Tests of the Efficiency of Steam Separators.

by

J.H.Whipple

R.A.Seaton.

TESTS OF THE EFFICIENCY OF STEAM SEPARATORS.

(1) Baum Separator (Vertical)

(2) Steam Appliance Co. Separator.(Horizontal)

(3) Hine Eliminator.(Horizontal)

Made in K.S.A.C.Mechanical Laboratory

Spring Term,1904.

I. Subject.

II. Method.

I. Calorimeter tests of steam before and after passing through separator.

2. Comparison of quality. What efficiency is.

3. Method of varying initial quality of steam.

III. Apparatus.

Including drawings and descriptions.

I. Piping.

2. Condensers.

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I. Baum Separator.

2. Steam Appliance Co's Separator.

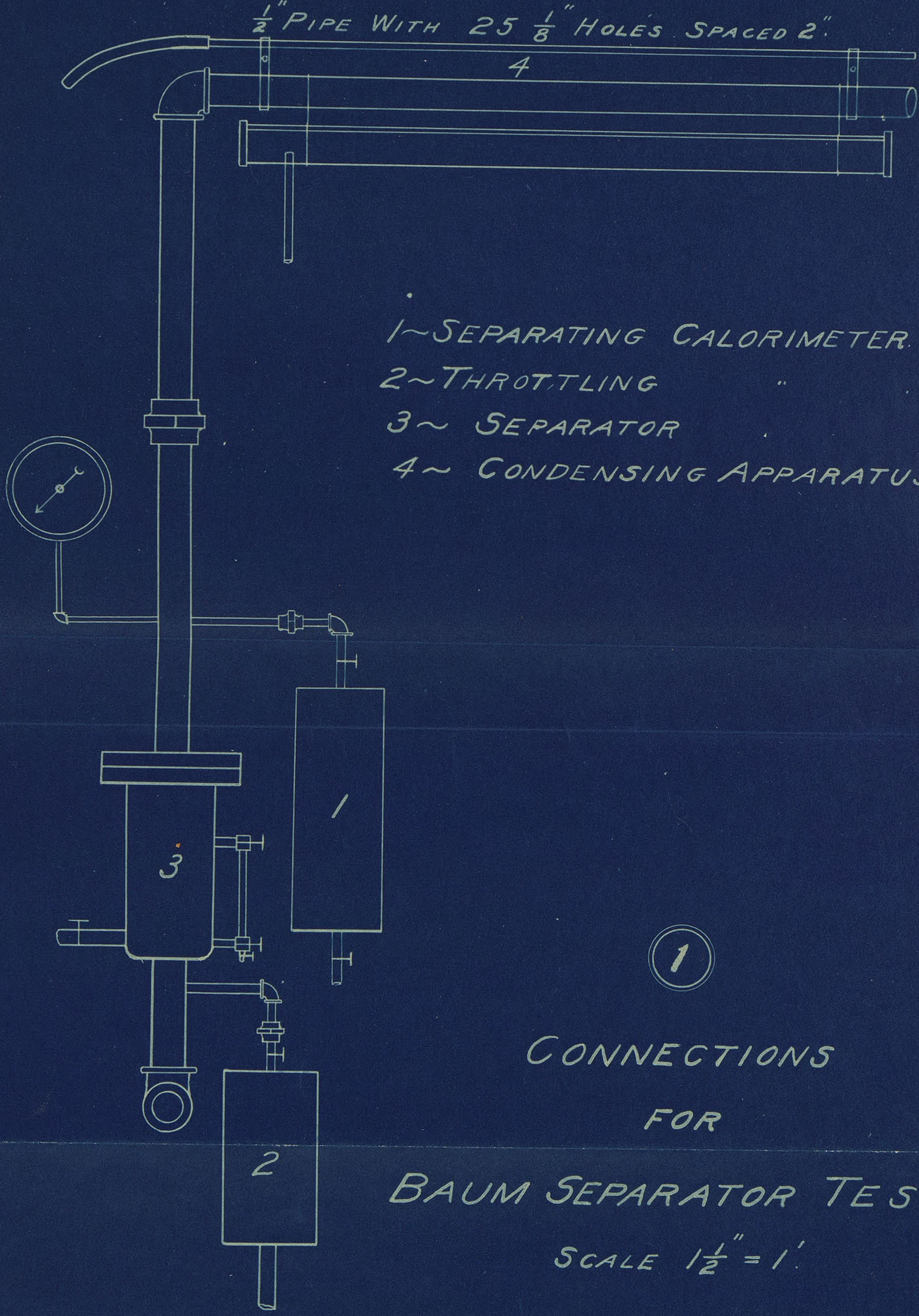
3. Hine Eliminator.

V. Conclusion.

Tests of the Efficiency of Steam Separators.

Unless steam is passed through a superheater after it leaves the boiler,it will carry with it a certain amount of entrained water. The violent ebulition in the boiler throws more or less water up in the steam space as spray,and some of this is carried along with the steam. Besides this,there is a certain amount of water in the steam caused by condensation in the pipes before it reaches the place where it is to be used. This water increases the initial condensation in the cylinder,and if there is a great deal of it present,may cause the cylinder heads to be blown out. To get rid of,so called "Steam Separators" are used. These depend for their action upon the fact that the water is several hundred times as heavy as the steam,and when the direction of flow of the steam is quickly changed,the inertia of the water carries it on out of the path of the steam into a chamber where it can be drawn off. Ribbed plates called baffles are usually used to collect the water and direct its flow.

In our tests of the efficiency of the separators,the "quality" of the steam,or the percentage of moisture it contained,was determined before it entered the separator,by means of a separating calorimeter, and after it left the separator,by means of a throttling calorimeter, or by means of a "Barrus" calorimeter.(All these instruments will be described fully farther on.) Knowing the initial and final qualities of the steam,the relative amount of water removed by the separator can be easily obtained. The efficiency of the separator is the ratio of the amount of water removed from the steam to the total amount carried by it before it entered the separator. For example: If the quality is .93 before entering the separator and .99 after leaving it,the efficiency is $\frac{.99 - .93}{1.00 - .93} = \frac{.06}{.07} = 86\%$.



1 ~ Separating Calorimeter.
2 ~ Throttling "
3 ~ Separator
4 ~ Condensing Apparatus.

(1)

Connections for Baum Separator Test

Scale 1½" = 1'.

RS

As the steam at our disposal was comparatively dry, and always carried about the same amount of water with it, it was necessary to be able to vary the initial quality by artificial means. Two methods were used. In the tests on the Baum Separator, numerous small jets of water were directed on the steam pipe, and for the tests on the horizontal separators, a water jacket was provided for the steam pipe.

The Baum Separator was installed in the steam pipe of the eight H.P. vertical engine of the laboratory and no modifications were made in the arrangement except those necessary for varying the quality of steam and securing a fair sample. The method adopted for varying the quality is clearly shown in Plate I. A I/2 inch pipe about 4 I/2 ft. long and perforated with 25 I/8 inch holes spaced 2 inches apart was supported by clamps about I I/2 inches above the steam pipe. This was connected by a rubber hose to a water cock which supplied the necessary means for regulating the flow of cooling water. The waste water was caught by a wooden trough hung under the steam pipe and carried to the sewer by another hose.

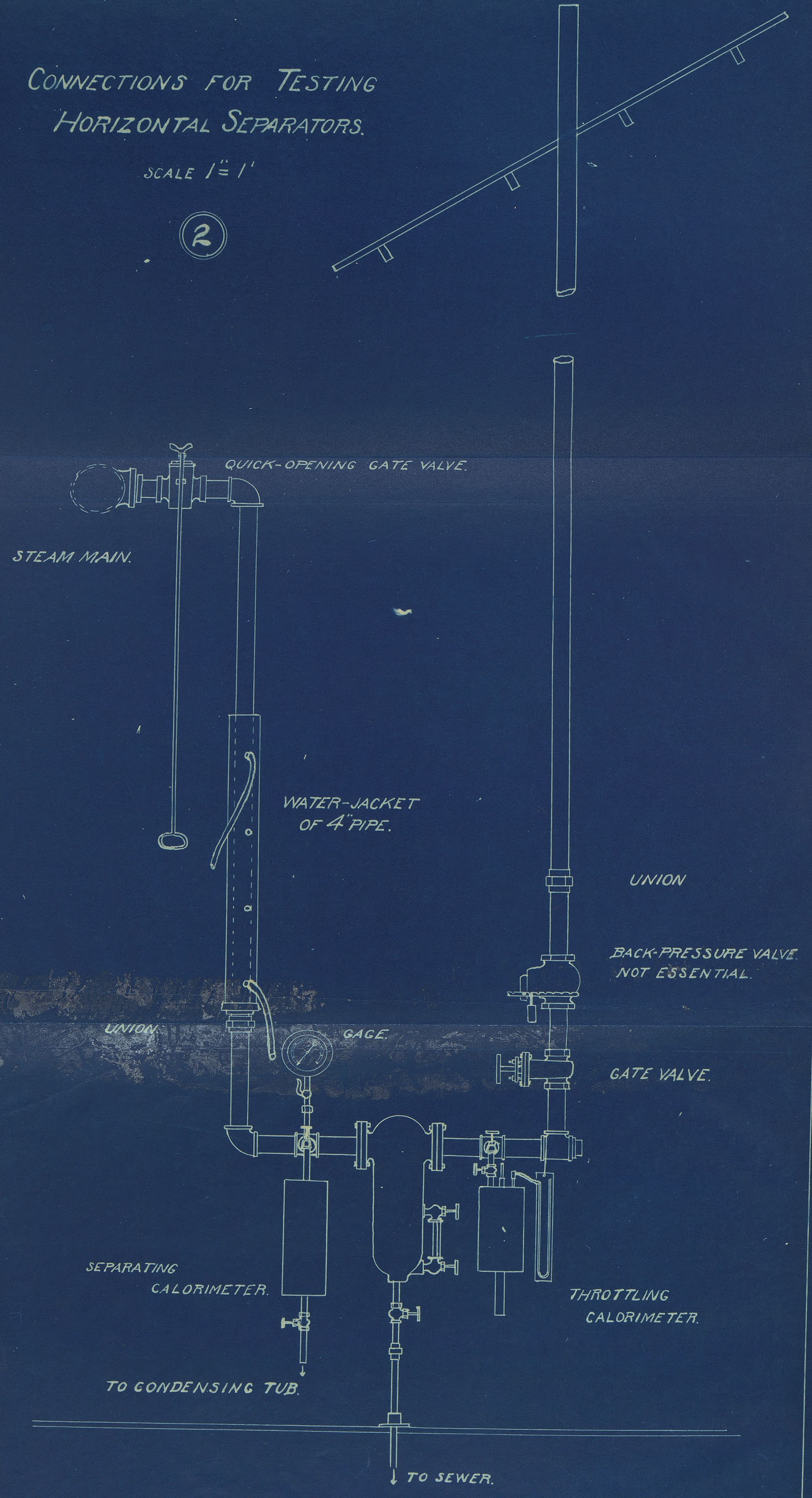
The steam pipe was drilled about 9 inches above and 2 inches below the separator and tapped for a I/2 inch pipe. After the sampling pipes were inserted and calorimeters connected as shown in the plate, all connections were well covered with wool to prevent condensation.

To test the horizontal separators the system of piping shown in Plate 2 was installed. Attached by a short nipple to the steam main is a quick-opening gate valve. Below this on the vertical section is a water jacket made of 4 inch pipe with a cast iron cap at the bottom. The top is left open. The jacket is drilled and tapped at intervals for I/2 inch pipe. The lower opening was usually

CONNECTIONS FOR TESTING HORIZONTAL SEPARATORS.

SCALE 1" = 1'

(2)



J.H.W.

used for the inlet for cooling water while the other three were used as outlets for waste water. The amount of steam condensed was regulaed by attaching the waste hose higher or lower on the jacket, and and plugging the remaining holes; also by the regulation of the inlet valve. The maximum depth of water jacket was thus about 3 feet while by attaching the waste pipe to lower hole and the supply pipe to the second the minimum water jacket could be made about 3 inches. The available range in initial quality of steam was found to be from about x =.860 to x =.990.

In addition to the separator fittings there were placed on the horizontal length of pipe two 2 inchx x 2 inch x 3/4 inch Tees, one on each side of the separator. The sampling pipes for the calorimeters which were in this case plugged and perforated were inserted through 3/4 inch x I/2 inch bushings in the 3/4 inch openings of the Tees, and extended to the center of the steam pipe. The Tees at the left of the separator (as shown in sketch) was also drilled and tapped for a pressure gauge which was necessary to complete the data for the throttling calorimeter.

In the vertical pipe which extended through the roof there was a 2 inch gate valve regulating the flow of steam through the separators.

A I/2 inch drain pipe with globe valve was led from the bottom of the separators through a floor plate to the sewer. It served thus as a support for the separator and piping system besides draining the separator.

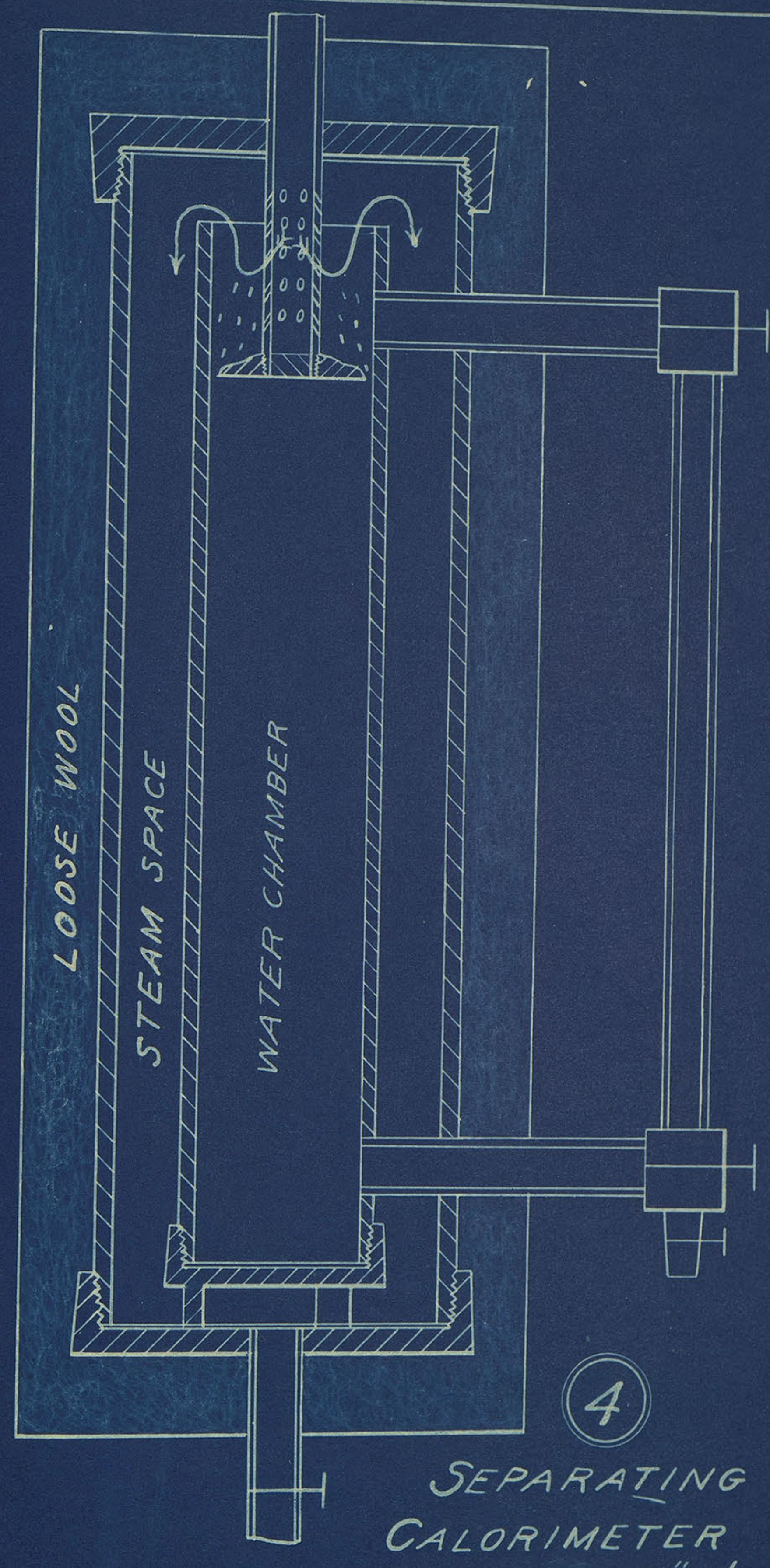
Three kinds of sampling pipes were used, as follows: I. open at the end, unperforated and extending to the center of steam pipe; 2. plugged at the end, perforated with about 48, I/8 inch holes and extending to the opposite wall of the steam pipe; and 3. plugged and perforated as before but extending only to the center of steam pipe.

All were of I/2 inch pipe and are shown in detail in the accompanying drawing. Plate 3. The first two were used only in the tests on the Baum separator while the latter was used with both the steam Appliance Co's Separator and the Hine Eliminator.

The Separating Calorimeter by which the quality of the steam was determined before it entered the separators is essentially a separator so arranged that the water taken from the steam can be measured by means of a scale on a gauge glass. The dry steam is led to a tub of water on the scales and condensed. Knowing then the amount of dry steam and the amount of water in the steam, the quality of the steam is obtained by dividing the weight of dry steam, by the combined weight of steam and water. For example: If the amount of water separated in a test is I0.5 oz. and the steam condensed in the tub ~~dividing~~ during the same time is I42 oz. then the quality of that sample is

$$\frac{142}{142 + 10.5} = .931.$$

Plate 4 gives a sectional view of our separating calorimeter. Steam enters through a half inch pipe which extends about two and a half inches through the cap. This pipe is plugged at the end and has in it numerous small holes about 3/32 of an inch in diameter extending downward at an angle of about 60°. Around the bottom of this pipe is a flange which helps to keep the water and steam from coming in contact after they are once separated. The water chamber consists of a 2 inch pipe capped at the bottom and extending to within about 3/4 of an inch of the top of main steam chamber. Legs on the bottom cap prevent the water chamber from interfering with the flow of the steam. The main chamber consists of a piece of 4 inch pipe capped at both ends. The upper cap is tapped for a I/2inch inlet pipe, and the lower one for a I/2 inch outlet pipe. A valve in the outlet pipe regulates the flow of steam. The sides of the two cham-



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SEPARATING CALORIMETER
SCALE 6"=1'

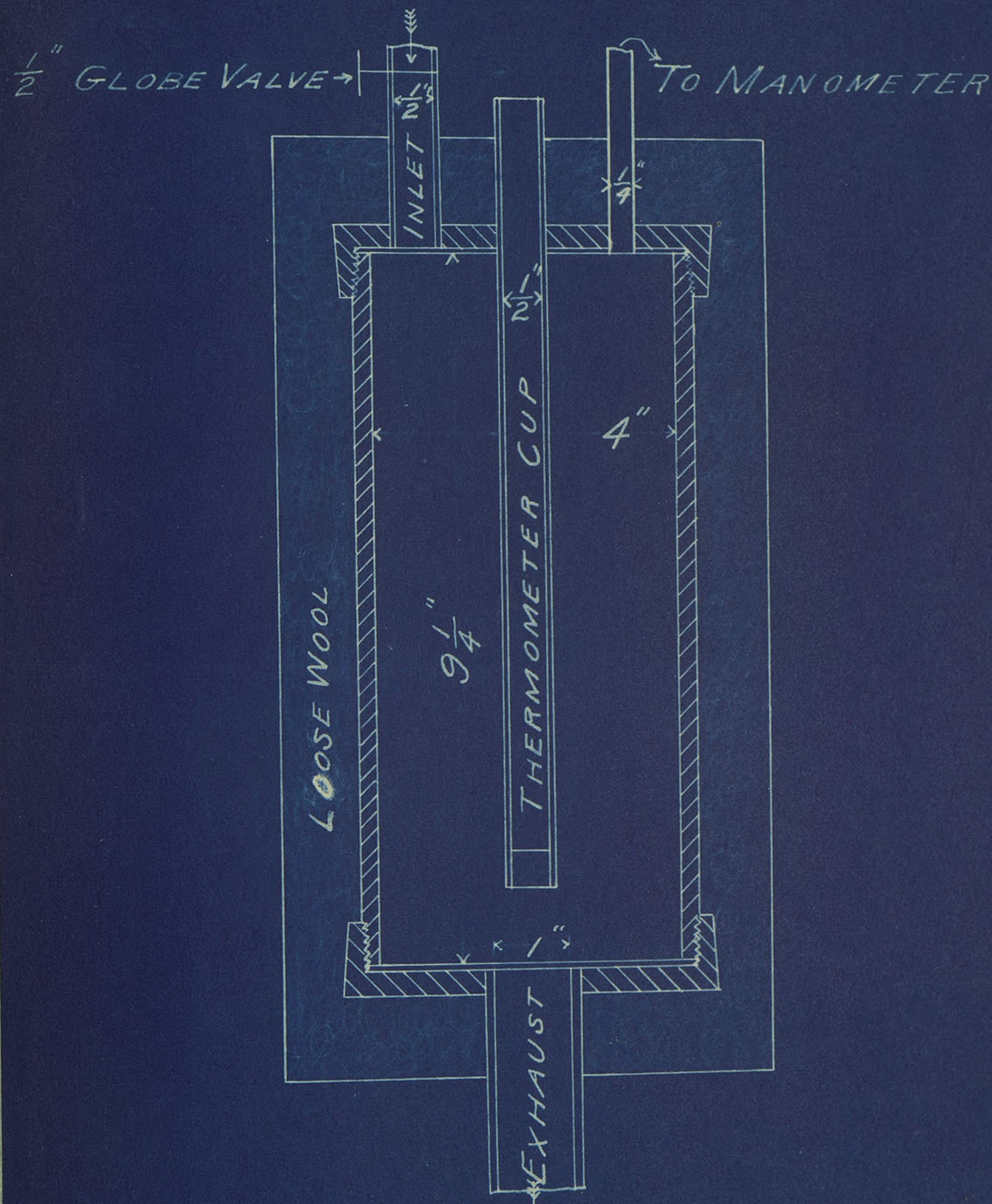
RS

bers are tapped for pipes which extend through the steam space into the water chamber,and at the other end are connected with a gage glass. Around the steam chamber is a packing of animal wool about an inch thick,enclosed in a galvanized iron cylinder. All openings in the cylinder are soldered,so it is air tight.

The action of the separator is as follows: Steam entering through the inlet acquires a downward direction in passing through the holes. To pass over the water chamber the direction must be reversed,and in so doing the water is thrown out and collects in the chamber,while the steam passes on to the outlet. Here it passes through the valve and by means of a rubber hose is led to the tub of water and condensed.

A sectional view of our Throttling Calorimeter is shown in Plate 5. It consists of a 4 inch pipe capped at both ends,surrounded by a layer of animal wool enclosed by an air tight sheet brass cylinder. The upper cap is tapped for a half inch inlet pipe,a I/2 inch thermometer cup and a I/4 inch pipe which is connected to a manometer tube by means of a piece of rubber tubing. The lower cap is tapped for a I inch outlet pipe which leads to the open air. The flow of steam is regulated by a valve in inlet pipe. The pressure and temperature in the calorimeter can be read by means of the manometer and thermometer. The pressure above the inlet valve is read by a gage on the main steam pipe.

The theory of this calorimeter is as follows:- The total heat of steam at a higher pressure is greater than that at a lower pressure,and very little if any heat is lost in passing through a reducing valve. Hence if the pressure of the steam is reduced,it will superheat or tend to superheat. However if there is moisture in the steam,this must all be evaporated before superheating can take place. The amount of superheating will depend directly on the amount



THROTTLING CALORIMETER

SCALE 6"~1'

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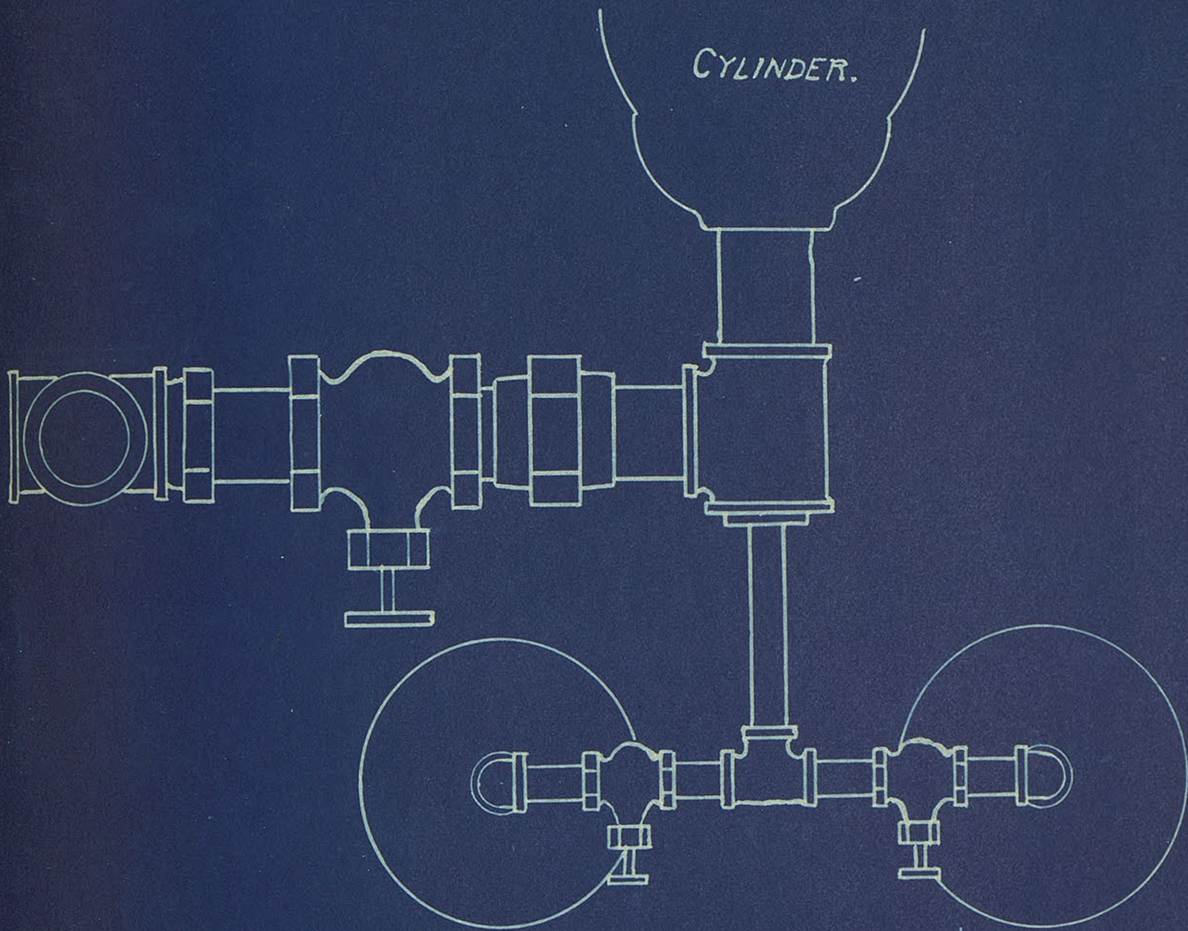
R.S.



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CONNECTIONS FOR
CALIBRATION TEST.

SCALE 3" = 1'

J.H.W.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.
ON CALIBRATION TEST.
DATE MAY 2ND. 1904
BAROMETER 28.85 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
R.A. SEATON.
J.H.WHIPPLE.

No.	Time.	Pressure in Steam Pipe.		Heat of Liquid.	Heat of Vaporization.	Calorimeter Pressure.		Total Heat.	Temperature Calorimeter.		Degree of Superheat.	Quality of Steam.	Remarks.
		Gage.	Abs. p	q	r	Gage.	Abs. p_1	λ_1	Corresponding to Pressure p_1 t_1	By Thermometer. t_s	$t_s - t_1$	x	
1	2:35	48				0.9				254.			
	:40	44				0.9				252.			
	:45	48				1.1				251.5			
	:50	55				0.9				253.			
	Av.=	49.	63	265.2	906.9	0.95	15.0	1146.9	213.	252.6	39.6	.993	
2.	3:00	42				.21				252.5			
	:05	49				.45				249.5			
	:10	65				.4				253.5			
	:15	64				.35				256.			
	:20	58				.3				258.			
	Av.=	56	70	272.2	902.1	.34	14.44	1146.3	211.1	253.9	42.8	.991	

Department of Mechanical Engineering, K. S. A. C.

Made at K.S.A.C.
Calibration test
On Calorimeters.
Date May 2nd 1904.

PRIMING LOG.
(Separating Calorimeter.)

Observers: R. A. Seaton.
J. H. Whipple.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start.	Stop.		Start.	Stop.			
			oz	oz		lbs. oz.	lbs. oz.			
1.	2:35	2:50	2.3	3.8	1.5	154 - 11	164 - 4	9 - 9	.990	
2.	3:00	3:20	1.9	4.	2.1	155 - 10	168 - 7.	12 - 13	.989	

of water in the steam.

If -

P = pressure above reducing valve;

Q = heat of liquid at pressure P;

R = heat of vaporization at pressure P;

p = pressure in calorimeter;

h = total heat of steam at pressure p;

t = temperature of vaporization at pressure p;

T = temperature in calorimeter,

then the amount of heat in the steam before passing the valve equals the amount of heat in the steam after passing the valve;or

$$XR + Q = h + c(T - t)$$

$$X = \frac{h + c(T - t) - Q}{R}$$

For example: If the gage pressure in the steam pipe is 68#, barometer reading 14.1#, calorimeter pressure,1# gage and calorimeter temperature 264°F,then P = 82#,p = 15.1#, h = 1147.0, t = 214, Q = 283.2 and R = 894.4.

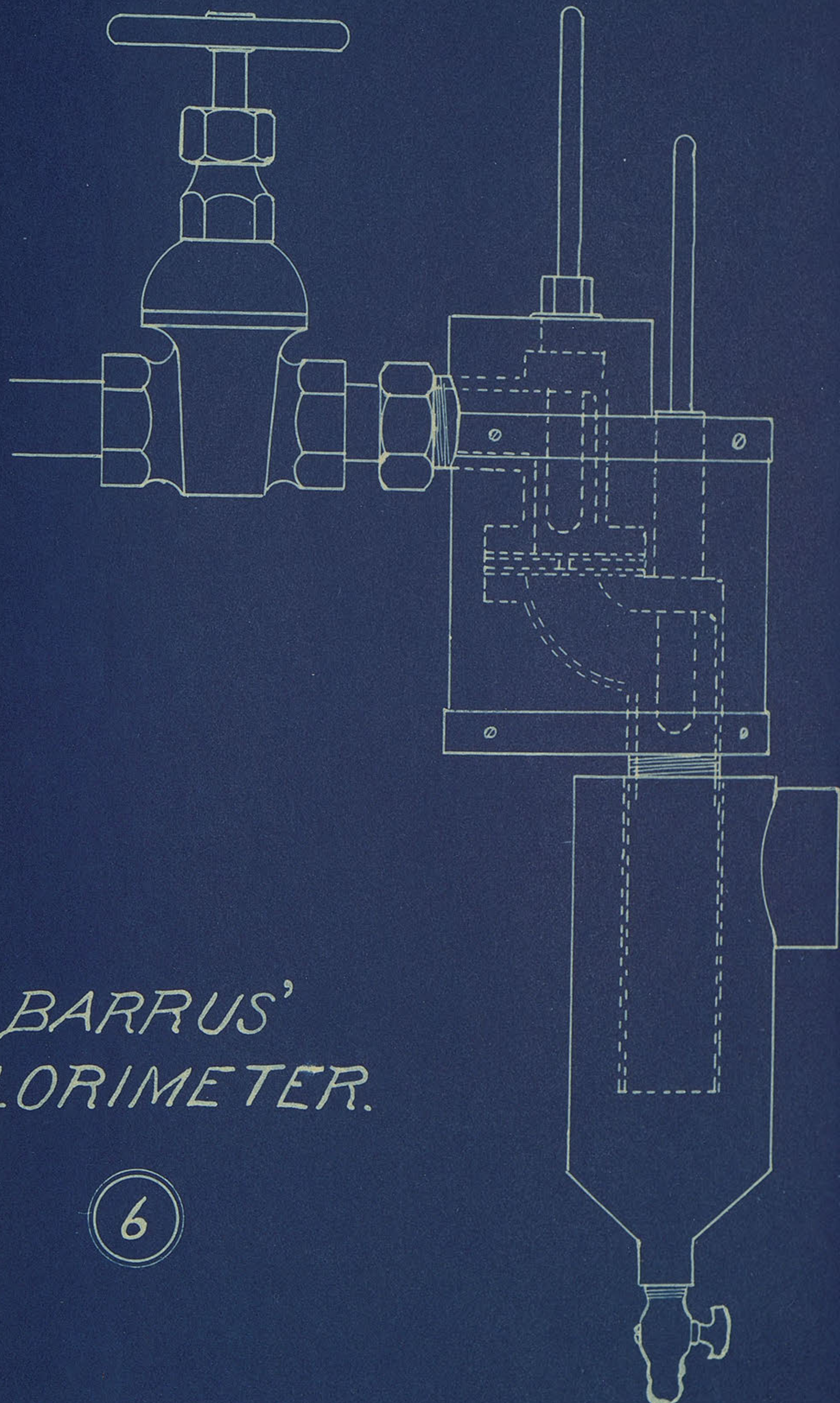
Then

$$X = \frac{1147 + .48(264 - 214) - 283.2}{894.4}$$

$$= .993.$$

The calorimeter is limited to use on fairly dry steam as,if there is too much water present,it will not all be evaporated and there will be no superheating. The exact amount of water allowable varies with the difference in pressures P and p, and for ordinary pressures is about three or four per cent.

The Barrus Calorimeter is described by the makers as follows "The accompanying cut (see Plate 6) shows the general features of the instrument. It consists of two parts,as indicated,which are



BARRUS'
CALORIMETER.

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J.H.W.

named the 'Heat Gauge', and the 'Separator'. The Heat Gauge is the first to receive the steam from the supply pipe. Having passed thro this portion of the apparatus, the steam emerges into the separator, and from this point it escapes through the side outlet to the atmosphere. The Heat Gauge consists of two chambers separated by plate containing an orifice. The two chambers are bolted together, and between the surfaces of the plate and the flanges, nonconducting material is placed to intercept the conduction of heat from one side to the other. The temperature of the steam in either chamber is obtained by means of a thermometer placed in a cup, in the manner shown. Radiation from the exterior is prevented by surrounding the whole with a metal casing, the intermediate space being filled with nonconducting material. The Separator consists of a vertical chamber in which the entering tube passes to a point near the bottom. The water contained in the steam drops to the bottom, and is there drained off through the regulating cock placed at the lower end."

It can be seen then that it consists essentially of a combined throttling and separating calorimeter. In our tests the separating part did not come into use, for the steam was dried by the Heat Gauge.

The method of obtaining the quality by the heat gauge is as follows:- From a table, the reading of the lower thermometer for dry and saturated steam corresponding to the temperature of the upper thermometer is obtained. From this is subtracted the actual reading of the lower thermometer, and the result is the cooling due to moisture. This divided by a tabular coefficient gives the amount of water in the steam.

The tables are as follows:-

Table I.

Temperature shown by Upper Thermometer. Deg. Fahr.	Normal Reading of Lower Thermometer Deg. Fahr.
280	250
290	256
300	262
310	268
320	274
330	280
340	286
350	292
360	298
370	304
380	310

Table 2.

Temperature shown by Upper Therm. Deg/ Fahr.	Coefficient.
280	21.8
300	21.5
320	~~2.11~~ 21.1
340	20.8
360	20.5
380	20.2

For example, If the upper thermometer reads 310°F, and the lower thermometer 233°F then from the table, the normal reading is 268, and the cooling due to moisture is 268 - 233 = 35°. Dividing this by the tabular coefficient corresponding to 310° or 21.3 we get 35÷ 21.3 =1.8% of moisture; or x=1 - .018 = .982.

Three separators were tested. The first was of the vertical type, inlet and outlet 2 inches, made by the Baum Separator and Machine Co., of Reading, Pa. The separating action is due to the fact that the direction of flow fo of the steam is suddenly changed from vertical to horizontal, over a ribs or baffles which catch the water and direct its flow.

The second set of tests were made on a separator built by the Steam Appliance Co., of Molwaukee, Wisconsin. It was of the horizontal type, with 2 inches inlet and outlet. In it there were three sets of baffle plates around and between which the steam was compelled to pass on its way from the inlet to the outlet, the direction of flow being reversed several times. The last tests were made on the Hine Eliminator, horizontal type, 2 inche inlet and outlet, sold by Jas. L. Robertson and Sons of New York City. In it the inlet and outlet are near the top of the separator, and extending down between them is a ribbed diaphragm, underneath which the steam must pass. The walls of the chamber are also ribbed to aid in the separation.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON BAUM SEPARATOR
DATE MAY 16, 1904.
BAROMETER 28.67 IN 14.05 LBS.

PRIMING LOG.
THROTTLING CALORIMETER.

OBSERVERS:
J. H. WHIPPLE.
R. A. SEATON.

No.	Time.	Pressure in Steam Pipe.		Heat of Liquid.	Heat of Vaporization.	Calorimeter Pressure.		Total Heat.	Temperature Calorimeter.		Degree of Superheat.	Quality of Steam.	Remarks.
		Gage.	Abs. p	q	r	Gage.	Abs. p_1	λ_1	Corresponding to Pressure p_1 t_1	By Thermometer. t_s	$t_s - t_1$	x	
1	1:45	40				2.0				252			
	47	42				2.1				253			
	49	43				2.1				255			
	51	45				2.0				257			
	53	46				2.1				258			UNPERFORA-
	AV. =	43	57	258.6	911.5	2.1	16.1	1148.0	217	255	38	.996	
2	2:10	46				1.7				259			
	12	47				2.0				259			TED SAMP-
	14	48				2.0				260			
	16	48				2.0				261			
	18	48				2.0				261			
	20	47				1.9				261			LING PIPES
	AV. =	47	61	263.0	908.5	1.9	15.9	1147.8	216	260	44	.997	
3	2:38	51				1.0				259			
	40	54				1.0				260			OPEN AT
	42	57				1.0				261			
	44	58				1.0				263			
	46	55				0.9				263			
	48	52				0.9				262			THE END.
	AV. =	54	68	270.3	903.3	1.0	15.0	1146.9	213	261	48	.996	
4	3:15	73				1.0				270			
	17	69				1.0				270			
	19	70				1.0				269			
	21	72				1.0				270			
	23	75				1.1				270			
	25	78				1.0				271			
	27	82				1.1				273			
	29	82				1.0				274			
	AV. =	75	89	289.2	890.1	1.0	15.0	1146.9	213	271	58	.995	
5	3:41	61				2.2				265			
	43	65				2.1				267			
	45	67				2.0				269			
	47	70				2.2				270			
	49	73				2.1				271			
	51	74				2.0				272			
	53	74				2.0	123456			273			
	AV. =	69	83	284.1	893.7	2.1	16.1	1148.0	217	270	53	.995	

DEPARTMENT OF MECHANICAL ENGINEERING. K. S. A. C.

MADE AT K. S. A. C.

ON BAUM SEPARATOR

DATE MAY 16, 1904.

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:

J. H. WHIPPLE.

R. A. SEATON.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start. oz	Stop. oz		Start. lbs. oz.	Stop. lbs. oz.			
1	1:45	1:53	0.5	1.5	1.0	168 - 11.5	175 - 12	6 - 15.5	.991	
2	2:10	2:20	3.9	5.0	1.1	166 - 2	176 - 1	9 - 15	.993	SAMPLING PIPES
3	2:38	2:48	2.7	3.7	1.0	170 - 14	180 - 13	9 - 15	.994	UNPERFORATED, WITH
4	3:15	3:29	3.1	4.6	1.5	168 - 14	179 - 12	10 - 14	.991	END OPEN.
5	3:41	3:53	4.7	6.0	1.3	173 - 8.5	186 - 2.5	12 - 10	.994	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON BAUM SEPARATOR
DATE MAY 23, 1904.
BAROMETER 28.8 IN 14.1 LBS.

PRIMING LOG.
THROTTLING CALORIMETER.

OBSERVERS:
J. H. WHIPPLE
R. A. SEATON

No.	Time.	Pressure in Steam Pipe.		Heat of Liquid.	Heat of Vaporization.	Calorimeter Pressure.		Total Heat.	Temperature Calorimeter.		Degree of Superheat.	Quality of Steam.	Remarks.
		Gage.	Abs. p	q	r	Gage.	Abs. p_1	λ_1	Corresponding to Pressure p_1 t_1	By Thermometer. t_2	$t_2 - t_1$	x	
1	11:48	65				1.0				259			
	50	67				1.0				261			
	52	69				1.0				263			NO LOAD ON
	54	66				1.0				264			
	56	61				0.9				264			ENGINE.
	58	56				1.0				263			
	12:00	53				0.9				263			
	AV. =	62	76	277.8	898.2	1.0	15.1	1147.0	213	262	49	.994	
2	1:43	62				1.2				225			
	45	65				1.0				228			
	47	65				1.0				232			NO LOAD ON
	49	67				1.0				236			
	51	67				1.0				237			ENGINE.
	53	62				1.0				238			
	55	66				1.0				239			
	57	64				1.0				242			
	AV. =	65	79	280.5	896.3	1.0	15.1	1147.0	213	235	22	.978	
3	2:16	62				1.1				234			
	18	65				1.1				228			
	20	61				0.9				224			
	22	58				0.9				222			
	24	60				1.0				216			
	26	61				1.0				214			
	28	62				1.0				214			
	AV. =	61	75	276.9	898.8	1.0	15.1	1147.0	213	222	9	.973	
4	2:40	78				1.0				244			COOLING WATER
	42	77				1.0				240			
	44	75				1.0				240			ON STEAM SUP-
	46	74				1.0				245			
	48	74				1.1				251			PLY PIPE FAILED.
	AV. =	76	90	290.0	889.6	1.0	15.1	1147.0	213	244	31	.980	

123456

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON BAUM SEPARATOR
DATE MAY 23, 1904.
BAROMETER 28.8 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
J. H. WHIPPLE.
R. A. SEATON.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
5	3:05	80				1.1				241			
	07	82				1.0				243			
	09	83				1.0				248			
	11	80				1.0				252			CONDENSING WATER FAILED.
	13	80				1.0				253			NO LOAD ON ENGINE.
	15	78				1.0				249			" " " "
	17	78				1.0				244			" " " "
	19	77				1.0				242			" " " "
	AV.=	80	94	293.2	887.3	1.0	15.1	1147.0	213	247	34	.981	
6	3:32	60				2.0				244			NO
	34	60				2.1				240			
	36	63				2.0				241			LOAD
	38	65				2.1				239			
	40	64				2.0				241			ON
	42	60				1.9				243			
	44	59				2.0				240			ENGINE.
	46	59				2.0				240			
	AV.=	61	75	276.9	898.2	2.0	16.1	1148.0	217	241	24	.983	

123456

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.

ON BAUM SEPARATOR

DATE MAY 23, 1904.

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:
J. H. WHIPPLE
R. A. SEATON.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start. oz	Stop. oz		Start. lbs. oz.	Stop. lbs. oz.			
1	11:48	12:00	3.75	4.0	0.75	159 - 10	165 - 0	5 - 6	.990	
2	1:44	1:57	1.5	4.25	2.75	153 - 8	163 - 11	10 - 3	.983	SAMPLING PIPES UNPER-
3	2:16	2:28	3.0	7.5	4.5	168 - 2	178 - 8	10 - 6	.974	FORATED, END OPEN.
4	2:40	2:52	2.0	2.75	0.75	157 - 00	161 - 8	4 - 8	.989	SAMPLING PIPES RUN
5	3:05	3:19	3.5	6.25	2.75	182 - 1	192 - 9	10 - 8	.984	TO CENTER OF SUPPLY
6	3:32	3:46	2.0	6.5	4.5	162 - 11	175 - 10	12 - 15	.978	PIPE.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C
ON BAUM SEPARATOR
DATE MAY 24, 1904.
BAROMETER 28.65 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
J. H. WHIPPLE
R. A. SEATON.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_2	Degree of Superheat. $t_2 - t_1$	Quality of Steam. x	Remarks.
1	1:51	67				1.0				237			
	53	68				1.0				238			
	55	69				1.0				240			
	57	69				1.0				238			
	59	67				1.0				238			
	2:01	70				1.0				244			
	03	72				1.0				238			
	05	73				1.0				238			
	07	66				1.0				238			
	AV.=	69	83	284.1	893.7	1.0	15.1	1147.0	213	239	26	.980	
2	2:24	63				1.0				251			
	26	63				1.0				257			
	28	65				1.0				260			
	30	72				1.0				262			
	32	75				1.0				264			
	34	75				1.0				266			
	36	72				1.0				267			
	38	74				1.0				267			
	AV.=	70	84	285.0	893.1	1.0	15.1	1147.0	213	262	49	.992	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.

ON BAUM SEPARATOR

DATE MAY 24, 1904.

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:

J. H. WHIPPLE.

R. A. SEATON.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start. oz.	Stop. oz		Start. lbs. oz.	Stop. lbs. oz.			
1	1:51	2:07	2.0	12.5	10.5	157 - 9	166 - 7	8 - 14	.931	PERFORATED SAMPLING
2	2:24	2:38	1.0	2.75	1.75	157 - 0	169 - 8	12 - 8	.991	PIPES WITH ENDS PLUGGED.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON BAUM SEPARATOR.
DATE MAY. 31ST 1904.
BAROMETER 28.7 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS: R. A. SEATON. J. H. WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_2	Degree of Superheat. $t_2 - t_1$	Quality of Steam. x	Remarks.
1.	2:40	67				1.				259			8 H.P. ENGINE.
	:42	65				1.				262			
	:44	63				1.				263			NO LOAD
	:46	67				1.				264			
	:48	68				1.1				265			NO COOLING WATER.
	:50	69				1				266			
	:52	72				1.1				266			
	:54	75				1				267			
	Av. =	68	82	283.2	894.4	1.	15.1	1147.0	214.	264.	50	.993	
2.	3:09	64				1.				229			NO LOAD. FULL
	:11	65				1.				219			COOLING WATER.
	:13	66				1.				215			
	:15	67				1.				215			
	:17	67				1.				220			
	:19	67				1.				222			
	:21	67				1.				224			
	:23	71				1.				224			
	Av. =	67	81	282.3	895.0	1.	15.1	1147.0	214.	221	7	.970	
3.	3:49	55				1.				249			NO LOAD. HALF
	:51	57				1.				251			COOLING WATER
	:53	59				1.				252			
	:55	60				1.				252			
	:57	59				1.				252			NOTE. FOR THIS
	:59	59				1.				252			SERIES SAMPLING
	4:01	55				0.9				253			PIPES WERE PER-
	:03	53				1.				253			FORATED AND
	:05	51				1.				252			PLUGGED AND
	:07	50				1.				251			EXTENDED TO OP-
	:09	51				1.				250			POSITE WALL OF
	Av. =	55	69	271.2	902.7	1.	15.1	1147.0	214	251	37	.990.	STEAM PIPE.

123456

DEPARTMENT OF MECHANICAL ENGINEERING. K. S. A. C.

MADE AT K.S.A.C.

ON Baum Separator.

DATE May 31st. 1904

PRIMING LOG.

(SEPARATING CALORIMETER.)

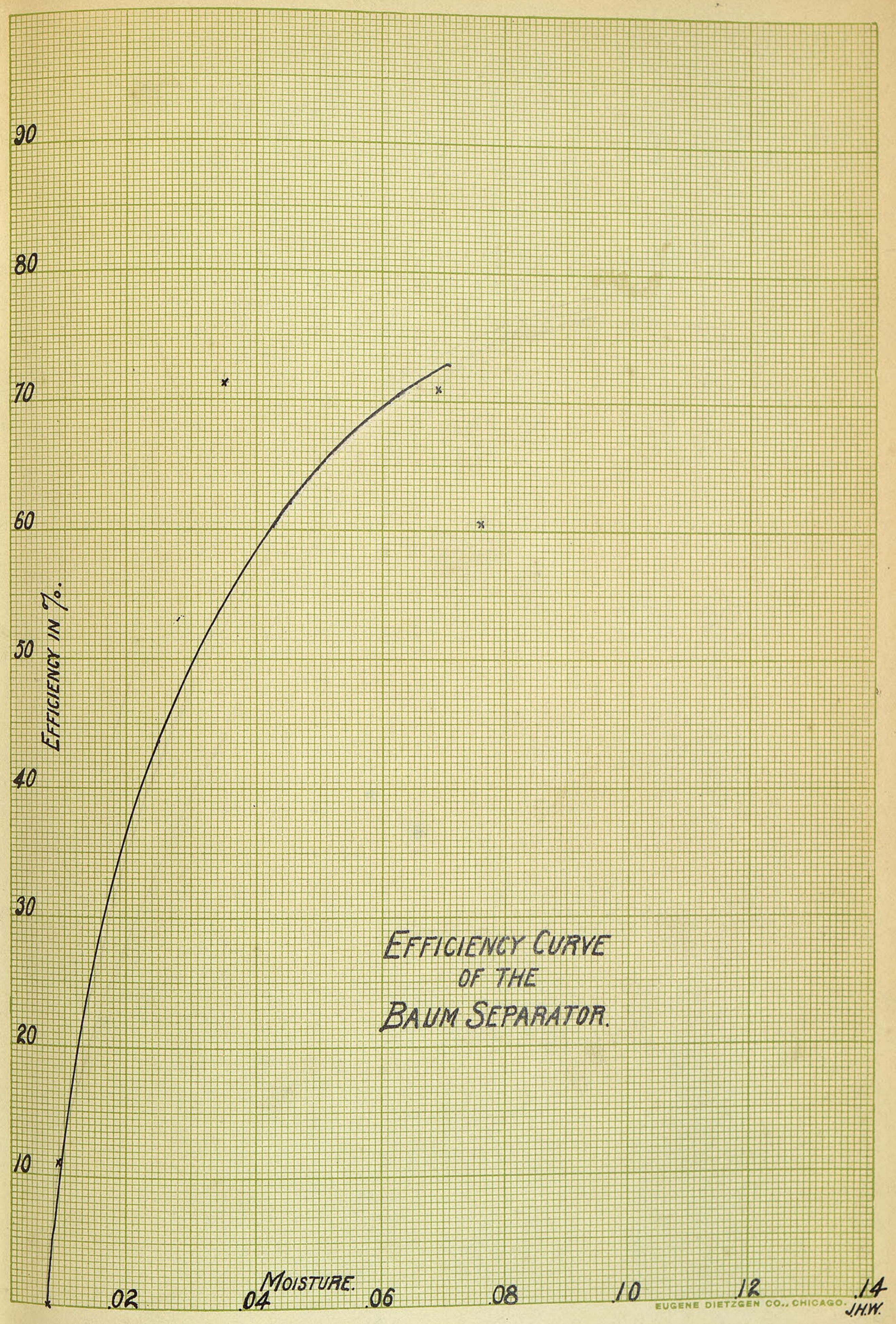
OBSERVERS: R.A. Seaton.
J.H. Whipple.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start. oz.	Stop. oz.		Start. lbs. oz.	Stop. lbs. oz.			
1	2:40	2:54	1.	2.25	1.25	191 - 3	202 - 4	11 - 1	.993	
2	3:04	3:25	2.	16.5	14.5	193 - 7	204 - 6	10 - 15	.924	
3	3:49	4:09	1.	7.5	6.5	195 - 9.5	207 - 8.5	11 - 15	.965	

1514/5-16

Efficiency of Baum Separator.

Date	No.	Initial Quality.	Final Quality.	Initial Moist.	Moisture removed	Eff. %.	Remarks.
5-16	1	.991	.996	.009	.005	T	Sampling pipes un- perforated and open
" "	2	.993	.997	.007	.004	h	at end. Probably
" "	3	.994	.996	.006	.002	r	calorimeters did not
" "	4	.991	.995	.009	.004	o	get fair samples.
" "	5	.994	.995	.006	.001	w	
5-23	1	.990	.994	.010	.004	n	Sampling pipes
" "	2	.983	.978	.017	.005	O	
" "	3	.974	.973	.026	.001	u	same as
" "	4	.989	.980	.011	.009	t	
" "	5	.984	.981	.016	.003		above.
" "	6	.978	.983	.022	.005		
5-24	1	.931	.980	.069	.049	71	Sampling pipes
" "	2	.991	.992	.009	.001	11	plugged and per-
"							forated, extending
5-31	1	.993	.993	.007	.000	0	to opposite
" "	2	.924	.970	.076	.046	60.5	wall of
" "	3	.965	.990	.035	.025	71.4	steam pipe.



EFFICIENCY CURVE
OF THE
BAUM SEPARATOR.
EFFICIENCY IN %.
90
80
70
60
50
40
30
20
10
MOISTURE.
.02
.04
.06
.08
.10
.12
.14
EUGENE DIETZGEN CO., CHICAGO.
J.H.W.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.
ON STEAM APPLIANCE CO'S SEPARATOR.
DATE JUNE 13TH. 1904
BAROMETER 29 IN 14.2 LBS.

PRIMING LOG.
THROTTLING CALORIMETER.

OBSERVERS:
R.A. SEATON.
J.H. WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_2	Degree of Superheat. t_2-t_1	Quality of Steam. x	Remarks.
1.	2:00	55				1.				249			
	:02	57				1.				250			
	:04	60				1.				252			
	:06	61				1.				253			
	:08	60				1.				254			
	:10	60				1.				255			
	:12	58				1.				255			
	:14	60				1.				255			
	Av.=	59	73	275.1	900.1	1.	15.2	1147.1	214	253	39	.990	
2	2:28	62				1.				246			
	:30	63				1.				249			
	:32	61				1.				252			
	:34	58				1.				252			
	:36	55				1.				251			
	:38	55				1.				248			
	Av.=	59	73	275.1	900.1	1.	15.2	1147.1	214	250	36	.988	
3	3:00	58				1.				242			
	:02	60				1.				242			
	:04	61				1.				246			
	:06	60				1.				252			
	:08	58				1.				254			
	:10	58				1.				254			
	:12	60				1.				253			
	:14	60				1.				253			
	Av.=	59	73	275.1	900.1	1.	15.2	1147.1	214	250	36	.988	
4.	3:27	60				1.				244			
	:29	59				1.				248			
	:31	58				1.				249			
	:33	58				1.				250			
	:35	59				1.				251			
	:37	59				1.				251			
	:39	59				1.				251			
	Av.=	59	73	275.1	900.1	1.	15.2	1147.1	214	251.	37	.989	

123456

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON STEAM APPLIANCE CO'S SEPARATOR.
DATE JUNE. 13TH. 1904.
BAROMETER 29 IN 14.2 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
R. A. SEATON.
J. H. WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
5.	3:55	58				1.				248			
	:57	62				1.				250			
	:59	61				1.				253			
	4:01	60				1.				255			
	:03	58				1.				255			
	:05	56				1.				254			
	Av. =	59	73	275.1	900.1	1.	15.2	1147.1	214	253	39	.990	
6	4:18	55				1.				247			
	:20	57				1.				248			
	:22	58				1.				249			
	:24	58				1.				250			
	:26	58				1.				250			
	:28	56				1.				250			
	Av. =	57	71	273.2	901.4	1.	15.2	1147.1	214	249	35	.987	
7.	4:47	57				1.				240			
	:49	53				1.				242			
	:51	52				1.				242			
	:53	52				1.				242			
	:55	52				1.				242			
	:57	55				1.				244			
	Av. =	54	68	270.3	903.3	1.	15.2	1147.1	214	242	28	.984	
8.	5:08	65				1.				249			
	:10	60				1.				254			
	:12	60				1.				253			
	:14	64				1.				251			
	:16	66				1.				253			
	:18	66				1.				256			
	Av. =	63	77	278.1	897.5	1.	15.2	1147.1	214	253	39	.990	

DEPARTMENT OF MECHANICAL ENGINEERING. K. S. A. C.

MADE AT K. S. A. C.
STEAM APPLIANCE CO'S SEPARATOR.
ON
DATE JUNE 13TH 1904.

PRIMING LOG.
(SEPARATING CALORIMETER.)

OBSERVERS: R. A. SEATON.
J. H. WHIPPLE.

No.	Time. Start.	Time. Stop.	Scale reading. Start. oz.	Scale reading. Stop. oz	Amount of water in steam.	Weight on scales. Start. lbs. oz.	Weight on scales. Stop. lbs. oz.	Condensed steam.	Quality of steam.	Remarks.
1.	2:00	2:14	3.0	13.0	10.	166 - 2	173 - 11	7 - 9	.924	
2.	2:28	2:38	2.5	14.5	12.	175 - 10	183 - 13	8 - 3	.923	
3.	3:02	3:14	1.0	10.5	9.5	180 - 4	188 - 10	8 - 6	.934	
4.	3:27	3:39	1.0	2.5	1.5	179 - 6	187 - 8	8 - 2	.989	
5	3:57	4:05	6.5	9.0	2.5	185 - 12	197 - 8	11 - 12	.987	
6.	4:18	4:28	3.	10.0	7.	175 - 4	190 - 2	14 - 14	.971	
7	4:45	4:57	6.	18.5	12.5	179 - 12	188 - 7	8 - 11	.917	
8.	5:08	5:18	7.	16.	9.	180 - 1	191 - 9	11 - 8.	.953	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.
ON STEAM APPLIANCE CO.'S SEPARATOR
DATE JUNE 14, 1904.
BAROMETER 29.0-28.9 IN 14.2 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
R. A. SEATON.
J. H. WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_2	Degree of Superheat. t_2-t_1	Quality of Steam. x	Remarks.
1	10:35	60				1.1				248			
	37	59				1.1				249			
	39	63				1.0				247			
	41	67				1.1				246			
	43	63				0.9				247			
	45	58				0.9				247			
	Av. =	62	76	277.8	898.2	1.0	15.2	1147.1	214	247	33	.985	
2	11:30	60				1.1				242			
	32	62				1.1				244			
	34	63				1.0				244			
	36	65				1.0				243			
	38	66				1.0				243			
	40	64				1.0				245			
	Av. =	63	77	278.7	897.5	1.0	15.2	1147.1	214	244	30	.984	
3.	2:00	73				1.0				250			
	02	72				1.1				251			
	04	70				1.0				252			
	06	65				0.9				250			
	08	65				1.0				250			
	10	68				1.0				250			
	Av. =	69	83	284.1	893.7	1.0	15.2	1147.1	214	250	36	.985	
4.	2:30	69				1.1				247			
	32	69				1.1				248			
	34	69				1.0				248			
	36	69				1.0				248			
	38	68				1.0				249			
	40	69				1.0				247			
	Av. =	69	83	284.1	893.7	1.0	15.2	1147.1	214	248	34	.984	

123456

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.
ON STEAM APPLIANCE CO'S SEPARATOR
DATE JUNE 14, 1904.
BAROMETER 28.9 IN 14.2 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
R. A. SEATON.
J. H. WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
5	3:00	68				1.0				242			
	02	70				1.1				245			
	04	71				1.1				245			
	06	72				1.0				246			
	08	68				0.9				247			
	10	71				1.0				248			
	Av.=	70	84	285.0	893.1	1.0	15.2	1147.1	214	246	32	.983	
6	3:30	70				1.0				246			
	32	66				0.9				249			
	34	65				1.0				250			
	36	68				1.0				250			
	38	71				1.1				249			
	40	74				1.0				248			
	Av. =	69	83	284.1	893.7	1.0	15.2	1147.1	214	249	35	.984	
7	4.00	68				0.9				247			
	02	67				0.9				248			
	04	66				1.0				248			
	06	66				1.0				250			
	08	65				1.0				250			
	10	68				1.0				249			
		67	81	282.3	895.0	1.0	15.2	1147.1	214	249	35	.985	

123456

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.

ON STEAM APPLIANCE CO.'S SEP.

DATE JUNE 14, 1904.

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:

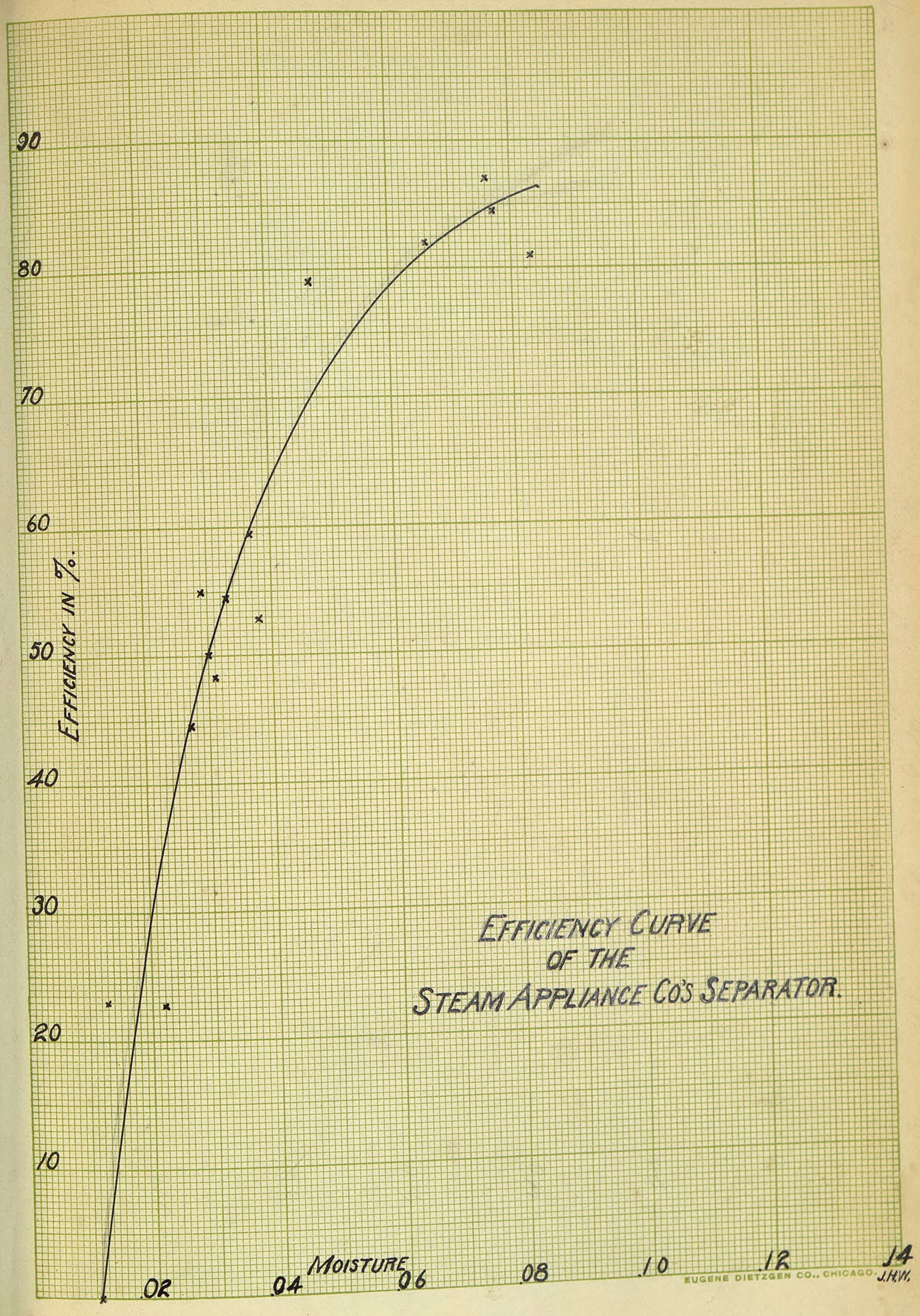
R. A. SEATON

J. H. WHIPPLE.

No.	Time.		Scale reading.		Amount of water in steam.	Weight on scales.		Condensed steam.	Quality of steam.	Remarks.
	Start.	Stop.	Start. oz.	Stop. oz.		Start. lbs. oz.	Stop. lbs. oz.			
1	10:35	10:45	1	5	4	186 - 8	195 - 10	9 - 2	.973	
2	11:30	11:40	4	7.5	3.5	178 - 2	187 - 11	9 - 9	.978	
3	2:00	2:08	3.5	8.5	5	178 - 0	187 - 14	9 - 14	.970	
4	2:30	2:40	5	9	4	184 - 9	191 - 14	7 - 5	.969	
5	3:00	3:10	2.5	11.5	9	185 - 14	199 - 15	14 - 1	.962	
6	3:30	3:40	5.5	12.5	7	183 - 2	194 - 7	11 - 5	.963	
7	4:00	4:10	1.5	6	4.5	185 - 8	193 - 13	8 - 5	.967	

Efficiency of Steam Appliance Co's Separator.

Date	No.	Initial Quality	Final Quality	Initial Moisture	Moisture Removed	Eff. %	Remarks.
6-13	1	.924	.990	.076	.066	87	
" "	2	.923	.988	.077	.065	84.5	
" "	3	.934	.988	.066	.054	82	
"" "	4	.989	.989	.011	.000	0	
" "	5	.987	.990	.013	.003	23	
" "	6	.971	.987	.028	.016	55	
" "	7	.917	.984	.083	.067	81	
" "	8	.953	.990	.047	.037	79	
6-14	1	.973	.985	.027	.012	44.5	
" "	2	.978	.983	.022	.005	22.7	
" "	3	.970	.985	.030	.015	50	
" "	4	.969	.984	.031	.015	48.4	
" "	5	.962	.982	.038	.020	52.7	
" "	6	.963	.985	.037	.022	59.5	
" "	7	.967	.985	.033	.018	54.6	



EFFICIENCY CURVE
OF THE
STEAM APPLIANCE CO'S SEPARATOR.
EFFICIENCY IN %.
90
80
70
60
50
40
30
20
10
MOISTURE
.02
.04
.06
.08
.10
.12
.14
EUGENE DIETZGEN CO., CHICAGO.
J.H.W.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.

ON HINE ELIMINATOR

DATE JUNE 15, 1904.

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:

J. H. WHIPPLE.

R.A. SEATON.

No.	Time. Start.	Time. Stop.	Scale reading. Start. (oz)	Scale reading. Stop. (oz)	Amount of water in steam.	Weight on scales. Start. (lbs. oz.)	Weight on scales. Stop. (lbs. oz.)	Condensed steam.	Quality of steam.	Remarks.
1	4:30	4:51	1.0	3.25	2.25	191 - 9	202 - 14	11 - 5	.987	
2	5:01	5:13	1.0	4.0	3.0	178 - 8	189 - 11	11 - 3	.984	
3	5:23	5:35	0.75	3.75	3.0	185 - 1	195 - 3	10 - 2	.982	

BARRUS CALORIMETER

No.	TIME	UPPER THER.	NORMAL	LOWER THER.	COOLING	COEF.	QUALITY
1	4:37	314°F		240°F			
	4:39	312		240			
	4:41	310		239			
	4:43	310		238			
	4:45	312		238			
	4:47	314		237			
	4:49	315		237			
	4:51	315		237			
	AV. =	313	270	238	32	21.2	.985
2	5:01	316°F		236°F			
	03	317		236			
	05	318		238			
	07	319		239			
	09	321		239			
	11	319		240			
	13	316		242			
	AV. =	318	273	239	34	21.1	.984
3	5:23	310°F		232°F			
	25	310		232			
	27	310		232			
	29	311		233			
	31	311		234			
	33	311		235			
	35	310		236			
	AV. =	310	268	233	35	21.3	.982

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.

ON HINE ELIMINATOR

DATE JUNE 18, 1904.

PRIMING LOG.
(SEPARATING CALORIMETER.)

OBSERVERS:
J. H. WHIPPLE.
R.A. SEATON.

No.	Time. Start.	Time. Stop.	Scale reading. Start. oz.	Scale reading. Stop. oz	Amount of water in steam.	Weight on scales. Start. lbs. oz.	Weight on scales. Stop. lbs. oz.	Condensed steam.	Quality of steam.	Remarks.
1	9:03	9:17	7.25	13.5	6.25	187 - 14	193 - 13	5 - 15	.939	
2	9:31	9:43	2.0	13.5	11.5	182 - 8	187 - 11	5 - 3	.860	

BARRUS CALORIMETER.

NO.	TIME	UPPER THER.	NORMAL	LOWER THER.	COOLING	COEF.	QUALITY	
1	9:03	284°F		214°F				
	05	284		214				
	07	284		214				
	09	284		214				
	11	283		215				
	13	283		214				
	15	282		214				
	17	281		214				
	AV.=	283	252	214	38	21.7	.983	
2	9:31	274°F		209°F				
	33	274		209				WATER DRIPPING FROM
	35	272		209				
	37	270		209				SEPARATING PART OF THE
	39	265		208				
	41	265		207				CALORIMETER WAS NEG-
	43	264		206				
	AV. =	269	243	208	35	22.0	.984	LIGIBLE.

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.
ON HINE ELIMINATOR. (BELOW)
DATE JUNE 18TH 1904
BAROMETER 28.85 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:
R.A.SEATON.
J.H.WHIPPLE.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
1	1:46	59				0.1				232			
	:48	58				0.1				233			
	:50	57				0.1				232			
	:52	57				0.1				230			
	:54	58				0.1				228			
	:56	58				0.1				227			
	:58	55				0.1				226			
	2:00	57				0.1				224			
	Av. =	57	71	273.2	901.4	0.1	14.2	1146.0	210	229	19	.978	
2.	2:12	53				0.1				229			
	:14	52				0.1				229			
	:16	52.5				0.1				229			
	:18	53				0.1				229			
	:20	54				0.1				229			
	:22	54				0.1				229			
	:24	52				0.1				230			
	:26	51				0.1				231			
	Av. =	52.7	66.7	269.0	904.2	0.1	14.2	1146.0	210	229.3	19.3	.980	
3	2:37	55				0.1				228			
	:39	54				0.1				229			
	:41	56				0.1				229			
	:43	58				0.1				229			
	:45	60				0.1				228			
	:47	57				0.1				227			
	:49	53				0.1				229			
	Av. =	56	70	272.2	902.1	0.1	14.2	1146.0	210	228.4	18.4	.978	
4.	3:00	61				0.1				228			
	:02	59				0.1				228			
	:04	57				0.1				229			
	:06	55				0.1				230			
	:08	55				0.1				230			
	:10	55				0.1				230			
	:12	56				0.1				229			
		57	71	273.2	901.4	0.1	14.2	1146.0	210	229	19	.978	

DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K.S.A.C.
ON Hine Eliminator. (Below)
DATE June 18th 1904.
BAROMETER 28.85 IN 14.1 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS: R.A. Seaton. J.H. Whipple.

No.	Time.	Pressure in Steam Pipe. Gage.	Abs. p	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Abs. p_1	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
5.	3:21	52				0.1				229			
	:23	47				0.1				230			
	:25	47				0.1				232			
	:27	49				0.1				232			
	:29	51				0.1				232			
	:31	52				0.1				231			
	Av. =	50	64	266.2	906.2	0.1	14.2	1146.0	210	231	21	.982	
6.	3:40	51				0.1				229			
	:42	51				0.1				229			
	:44	52				0.1				230			
	:46	53				0.1				230			
	:48	54				0.1				230			
	:50	55				0.1				227			
	Av. =	53	67.	269.3	904.0	0.1	14.2	1146.0	210	229.	19.	.980	
7	4:05	49				0.1				215			
	:07	50				0.1				212			
	:09	50				0.1				211			
	:11	51				0.1				210			
	:13	52				0.1				210			
	:15	48				0.1				210.5			
	:17	47				0.1				210.5			
	:19	49				0.1				210.5			
	Av. =	49.5	63.6	265.8	905.8	0.1	14.2	1146.0	210	211.	1	.972	

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DEPARTMENT OF MECHANICAL ENGINEERING, K. S. A. C.

MADE AT K. S. A. C.

ON HINE ELIMINATOR

DATE JUNE 18, 1904

PRIMING LOG.
(SEPARATING CALORIMETER.)

OBSERVERS:
J. H. WHIPPLE.
R. A. SEATON.

No.	Time. Start.	Time. Stop.	Scale reading. Start. oz	Scale reading. Stop. oz	Amount of water in steam.	Weight on scales. Start. lbs. oz.	Weight on scales. Stop. lbs. oz.	Condensed steam.	Quality of steam.	Remarks.
1	1:45	2:00	5.25	6.5	1.25	187 - 3	192 - 7	5 - 4	.985	SAMPLING PIPES PERFOR-
2	2:12	2:26	2.25	4.75	2.5	178 - 14	186 - 8	7 - 10	.980	ATED, EXTENDING HALF
3	2:37	2:49	2.25	4.5	2.25	149 - 4	154 - 4	5 - 0	.973	WAY ACROSS SUPPLY PIPE,
4	3:00	3:12	4.0	6.5	2.5	136 - 9	141 - 3	4 - 10	.967	ENDS PLUGGED.
5	3:21	3:31	1.75	4.5	2.75	141 - 3	146 - 8	5 - 5	.968	
6	3:40	3:50	1.75	5.0	3.25	131 - 12	138 - 0	6 - 4	.968	
7	4:05	4:19	6.5	11.0	5.5	126 - 13	136 - 11	9 - 14	.966	

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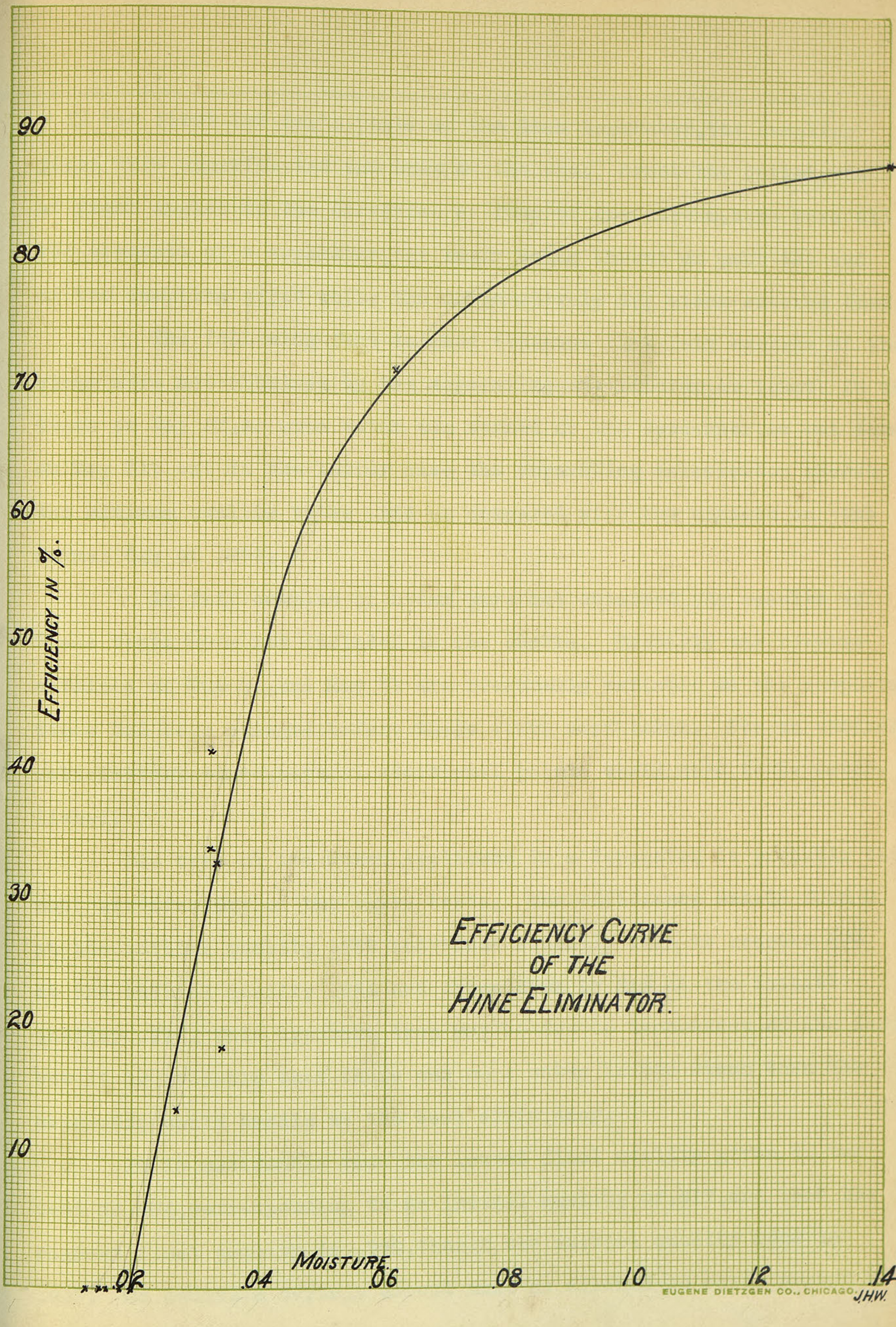
Efficiency of Hine Eliminator.

Date	No	Initial Quality	Final Quality	Initial Moisture	Moisture Removed	Eff %	Remarks.
June							Final quality taken by
15	1	.987	.985	.013	.002	0	Barrus
"	2	.984	.884	.016	.000	0	Calorimeter.
"	3	.982	.982	.018	.000	0	
June A.M. 18	1	.939	.983	.061	.044	72	Final quality
"	2	.860	.984	.140	.124	88.5	takenb by Barrus
"	3	.					Calorimeter.
P.M. 18	1	.985	.978	.015	.007	0	Final quality
"	2	.980	.980	.020	.000	0	taken by Throttling
"	3	.973	.978	.027	.005	14	Calorimeter.
"	4	.967	.978	.033	.011	33.3	
"	5	.968	.982	.032	.014	44	
"	6	.968	.980	.032	.012	32	
"	7	.966	.972	.034	.006	18.7	→Throttling Calorimeter not working satisfactorily.



EFFICIENCY CURVE
OF THE
HINE ELIMINATOR.
EFFICIENCY IN %.
MOISTURE.
90
80
70
60
50
40
30
20
10
.02
.04
.06
.08
.10
.12
.14
EUGENE DIETZGEN CO., CHICAGO.
J.H.W.

In the first two day's tests on the Baum Separator, the sampling pipes were unperforated and open at the end. Since the outlet was at right angles to the direction of flow of the steam, here were all the elements of a separator, the water being thrown on past the end of the sampling pipes while the comparatively dry steam entered them.

The following fact is good evidence that fair samples of the steam were not obtained by the separating calorimeter, at least: In the tests on May 23, as much water was turned on the condenser, as was done on May 31; but in the latter case the separating calorimeter showed the minimum quality to be .924 as compared with the minimum on the former day of .974.

As fair samples of steam were not obtained, the results of these tests were not included in the curves. Probably the results obtained on May 24, and May 31 are reasonably reliable as the sampling pipes had been changed before these tests were taken. For an entirely satisfactory curve, several additional points would need to be established.

The test on the Steam Appliance Co's Separator is probably the most satisfactory of the three tests. The efficiency starts from 0 at the initial quality .989 and rises steadily till it reaches 87% at the initial quality .924 and drops down to 81% at the initial quality .917. This apparant drop may be due to inaccuracy of the tests but it is probably that there was more water in the steam than the separator could handle at the best efficiency.

It is noticeable that the lowest final quality given in the test is .984, corresponding to an initial quality of .917, and that the highest final quality is .990, though the initial quality rose to .987. Of course a certain amount must be allowed to cover errors of the test.

The test on the Hine Eliminator shows remarkably poor results on low initial qualities,the efficiency remaining 0,down to,and including the initial quality .980. The efficiency runs considerably lower than on the Steam Appliance Co's Separator though it rose reasonably well on very wet steam.

The final quality of the steam is noticeably lower than for the other horizontal separator,ranging from .978 to .985.

The following conclusions would seem to be justified by the test.

(1) Unperforated sampling pipes open at the end do not give a fair sample of steam.

(2) For qualities of steam above .990,the separators are practically useless.

(3) The quality of steam delivered by the separators depends to a certain extent upon the quality of steam entering them.

(4) The efficiency rises very rapidly when the initial quality drops below about .990 (or in the case of the Hine .980),making a fairly smooth,typical efficiency curve,with the knee of the curve between about 70% and 90% efficiency.

(5) Since the final quality remains fairly high,it is probable that if proper arrangements were made for automatically trapping off the waste water,the separators would successfully shield the engine from sudden rushes of water in the steam pipe.