REVIEW OF THE URBANA AND CHAMPAIGN STREET RAILWAY POWER AND HEATING PLANT

...BY...

Edward George Eidam
AND
Smith Yule Hughes

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

EDWARD GEORGE EIDAM AND SMITH YULE HUGHES

ENTITLED REVIEW OF THE URBANA AND CHAMPAIGN STREET RAILWAY POWER AND HEATING PLANT

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Mechanical Engineering

L. P. Breckenridge

HEAD OF DEPARTMENT OF Mechanical Engineering

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REVIEW OF THE URBANA AND CHAMPAIGN STREET RAILWAY POWER AND HEATING PLANT.

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REVIEW OF THE URBANA AND CHAMPAIGN RAILWAY POWER AND HEATING PLANT.

I. OBJECT.

With a view of studying the workings of a modern Power and Heating Plant, the authors have compiled the information contained in this thesis, from the Urbana and Champaign Street Railway Power and Heating Plant.

II. LOCATION.

The Bower Plant of the Urbana and Champaign Railway, Gas and Electric Co, is located on Hickory street in Champaign one block north of the C. C. C. & St. L. R. R. tracks. This location is about one half mile from the business portion of the city.

III. DESCRIPTION.

The Plant is entirely contained in one building, the two main divisions, the engine and boiler rooms being separated by a brick wall. The building is 165 feet long, the boiler room being 60 feet wide, and the engine room 83 feet wide. The floor of the engine room is about 3 feet higher than that of the boiler room.

1. Boiler Room.

The inside dimensions of the boiler room, are 99 feet and 57 feet respectively. The accompanying drawing of the plant shows the location of the boilers, pumps, heater, coal bins, steam mains etc.

A. Boilers.

The equipment consists of six boilers , all of the water-tube type, carrying an average pressure of 110 pounds.

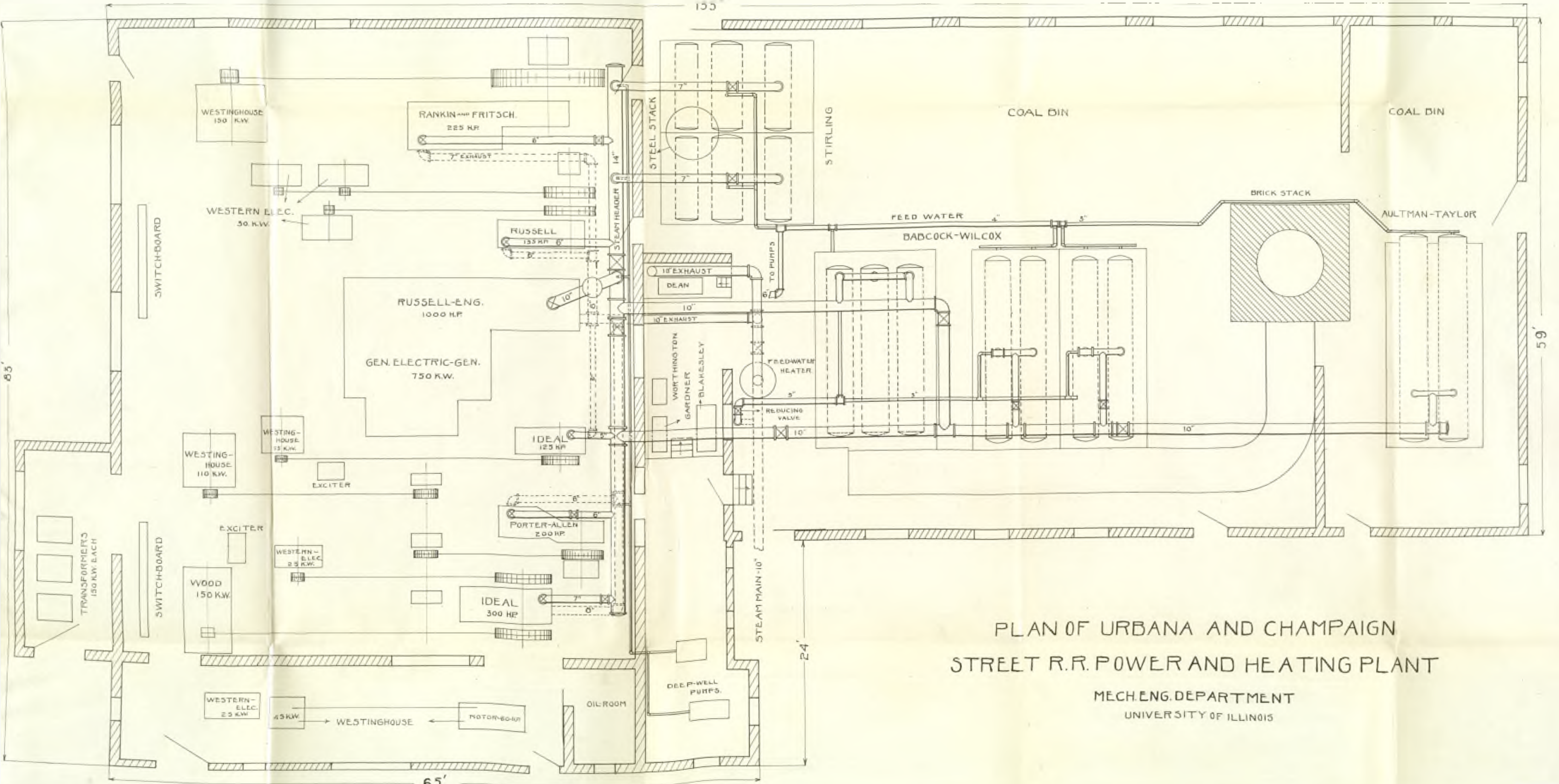
		Rating. (H.P.)
No 1. is an Aultman and Taylor, (B&W. type)	2 drums	270
No. 2 is a B. & W. Boiler	2 drums	250
No. 3 is the same		250
No. 4 is a B. & W. Boiler	3 drums	270
No. 5 is a Stirling Boiler	3 drums	260
No. 6 Same		260
Total Rating		1560

Nos. 2&3 were installed in 1893 and have been in use ever since. No. 4 is an old World's Fair boiler and was installed in 1894-5. No. 1 was added to the equipment in 1900 and Nos. 5&6 were put in during the summer of 1903. All the boilers are hand fired, the fire being kept at an average depth of eight inches.

B. Feed Water.

The feed water for the plant is supplied from two deep-wells. One of these has a six inch casing and is 160 feet deep. The other is an 8 inch well and is 176 feet deep.

The water contains a total of 23.38 grains per gallon of solid material of which 18.3 grains are scaling ingredients.



PLAN OF URBANA AND CHAMPAIGN STREET R.R. POWER AND HEATING PLANT

MECH. ENG. DEPARTMENT
UNIVERSITY OF ILLINOIS

PLATE I

Of this, silica is 1.07, iron oxide .25, carbonate of lime 11.71, carbonate of magnesium 2.62, and sulphate of magnesium is 2.65. As all but the sulphates are easily removed, this water is considered a good feed-water. The water is first pumped into a reservoir on the roof of the building. From this place it is pumped into an exhaust steam feed water heater, manufactured by the National Pipe Vending Co. Cincinnati Ohio.

C. Pumps.

Besides two deep-well pumps, the plant uses four of the horizontal, double acting, duplex type. A 6"x4"x6" Worthington, is used to supply the heater. Two of the others, a Blakesley 14"x14"x10" and a Deane 7"x4"x10", are used to pump from the heater to the boilers. Besides these a Gardner 7"x4"x10" pump may be used either for feeding the heater or the boilers. There is also a No. 13 1/2 Lunkenbeimer Injector connected into the feed pipe, which may be used if necessary.

D. Coal.

Slack coal and screenings are used almost entirely in firing the boilers. During the last few years the coal has with few exceptions been obtained from the Odin andPana mines. The average coal has a calorific value of 10000 to 11000 B.T.U., and contains from 15% to 18% ash.

E. Stacks.

Two stacks are used by the plant. The first is a brick one of eight feet inter nal diameter and 130 feet high. The up-takes from boilers 1,2,3, and 4 enter this stack.

The second stack is of steel, and is placed directly over the two Stirling boilers. It has an internal diameter of 6 feet, and rises to a height of 150 feet. This stack is, of half inch plates, unlined and supported by a number of guys.

2. Engine Room.

The engine room is 52 by 81 feet, with an average height of 20 feet. A 14 inch steam header extends across the east side of the room, from which the steam is drawn for the various engines.

A. Engines.

The following table shows the engines inuse at present.

Name	Type	Type of valve	H.P.
1. Ideal	High Speed	Piston	300
2. Porter-Allen	High Speed	Plain Slide	200
3. Ideal	High Speed	Piston	125
4. Russell	Medium Speed	Meyer	1000
5. Russell	High Speed	Plain Slide	135
6. Rankin & Fritsch	Low Speed:	Carliss	225
		Total H. P.	1985

B. Generators.

The following table which is self explanatory shows the generators now in use;

Name	Type	Driven by Engine	Manner of Conn.	Cap: K.W.
1. Wood	Alternator	Ideal No. 1.	Belt	150
2. Western Elec	Arc	Ideal No.1	Belt	25
3. Westinghouse	Direct current	Porter-Allen	Belt	110
4. Westinghouse	Alternator	Ideal No. 3.	Belt	50

Name	Type	Driven by Engine	Manner Of Conn.	Cap K.W.
5. General Electric	Double Current	Russell	Direct	500
6. Western Electric	Arc	Small Russell	Belt	30
7. Western Electric	Arc	Small Russell	Belt	30
8. Western Electric	Arc	Small Russell	Belt	30
9. Westinghouse	Direct Current	Rankin&Fritsch	Belt	150
			Total Capacity	1075 K.W.

C. Transformers.

There are three transformers, each of 150 K.W. capacity, used to step up the current from 370 volts to 15000 volts. These are used in connection with the high tension system, of which further mention will be made.

The above table does not mention a 60 H.P. Westinghouse motor which takes its current from the D. C. side of the double current generator, and runs a 45 K. W. Westinghouse Alternator. This machine supplies current for the incandescent lights which may be in use during the day.

IV. PERFORMANCE OF PLANT.

The performance of the plant will be considered under three headings, namely, Light, Heat, and Power.

1. Light.

As usual current is furnished for both incandescent and arc lights.

A. Arc Lighting.

The current for the arc lights of the city is furnished by four machines, all of which are built by the Western Electric Co, supplying the current for 40 lights each.

There are at present about 165 lamps in use all of which are of the open arc direct current type.

The lights are run on a moonlight schedule and burn till morning. Current for arc lighting is supplied to the city at the rate of $69 per year for each lamp.

B. Incandescent Lighting.

The current for the incandescent lights is furnished by three machines, one of which is run by the motor as has been stated, and supplies the current for use during the day. One of these machines is a Westinghouse and is run from the smaller Ideal engine. The other is a Wood machine and is run from the larger Ideal. They supply current for the lights used during the evening and night. The two machines have a capacity of 200 K. W.

All lamps run on a voltage of 110. The total number of incandescent lamps in use in the city is approximately 2000. The price charged is 15 cents per K. W. hour.

2 Heat.

Heat is furnished to 120 buildings in the business district of the city. This heat is supplied by the exhaust from the engines in use, together with enough live steam to keep up the required pressure in the mains.

A. System.

The "Holly" system of district steam heating is used.

(a) Mains.

The main leading from the plant is 10 inches in diameter. The accompanying drawing shows the sizes of all steam

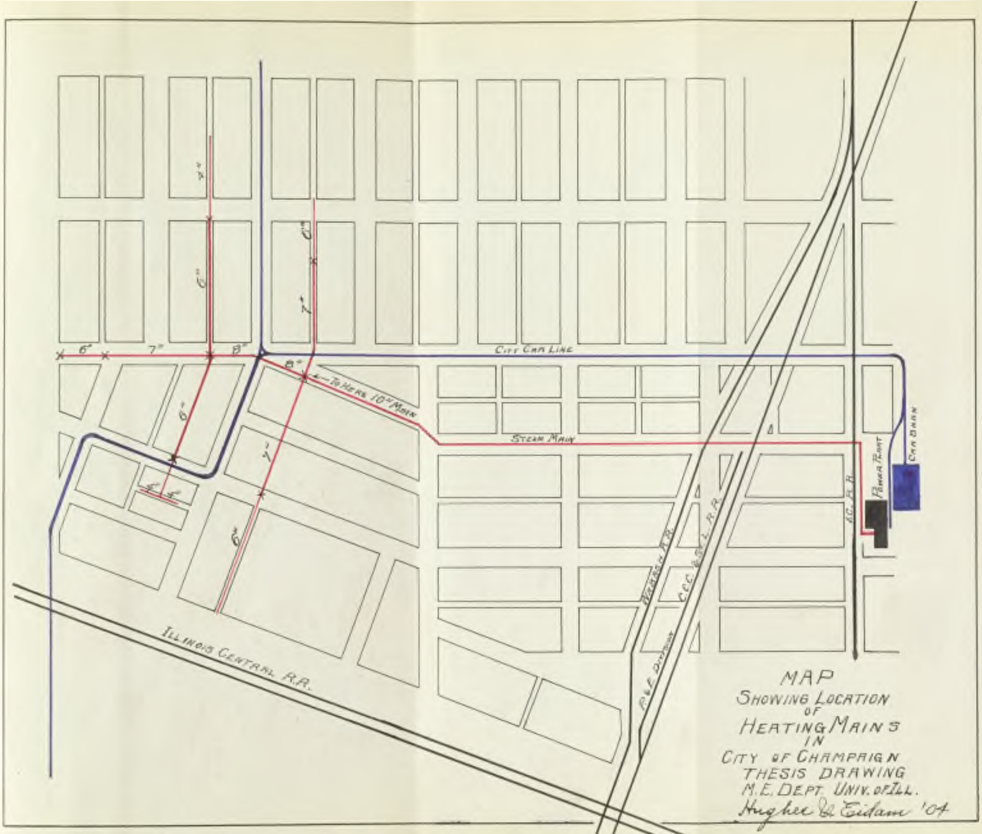

City Car Line
Steam Main
To Here 10" Main
Illinois Central R.R.
Wabash R.R.
C.C.C. & St. L. R.R.
P. & E. Division
I.C. R.R.
Power Plant
Car Barn
MAP
Showing Location
of
Heating Mains
in
City of Champaign
Thesis Drawing
M.E. Dept. Univ. of Ill.
Hughes & Eidam '04

PLATE II.

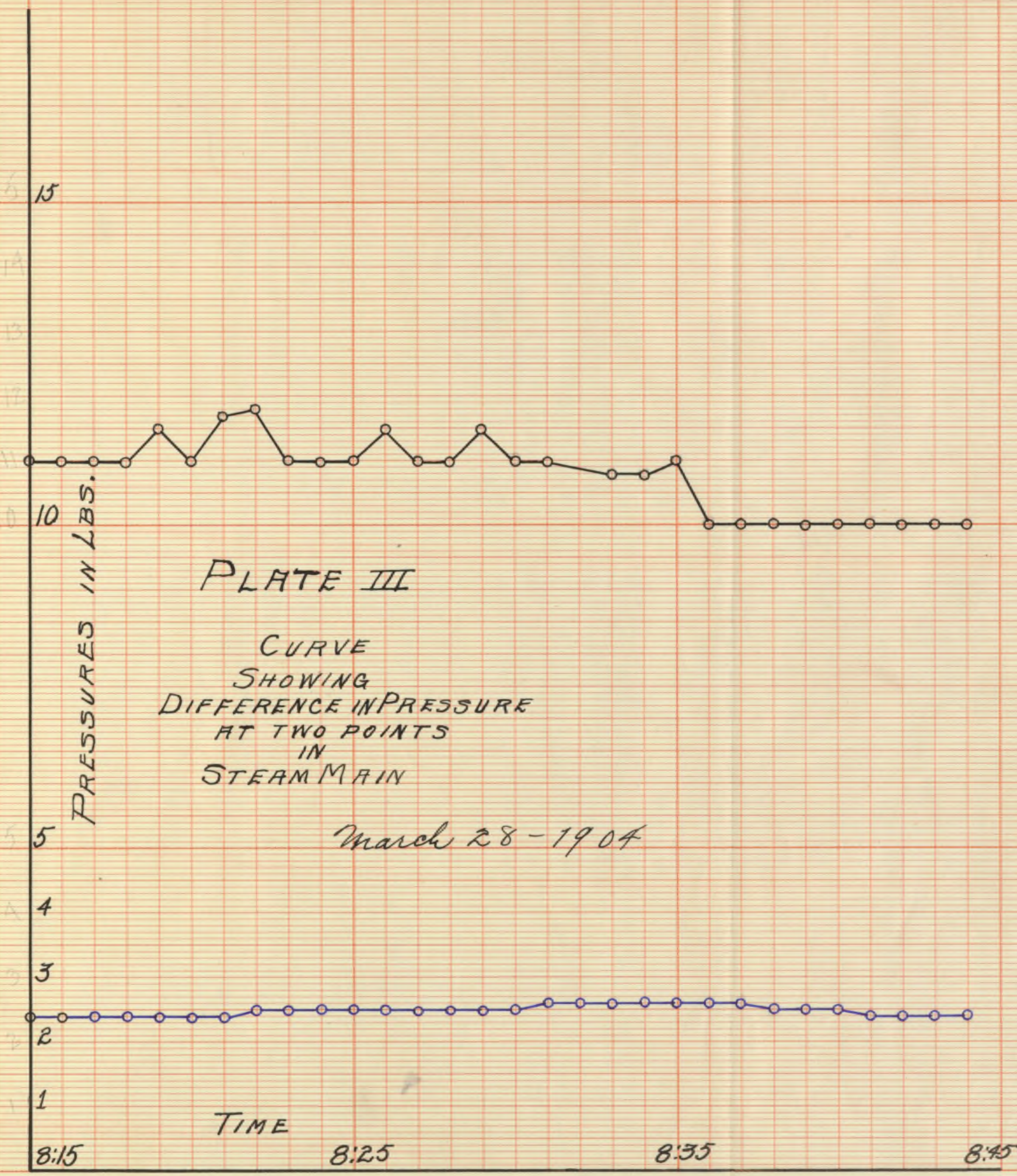
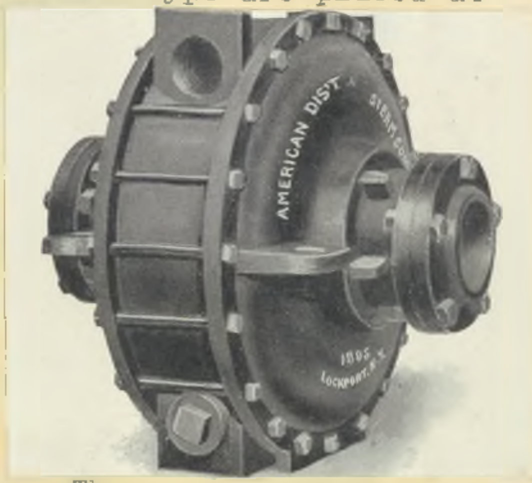


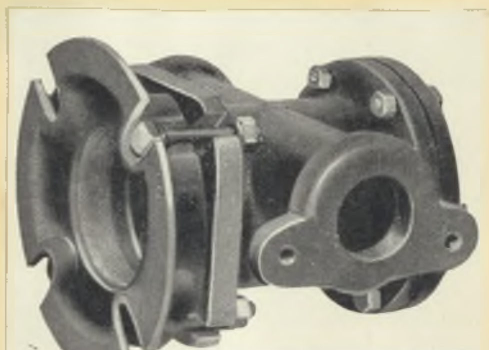
PLATE III
CURVE
SHOWING
DIFFERENCE IN PRESSURE
AT TWO POINTS
IN
STEAM MAIN
March 28 - 1904
PRESSURES IN LBS.
15
10
5
4
3
2
1
TIME
8:15
8:25
8:35
8:45

mains and branches. Their total length is somewhat more than one mile. All mains are at an average depth of four feet.

To provide for the expansion and contraction of the pipe, devices called "variators" of the double type are placed at intervals of 100 feet. These variators are placed only in sections of mains having no offset or deviation from a straight line. Special fittings called "Anchor Specials" are the fixed points in the mains, from which expansion



takes place toward the variators. These are so constructed that if it be required, a deviation from a straight, or a change in grade, can be made to the extent of 3 feet, in 100. By means of a saddle and collar device, anchorage being attached, there is no possibility of the pipe creeping, or in any way changing its position, even on a steep

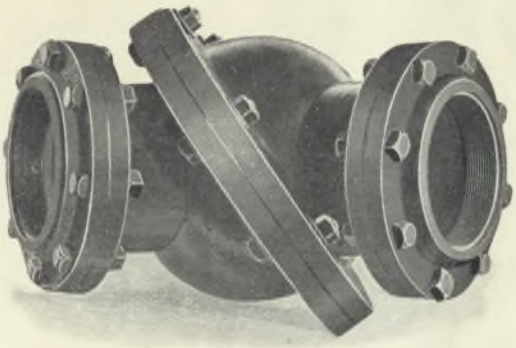


ANCHOR SPECIAL,
SIDE OPENINGS ECCENTRIC.

grade. All service connections are made either at the variators or at the anchor specials, which are the only fixed points in the line.

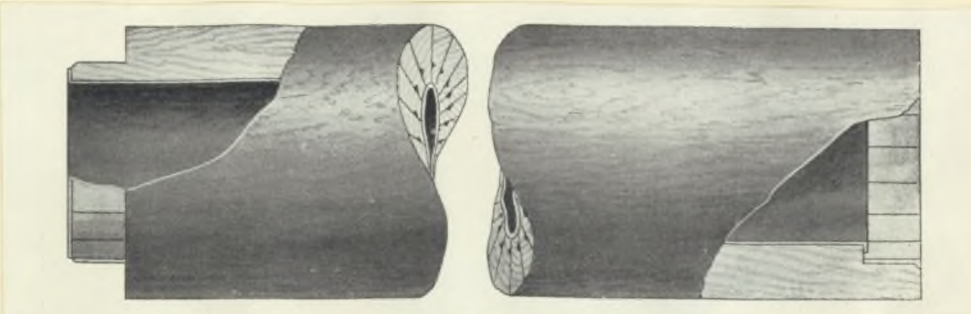
Flanged angle joints, similar to the illustration in Fig. , are used to make angles in line of pipe. These can be set at any desired angle from 0 to 90 degrees.

FLANGED ANGLE JOINT

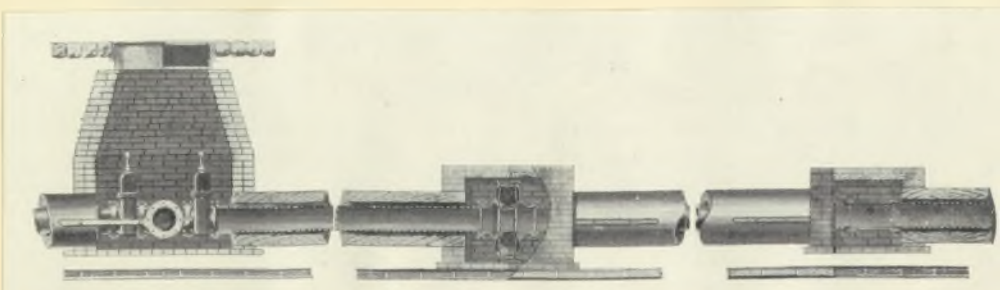


Insulation.

The iron pipe is covered with asbestos, and inclosed in a tin lined wood casing (See Fig.), having a shell of four

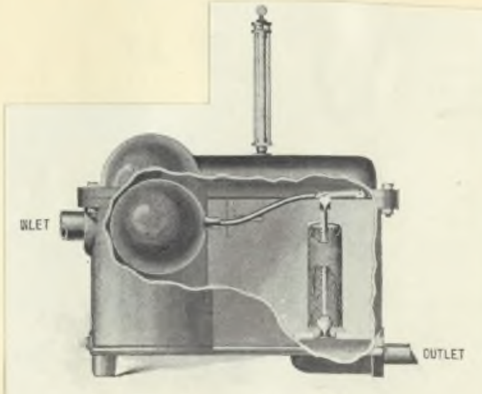


inches, with a dead air space of one inch between the tin and the asbestos covered pipe. In the manufacture of the casing the wood is kiln-dried and treated with creosote to preserve it and make it impervious to water. To further protect it, the outside is coated with asphaltum, pitch and sawdust. The general construction of mains, coverings, variators, etc., is shown in the accompanying illustration (Fig).



All unavoidable pockets in the line are freed from water of condensation by means of automatic traps. Fig shows the type of trap used.

(b) Pressure in Mains.



EMPIRE STEAM TRAP

During the coldest season a pressure of from 12 to 17 pounds gauge is maintained in the main at the plant. During the spring and fall the pressure varies with the intensity of the weather, and ranges from 5 to 12 pounds. The pressure is regulated by a seven inch reducing valve, which "cuts in" live steam, when the exhaust from the engines is insufficient to keep up the desired pressure in the main.

(c) Distribution.

Heat is distributed to the following 101 subscribers:

MAIN STREET.

H. Swannell & Son.	No. 1 & 3.
Ferguson & Craig.	No. 5.
Dr. Zorger.	No. 5 & 5.
D. H. Lloyd & Son.	No. 7.
J. B. McKinley.	No. 9 & 11.
B. Long. (downstairs)	No. 9.
Champaign Nat. Bank.	No. 13.

Subscribers(continued).

G. C. Willis.	No. 15 & 17.
A. W. Spaulding.	No. 19.
J. R. Scott.	No. 21.
W. B. McKinley.	No. 23, 25, & 27.
News Office.	No. 29.
Ben Mollet.	No. 33.
D. B. Harbison.	No. 33.
Meis Bros.	No. 35 & 37.
P. T. B. Matheny.	No. 53.
Jones Resturant.	No. 57.
Thos. Coffey.	No. 51.
John Ahern.	No. 40.
Lietz & Vaughn.	No. 38.
First National Bank.	No. 32.
Emporium Bazaar.	No. 30.
Thos. H. Trevett.	No. 28.
Mittendorfe & Kiler.	No. 24 & 26.
Masonic Temple.	No. 20 & 22.
Trevett & Mattis.	No. 16 & 18.
Geo. W. Gen.	No. 18.
A. E. Weusteman.	No. 14.
Illinois Title & Trust Co.	No. 10.
Dallenbach Bros.	No. 8.
Armstrong Shoe Co.	No. 2.

MARKET STREET.

Edward davis.	No. 55.

Subscribers (Continued).

WALNUT STREET.

J. W. Stipes.	No. 18.
Champaign Co. Times.	No. 24 & 26.
Frank Wilcox.	No. 32.
Champaign Hotel.	No. 36.
T. B. Sherfy.	No. 44.
Ahrens Bldg. (H. C.).	No. 53 & 55.
Post Office.	No. 31, 33, 35, 37.
W. H. Miller.	No. 27, 29.
J. Wallace.	No. 25.
Walsh Henck.	No. 15.

TAYLOR STREET.

Phillip Bldg.	No. 17.
L. Van Wegen.	No. 14 & 16.
Nicolet & Lloyde.	No. 16.
Welch's Bowling Alley.	No. 14.

NEIL STREET.

Reickhoff's Bakery.	No. 103.
Reed Cassingham.	No. 101.
Grand Hotel. W. University Ave.	NO. 103.
Percival & Moorehead. So. Neil St.	No. 100.
City Hall and Fire Dept. N. Neil St.	No. 2.
C. H. Baddeley.	No. 5, 7, & 9.
I. O. O. F. (over Baddeley's)	
Monissey Stipes.	No. 17, 19, 21.

Subscribers (Continued).

Illinois Bldg.

Walf Lewis(Economy)	No. 17, 19, 21.
Walker Opera House. Cor. Neil & Park St.	
Gulick Tailoring Co.	No. 37.
Beardsley Bldg.	No. 39 1/2.
Elk Billard Room	No. 39.
Chas Maurer.	No. 41.
C. F. Hamilton (Rugg Bldg)	No. 51 & 53.
H. C. Kariher.	No. 55 & 57.
D. E. Harris & Co.	No. 61.
W. E. Noble.	No. 63.
G. W. Martin.	No. 65.
R. L. Dunlap.	No. 67.
H. J. Clark.	No. 73.
Mrs. Tucker.	No. 71.
Lipp & Longden. Cor Neil & Hill St.	
Beardsley Hotel. Cor. Neil & Hill.	
W. Faulkner.	
T. C. Saunders.	No. 36 1/2.
Blaisdell Bros.	No. 36.
Citizens Bank.	No. 34.
McKeoun & Green.	No. 26.
Miss Price. (over)	No. 26.
Mrs. Wm Price.	No. 18.
Wm. Price Est.	No. 16.

Subscribers (Continued).

HICKORY STREET.

Gazette Bldg. (Hickory & Neil).	
E. M. Burr & Co.	No. 16 H
Dr. Braithwaite. (Cor. Washington & Hic)	
Coliseum. (Corner Washington& Hickory).	
Dave Price.	No. 501.
L. Hill.	No. 8.

HILL STREET.

C. H. Baddeley.	No. 105.
J. B. Woodcock.	No. 107.
E. S. Swigart.	No. 111.
E. A. Robinson.	No. 112.
T. B. Wafe.	No. 110.
Elk Auditorium.	No. 108.

CHURCH STREET.

Hamilton Bldg.	No. 107& 109.
Mrs. L. V. Russell(over).	No. 111.
Dr. H. C. Harvard.	No. 113.
Mrs. A. C. Kincard.	No. 112.
Mrs. A. T. Hall.	No. 201.
Mrs. A. T. Hall(North Randolph St).	No. 203.
Dr. H. C. Howard.(North Randolph St)	No. 204.

PARK STREET.

J. Ahern.	No. 108.
Mrs. A.T. Hall.	No. 112.
Miss. M. Coffman.	No. 201.
Miss. Arnott.	No. 204.

Contracts are made with each subscriber for periods ranging from (1) to (5) years, the constracts being to supply enough steam to keep buildings well heated. The basis upon which the contracts are made is $2.50 per thousand cu feet for stores, and $5.00 per thousand cubic feet for dwellings, but owing to various conditions, such as the heating of halls which are used only occasionally, this rule is not followed. Besides this, in a few cases the steam is metered, and a charge of 50 cents per 1000 pounds is made. The quantity of steam used is determined by metering the total amount of water condensed in the building.

Installation in Buildings.

Since the heating systems for the various buildings have not been installed by any one company, the forms of radiators and the manner of piping are not uniform. Radiators of all makes, styles, and sizes are in use. The cost of installation varies from 75 cents to $1.00 per square foot of radiation.

In large buildings where there is a considerable amount of condensed water, cooling coils and traps are placed in the basement. These coils are often boxed, with ducts leading to a register in the floor above. By this means much of the remaining heat is abstracted from the water. From the trap the water passes into the sewer, none of the condensed water being returned to the plant.

Radiation.

With a view of determining, the accuracy of the rules for proportioning radiating surface, and studying the various conditions governing such proportion, measurements were made on a number of buildings in the business district of the city. These buildings may be classified as stores and offices, built of either stone or brick. The principal features such as cubical contents, outside wall, glass area and radiating surface are given in the following table columns 1 to 7 inclusive. Columns 8 to 11 inclusive give the estimated amount of radiation required according to Mills Rule. (See, Mills Warming and Ventilation Vol II Page 478). Column 12 shows the ratio of the actual number of sqare feet, of radiation to the cubic contents. Column 13 indicates whether ornot the present radiation is sufficient to heat the building properly. This information was obtained from the subscribers. (A) indicates an excess of radiation; (B) indicates the proper amount and (C) indicates an insufficient amount.

Building.	Floor	Cu.Ft of Air Space	Sq.Ft of Outer Wall	Sq.Ft of Glass	SQ.FT.OF RADIATION From Radiators	Exposed Pipe	Total	SAME BY MILL'S RULE. Space :: Cu.Ft 200	Wall :: Sq.Ft 20	Glass :: Sq.Ft 2	Total	Ratio Heating Surface To Cu.Ft Space	Class
	1	2	3	4	5	6	7	8	9	10	11	12	13
First National Bank	B	8486	520	170		133	133	42.5	26	85	153.5	63.7	B
	1	28050	1940	331	631.6	49.1	680.7	140.3	97	165.5	402.8	41.3	A
	2	19600	1740	410	210	210	420	98	87	205	390	46.7	B
Emporium Bazaar	B	2000	40	20	62	6.5	68.5	10	2	10	22	29.4	A
	1	26150	621	320	210	29.5	239.5	130.7	31	160	321.7	109.1	B
	2	6100	621	135	157		157	30.5	31	67.5	129	38.8	B
T. H. Trevett	1	25300	644	311	200	10.4	210.4	126.5	32.2	155.5	314.2	120	B
	2	9340	322	120	75		75	46.7	16.1	60	122.8	124.8	C
Mittendorf & Kiler	B	31500	282	60	75	151	226	157.5	14.1	30	2016	139.4	B
	1	52000	660	622	425	26	451	260	33	311	604	115.2	A
	2	52000	1050	270	195		195	260	52.5	185	497.5	266.9	A
Masonic Temple	1	44700	510	565	240	71.9	311.9	223.5	25.5	282.5	531.5	143.4	B
	2	39200	500	283.5	290	20.9	310.9	196	25	141.7	362.7	126.1	B
	3	57400	3600	300	510		510	287	180	150	617	112.6	A
Kaufman's	B	17650	1040	78		147.5	147.5	88.3	52	39	179.3	119.6	B
	1	50980	2532	377	242.5	135.7	377.2	254.9	126.6	188	569.5	135.5	A
T. &.M. and K.	2	17270	2033	240		208	208	81.4	102	120	303.4	83.0	B
Trevett & Mattis	1	20565	416	249.5	380		380	102.8	20.8	124.7	247.8	54.1	A
	2	38500	806	194	599	22.6	621.6	192.5	40.3	87	319.8	67.9	B
Weustman	1	20200	263	269	202	28.8	230.8	101	13.2	134.5	248.7	84.9	A
	2	16250	240	133	236		236	81.3	12	66.5	159.8	68.8	B
	2	11900	230	85	185		185	59.5	12	42.5	114.0	64.4	B
Illinois Title & Trust	1	21700	302	258	260	30	290	108.5	15	129	252.5	74.9	A
	2	16400	385	117	228		228	82	19.7	58.5	159.2	71.9	B
Dallenbach	1	450	140	36	80		80	2.2	7	18	27.2	5.6	A
	2	19900	395	122	218		218	100	19.7	61	180.7	91.3	C
Eggleston	1	24000	540	260	167	21	188	120	27	130	277	127.5	B
	B	12000	240	38		98	98	60	12	19	91	122.6	B

Building.	Floor	Cu.Ft of Air Space	Sq.Ft of Outer Wall	Sq.Ft of Glass	SQ.FT.OF RADIATION From Radiators	Exposed Pipe	Total	SAME BY MILL'S RULE. Space :: Cu.Ft 200	Wall :: Sq.Ft 20	Glass ::: Sq.Ft 2	Total	RatIO Heating Surface To Cu.Ft Space	Class
	1	2	3	4	5	6	7	8	9	10	11	12	13
Armstrong	B	8300	300	109	222	70	292	41.5	15	54.5	101	28.4	A
	1	17000	1000	197	166		166	85	50	98	233	102.5	B
	2	35900	1350	368	120	399	519	179.5	67	184	410.5	69.2	B
	1	33600	1860	338	500	151	651	168	93	169	430	51.5	A
Swanell & Co	1	33600	790	373	314	30	344	168	39.5	186.5	394	97.7	C
	2	45500	2000	420	355	36	391	227.5	100	210	537.5	116.3	B
B. B. C.	3	62000	2960	336	640		640	310	148	168	626	96.9	A
Furgerson & Craig	1	18850	240	210	253		253	94	12	105	211	66.6	A
Dr. Zorger	2	25300	850	214	211	11	222	126.5	42.5	107	376	113.9	B
Lloyd's	1	35800	920	593	574	15	589	179	46	196.5	421.5	60.9	A
	2	9700	1200	164	91		91	48.5	60	82	190.5	106.7	B
	B	11400				43	43	57			57	264.9	C
	1	25500	40	263	295	39	334	127.5	2	136.5	266	76.4	B
J. B. McKinley.	B	7500	50	124	92	4	96	37.5	2.5	62	92	78.0	B
	B	14800	200		100	23	123	74	10		84	120.3	C
	1	33200	400	206	208	29	237	166	20	103	289	141.0	B
	2	30400	820	232.5	440		440	152	41	117	310	69.1	B
Champaign National	1	46200	2100	392	503	14	517	231	105	196	532	89.4	B
	2	28500	1820	258	299	13	312	142.5	127.5	91	361	91.2	B
	3	29800	1860	300	308		308	149	93	150	392	96.8	B
Willis & Co	1	66500	2760	544	672	197	869	332.5	138	272	736.5	76.6	B
	2	38040	1970	312	369		369	190.2	98.5	156	445	91.6	B
Spaulding	1	22200	630	277	302	26	328	111	31.5	138.5	281	67.6	A
	2	18600	540	128	245		245	93	27	64	184	76.0	B
	B	10300	180	142	116	67.5	183.5	51.5	9	71	131.5	56.1	A
J. R. Scott & Co	1	14900	340	210	315	8	323	74.5	17	105	196.5	46.1	A
	2	13700	350	276	245		245	68.5	17.5	138	224	55.9	B

Building.	Floor	Cu.Ft of Air Space	Sq.Ft of Outer Wall	Sq.Ft of Glass	SQ.FT. OF RADIATION: From Radiators	SQ.FT. OF RADIATION: Exposed Pipe	SQ.FT. OF RADIATION: Total	SAME BY MILL'S RULE.: Space :: Cu.Ft 200	SAME BY MILL'S RULE.: Wall :: Sq.Ft 20	SAME BY MILL'S RULE.: Glass :: Sq.Ft 2	SAME BY MILL'S RULE.: Total	Ratio Heating Surface To Cu.Ft Space	Class
	1	2	3	4	5	6	7	8	9	10	11	12	13
	B	18400	200			91	91	92	10		102	202.1	C
	1	31000	1250	204	594		594	235	90	148	473	79.1	B
	2	16000	550	92	Note:2nd Heated From 1st								B
W. B. McKinley	1	23600	230	290	250		250	118	11.5	145	274.5	94.5	B
	B	9700	490	152	140	125.7	265.7	48.5	24.5	76	149	36.4	A
	1	23000	1260	441	390	15	405	115	63	220.5	298.5	56.8	B
	2	22400	1460	276	285		285	112	73	138	323	78.5	B
	B	19700	700	120		230	230	98.5	35	60	193.5	85.7	B
News Office	1	32000	1680	394	462	42	504	160	84	197	441	63.5	A
	2	24600	1400	204	445		445	123	70	102	295	55.3	B
Ben Mollet	1	29000	373	271	295	40	335	145	186.5	135.5	467	86.5	B
	2	9900	600	60	75		75	49.5	30	30	109.5	132	B
	B	26400	160		140		140	132	8		140	187.5	B
Meis	1	37500	370	491	356	27	383	187.5	18.5	245.5	451.5	98.0	B
	2	43200	640	363	400		400	216	32	182	430	108	B
Coffey	1	33800	410	321	450		450	169	20.5	160.5	350	73.0	B
Matheny	1	39400	550	291	130			187	27.5	140.5	355		
	2	30000	640-Glass		200		200	150			100	150	
Jones	1	21000	1160	350	480	70	550	105	56	175	336	38.2	B
Ahern	1	23800	1230	469	247	24	271	119	61.5	235.5	416	88.0	B
	2	22000	1340	234	204		204	110	67	117	294	108	B
Buffet	1	20800	240	280	246	24	270	104	12	140	256	77.0	B
	2	20800	310	208	148		148	104	15	104	213	140	B

These tables show that some buildings do not have enough radiation according to Mill's Rule and yet the actual radaition is too great. For instance the actual radiation in Mittendorf & Kiler's Furniture store Nos, 24 to 26 Main Street, a two story brick building, each floor of which is 47x79x14 feet, is 451 and 195 square feet,' on first and second floors, respectively. By Mill's Rule there ought to be 604 and 497 square feet respec-tively. This building had no partitions on either floor, and a broad open stairway led from one floor to the other. The proprie tors stated that some of the radiators on the secondfloor were never turned on: The ratio of the radiating surface to the cubic contents for the two floors is 115 and 267 respectively, or 161 for the building as a whole.

In contrast to this example, is the second floor of Trevett & Mattis Brick building, No. 16 & 19 Main Street. This floor is 40x77x12 1/2 feet, and has 621 square feet of actual radia-tion. By Mill's Rule it should have but 319.8 feet. This floor is divided into several offices and has a large hall open to the stairway. The ratio of actual radiation to cubic feet of space is 67.9 and as is shown in column 13, this is none too small.

The office of the Street Railway, Gas& Electric Co, at 27 Main St., a floor 20x 89x13, with several large apartments has 405 square feet of actual radiation. This is very close to 398.5 square feet as given by Mill's Rule. The ratio of heating surface to cubic feet space is 56.8.

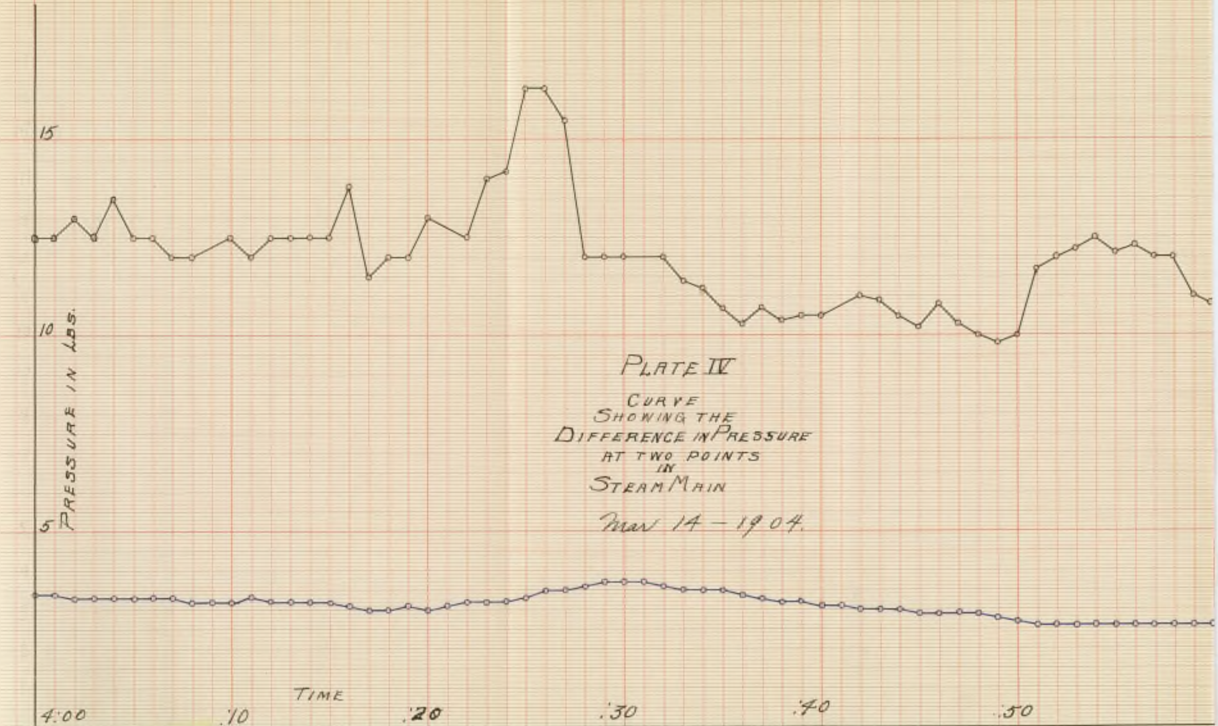
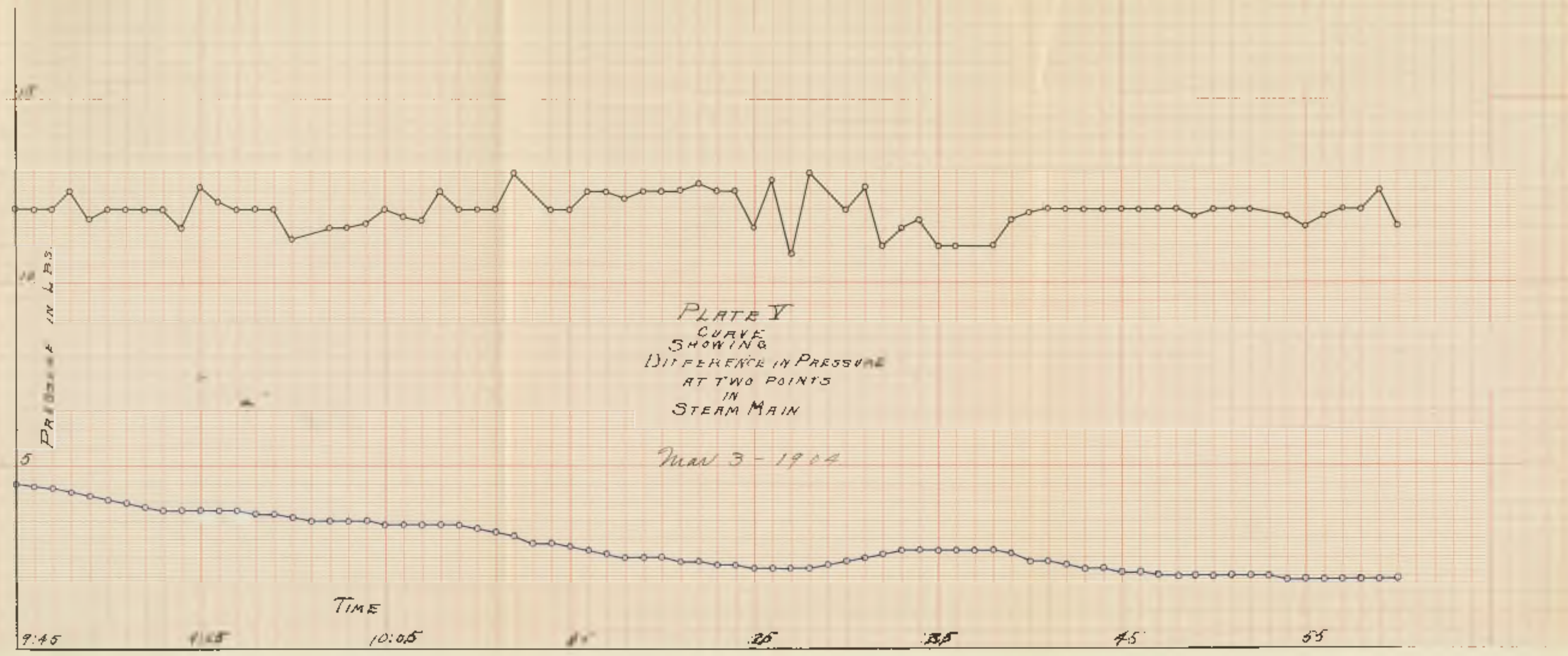


PLATE IV
CURVE
SHOWING THE
DIFFERENCE IN PRESSURE
AT TWO POINTS
IN
STEAM MAIN
May 14 – 1904.
PRESSURE IN LBS.
15
10
5
TIME
4:00
:10
:20
:30
:40
:50



15
10
5
Pressure in Lbs.
Plate V
Curve
Showing
Difference in Pressure
at Two Points
in
Steam Main
Mar 3 - 1904
Time
9:45
10:05
25
35
45
55

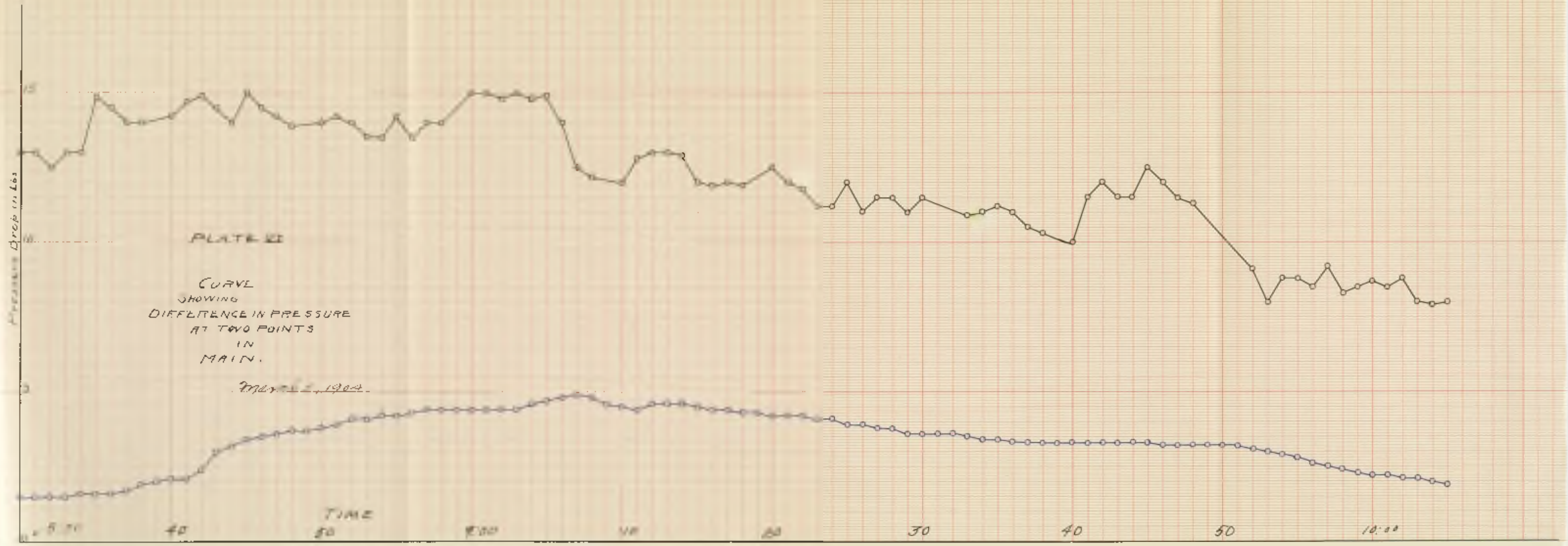


PLATE XI
CURVE
SHOWING
DIFFERENCE IN PRESSURE
AT TWO POINTS
IN
MAIN.
1904
Pressure Drop in Lbs
15
10
5
0
TIME
5:30
40
50
9:00
10
20
30
40
50
10:00

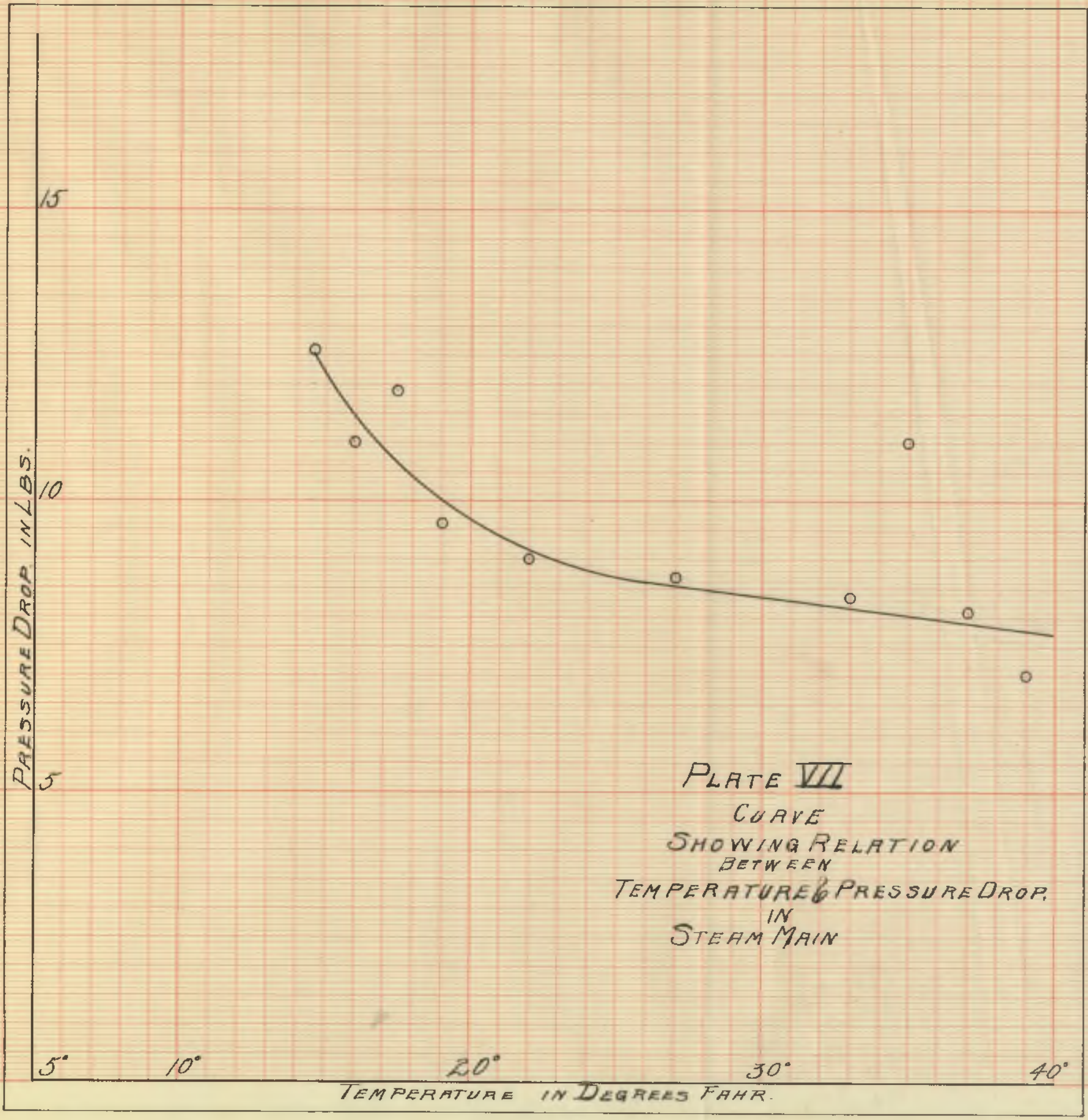


PLATE VII
CURVE
SHOWING RELATION
BETWEEN
TEMPERATURE & PRESSURE DROP.
IN
STEAM MAIN
PRESSURE DROP IN LBS.
15
10
5
5°
10°
20°
30°
40°
TEMPERATURE IN DEGREES FAHR.

The first two are more extreme cases, but a careful study of the table will show that they only indicate the general tendency; i.e.; in calculating the necessary amount of radiation for large buildings with a small amount of exposed wall and no partitions, Mill's Rule gives too high values, whereas for buildings divided into offices and other small rooms the figures are low.

C. Variation of pressure in Mains.

In order to determine the drop of pressure between two points in the mains, a number of tests were made. Simultaneous readings were taken at the Power Plant and at the office of the St. R. R. Co. located at the corner of Main and Walnut Streets. At the Power Plant, a calibrated Crosby Gage (0 pounds to 30 pounds) was connected to the main just beyond the reducing valve. At the office, a mercury gage was connected to a two inch pipe in the basement. The company tries to maintain a pressure of about two pounds in this gage. The duration of the tests ranged from 30 minutes, to an hour and a half, during which time simultaneous readings were taken every minute. From these readings curves were plotted(See plates III, IV, V, & VI.)which show the variation in pressure at the two points and the drop in pressure between them. During the tests the temperature of the outside air was observed, and another curve (See Plate VII) was plotted which shows the average drop in pressure corresponding to the different temperatures. This curve indicates that the drop in pressure varies inversely with the temperature.

POWER.

Distribution.

Direct Current.

Direct current is furnished by three generators; two Westinghouse, and the direct connected General Electric. Since the installation of the latter, the first two of these are seldom used, being simply held in reserve. Direct current is used to charge the lines of the Champaign and Urbana Street R.R. and the west end of the D.U.C. R.R. line.

High Tension System.

Current is taken off the A. C. side of the direct-connected generator at 370 volts, and is stepped-up to 15000 volts in three transformers, after which it is conducted to a sub-station of the D.U.C. Electric R.R. at Fithian. Here it is converted into D.C. current by rotaries and used to charge the line of the D.U.C.Electric R.R.

Cost.

In order to obtain the cost of power at the switch-board, a test was made April 18, 1904. All the steam was furnished by the two Stirling Boilers. The power was generated by the large Russel Engine and the Direct Connected Generator. The high tension system was not in use at this time and no current was taken off the A.C. side of the generator. The test was run continuously for eight hours and 45 minutes. During this time 11.57 Tons of coal were consumed. At $1.10 per ton the cost of this coal would be $12.70, or $1.45 per hour. The generator delivered an average of 195 Kilo-Watts per hour at the switch-board. This shows a cost of $.00745 per Kilo-Watts hour for fuel.

During the test the engine was running at less than one-third of its normal capacity, hence these figures do not represent its most economical performance.

V. CONCLUSION.

Since the installation of the new direct-connected unit, the plant may be said to have an up-to-date equipment, and as the exhaust steam is used for heating purposes it is run on an economical basis.