not attempt to tell 200 piano manufacturers what to do. I tried it twice in my life and made no headway."

Paul B. Klugh: "If I conveyed through what I said that you would be placed in the position of dictating, that was not my purpose. I placed it purely on commercial grounds. The

action maker says to the prospective customer, 'If you buy what I make in large quantities, I can afford to sell you for less than if I must have special castings made.' I don't see how it would concern you how he sets it. It is up to him to find out how to utilize that action in order to save the difference in price."

F. H. Abendschein: "It would require two stocks of brackets, two sets of cauls for making frames. Suppose we adopted a standardized bracket and developed the standardization to six lengths of brackets. The difference would only be below the action rail to compensate for various heights of action. Suppose we followed out the line of argument you gave. Suppose we accepted the standardized brackets. It would mean capital invested. It takes maybe two months to get the brackets; would you take something on hand?"

Paul B. Klugh: "If there is anything in standardization, it would be from what you will make in big quantities. Don't you think ultimately it would take less capital?"

F. H. Abendschein: "That is a large question to answer offhand."

Mark P. Campbell: "Do you carry now the different brackets in stock? You would be referring back to a standard bracket.

"Mr. Wood spoke of going to the trade. Specifications would be necessary to go with that standardized action; where it should be set—just as every machine which comes to our mills has specifications for its use. If we vary from the specifications we don't get results."

F. H. Abendschein: "I have taken this drawing around to the best piano manufacturers and they say it is all right in theory but not in practice. They fail to see the difference in theory and practice. It is like tunneling from two opposite directions, without much hope of meeting."

Mark P. Campbell: "If we don't start we will never get those tunnels to meet. The object of these meetings is that very purpose—that we may get together. Let us get standardization. Average the weights. Bring it down to a commercial basis and get those two tunnels meeting in the center, starting from opposite points. Let us get a line of thinking in the trade between action maker, case maker and plate maker."

F. Pfannstiehl: "How many manufacturers send in their specifications, including gate patterns, for actions when they are starting to do business?"

F. H. Abendschein: "Very few."

F. Pfannstiehl: "I have sent specifications to various action manufacturers and in every instance we have accepted their bracket. If that is true, it can be carried out in every line. You possibly can standardize down to three points."

F. H. Abendschein: "There are a lot of piano manufacturers who insist on a certain position for their top bolts. Suppose I go to some factory and they point out a case for an action to be built. I take the distance from the striking point to the bed, that being the thing that interests us most, as from that we get the length of the sticker. We go to our sample board and select a bracket which is nearest to that required."

F. Pfannstiehl: "I have never found it necessary to make wooden patterns, as the action maker has models on hand that will answer very well."

F. H. Abendschein: "Sometimes we have a gate that can be altered; if it is not too involved we make it in our own shop, or if it is too difficult, we send it to the foundry."

F. Pfannstiehl: "Is there not on the market an adjustable bracket?"

F. H. Abendschein: "It has not proved satisfactory because they employ a machine screw to hold it together. The contacting surface of the two parts is corrugated. The casting is rather rough and the machine screw holes are not always bored in the proper spot and you cannot bring the parts of the bracket in proper contact."

F. Pfannstiehl: "Could you not stamp it out?"

F. H. Abendschein: "Unless you could standardize six or twelve different kinds you would continually be making new dies."

Paul B. Klugh: "Is a stamped bracket cheaper than cast?"

F. H. Abendschein: "It might be."

Paul B. Klugh: "If you could get it down to four or six kinds of brackets then you could afford to have dies made and the net results would be a saving."

C. H. Wood: "I don't think there is a man in this room who can state whether stamped brackets are practicable; I don't think there is anyone in the action business able to state that.

There is a great difference in the rigidity of cast iron, sheet steel and rods. The question of dies is an important matter and I don't believe this trade could ever get down to four brackets."

Paul B. Klugh: "Why do you think that?"

C. H. Wood: "Because you have so many variations in stickers, in scales—all individual ideas; to come down to four from 2,000 is carrying it to an impossible point."

Paul B. Klugh: "2,000?"

C. H. Wood: "I have 276 that are live and I don't know how many have been scrapped. I attempted just the thing Mr. Klugh was talking about, in 1907-8, and made a satisfactory bracket all the way through. It was mostly ignorance that led me into it and when I got through I scrapped 2,700 sets. Now, there have been great changes since then, but I have not forgotten that experience."

Paul B. Klugh: "Would you say there is nothing to be done?"

C. H. Wood: "I say by all means something is to be done, but the first thing to do is to let one man, or some men, in the piano business, who understand it, place a drawing, a blueprint or something before the action maker that you consider satisfactory. We will be glad to work from it and probably be able to go farther than you thought possible. I, personally, don't understand piano building. I meet all kinds of opinions on the subject. One man tells me that the back felt must be a certain thickness; another man says if it is that thickness he cannot use it at all. I go from pillar to post to do the best I can under the circumstances."

F. E. Morton: "Mr. Klugh states the action maker should take the initiative. I feel the piano manufacturers should have a chance to express themselves fully in the matter. That expression could take any line you see fit. I think we should hear from more piano men on this subject."

Paul B. Klugh: "If you don't mind, I would like to insist upon an answer to my question regarding standardization by the action makers."

C. H. Wood: "I will say, no."

A. T. Strauch: "I wouldn't attempt to educate the trade—it's too expensive."

C. H. Wood: "I feel sure I would not succeed. I wouldn't mind the pioneer part of it if I understood the piano business. I don't know what is true, what is prejudice or what is guess work. I am up against all three. Take the difference, for instance, of between six and eight and a quarter pounds in an action of the same sticker length."

Paul B. Klugh: "A wide variation. Either one or the other is wrong, isn't it?"

C. H. Wood: "I don't know, both are successful firms."

Paul B. Klugh: "Either one or the other is right."

C. H. Wood: "Maybe a margin of safety is figured."

Paul B. Klugh: "If that man has broken brackets, you would hear of it in a hurry?"

C. H. Wood: "That might happen in transportation."

Paul B. Klugh: "If it is so light it will break in transportation, it strikes me the bracket should be heavier."

C. H. Wood: "The heavier ones break also."

Paul B. Klugh: "You must have some idea of what is right—take an average between the two."

C. H. Wood: "Eight and a quarter pounds is more than necessary but I would be afraid to say that six pounds is heavy enough. Left to myself, I would straddle the two.

"What is your objection to having the piano manufacturers give the action makers an idea of what they are willing to accept as a standard?"

Paul B. Klugh: "It is difficult to get so many of them together.

"My mind does not run just to the saving in material only. That is one small end. If we could ever standardize the piano bracket and other things in piano actions, from many little things a tremendous saving would be had in the course of a year. That is one of the objects of these meetings."

A. T. Strauch: "The costs come in the variation in height of the action, which forces an action maker, when he wants six, to make up six sets of stickers. 100 sets of actions require 100 sets of stickers. There may be only one sixteenth inch difference but you cannot use them. The customer will not take them. The matter of saving on a set of brackets of two pounds would be only about ten cents on a set of actions. You will get standardized actions when your

pianos are more nearly standardized. Why, are we to go to you and say you must change your scale in order to use the goods we offer you?"

Paul B. Klugh: "You don't get my point. I don't say you should refuse to make the customer what he wants, as you always have done, but you can offer the standardized action at a lower price and the piano man would help you."

Mark P. Campbell: "Mr. Wood, what is the greatest number of actions you make from any set of brackets in a year?"

C. H. Wood: "No two alike except by accident. Sometimes a customer might want 100 in an emergency and take the nearest we had."

Mark P. Campbell: "Action brackets are very much as they were 25 or 30 years ago, are they not?"

A. T. Strauch: "Yes. If there is a little variation, the manufacturer builds up on the bottom of his bracket. He builds up in putting his action on the key frame and in building up he takes up any little variation."

Mark P. Campbell: "No attempt to change the bracket?"

A. T. Strauch: "No."

Mark P. Campbell: "Could there be, to reduce the cost of the bracket?"

A. T. Strauch: "It would almost be impossible to make a reduction in the present style of bracket."

Mark P. Campbell: "In our attempts at saving and standardization, we have saved nearly 50 per cent on brackets by changing the form. I should think you could make a saving on that two pounds of iron referred to."

C. H. Wood: "He said if six instead of eight and a quarter pounds were used the saving would be ten cents."

A. T. Strauch: "We could take out two pounds in the grand and have it safe."

Mark P. Campbell: "We have no trouble with our brackets and they are going all over the country."

A. T. Strauch: "I doubt whether yours would vary a quarter of a pound from ours."

Mark P. Campbell: "Our quantity would not be greater than Mr. Strauch's in the market of his grands. An actual saving has been made and I should be very glad to compare the figures with you for the benefit of the industry if the bracket could be accepted. We are satisfied with it because of the experience we have had. We have had no adverse experience."

A. T. Strauch: "What does a set of your brackets cost?"

Mark P. Campbell: "Thirty nine cents. Does that mean 50 per cent of your cost?"

A. T. Strauch: "Not quite, about 40 per cent."

Mark P. Campbell: "There is a material saving in six thousand sets of brackets."

A. T. Strauch: "As I remember, about 25 cents on a set of brackets."

F. E. Morton: "Mr. Klugh, would the appointment of a committee of piano manufacturers, with the assistance of a good engineer to report at a given time to a given body, meet the requirements you have in mind?"

Paul B. Klugh: "I think that would more nearly meet Mr. Wood's than mine."

C. H. Wood: "Mr. Morton, and Mr. Klugh, how many manufacturers here tonight are prepared to say to the action makers here, 'We will take any standard action bracket'?"

Paul B. Klugh: "If you were to say here tonight, 'I will make an action with standardized bracket and that action will cost me no more to make than one with a special bracket,' irrespective of the statement of Mr. Strauch, and I believe myself it would be an expense at first, if you were to say, 'I will make that standardized bracket action and if that is used in sufficient quantities for me to produce that as a standard article, I will sell it for less—I won't tie you to a figure—but sell it for less than these custom made,' I think there is not a piano manufacturer in the room who will not think it over."

C. H. Wood: "Without the slightest desire to criticise the industry, I wish to call your attention to the fact that it probably costs more money than you could possibly save, in the changes made by piano manufacturers on brackets; and sometimes the action maker is given no notice—he will have to scrap a great many brackets. I think more money is wasted in this respect than could be saved by standardization."

F. H. Abendschein: "I think you are absolutely right."

A. T. Strauch: "This would apply also to stickers."

Mark P. Campbell: "How many action makers are there?"

C. H. Wood: "Eleven."

Mark P. Campbell: "A very small body compared with the piano makers. It would be easier for eleven men to get together than for 200 piano makers."

A. T. Strauch: "We might get together and ask them to standardize their scales."

Mark P. Campbell: "You would oblige them. It is to the right end."

Paul B. Klugh: "Not so much of a joke as you may think it is, Mr. Strauch. You would see the scales changed in a hurry.

"When you get to working on standardizing you can carry it to a point of standardizing action brackets, length of stickers and centers and you can go so far as to standardize the divisions."

A. T. Strauch: "If you do change the brackets, what can you save? Not more than ten cents. Mr. Klugh believes there would be sufficient saving finally that it would amount to something for the piano man. In one item I cannot agree with him."

C. H. Wood: "I think the important factor is a movement toward standardization."

A. T. Strauch: "You mean general standardization?"

C. H. Wood: "Start with one thing and keep on with the others."

F. E. Morton: "Just to break in one moment before anyone leaves. We are all very much indebted to Dr. D. R. Hodgdon for his interest in this work and in his placing the problems of the piano manufacturer in the College of Technology before the students as part of their work. I want to say that this College of Technology is in a position to use action models to very great advantage in problems in physics as well as construction problems which will eventually come to the piano action makers and piano makers, which problems will be given consideration by the faculty and students. I am going to ask contributions to the laboratories of the College of Technology of Newark, New Jersey, assuring you that having tried it in other ways the benefits are reflected very quickly to the trade and industry as a whole.

"I went into the laboratory the other day and surprised the Doctor in clearing up a strung back and parts of pianos with the help of which he had been giving a lecture to students on piano making and I think if the educational institutions of this country will make our problems theirs, it is a real privilege to assist."

Mr. Klugh introduced Mr. C. A. Grinnell, as a successful dealer and manufacturer who, because of his progressiveness, has espoused the cause of the general trade, and as president of the Music Industries Chamber of Commerce, is throwing his great influence into the campaign for a musical nation.

C. A. Grinnell: "Mr. Chairman and Gentlemen: I have been exceedingly interested in this meeting and it seems to me that such earnest and sincere discussion and exchange of ideas must lead to splendid results. Nothing has transpired in many years, and I have had nearly forty years in this industry, which has interested me more than reading at long distance the accounts of your conferences here in this city. It is simply marvelous. If others of the dealers have taken as deep interest as I, I am sure that the work you have done here will carry throughout our entire land and a great benefit will result therefrom. It is, of course, a great pleasure and a very great opportunity for the manufacturers of this city and of this vicinity to get together and discuss in the frank way you do, the vital things concerning the manufacture of our merchandise and I want to commend you on the splendid work you have done. Your questions, your sincerity, your close attention—I have never seen a lot of seekers who seemed to be more intent, more earnest than you have been tonight—and your discussion so pleasantly carried on, the cards thrown on the table and the discussions above board, leads me to a thought in connection with larger gatherings and broader viewpoints of men getting together in association work, not merely in our industry but in many other lines. In passing I want to say I think there has never been a time in the history of our trade when such deep thought has been centered on the benefits to the industry and benefits to the public as is now being centered on the music industry of America. America, to an extent, is looking to this organization, to the meeting of you gentlemen, for future direction and future development. The world, in turn, is looking to America.

I am very enthusiastic over the prospects because when serious minded men get together discussing things of such vital interest there must be wonderful results following.

"I wish to thank you for the opportunity of being here; it has been a very great pleasure although I hardly hoped I might have this pleasure while reading the articles, and I hope you will all be as earnest in endeavoring to contribute your portion of support to the industry and to the great cause of music, which is confronting us at this time. The war has done lots for us; it has shown us things in a way that we have never thought before. I trust that we may meet you all on the second day of June, in Chicago; that you will be with us in as serious mood as you have been here tonight and that we may work out for music the splendid plane it should occupy."

F. E. Morton: "A change of scales has been suggested to bring about a possible standardization. I want once more, then, to call to your attention that with a uniform tension scale the action work down almost to the break on either uprights or grands will be identical. Under this treatment the hammer line distance is a matter of simple adjustment. If you were to build a uniform tension scale in grand or upright, your sweep and line of bridge is the same in all to the point where you must compromise. The number of bass and treble strings, respectively, is so nearly standardized as to necessitate only two or three patterns. That will give us one constant in solving this equation. It seems to me the question now is, what can be done to lead us into such practice as will make standardization possible? We have already taken up a number of subjects and I am confident a better understanding obtains between the manufacturers and those upon whom they are dependent for material. This alone will tend to bring standardization closer. Better understanding will bring about better practice.

"This is the last meeting of the series. On next Wedensday night a session will be held at the Piano Club, where will be shown moving pictures of the manufacture of wire from the ore to the use of the finished product in the piano, pipe organ and harp."

M. J. de Rochemont: "I move that a committee consisting of practical piano men and mechanical engineers be appointed by the chairman to submit specifications of standardized action brackets."

Paul B. Klugh: "I second that motion. They should be practical men. We have some practical men right here in the room."

The motion was unanimously carried and the chairman stated he would name the committee after conferring with the officers of the New York Piano Manufacturers' Association.

F. E. Morton: "I want to thank you gentlemen for your responsiveness. Some satisfaction is derived from action, but 90 per cent comes from the response to such action. I hope I shall be privileged to confer with you in your respective factories. I want to thank you for your attendance here and help you have given. This is not a one man job, as I remarked before. It is a conference; a getting together of men who are in earnest, whose ideas are progressive and you have given all the evidence of filling that bill."

BRIGHAM YOUNG UNIVERSITY
3 1197 00598 1938

DATE DUE

DEC 2 1 1992			
		NOV 0 6 2002	
OCT 2 6 1995	MAR 1 3 2003		
OCT 3 0 1996			
MAR 2 8 1997	MAR 1 1 2003		
MAR 1 8 1997	DEC 1 2 2003		
	DEC 1 5 2003		
FEB 0 4 1999	OCT 1 7 2009		
FEB 0 4 1999			
OCT 0 1 1990			
OCT 0 8 1993			
DEC 1 6 1993			
DEC 1 7 1993			
MAR 1 4 2000			
MAR 0 7 2000			
NOV 2 0 2002			

DEMCO 38-297

REPRINTED BY THE VESTAL PRESS, VESTAL, NEW YORK