Publications of the

BRITISH FIRE PREVENTION COMMITTEE.—No. 11.

Edited by Edwin O. Sachs.

FIRE TESTS

WITH

UNPROTECTED COLUMNS.

A Report, by

THE COMMITTEE ON "FIRE-PROOFING" TESTS,

NEW YORK.

WITH TWELVE DOUBLE PLATES.

AND NUMEROUS ILLUSTRATIONS INTERSPERSED IN THE TEXT.

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BRITISH FIRE PREVENTION COMMITTEE.

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OBJECTS:

The main objects of the Committee are :—

To direct attention to the urgent need for increased protection of life and property from fire by the adoption of preventive measures.

To use its influence in every direction towards minimising the possibilities and dangers of fire.

To bring together those scientifically interested in the subject of Fire Prevention.

To arrange periodical meetings for the discussion of practical questions bearing on the same.

To establish a reading-room, library and collections for purposes of research, and for supplying recent and authentic information on the subject of Fire Prevention.

To publish from time to time papers specially prepared for the Committee, together with records, extracts and translations.

To undertake such independent investigations and tests of materials, methods and appliances as may be considered advisable.

The Committee does not hold itself in any way responsible for the opinions expressed, or methods advocated, by members and others who kindly contribute to these publications.

Comments on the opinions expressed in these papers, or further information on the subjects under consideration, are cordially invited by the Executive, at whose discretion they will be circulated among the members of the Committee.

NOTE.

THE series of independent tests with fire-resisting materials, systems, and appliances, which is about to be inaugurated by this Committee, renders it desirable for the Executive to publish the results of similar investigations, if any, which have been carried out by others, thereby enabling members to institute instructive comparisons.

Unfortunately, however, the results of but few investigations are available; for no independent research has, so far, been carried out in this country, whilst what has been done in the United States or on the Continent is very small. As a matter of fact, there has only been one attempt at really systematic and independent testing, namely, at Brooklyn, U.S.A. There have been some other tests at Hamburg and New York which some might classify as official, but they were either investigations made by the officials of public bodies with the view of specifying the work of certain makers or inventors, or the selection of materials, &c., most suitable for their own particular purposes at the time being, or they were "comparative" tests between rival manufacturers.

The first series of independent tests at Brooklyn was undertaken with the unprotected iron column or support, and it is the report of the Committee of Fire-proofing Tests on this series, which forms the subject of the present publication. That the Executive of the British Fire Prevention Committee are able to present it, together with reproductions of the excellent photographs

taken on the spot, is due to the kindness of the American Committee, and also to the representatives of the American Institute of Mechanical Engineers, who have so courteously put the necessary blocks at our disposal. I am sure that the members of the British Fire Prevention Committee will not be slow to appreciate the assistance so willingly granted them in the United States.

It is not my purpose to enter into an account of the tests in question further than to say that, as with all work of this kind, a very large number of difficulties had to be overcome

I should, I think however, point out that the plant used at New York for this series of tests consisted of the brick testing hut shown in the illustrations, which was fed by gas supplied from the Committee's own generator, at times assisted by a spray of naphtha. To procure the necessary pressure on the columns during the investigations, hydraulic power was used, whilst the records were aken with the aid of a pyrometer. The reports, as will be seen, simply contain a statement of facts, supplemented by a detailed log of the occurrences in each case, and every experiment was duly attested by responsible representatives of the body undertaking the research.

But I need add nothing further to what I have said regarding the report here published, which, with its illustrations, should explain itself and serve as a valuable contribution to the subject.

To those who desire to see all constructional ironwork suitably protected from the effects of fire, the data given should serve as a basis for formulating their requirements, inasmuch as the report shows very exactly to what extent the unprotected supports offered resistance under the specific conditions described.

EDWIN O. SACHS.

October 10th, 1898.

FIRE TESTS

WITH

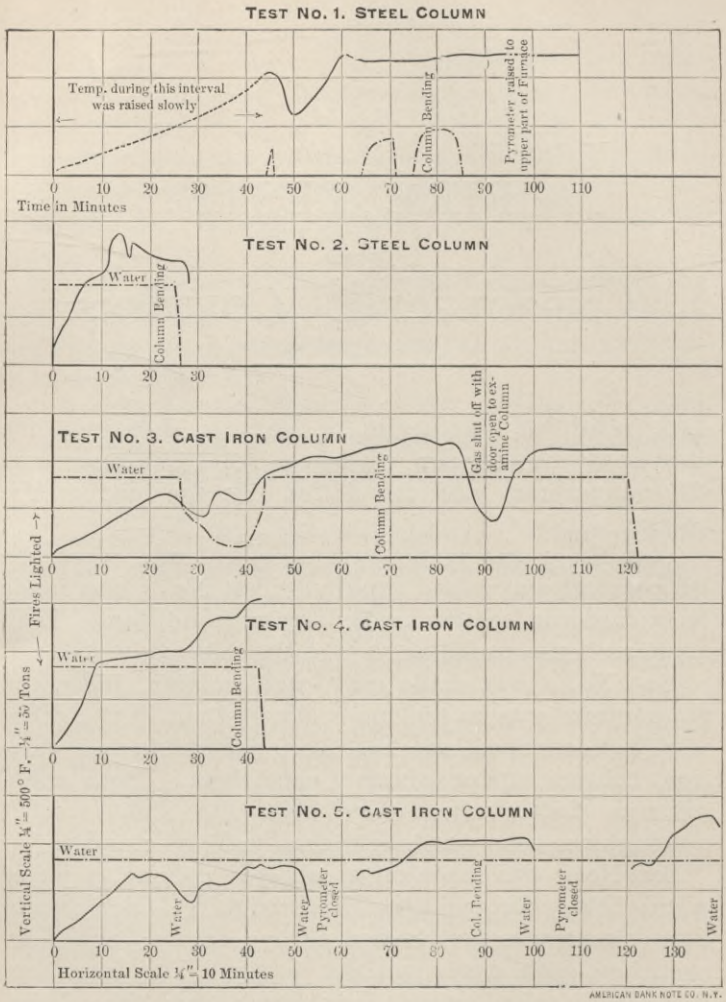
UNPROTECTED COLUMNS.

THE result of this series of tests is shown in the accompanying diagram, where the solid line represents the temperature and the dotted line the load on the column.

Test No. 1 was made on a steel column, when the temperature was raised rapidly. Test No. 3 was made on a cast-iron column under similar conditions. Both columns began to fail as soon as they showed "red."

Test No. 2 was made on a steel column, when the temperature was raised more slowly than in the other tests just described, and Test No. 4 was made on a cast-iron column under similar conditions. Both these columns failed when they began to show "red," although the time was longer than in Tests 1 and 3.

Test No. 5 was made on a cast-iron column, a jet of water being thrown upon it through a $\frac{3}{4}$-inch nozzle The column was first heated to 675 degrees and then quenched with water without injury. The heat was then slowly raised again to 775 degrees, and the column again quenched with water. The heat was then raised slowly to a temperature of 1,075 degrees, and the column, which then showed a "dull redness," was again quenched with water. The heat was then raised again to 1,300 degrees, and the column, which now showed a "bright red," was again quenched with water. The column was beginning to yield by bending just before the last application of the water. The column was apparently unaffected by water, although it failed by bending under the load, the same as in cases 3 and 4.

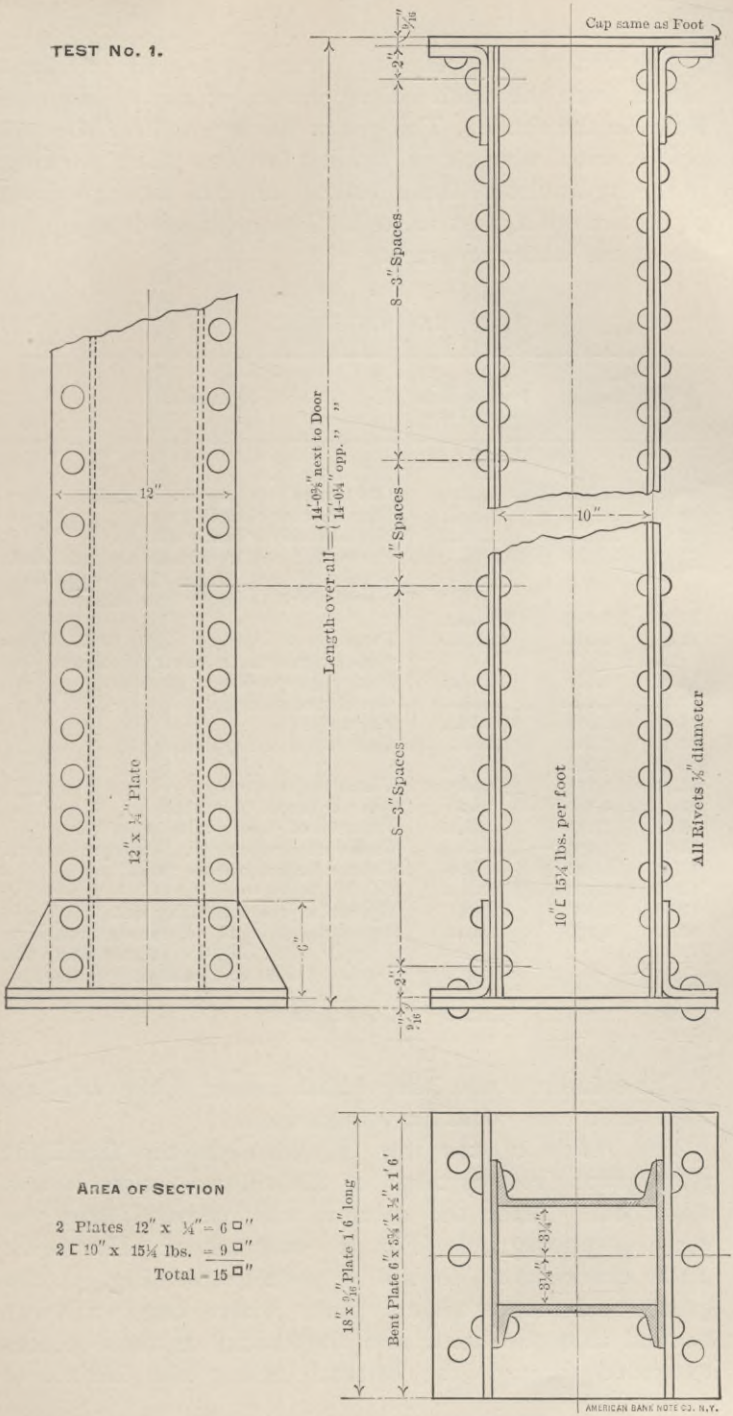


COLUMN TEST No. 1.

Fire test without water. Steel column.

The walls of the furnace were of common brick, and the door was closed with a double thickness of sheet iron, which made the opening practically tight. The column was a Carnegie Steel Box Channel of the dimensions as shown in the illustration (Fig. 2), and was unprotected.

Fig. 2.


TEST No. 1.
Cap same as Foot
8—3" Spaces
4" Spaces
6—3" Spaces
Length over all = 14'-0⅜" next to Door / 14'-0¾" "opp." "
12"
12" x ¼" Plate
6"
10"
10" C 15¼ lbs. per foot
All Rivets ⅞" diameter
18 x ⅝" Plate 1'6" long
Bent Plate 6"x 5¾" x ¼" x 1'6'
3¼"
3¼"
AREA OF SECTION
2 Plates 12" x ¼" = 6 □"
2 C 10" x 15¼ lbs. = 9 □"
Total = 15 □"
AMERICAN BANK NOTE CO. N.Y.

The weather was clear and warm, with only a slight breeze from the west. Temperature of air, 80 degrees Fahr. in the shade. The gas producer was fired the day before, with valve closed against furnace. The packing in the hydraulic cylinder leaked, and the fitting of the pipe gave out as test started. These causes delayed the use of the water pressure.

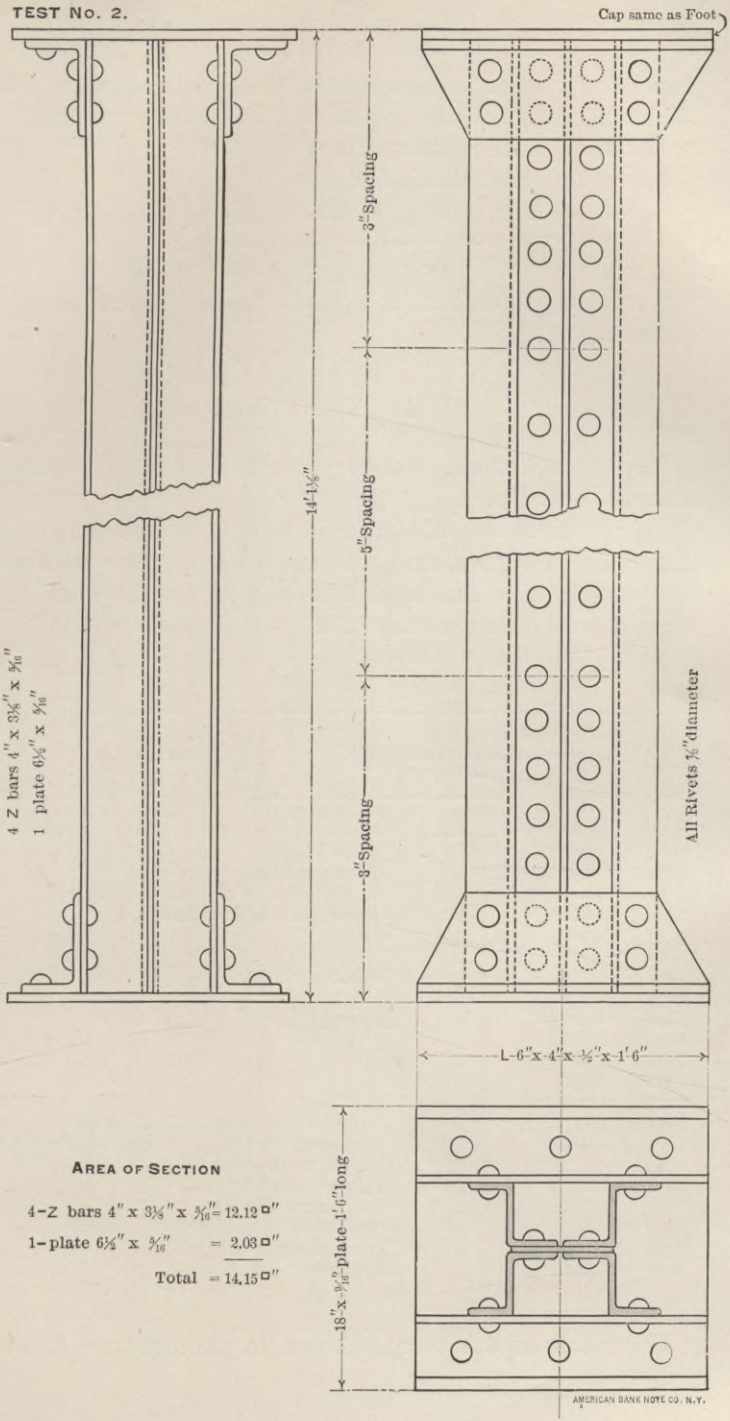
LOG OF TRIAL.

Time. H. M.	Pyrometer. Degrees Fahr.	Hydraulic Pressure. Total Load Tons.	Remarks.
10.35	.....	.....	Wood fire lit.
10.45	.....	.....	Gas turned into furnace.
11.02	.....	.....	Furnace door closed.
11.03	.....	.....	Naphtha valve slightly opened.
11.13	.....	.....	Pyrometer put in furnace through lower hole, $2\frac{1}{2}$ feet above the furnace door, with point 12 inches from column.
11.19	1,025	.....	
11.20	1,050	.....	Pressure on column. Light load. Pyrometer point 24 inches from column.
11.25	600	.....	Raking gas-producer; gas shut.
11.28	.....	.....	Gas turned on again.
11.33	1,025	.....	No naphtha.
11.36	1,225	.....	Half faucet of naphtha.
11.38	1,200	.....	
11.40	1,175	14.13	Water pressure on.
11.41	1,180	28.26	Quarter faucet of naphtha.
11.46	1,175	.....	Pressure off, water valve repacked.
11.50	1,175	.....	Closed all air openings. Water pressure on.
11.55	1,200	48.06	Column began to show "red."
11.56	1,210	.....	Column began to yield.
11.59	1,225	42.41	Hydraulic pressure falling fast.
12.10	1,230	.....	Pyrometer shut off. Pyrometer raised to upper hole, $8\frac{1}{2}$ feet above floor, and point 3 feet from column.
12.16	1,230	.....	
12.25	1,250	.....	Gas shut off.

The column would have failed sooner if the working load of 80 tons could have been used.

The result of the test is shown in the flashlight photograph (Fig. 3) taken of the column before it was disturbed. After the column was removed from the furnace, photograph (Fig. 4) was taken. The brick walls cracked, as shown in photograph (Fig. 5), the greatest damage taking place where one wall was bonded into the next, and the cracks at these places extended through the bricks. Along the horizontal

Fig. 6.


TEST No. 2.
Cap same as Foot
3" Spacing
5" Spacing
3" Spacing
14'1⅛"
4 Z bars 4" x 3⅛" x 5/16"
1 plate 6½" x 5/16"
All Rivets ⅞" diameter
L-6"x4"x½"x1'6"
18"x 9/16" plate 1'6" long
AREA OF SECTION
4-Z bars 4" x 3⅛" x 5/16" = 12.12 □"
1-plate 6½" x 5/16" = 2.03 □"
Total = 14.15 □"
AMERICAN BANK NOTE CO. N.Y.

joints the walls cracked most on the bond courses. All the walls were hot, the eight-inch wall being too hot to hold the hand in contact with it.

Strength by Gordon's formula:

Breaking strength per sq. in. .....45,630 lbs.
Area of cross section.....15 sq. in.
Breaking load, 15 × 45,630.....684,450 lbs. 342 tons.

Actual greatest load, cold, 141.4 tons, with no change of form.

COLUMN TEST No. 2.

Fire test without water. Steel column. Furnace same as Test No. 1.

The column was a Carnegie steel Z-bar, as shown in illustration (Fig. 6), and was uncovered. The weather was clear and warm, with a moderate breeze from the north-west. Temperature of air, 80 in shade.

LOG OF TRIAL.

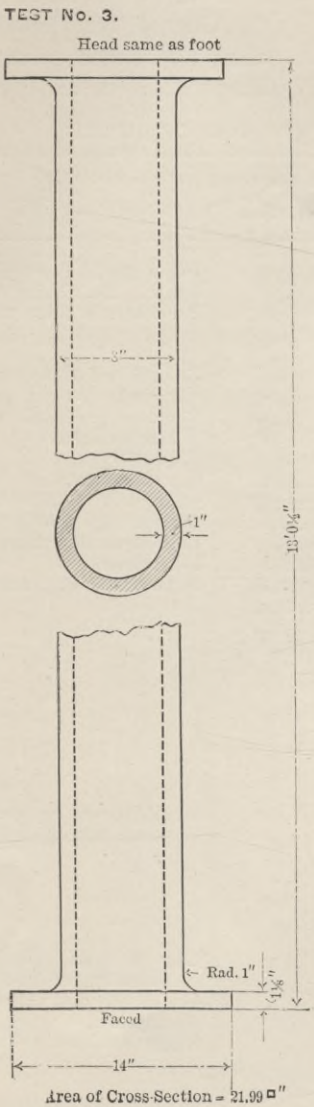
Time. H. M.	Pyrometer. Degrees Fahr.	Hydraulic Pressure. Total Load Tons.	Remarks.
2.23	80	.....	Pyrometer point 3 feet from column.
2.24	200	84.8	Wood fire lit.
2.30	850	,,	Gas turned on.
2.33	.....	,,	Door closed. Full cock of naphtha.
2.35	1,000	,,	One-quarter cock of naphtha.
2.36	1,300	,,	
2.37	1,350	,,	
2.38	1,375	,,	Naphtha closed.
2.39	1,300	,,	
2.40	1,125	,,	One-eighth cock of naphtha.
2.40½	1,300	,,	
2.41	1,325	,,	
2.42	1,250	,,	
2.43	1,200	,,	
2.44	1,175	,,	Naphtha cock closed to "dropping."
2.45	.....	,,	Pyrometer moved to 2 feet from column as flame touched point.
2.46	1,125	,,	Column began to yield.
2.47	1,125	,,	Column yielding fast.
2.49	1,100	,,	Impossible to maintain hyd. pressure.
2.51	1,100	,,	Pump and gas stopped.
2.52	900	,,	Pyrometer closed.

The result of this test is shown in photographs (Figs. 7 and 8).

Strength by Gordon's formula:

Breaking strength per sq. in.....42,820 lbs.
Area of cross section .....14.15 sq. in.
Breaking load, 14.15 × 42,820.....605,900 lbs. 303 tons.

Fig. 9.



COLUMN TEST No. 3.

Fire test without water. Cast-iron column. Furnace same as Tests 1 and 2.

The column was a cast-iron, hollow, round column, with flanges faced on both ends, as shown in illustration (Fig. 9), and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York.

The weather was clear and warm, with a slight breeze from south-west. Temperature of air, 75 degrees Fahr.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Degrees Fahr.	Hydraulic Pressure. Total Load Tons.	Remarks.
2.32	.....	14.1	Wood fire lit.
2.45	.....	84.8	Gas lit. Door being closed.
2.50	.....	,,	Pyrometer in place, 18 in. from column.
2.51	575	,,	
2.54	625	,,	
2.57	625	,,	Gas shut off to poke producer.
2.59	500	,,	
3.00	475	56.5	Removed some loose bricks that interfered with tuyeres.
3.04	425	28.2	
3.05	450	.....	Gas turned on, door closed.
3.06	650	15.5	
3.08	667	.....	Air openings closed.
3.12	600	11.3	Door down to arrange bricks.
3.13	625	.....	Door closed.
3.13½	650	.....	Naphtha valve opened one-half
3.14	750	.....	
3.15	812	42.4	
3.17	900	84.8	
3.21	950	,,	
3.23	1,000	,,	
3.25	1,025	,,	
3.28	1,050	,,	
3.30	1,025	,,	
3.32	1,050	,,	
3.36	1,100	,,	
3.37	1,125	,,	Slight redness reported by some.
3.40	1,137	,,	Column reported slightly bent.
3.43	1,175	,,	
3.44	1,200	,,	
3.47	1,250	,,	
3.50	1,225	,,	
3.52	1,175	,,	
3.55	1,200	,,	Gas shut off. Door down. Column decidedly red and bent.
4.04	387	,,	Gas on and door closed.
4.08	925	,,	No naphtha.
4.09	925	,,	Naphtha turned on half cock.
4.10	1,000	,,	
4.15	1,112	,,	
4.32	1,125	,,	Gas shut off. Stopped pumping.

Strength by Gordon's formula was as follows:

Breaking strength .....902,000 lbs.
Safe load, $\frac{1}{5} \times 902{,}000$.....180,400 lbs. 90.2 tons.

The result of Test No. 3 is shown in photographs (Figs. 10 and 11).

COLUMN TEST No. 4.

Fire test without water. Cast-iron column. Furnace same as Tests 1, 2, and 3.

The column was a cast-iron, hollow, round column with flanges faced on both ends, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York. The column was the same as illustrated in Fig. 9, with the following exceptions: Length over all, 13 feet $\frac{1}{4}$ inch; thickness of flanges, $1\frac{5}{8}$ inches: flanges re-enforced by four ribs, each $\frac{7}{8}$ inch thick, reaching from outer end of flange to cylinder, at an angle of about 45 degrees.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Degrees Fahr.	Hydraulic Pressure. Total Load Tons.	Remarks.
2.22	.....	.....	Wood fire lighted.
2.25	.....	84.8	Gas lighted.
2.28	.....	,,	Pyrometer placed 18 in. from column.
2.29	.....	,,	Door closed.
2.30	675	,,	
2.31	875	,,	
2.33	900	,,	
2.35	912	,,	
2.40	950	,,	
2.43	975	,,	
2.44	1,000	,,	
2.45	1,000	,,	
2.49	1,000	,,	Naphtha used, one-quarter cock.
2.51	1,100	,,	
2.52	1,125	,,	More naphtha, three-eighths cock.
2.53	1,200	,,	More gas.
2.54	1,300	96.1	
2.54½	1,325	84.8	
2.57	1,350	,,	Column bending.
2.59	1,350	,,	More naphtha, one-half cock.
3.01	1,375	,,	Color reported.
3.03	1,500	,,	
3.03½	1,525	,,	Column yielding fast.
3.05	1,550	,,	Column broke suddenly..

The result of the test is shown in photographs (Figs. 12 and 13). The fracture occurred at about the centre of the column, where the deflection was the greatest. There was a crack about five inches long, about seven inches above the fracture on the convex side of the column, showing that the column first pulled apart on the outside of the bend. No water was thrown on this column during the test.

COLUMN TEST No. 5.

Fire test with water. Cast-iron column. Furnace, same as Tests No. 1, 2, 3 and 4.

The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York. The column was the same as illustrated in Fig. 9, with the following exceptions: flanges were $1\frac{5}{8}$ inches thick and were re-enforced with four ribs, as in Test No. 4. There was a slight defect in this casting, there being a porous portion a few inches long on one side, about 3 feet 6 inches from he lower end.

The weather was partly cloudy and sultry. There was a strong wind from the south-west. Temperature of the atmosphere was 80 degrees Fahr.

Water was thrown upon the column through about 50 feet of $2\frac{1}{2}$-inch rubber hose and a $\frac{3}{4}$-inch nozzle. The pressure at the hydrant was fifty pounds.

The result of this test is shown in photograph (Fig. 14).

The column was very red when the water was thrown on it the last time. The brick walls and arch roof cracked when water fell on them. The column was badly bent, but otherwise appeared uninjured.

LOG OF TRIAL

Time. H. M.	Pyrometer. Degrees Fahr.	Hydraulic Pressure. Total Load Tons.	Remarks.
2.16	.....	84.8	Wood fire lighted.
2.28	.....	,,	Gas lighted.
2.29	600	,,	Door closed. Pyrometer in place 18 inches from column.
2.31	625	,,	
2.32	675	,,	
2.33	700	,,	
2.36	675	,,	Pyrometer moved back 5 feet from column.
2.40	625	,,	
2.41	675	,,	
2.42	525	,,	Water thrown on column one minute.
2.43	450	,,	Door open. Fire out.
2.44	400	,,	Door open. Fire relighted.
2.46	425	,,	Door closed.
2.47	540	,,	
2.49	1,000	,,	Heat raising too fast.
2.51	650	,,	
2.52	675	,,	
2.55	700	,,	
2.58	750	,,	Pyrometer 3 feet from column.
2.59	800	,,	
3.01	740	,,	
3.02	750	,,	Pyrometer 18 inches from column.
3.05	785	,,	Pyrometer moved back 5 feet from column.
3.06	775	,,	
3.09	400	,,	Water on column ½ minute. Fire out. Door down.
3.16	.....	,,	Gas relighted. Door closed.
3.19	675	,,	Pyrometer 18 inches from column.
3.22	700	,,	More air admitted.
3.24	725	,,	
3.27	775	,,	
3.28	800	,,	
3.30	900	,,	
3.35	1,025	,,	
3.40	1,025	,,	
3.47	1,050	,,	
3.50	1,050	,,	Column red.
3.55	1,075	,,	Water on column ½ minute. Fire out. Door down. More water on column as it was still red.
4.13	.....	,,	Gas relighted.
4.17	750	,,	Pyrometer 18 inches from column.
4.21	787	,,	Naphtha, one-half cock.
4.23	900	,,	
4.24	1,025	,,	
4.27	1,150	,,	
4.29	1,200	,,	
4.30	1,250	,,	Column getting red.
4.31	1,275	,,	Column bending.
4.32	1,280	,,	
4.34	1,300	,,	Pyrometer moved back. Water on column one minute.
4.35	.....	,,	Door down, and water on column again two minutes.

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Fig. 5.

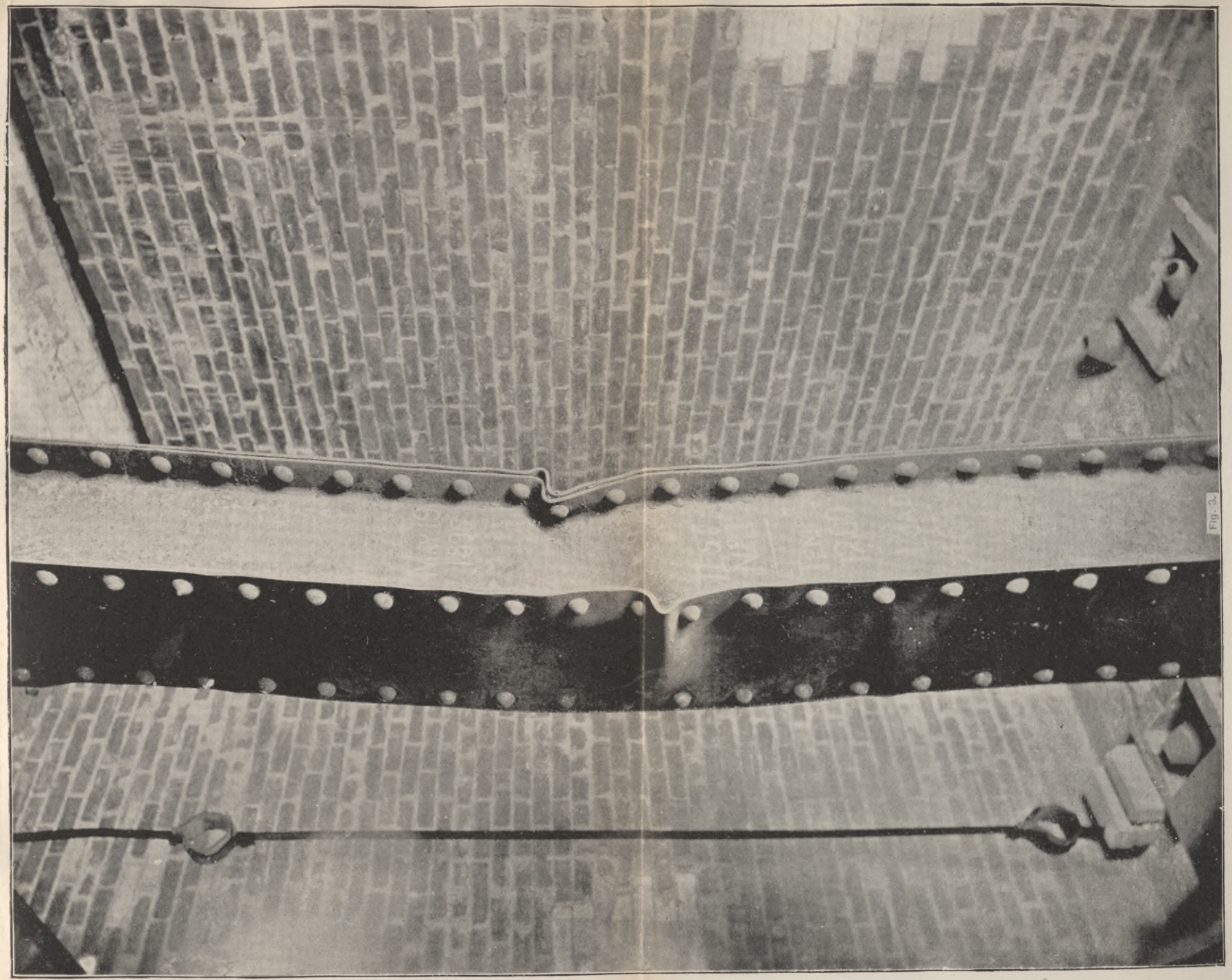

Fig. 3.


COLUMN
Nº 1
MAY 19
1896
TEST
Nº 1
TEMPTº
1200°
LOAD
46 TONS
FIRE PROOFING TEST Nº 1
MAY 19TH 1896
TEMPERATURE 1200°. LOAD 46 TONS
MADE AT
THE CONTINENTAL IRON WORKS
BROOKLYN N.Y.

Fig. 4.

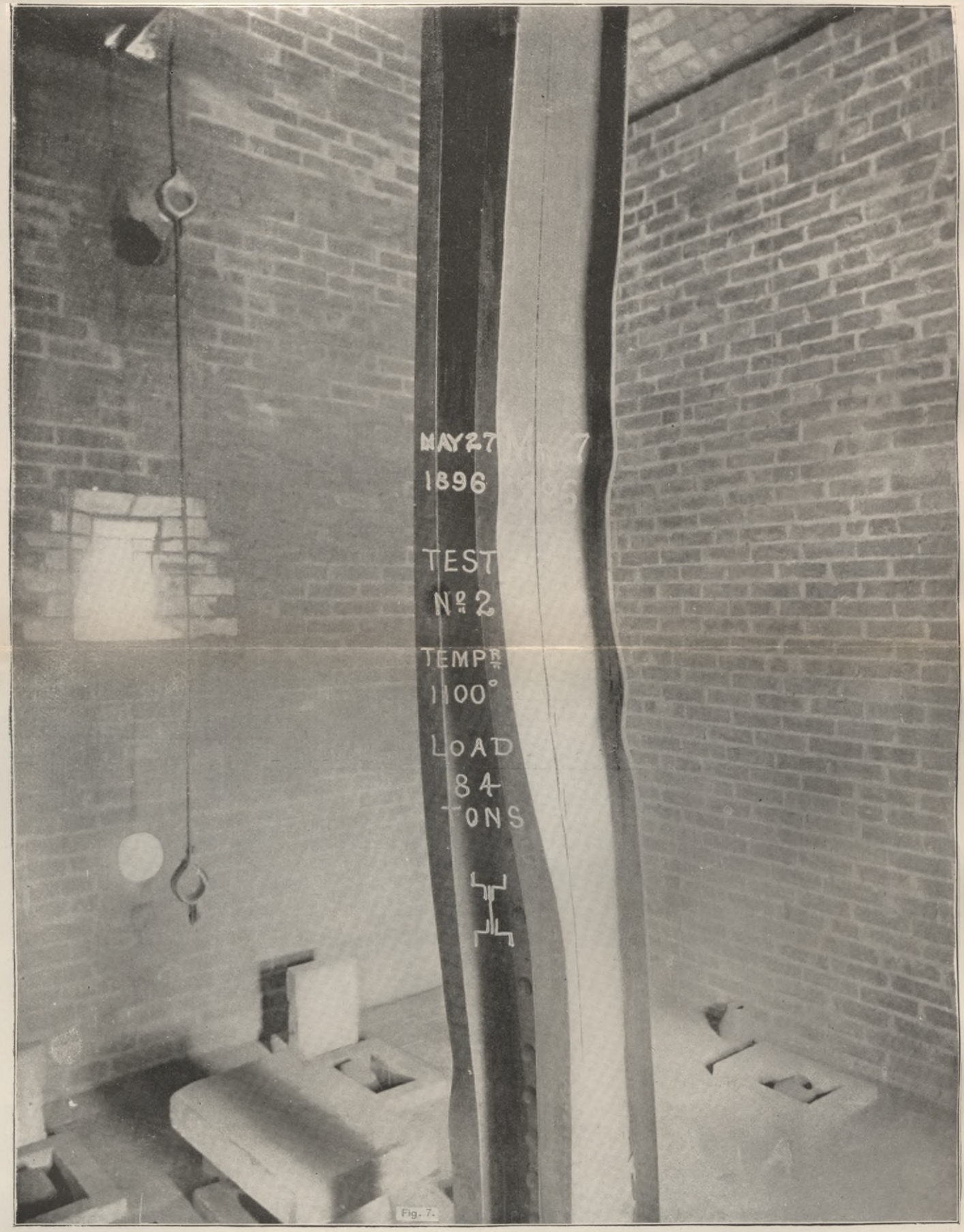

Fig. 7.


FIRE PROOFING TEST Nº 2.
MAY 27TH 1896.
TEMPERATURE. 1100 LOAD 84 TONS.
MADE AT
THE CONTINENAL IRON WORKS.
BROOKLYN. N.Y.
May 27
896
TEST
Nº2
1100
84

Fig. 8.

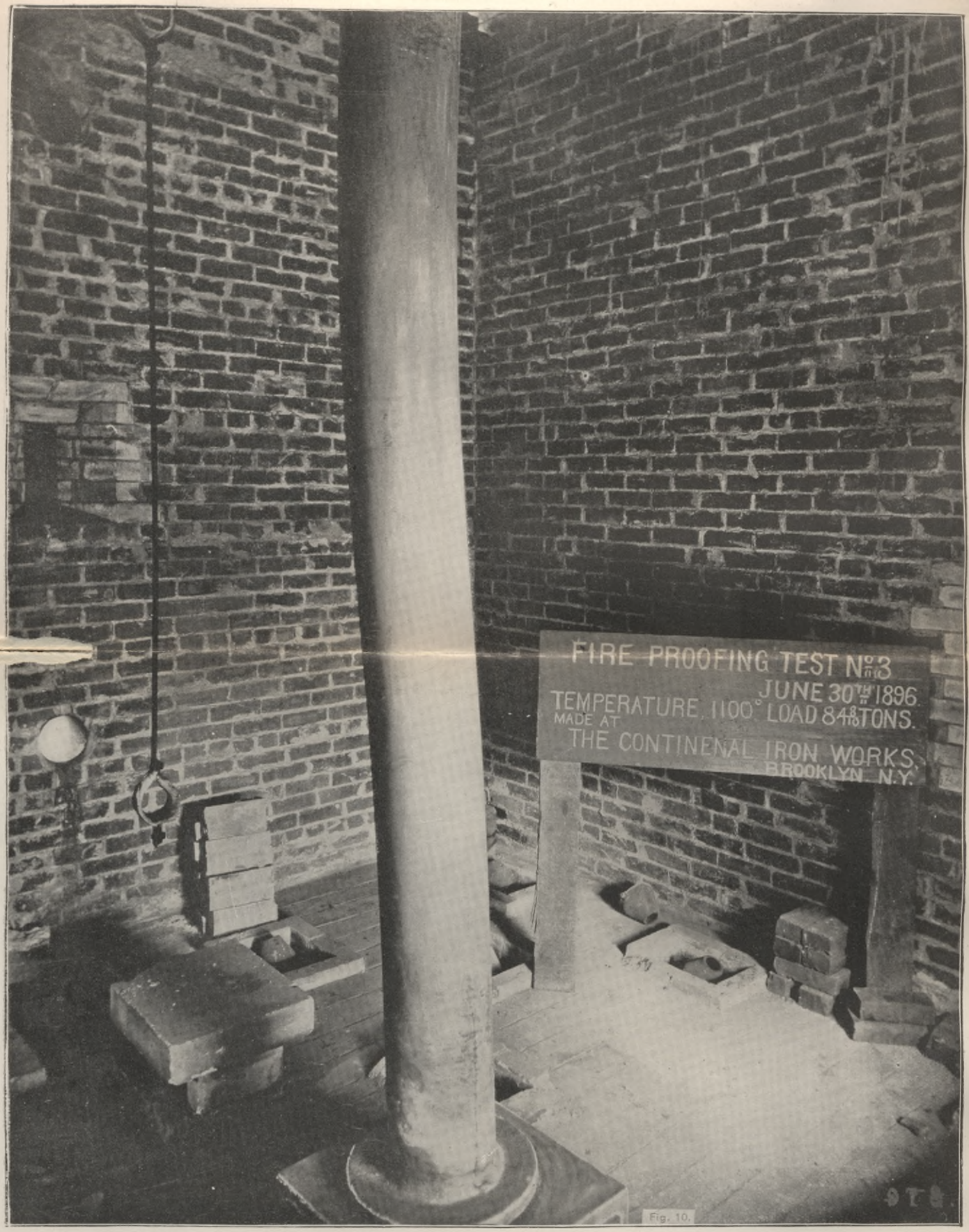
FIRE PROOFING TEST No 3
JUNE 30TH 1896.
TEMPERATURE, 1100° LOAD 84 8/10 TONS.
MADE AT
THE CONTINENTAL IRON WORKS.
BROOKLYN N.Y.

Fig. 10.


COLUMN
No 3
TEST
No 3
FIRE PROOFING TEST No 3.
JUNE 30TH 1896
TEMPERATURE, 1100°. LOAD 84⅛ TONS.
MADE AT
THE CONTINENAL IRON WORKS
BROOKLYN N.Y.

Fig. 11.


FIRE PROOFING TEST No 4
JULY 8TH 1896
TEMPERATURE, 1550. LOAD 8½ TONS.
MADE AT
THE CONTINENAL IRON WORKS.
BROOKLYN, N.Y.

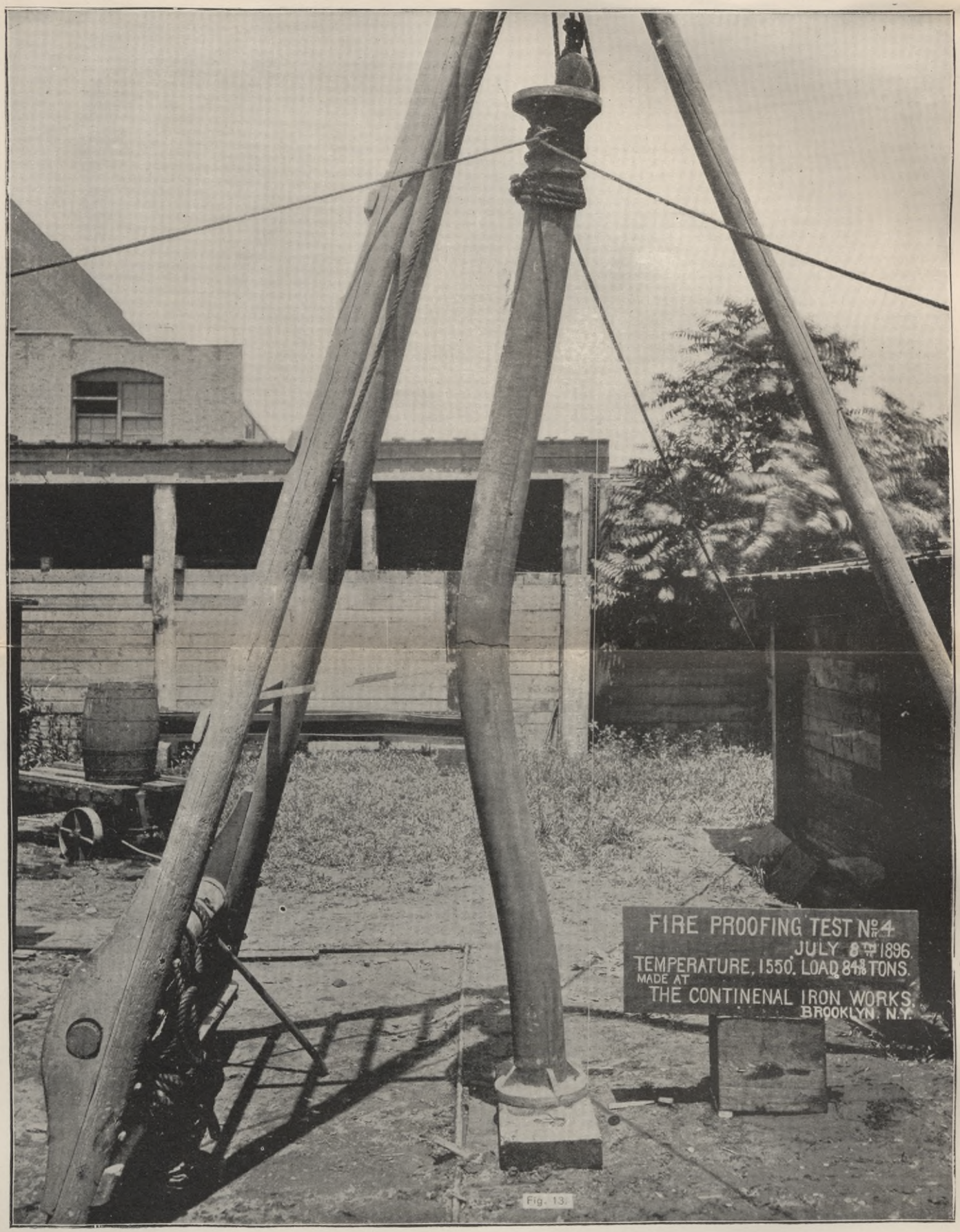
FIRE PROOFING TEST No 4
JULY 8TH 1896.
TEMPERATURE, 1550. LOAD 84⅛ TONS.
MADE AT
THE CONTINENAL IRON WORKS.
BROOKLYN. N.Y.

Fig. 13.


COLUMN
No5
TEST
No5
FIRE PROOFING TEST No 5
JULY 10TH 1896
TEMPERATURE. 1300. LOAD 84 1/8 TONS.
MADE AT
THE CONTINENAL IRON WORKS.
BROOKLYN. N.Y.

Fig. 14.


THOMAS C. JENKINS
OFFICE & WAREHOUSE