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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, June 15, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2061.

(Subsequent to Investigation Report)
(No. 2060, June 5, 1946.)

Stress Analysis with Brittle Lacquer,
Performed on a Cast Magnesium Piano Plate. - Part II.

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(Copy No. 17.)

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(Investigation)
(Report No. 2061.)

Abstract.

In the first part of this investigation, the qualitative distribution of stresses in a cast magnesium piano plate, fixed to a wooden resonance box, was determined by application of Stresscoats Nos. 1200 and 1204. This report describes the second part of the investigation, in which the piano plate was again loaded twice, by tuning the strings up to the pitch and then spraying, with Stresscoat No. 1206 in the third test and with No. 1208 in the fourth test. After drying the stresscoat and relaxing the strings, stresscoat patterns were obtained, as before, in areas compressed while under load. All characteristic stress patterns are shown in photographs and the results are discussed.

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A June 15, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2061.

(Subsequent to Investigation Report)
(No. 2060, June 5, 1946.)

Stress Analysis with Brittle Lacquer,
Performed on a Cast Magnesium Piano Plate. - Part II.

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Origin of the Investigation:

The magnesium piano plate was submitted by Dominion Magnesium Limited, Toronto, Ontario, for a stress analysis investigation in order to check the present design and obtain suggestions which should be applied in production.

Introduction:

The "stresscoat" technique is applied to complicated structures where the calculation of stresses is very difficult and time-consuming. The surface of the structure under investigation is sprayed with a brittle lacquer. After drying the lacquer and loading, the coating breaks, giving cracks

(Introduction, cont'd) -

directed perpendicularly to the direction of principal tensile stresses. In this investigation the piano plate was first loaded by tuning the strings up to the pitch and then sprayed with the stresscoat. After drying, the strings were gradually released and the lacquer, being now exposed to tension, cracked in placed previously loaded in compression. Two stress coatings were used, Nos. 1206 and 1208. The characteristic strain at which the stress pattern starts to form was determined in two ways: first, by using the calibration strips and, secondly, by using the Chart No. 8 supplied by the Stresscoat Division of the Magnaflux Corporation, Chicago, Illinois. The technique is described in full in the Operating Instructions booklet for Stresscoat, issued by the Magnaflux Corporation (see also Investigation Report No. 2060, dated June 5, 1946).

Description of the Magnesium Piano Plate:

A sketch of the piano plate is shown in Figures 1 and 2 (in the Appendix) and a general view is shown in Figure 3 (on Page 3).

The plate was made from Magnesium Alloy AZ80X, not heat treated, used in the 'as cast' condition. The magnesium metal used in this casting was produced by the silicon reduction process in the plant of Dominion Magnesium Limited at Haley, Ontario. The plate was cast at Light Alloys Limited, Renfrew, Ontario.

Results of Investigation:

Test No. 3.*

Stresscoat No. 1206 was used. The calibration results of this stresscoat are given in Table I. The strain sensitivity of the lacquer used (No. 1206) was about 600 micro-inches per inch, a comparatively sensitive coat as

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* Tests Nos. 1 and 2 appear in Investigation Report No. 2060.

(Results of Investigation, cont'd) -

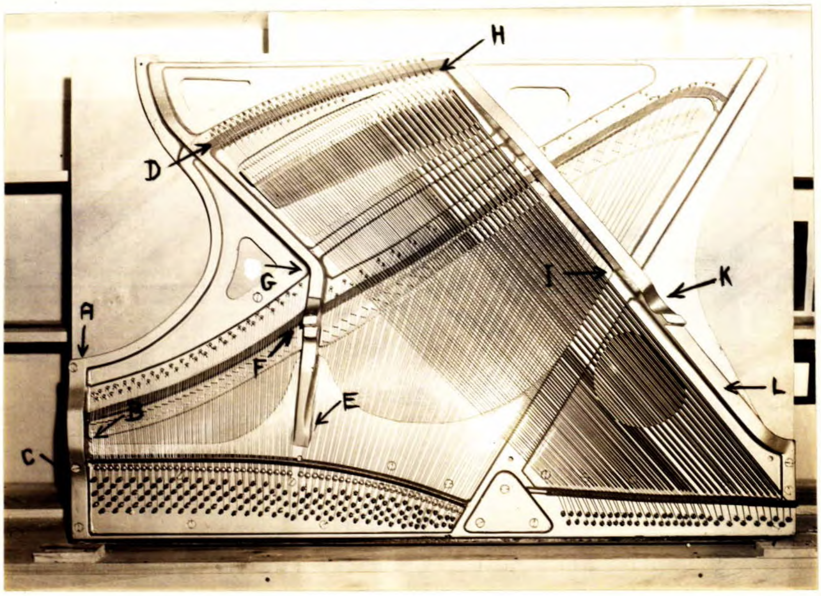
compared with the Stresscoats Nos. 1200 and 1204 used previously on the same plate (see Investigation Report No. 2060).

The loading on the magnesium plate was applied by tuning up to the same pitch as before while the plate was mounted on a strong wooden resonance box. After tuning and during relaxation of the strings, the piano back was kept at constant atmospheric conditions (given in Table I).

Distinctive strain patterns in this test were obtained in regions A, B, C, D, E, F, I, K and L marked in Figure 3. The details of the pattern in these places are shown in Figures 4 to 16 inclusive.

To obtain some approximate information about the total dimensional changes, diagonal measurements were taken before and after tuning. These measurements were taken between seven points A, B, C, D, E, F, and G marked in Figure 1. The results are given in Table II.

Figure 3.



VIEW OF MAGNESIUM PIANO PLATE.

(Tables I and II follow, on Pages 4)
(and 5.)

TABLE I - Stresscoat Calibration, Test No. 3.

DATE OF SPRAYING Day	DATE OF SPRAYING Hour	Strip No.	Stress-coat No.	WHEN LOADED a) After drying, b) before drying.	STRAIN, micro-inches At 1st break	STRAIN, micro-inches At 2nd break	Strain Sensitivity as taken from Chart No. 8	DRYING TEMPERATURE, ° F. Wet Bulb	DRYING TEMPERATURE, ° F. Dry Bulb	LOADING TEMPERATURE, ° F. Wet Bulb	LOADING TEMPERATURE, ° F. Dry Bulb	DATE OF LOADING OR UNLOADING Day	DATE OF LOADING OR UNLOADING Hour	REMARKS
March 16, 1946.	2 p.m.	A	1206	b	580		600	55.0	72.5	55.0	72.5	Mar 17	2 p.m.	Sensitivity test; piano and calibration strips tested.
"	"	B	"	b	600		"							
"	"	C	"	a	600		"							
"	"	D	"	a	600		"							

Remark: As a guide in the interpretation of the stress patterns the strain sensitivity is regarded as 600 micro-inches per inch.

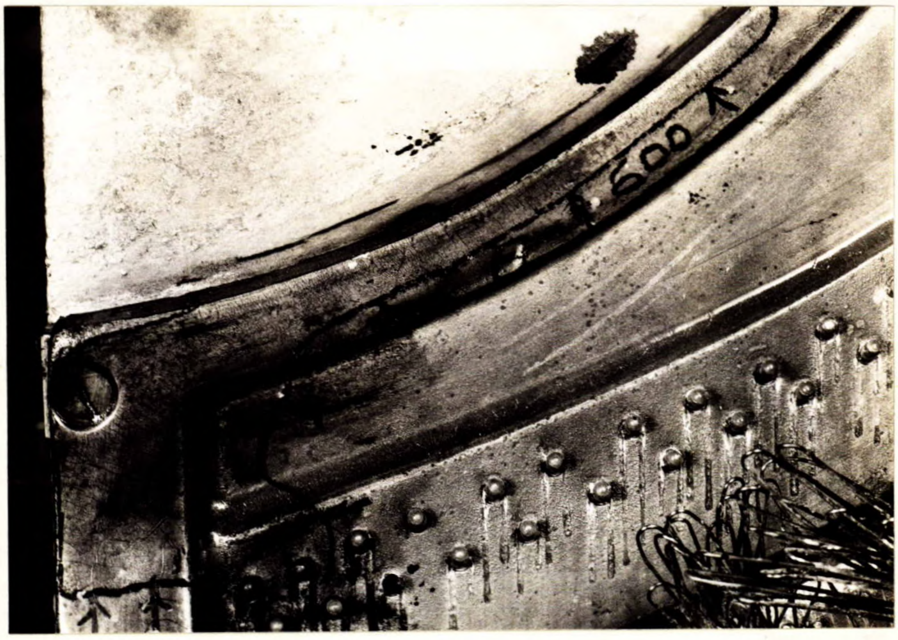
-

(Results of Investigation, cont'd) -

TABLE II.

Distance	After Tuning, inch	Before Tuning, inch	Difference, inch (approx.)
AE	34 38/64	34 41/64	-3/64
BE	35 41/64	35 48/64	-7/46
CE	43 1/64	43 3/64	-2/64
BF	36 30/64	36 34/64	-4/64
CF	34 59/64	34 62/64	-3/64
DF	40 10/64	40 14/64	-4/64
DG	31 3/64	30 62/64	+5/64
AG	60 14/64	60 17/64	-3/64

Figure 4.



Region "A" of the magnesium plate shows cracks as marked with a pencil and arrows pointing to the places where stress patterns have been noticed. The left corner of that region is under compression.

-

Figure 5.

Closely spaced cracks in region "B", on the vertical beam A-C, indicate that this beam is bent towards the centre portion of the piano plate.

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Figure 6.

The inside edge shows the existence of compresssion stresses in region "C". Stress patterns are directed parallel to the bottom edge of the plate.

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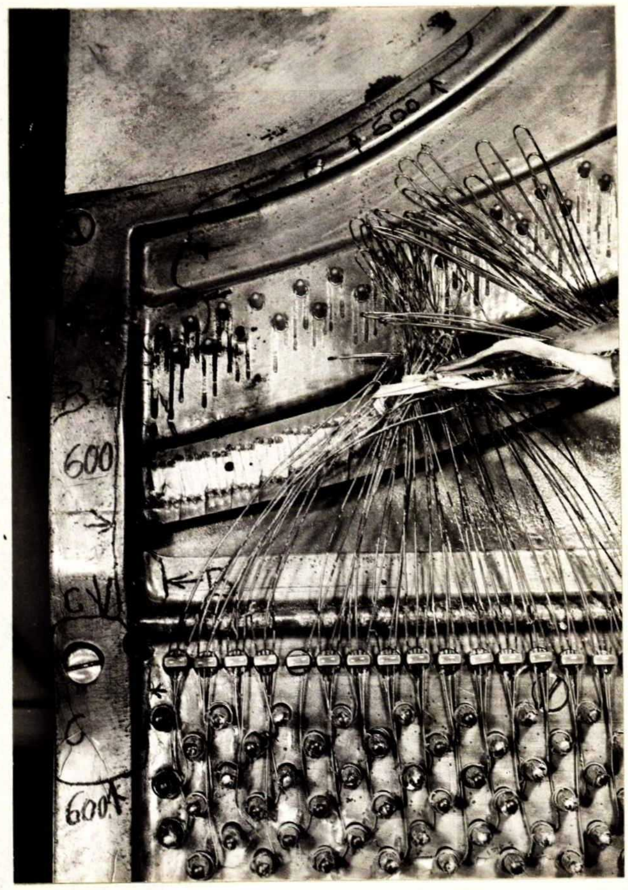
(Results of Investigation, cont'd) -

Figure 7.



The left part of the plate with regions A, B and C was shown before, separately, in Figures 4, 5 and 6. The vertical column, B-C, takes a large proportion of the pull-load superimposed by the strings. Compression and bending loading of the column are evident.

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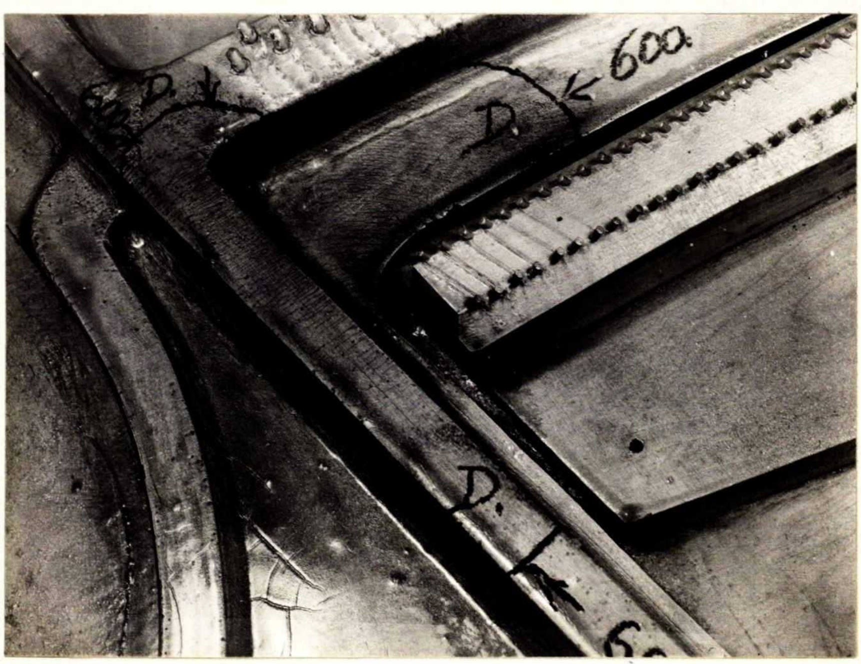
Figure 8.



The left corner of the top beam, marked as region "D", shows on the left edge a compression load with a maximum directed parallel to the edge of the rib. Also, a part of the plate on the right side of the edge is covered with stress patterns at 45 degrees to this edge.

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(Results of Investigation, cont'd) -

Figure 9.

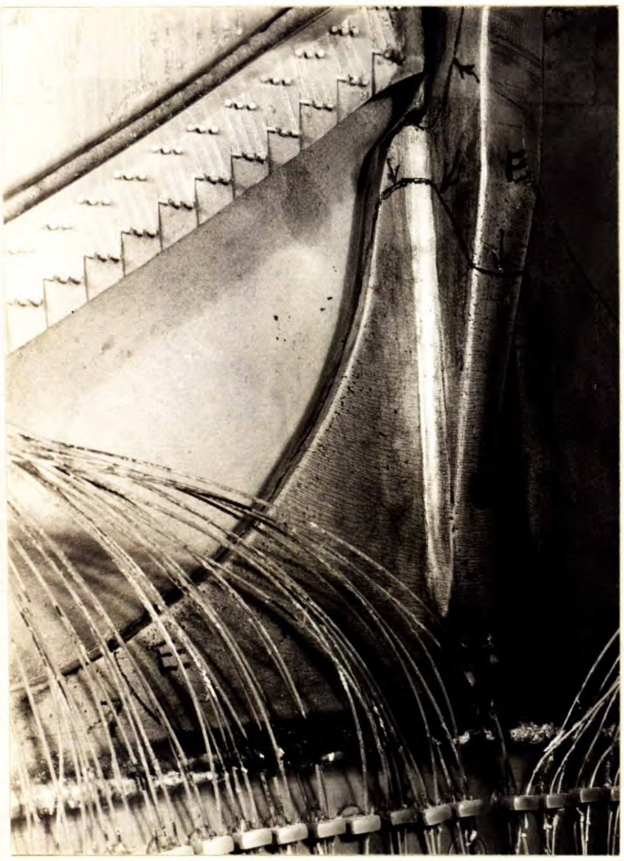
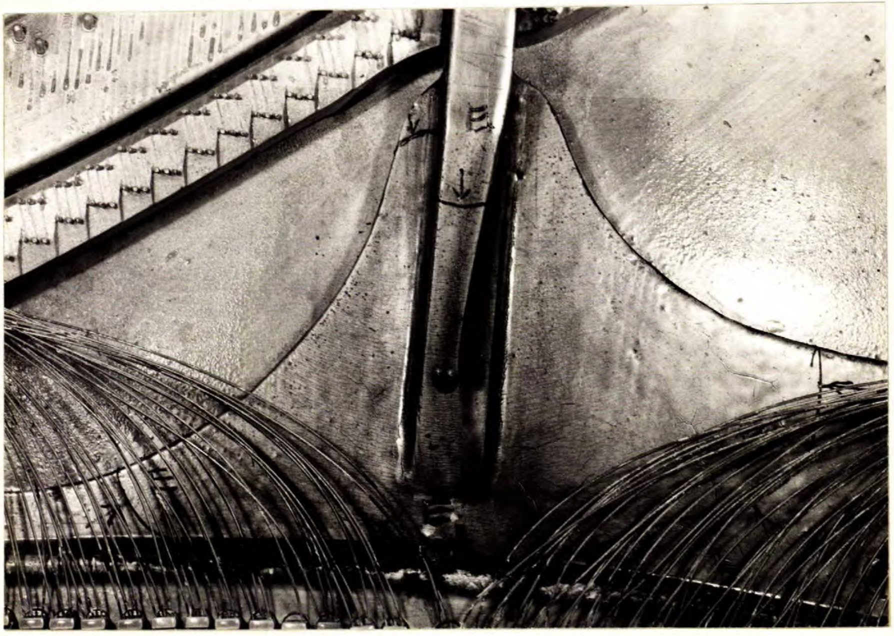


Figure 10.

Figure 11.



Region "E", at the end of the second vertical column, is shown in Figures 9, 10 and 11. The stress patterns in the region prove the presence of compression stresses caused by the load transmitted from the upper and lower parts of the plate.

(Results of Investigation, cont'd) -

Figure 12.

In the region "G", the cracks in the stress pattern observed show compression load on the inside of the curvature. In the region "F", on the upper part of the column adjacent to the main diagonal beam, a dense stress pattern was observed. The position of this stress pattern proves the presence of a high eccentric compression load.

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Figure 13.

The upper right-hand corner, marked as region "H", has shown stress patterns as contoured by pencil. Some concentration of compression stresses in that corner is indicated.

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(Results of Investigation, cont'd) -

Figure 14.

The region "I" shows the lower part of the main column adjacent to the main diagonal beam; the presence of the eccentric compression load is evident.

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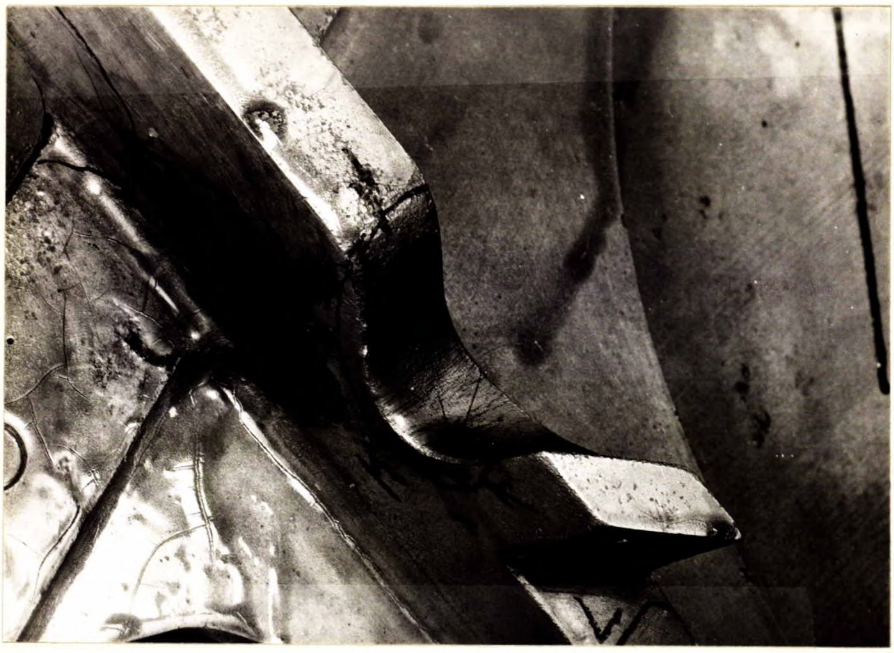
Figure 15.



The deep round cut in the main column is covered with stress patterns which show the concentration of compression stresses and also indicate the eccentric compression load in the column.

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(Results of Investigation, cont'd) -

Figure 16.

The lower part of the column in region "L" is covered with stress patterns on the top surface and on the sides to nearly half the depth of the rib. This also proves the presence of eccentric compression load.

Discussion of Results; Conclusions:

Figures 4 to 16 show the characteristic stress patterns observed in regions A, B, C, D, E, F, G, H, I, K and L of the analysed magnesium piano plate. All the stress patterns prove the presence of compression stresses, combined with a bending effect, which as a whole might be called eccentric compression loading. The regions most strained appear to be regions B and E and these are the places which should be chosen first for investigation by SR-4 Strain gauges. These tests, and previous tests described in Investigation Report No. 2060, have shown the directions of maximum strain which are perpendicular to the cracks in the stress patterns. The determined directions of principal strains in the investigated regions will be used for guidance in positioning the measuring length of SR-4 strain gauges to be used in further analysis.

From the general shape of the piano plate under test, it may be noticed that the resultant of the tension from all strings is placed eccentrically to the centroids of the sections examined and for that reason practically all sections are exposed to eccentric loading.

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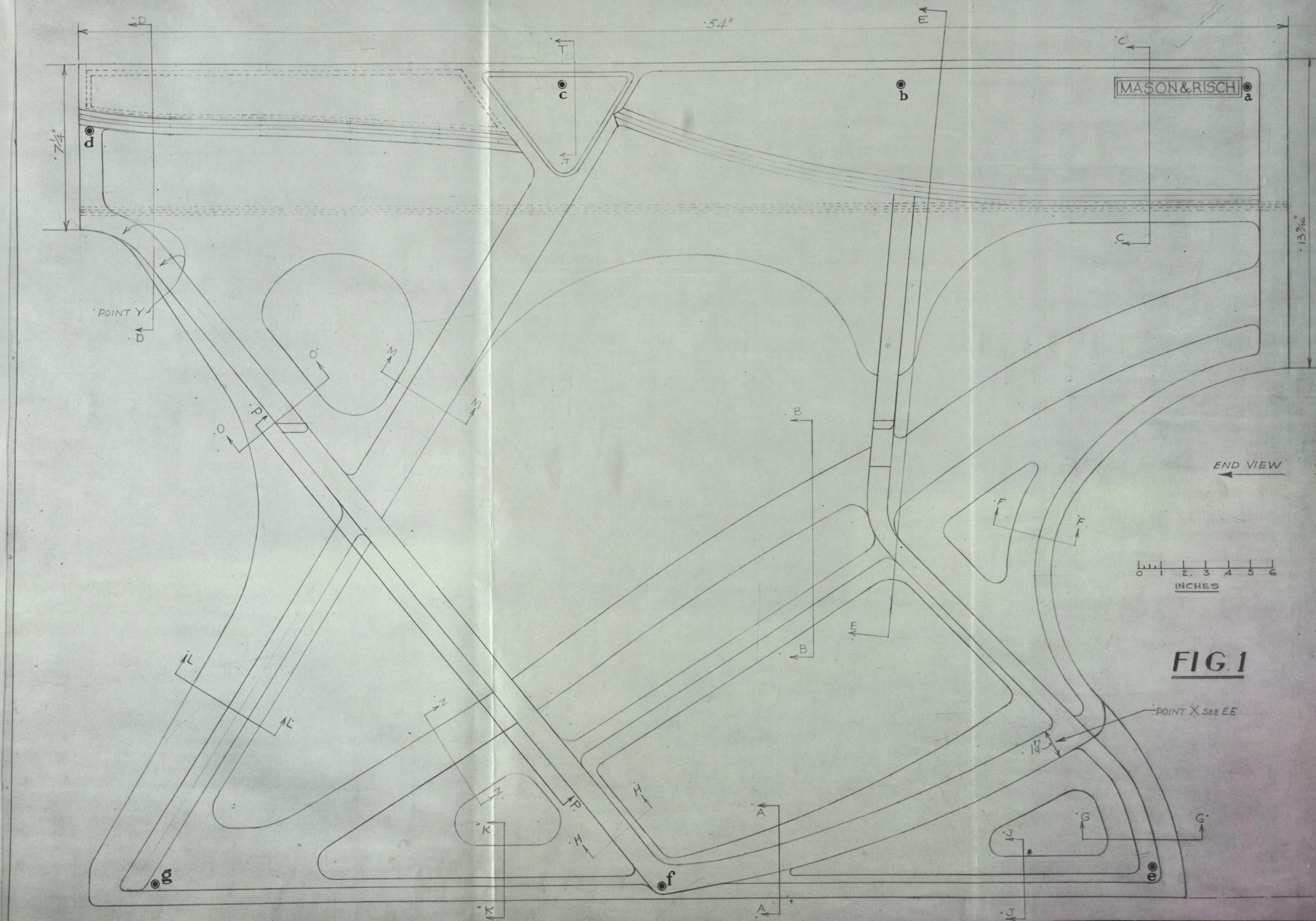
TWW:RT:LB.

(Figures 1 and 2)
(now follow,)
(as an appendix,)
(on Pages 13 and 14.)



54"
MASON & RISCH
7¼"
13 9/16"
36½"
POINT Y
END VIEW
0 1 2 3 4 5 6
INCHES
POINT X SEE EE
1¼"
a
b
c
d
e
f
g

FIG. 1

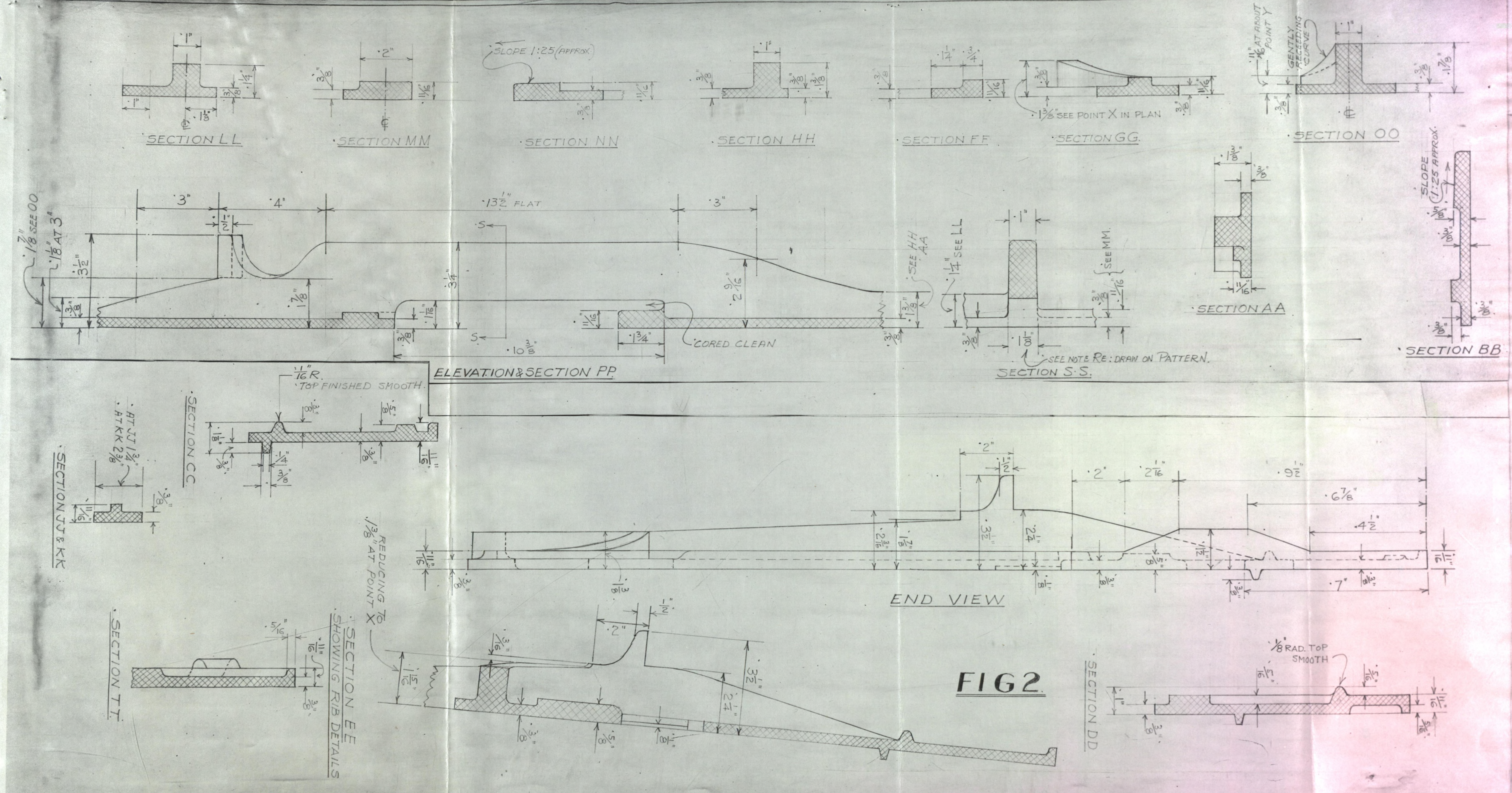

SECTION LL
SECTION MM
SLOPE 1:25 (APPROX)
SECTION NN
SECTION HH
SECTION FF
1 3/8" SEE POINT X IN PLAN
SECTION GG
11/16" AT ABOUT POINT Y
GENTLY RECEDING CURVE
SECTION OO
13 1/2" FLAT
1 7/8" SEE OO
1 1/8" AT 3"
SEE HH AA
CORED CLEAN
ELEVATION & SECTION PP
1 1/4" SEE LL
SEE MM
SEE NOTE RE: DRAW ON PATTERN.
SECTION S·S.
SECTION AA
SLOPE 1:25 APPROX.
SECTION BB
1/16" R.
TOP FINISHED SMOOTH.
SECTION CC
AT JJ 1 3/4"
AT KK 2 3/8"
SECTION JJ & KK
END VIEW
REDUCING TO 1 3/8" AT POINT X
SECTION TT.
SECTION EE SHOWING RIB DETAILS
SECTION DD
1/8" RAD. TOP SMOOTH

FIG 2.