T H E S I S

TEST OF BOILER AND ENGINE
AT FLOUR MILL OF THE LONG BARNER MILLING COMPANY.

D O N A L D R O S S

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KANSAS STATE AGRICULTURAL COLLEGE

TEST OF BOILER AND ENGINE AT FLOUR MILL OF THE LONG BARNER MILLING COMPANY.

The test was made on the boiler and engine at the flour mill of the Long-Barner Milling Company. The boiler was installed in a great hurry two years ago as the old one was worn out. It is eighteen feet long, seventy-two inches in diameter, and a total heating surface of 1539 square feet. There are thirty-three square feet of grate surface. The boiler was manufactured by Joseph Bromich, of Topeka, and installed in 1905.

The fuel used was Weir City nut coal, some of the best that can be secured here for steaming purposes. A fresh car-load had just been received the week before, and was stored in a covered shed, so that there could be no deterioration by weathering.

Power is transmitted by belts from a long engine shaft that runs through the engine room wall to the basement under the mill proper. Speed was taken with a revolution counter and stop watch from the inner end of this shaft. A heavy sixteen foot cast iron fly wheel is on this shaft in the engine room.

The engine is of the plain slide valve type. It is a horizontal engine, manufactured by the Atlas Engine Company, and has been in almost continuous service in the basement of this mill for the past twenty-five years. It is rated as a seventy-five horse power engine. The

mechanical clearance in the head end is three-eighths of an inch, while the crank end has but three-sixteenths of an inch. The steam chest is placed on the side of the cylinder. Steam is supplied from the boiler by a three and one-half inch pipe, which runs about twenty feet from the steam dome south into the store-room, and then down to the engine. The horizontal portion slopes about one-eighth to the foot. The exhaust steam passes from the engine into an open feed water heater, placed near the engine; after giving up a portion of its heat to the water it is conducted up through the roof by means of a six inch galvanized iron pipe. Water is pumped from this heater to the boiler by a small duplex pump which keeps the water at nearly a constant level in the heater; the supply is regulated by opening or closing a small valve in the one-half inch supply pipe which leads from the city mains into the top of the heater. The accompanying sketch shows a detail of the piping system. This pipe leading to the heater was cut and three valves put in; from the first one a pipe led up through the floor into the store-room and carried water to the weighing tanks; the second valve was closed during the test so that no water could get through the pipe to the heater. The third valve was used to regulate the supply of water from the supply tank to the heater. Two tall tanks were each placed on a pair of scales in such a position that the outlet valves could be opened and the water run into the large supply tank.

A hose ran from the supply tank and could be used to fill either tank. As these tanks were filled, they were weighed, emptied into the supply tank and weighed empty to get the quantity of water. The temperature of the water was taken every thirty minutes by lowering a thermometer into it. In order to get the temperature of the water fed to the boiler, a brass valve containing a thermometer cup was put in the pipe between the pump and the boiler and readings taken at intervals of fifteen minutes. In order to take indicator cards a reducing motion shown in the accompanying sketch was made in the College machine shops. It is a form of straight line motion, and is designed so that the twenty-four inch stroke of the engine will give the recording drum on the indicator a four inch motion. The upright, on which the arm swings, is fastened to the top of the cross-head guides and is so placed that the swinging arm will stand in a vertical position when the engine is at mid-stroke. The maple rod, to which the indicator chords are attached, runs back over the steam cylinder and is held in position by two upright supports attached to the end of the cylinder. These uprights each bear two rollers, through which the rod slides so as to give as little friction as possible.

The coal was weighed before being wheeled to the engine room and the ashes were weighed dry. As the mill was in operation it was impossible to draw the fires before and after the test, so the grates were thoroughly

cleaned one-half hour before the times of starting and stopping, and the test was started and stopped with the depth of the fire as nearly the same as could be determined by the eye. The levels of the water in the boiler and feed water heater and supply tank were also brought to the same height at the end as it was at the start.

A throttling calorimeter was placed in the steam pipe in the store-room. The supply pipe to the calorimeter was drilled full of small holes and the end plugged where it is screwed into the main pipe; this end reached nearly across the steam pipe, as this has been found by experiment to give the best results. A separating calorimeter was attached to the steam pipe near the engine. Readings were taken on these calorimeters every thirty minutes. Before taking the readings on the throttling calorimeter, the steam was admitted and allowed to pass through for about seven minutes in order to warm the calorimeter up and get it in working condition. The separating calorimeter was run for ten minutes and the rise in the separator as shown by the glass was measured. A barrel was two-thirds filled with cold water before each observation and the gain in weight of the barrel was taken into which the steam had been conducted and condensed. After the test the separator was calibrated for the different heights in the glass.

After all preparations were made the test was started

at 7:30 A. M. on May 28th, 1907, and ended at 5:30 P. M., making a ten hour continuous run. The test was carried on by the senior class of mechanical engineers, and all data and readings were taken by them. The interval of fifteen minutes between the taking of indicator cards allowed them to be measured and checked by the observers. The results of the cards, with the horse power for each reading is shown by the accompanying log.

The steam gage and other instruments used were calibrated and the results given are corrected from these observations.

Conclusions.

The first four readings of the throttling calorimeter did not give superheated steam and were useless, as results can not be obtained if the steam does not superheat on being throttled in the calorimeter. This form of calorimeter will not give satisfactory results if the steam is under ninety-seven per cent dry. When no superheat was obtained the engineer lowered the water level in the boiler, and thereafter fairly good results were obtained.

With the exception of four readings between 11:30 and 1:30 the separating calorimeter gave nearly the same readings. That the readings of the two calorimeters do not correspond might result from the sloping steam pipe, water collecting in it until enough had accumulated to

present a surface to the steam which would then carry the water over into the engine cylinder. These calorimeters gave nearly the same results when used for a thesis test by Messrs. Seaton and Whipple in 1905. The throttling calorimeter gave .996 as the condition of the steam, while the other separated .991, but this small difference would not account for the difference of one per cent in these results.

The indicator cards seem to run very nearly even for the two ends of the cylinder. A great loss occurs in the steam pressure which was 90.34 pounds at the boiler and only had an average maximum pressure in the cylinder of 49.93 pounds. This loss of 40.07 pounds can not be entirely due to friction in the pipe between the boiler and engine, but must be due to too small steam pipe or insufficient ports. This is also shown in the cards, as the line falls from almost the beginning of the card until cut off. The three and one-half steam pipe is undoubtedly too small to furnish sufficient steam to an engine of this size. The expansion line after cut-off follows a hyperbola curve during its first half, then the curve drops below the expansion line as shown in the accompanying card. This and the fact that cut-off occurs so late gives very high pressure at release and much of the efficiency is lost as a result.

Release occurs at 97.607 of the stroke and the release runs parallel to the atmosphere line, showing that the exhaust pipe is large enough. The back pressure of the

steam going through the feed water heater is not high, for the pressure is two pounds above the atmosphere line.

Compression is at 17.43 per cent of the stroke and gives a very good compression curve. Cut-off is at 69.26 per cent of the stroke for the crank end and 74.43 for head end.

The horse-power of the two ends varies from 89.15 at 4:15 P. M. to 49.02 at 10:45 A. M. This was caused by different loads being thrown on the machinery. The average areas of the cards vary only .01, being 2.28 square inches for the head end and 2.29 for the crank. This shows that the valve is set nearly the same for the two ends. The diameter of the piston rod being two and one-fourth inches and the average revolutions per minute 129.42 gives 22.13 horse-power for head end, and 21.05 for the crank.

The irregular expansion line is probably due to leakage in the valve, this or a weak spring accounting for such a line.

Suggestions.

By trial it was found that the engineer was carrying his water line too high. When this was lowered much drier steam was obtained. Some trouble had been experienced by the boiler foaming. If the water line is kept at the level carried through the greater part of the test, this foaming would be eliminated and better steam efficiency

obtained. The steam pipe is uncovered for half its length and probably considerable condensation of steam occurs in this length. It would give better steam were this covered.

There would not be such an admission line if the steam pipe was larger. A steam pipe of not less than four inches should be used; then better steam economy and larger horse-power would be secured.

The cut-off occurs at nearly the three-quarters stroke, which is the usual occurrence for a slide valve. To secure an earlier cut-off another valve would be necessary.

The release can only be secured at a lower pressure by changing the angular advance and this could be done by putting in an off-set key, but this would change the other events, so is not desirable.

C E Per Cent at Events of Stroke.

No. card	Cut-off	Release	Compression
2	67.2	97	16
8	67.2	98	19.5
14	70.5	97.5	16.5
22	66.5	97.5	16
30	69	97.75	17
36	72	98	19.5
41	72.4	97.5	17.5
aver.	69.26	97.607	17.43

H E Percentages.

2	71	97	16
8	72	98	19.5
14	69.5	97.5	16.5
22	74	97.5	16
30	76	97.75	17
36	76.5	98	19.5
41	72	97.5	17.5
aver.	74.43	97.607	17.43

1609

Pressures at Events of Stroke.

H E

Card No.	Admission	Cut-off	Release	Comp.	Maximum pressure of card	Loss in pressure from boiler	Boiler pressure
2	39	22	14	3.5	50	40	90
8	40	23.5	14.5	4.5	52	38	90
14	38	23	15	4.5	50	40	90
22	39.5	21	14	5	49	41	90
30	39	22.5	15	5.5	50	40	90
36	40	22	19	4	48	41	89
41	38	23	15	5	50.5	40.5	91
aver.	39.07	22.41	15.21	4.57	49.93	40.07	90

C E

2	40	28.5	16.5	4.5	48	42	90
8	34.5	27	19	5	50	40	90
14	35	26	16	4	48	42	90
22	34	24	13	4	46.5	43.5	90
30	34	23	13	5	47	43	90
36	33	22.5	12.5	4	46	43	89
41	35	20	15	4	49	42	91
aver.	39.07	24.43	15	4.5	47.787	42.21	90

1610

1611

DATA AND RESULTS OF EVAPORATIVE TESTS.

Arranged in accordance with the short form advised by the boiler test committee of the American Society of Mechanical Engineers.

Grate surface	33 SQ. FT.
Water heating surface	1539 SQ. FT.
Ratio of grate to water heating surface	1:46.7
Kind of fuel	WIER CITY NUT

TOTAL QUANTITIES.

1. Date of trial	MAY, 28, 1907
2. Duration of trial in hours	10 HOURS
3. Weight of coal fired	3854.5
4. Per cent of water in coal	DRY
5. Total weight of coal consumed, in pounds	3854.5
6. Total ash and refuse	542.5
7. Percentage ash and refuse in coal	14.07 %
8. Total weight of water fed to boiler	25546
9. Condition of steam	.98 DRY
10. Equivalent water apparently evaporated from and at 212° F.	26842.8
11. Equivalent water actually evaporated from and at 212° (corrected for moisture in steam)	26378

HOURLY QUANTITIES.

12. Pounds coal consumed per hour	385.45#
13. Coal per hour per square foot of grate surface	11.68
14. Pounds feed water per hour	2554.6
15. Equivalent water evaporated per hour from and at 212° F. (corrected for moisture in steam)	2637.8
16. Equivalent water evaporated per square foot of heating surface per hour	1.714

AVERAGE BOILER PRESSURES, TEMPERATURES, ETC.

17. Average boiler pressure, pounds per square inch, gage	90.34
18. Average boiler pressure, pounds per square inch, absolute	104.60
19. Average temperature of feed water, Fahrenheit	199.17°F
20. Average temperature of boiler room, Fahrenheit	75.75°F
21. Average temperature of outside air, Fahrenheit	62.2°F
22. Barometer (29.05 INCHES)	14.26#

HORSE-POWER.

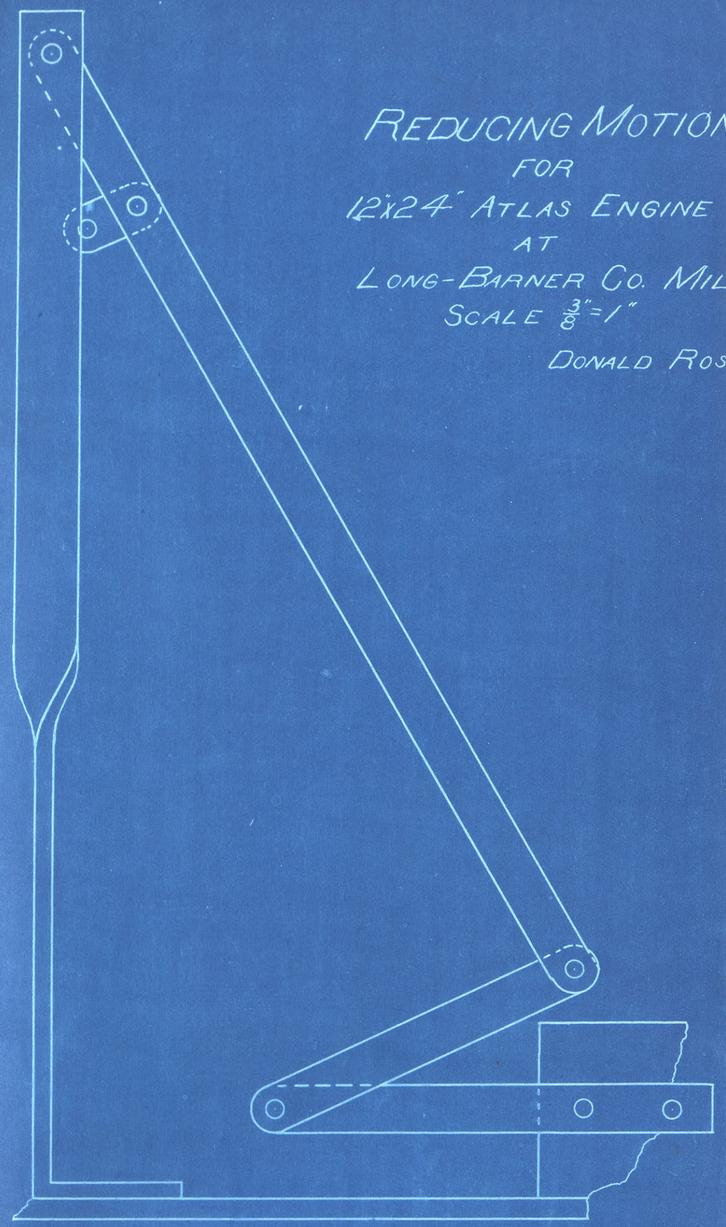
23. Horse-power developed	76.45
24. Builders' rated horse-power	150
25. Percentage of builders' rated horse-power	50.94 %

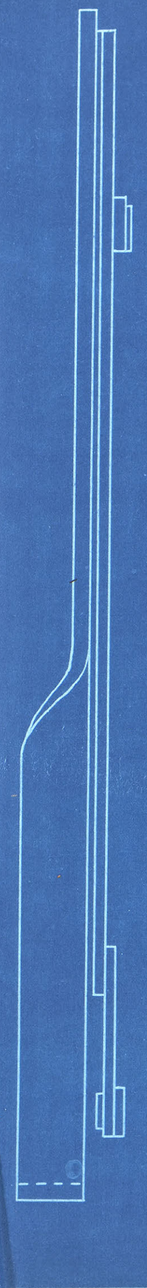
ECONOMIC RESULTS.

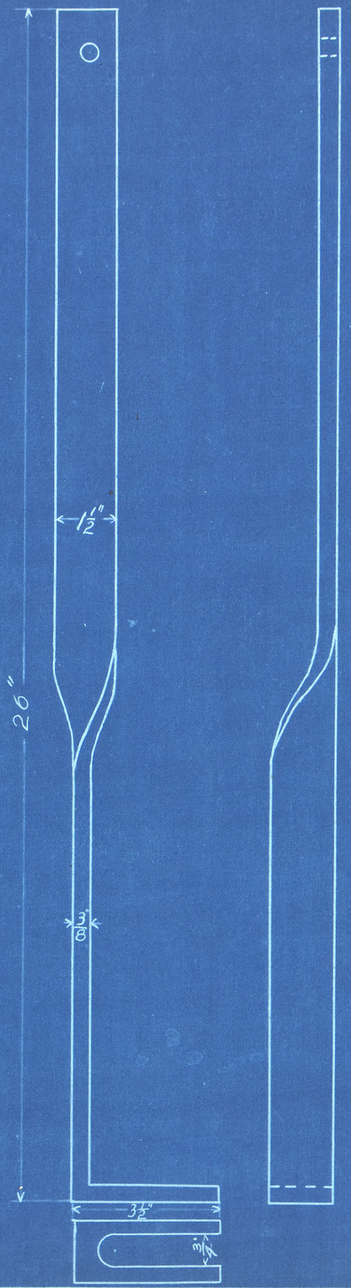
26. Water apparently evaporated per pound of coal under actual conditions	6.629
27. Equivalent water actually evaporated from and at 212° F., per pound of coal fired	6.841
28. Equivalent evaporation from and at 212° F., per pound of dry coal	6.841
29. Equivalent evaporation from and at 212° F., per pound of combustible	7.956

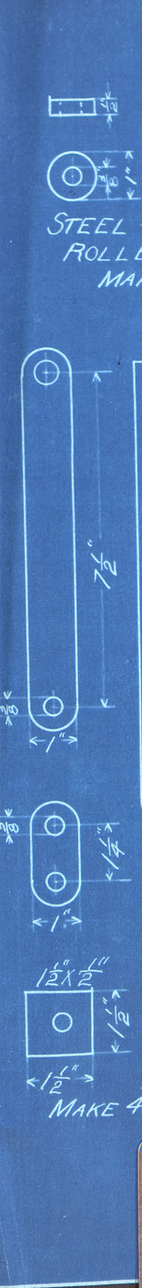
REDUCING MOTION
FOR
12"x24" ATLAS ENGINE
AT
LONG-BARNER CO. MILL
SCALE $\frac{3}{8}$"=1"

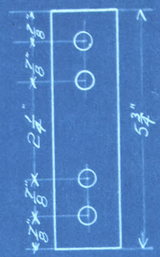
DONALD ROSS











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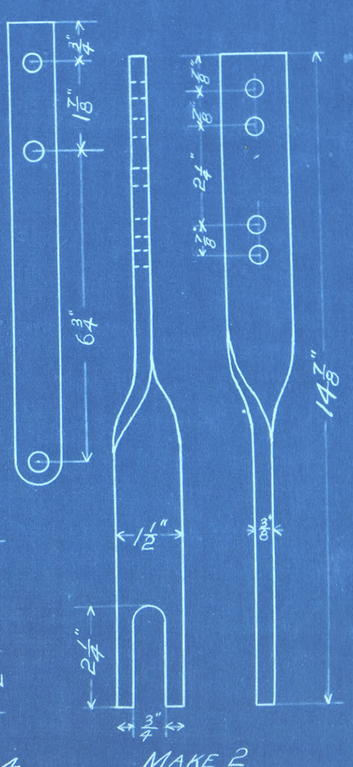
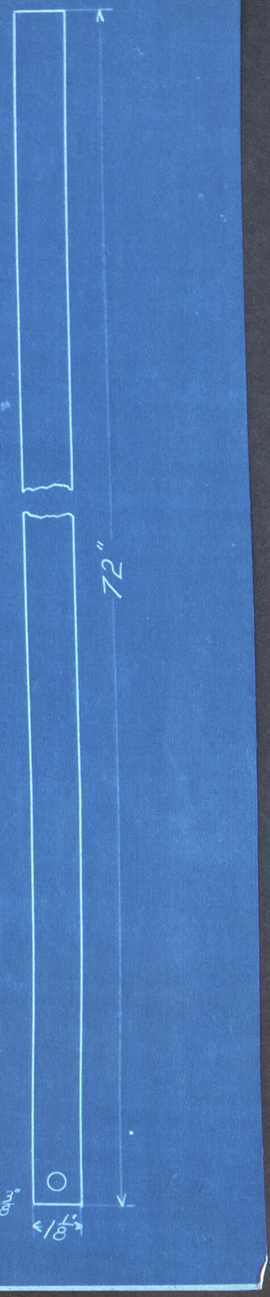
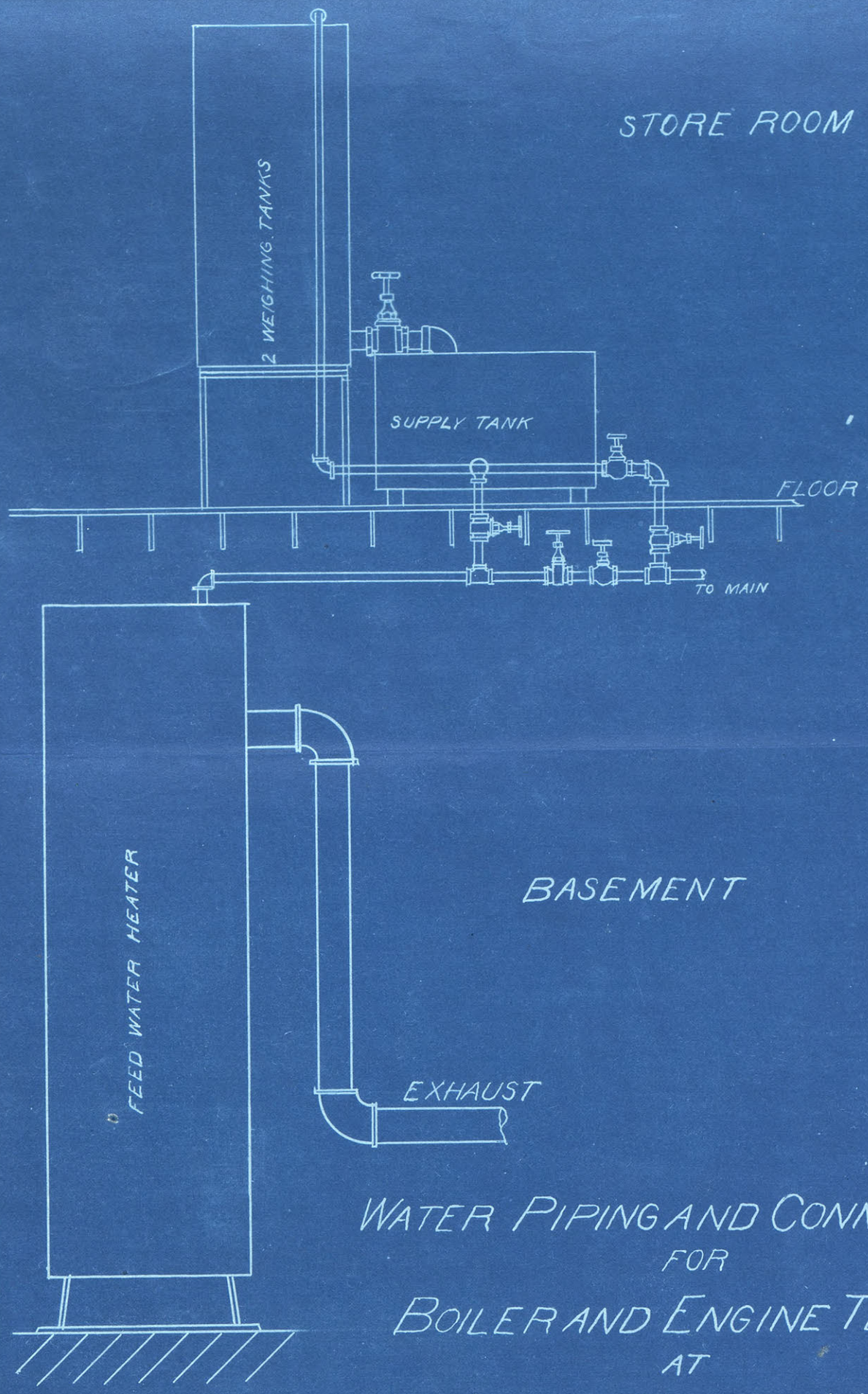


MAKE 2



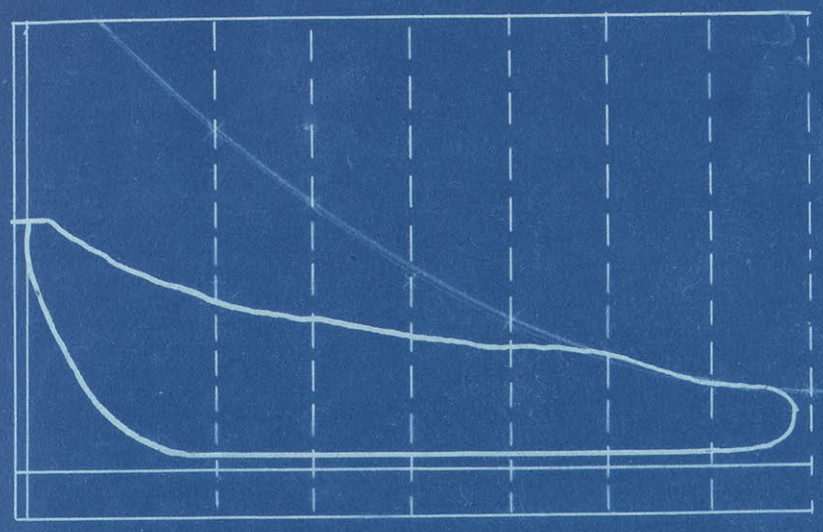
MAPLE
6"x1⅛"x8¾"



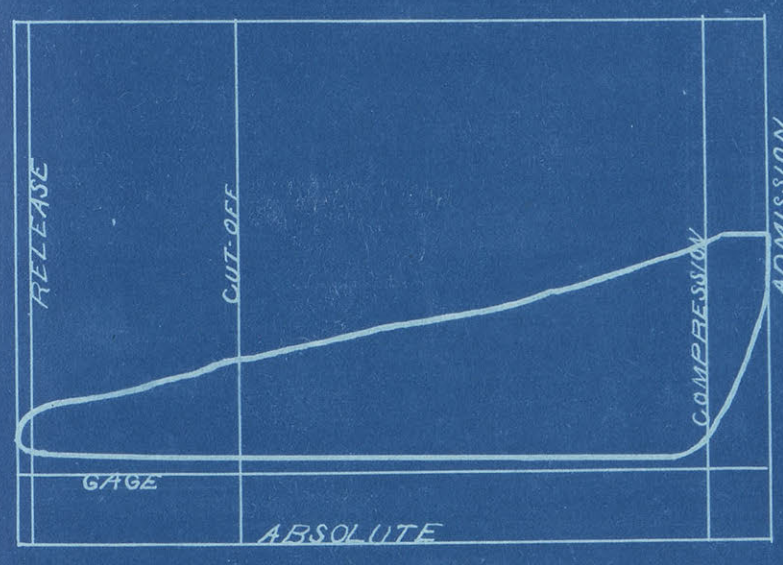
WATER PIPING AND CONNECTIONS FOR BOILER AND ENGINE TEST AT LONG-BARNER MILL

SCALE - $\frac{1}{2}$" = 1'

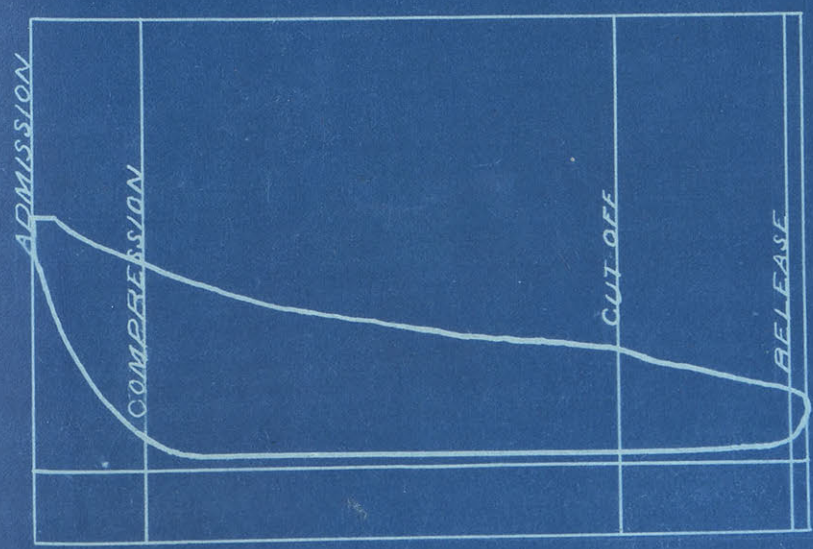
DONALD ROSS.



HYPERBOLA
CURVE



CARD No. 30.
AREA 2.46
LENGTH 3.87
M.E.P. 25.30.



CARD NO. 30
LENGTH 3.82
AREA 2.27
M.E.P. 23.76.

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

TEST MADE AT MANHATTAN, KAN

ON LONG-BARNER MILL

DATE MAY 28, 1907

Log of Boiler Trial.

OBSERVERS:

Time.	Pressures.		Temperatures, °F.				Weights.									Remarks.
							Coal.			Cinders.			Water.			
	Barometer.	Steam Gage.	External Air.	Boiler Room.	Feed Water.	Flue Gases.	Gross.	Tare.	Net.	Gross.	Tare.	Net.	Gross.	Tare.	Net.	
7:30		88	59	73	195		198	70	128				726	159	567	
7:45		92	59	73	197		211.5	70	141.5				696.5	173	523.5	
8:00		90	60	70	199		212	70	142				811	165	646	
8:15		91	60	73	199		217.5	70	147.5				809	112.5	636.5	
8:30		89	61	74	199.7		210	70	140				981	162	819	
8:45		93	61.5	74	197.7		225.5	70	155.5				692.5	156.5	536	
9:00		93	63	74	198.5		220	70	150				960	149.5	810.5	
9:15		90	64	73	199		220	70	150				673	149.5	523.5	
9:30		90	64	75	200.3		220	70	150				786.5	140.5	646	
9:45		90	64	76	200.3		220	70	150				774.5	138.5	636	
10:00		90	65	75	201.2		220	70	150				803	139	664	
10:15		90	66	78	201.2		220	70	150				751.5	137.5	614	
10:30		90.5	66	77	200.2		220	70	150				755	135	620	
10:45		90	67	75	199		220	70	150				749	131.5	662.5	
11:00		90	67	75	199		220	70	150				721.5	145.5	576.	
11:15		90	67	78	200.3		220	70	150				712	135.5	576.5	
11:30		91	68	76	200.3		220	70	150				710	140	570	
11:45		90	68	78	199		220	70	150				713.5	135	578.5	
12:00		90	68	76	199		220	70	150				706	137	569	
12:15		90	69	78.5	199		220	70	150				704.5	138	566.5	
12:30		90	69	78	199		220	70	150				708	148.5	559.5	
12:45		90	69	78	199.5		220	70	150				704	137.5	566.5	
1:00		90	68.5	77	199.5		220	70	150				706.5	142.5	564	
1:15		90	69	79	200.3		220	70	150				727.5	135.5	592	
1:30		90	69	75	200.3								700	150	550	
1:45		90.5	69.5	78	198								704	151	553	
2:00		89.5	69	76	197.6								653	138	515	
2:15		92	67	75	199.5								702	141.5	560.5	
2:30		90	68	75	199								700	141	595	
2:45		90	66	76	199								723	144.5	578.5	
3:00		86.5	66	75	200.3								706	146	560	
3:15		93	66	75	200.3								767	150	617	
3:30		90	66	74	199											
3:45		93	65	73	199											
4:00		90	64	73	199											
Total,		5162	2297.5	2638.5	6963.1		5234.5	1680	3554.5				23782	4666	19116	
Average.			65.35													

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

TEST MADE AT MANHATTAN, KAN
LONG-BARNER MILL
ON 12"x24" ATLAS ENGINE
DATE MAY, 28, 1907

LOG OF BOILER TRIAL.

OBSERVERS:

Time.	Pressures.		Temperatures, °F.				Weights.									Remarks.
							Coal.			Cinders.			Water.			
	Barom-eter.	Steam Gage.	External Air.	Boiler Room.	Feed Water.	Flue Gases.	Gross.	Tare.	Net.	Gross.	Tare.	Net.	Gross.	Tare.	Net.	
4:15		90	61	71	199		220	70	150	216.5	70	146.5	706	153	553	
4:30		89	60	72	199		220	70	150	189.5	70	119.5	713	150	563	
4:45		86	63	83	201.2					173.5	70	103.5	722	131	591	
5:00		93	63	87	201.2					188.5	70	118.5	729.5	102	627.5	
5:15		93	63	79	201.4					124.5	70	54.5	821	307	514	
5:30		91	63	76.5	201.2								816	566	250	
TOTAL, SHEET 2		542	253	468.5	1203		440	140	300	892.5	350		542.5	4507.5	1409	3098.5
TOTAL, SHEET 1		3162	2297.5	2638.5	6963.1		5234.5	1680	3554.5					23782.	4066	19116
Total,		3704	2550.5	3107	8166.1		5674.5	1820	3858.5				542.5	28289.5	6075	22214.5
Average,		90.34	62.20	75.75	199.17											

DEPARTMEN OF MECHANICAL ENGINEERING.

LOG OF ENGINE TRIAL

LONG-BARNER MILL

No Card	Time	R.P.M.	Area		M.E.P.		I.H.P.		
			H.E.	C.E	H.E	C.E	H.E.	C.E	TOTAL
1	7:30	131	2.20	2.25	22.85	24.32	20.58	21.07	41.56
2	7:45	131	2.20	2.30	22.85	24.85	20.49	21.53	41.92
3	8:00	131	2.29	2.36	23.50	25.50	20.09	22.09	42.08
4	8:15	129	2.29	2.34	23.79	25.30	21.03	21.58	42.62
5	8:30	128	2.33	2.39	23.90	26.16	21.05	22.15	43.20
6	8:45	130	2.25	2.34	23.38	23.64	20.83	20.32	41.15
7	9:00	128	2.46	2.38	2540	25.12	2227	21.31	43.58
8	9:15	129	244	2.46	2535	25.30	2241	21.58	43.99
9	9:30	127	2:39	246	24.75	26.73	21.64	2245	44.09
10	9:45	130	2.37	2.46	24.54	26.90	21.89	23.13	45.01
11	10:00	128	2.28	2.32	23.70	25.59	20.83	21.66	4249
12	10:15	129	2:30	2.32	23.64	2549	21.03	21.75	42.78
13	10:30	130	2.31	2.33	24.31	25.60	21.66	22.00	43.66
14	10:45	129	2.75	2.54	28.70	27.73	25.37	23.65	49.02
15	11:00	127	2.34	2.38	2440	2447	21.24	20.55	41.79
16	11:15	128.5	2.35	2.29	2449	2490	21.57	21.08	42.65
17	11:30	130	2.34	243	2442	2642	21.77	2266	4443
18	11:45	130	2.33	2.30	23.90	25.30	21.29	21.75	43.07
19	12:00	130.5	2.25	2.25	24.60	23.81	22.03	20.54	42.57
20	12:15	131	2.10	2.22	22.30	23.38	19.99	20.25	40.24
21	12:30	131.5	2.15	2.26	22.50	23.70	20.25	20.61	40.87
22	12:45	129	2.17	2.25	22.60	23.81	19.98	20.31	40.29
23	1:00	129	2.18	2.18	22.60	24.24	19.98	20.68	40.66
24	1:15	130	2.15	2.18	2240	23.05	19.93	19.81	39.84
25	1:30	129	2.24	2.25	23.10	2390	20.39	20.39	40.78
26	1:45	130	2.34	223	24.47	23.72	21.78	20.39	42.17
27	2:00	130.5	2.27	2.36	23.58	25.04	21.08	21.61	42.69
28	2:15	129.5	2.30	2.30	2390	24.59	21.18	21.06	42.24
29	2:30	127	2.29	2.30	2391	24.46	20.78	20.54	41.32
30	2:45	130	227	2.28	23.76	24.38	21.14	20.96	42.10
31	3:00	128	2.24	2.30	23.30	24.60	20.58	20.82	41.40
32	3:15	130	2.24	2.31	23.30	2484	20.73	21.35	42.08
33	3:30	129	2.25	2.35	25.92	25.06	22.88	21.38	44.26
34	3:45	132	2.22	2.22	23.72	23.60	21.43	20.62	42.05
35	4:00	130	223	2.27	2298	24.14	2045	20.75	41.20
TOTAL		4531.5	80.11	81.15	908.66	869.45	741.62	745.38	1487.00

DEPARTMENT OF MECHANICAL ENGINEERING

LOG OF ENGINE TRIAL

Card No.	Time	R.P.M.	AREA		M.E.P.		I.H.P.		
			H.E.	C.E.	H.E.	C.E.	H.E.	C.E.	TOTAL
36	4:15	130	2.13	2.11	21.95	22.81	19.56	19.59	39.15
37	4:30	130	2.15	2.10	22.32	22.69	19.89	19.51	39.40
38	4:45	128	2.16	2.14	22.42	23.13	19.67	19.58	39.25
39	5:00	130	2.20	2.17	23.20	23.45	20.67	20.16	40.83
40	5:15	129	2.35	2.19	24.40	23.67	21.57	20.19	42.76
41	5:30	128	2.33	2.18	24.36	23.56	21.37	19.95	41.32
TOTAL FOR SHEET 2		775	13.32	12.89	138.67	139.31	122.73	118.98	242.73
TOTAL FOR SHEET 1		4531.5	80.11	81.15	908.66	869.54	741.62	745.38	1487.00
TOTAL		5306.5	93.43	94.05	1047.33	1008.85	864.35	863.36	1729.73
AVERAGE		129.42	2.28	2.29	25.54	24.61	22.13	21.05	43.18

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

MADE AT MANHATTAN, KAN.
ON LONG-BARNER MILL
DATE MAY, 28, 1907
BAROMETER 28.05 IN 14.26 LBS.

PRIMING LOG.

THROTTLING CALORIMETER.

OBSERVERS:

No.	Time.	Pressure in Steam Pipe. Gage.	Pressure in Steam Pipe. Abs. p_1	Heat of Liquid. q	Heat of Vaporization. r	Calorimeter Pressure. Gage.	Calorimeter Pressure. Abs. p	Total Heat. λ_1	Temperature Calorimeter. Corresponding to Pressure p_1 t_1	Temperature Calorimeter. By Thermometer. t_s	Degree of Superheat. $t_s - t_1$	Quality of Steam. x	Remarks.
1	7:38	88	102.26			2.00	16.26			212			
2	8:03	90	104.26			3.00	17.26			213			
3	8:30	89	103.26			2.40	16.66			213			
4	9:00	93	107.26			4.50	18.76			220			No SUPER HEAT
5	9:30	90	104.26	301.08	881.67	4.00	18.26	1150.03	223.13	232	8.87	96.77	
6	10:00	90	104.26	301.08	881.67	3.95	18.21	1150.00	222.99	230	7.01	96.67	
7	10:30	90	104.26	301.08	881.97	4.00	18.26	1150.00	223.13	230	6.87	96.63	
8	11:02	90	104.26	301.08	881.67	4.50	18.76	1150.40	224.55	244	19.45	97.39	
9	11:30	90.5	104.76	301.43	881.42	4.50	18.76	1150.40	224.55	252	27.45	97.82	
10	12:00	90.5	104.76	301.43	881.42	4.10	18.36	1150.11	223.42	248	24.58	97.68	
11	12:30	90	104.26	301.08	881.67	4.15	18.41	1150.17	223.56	246	22.44	97.53	
12	1:00	90	104.26	301.08	881.67	4.30	18.56	1150.30	223.99	249	25.01	97.68	
13	1:30	90	104.26	301.08	881.67	4.25	18.51	1150.26	223.85	248	25.15	97.71	
14	2:00	90	104.26	301.08	881.67	4.20	18.46	1150.21	223.71	248	24.29	97.64	
15	2:30	90	104.26	301.08	881.67	4.30	18.56	1150.30	223.99	247	23.01	97.57	
16	3:00	86	100.26	298.10	883.90	4.42	18.68	1150.41	224.33	246	21.67	97.52	
17	3:30	90	104.26	301.08	881.67	4.10	18.36	1150.11	223.42	246	22.58	97.53	
18	4:00	90	104.26	301.08	881.67	4.00	18.26	1150.03	223.13	248	24.87	97.65	
19	4:30	89	103.26	300.31	882.24	4.10	18.36	1150.11	223.42	254	30.58	97.98	
20	5:00	93	107.26	303.21	880.24	4.30	18.56	1150.30	223.99	250	26.01	97.66	
21	5:30	91	105.26	301.78	881.17	4.60	18.86	1150.57	224.84	248	23.16	97.59	

123456

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

MADE AT LONG-BARNER MILL

ON /

DATE MAY 28, 1907

PRIMING LOG.

(SEPARATING CALORIMETER.)

OBSERVERS:

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	7:30	7:40	1.5	3.375	1.875	283 - 0	290 - 8	7 - 8	98.70	
2	8:00	8:10	.25	2.625	2.375	267 - 6	276 - 4.5	8 - 11.5	98.50	
3	8:30	8:40	.128	2.5	2.375	263 - 8	272 - 4	8 - 12	98.52	
4	9:00	9:10	.75	2.75	2.00	253 - 0	260 - 8	7 - 8	98.30	
5	9:30	9:40	1.00	3.5	2.50	251 - 1	260 - 0	8 - 15	98.27	
6	10:00	10:10	0.	3.375	3.375	253 - 8	264 - 5	10 - 13	98.00	
7	10:30	10:40	.75	2.62	1.875	252 - 5	257 - 15	5 - 10	98.12	
8	11:00	11:10	.75	2.75	2.00	253 - 0	259 - 4	6 - 4	98.03	
9	11:30	11:40	1.125	3.625	2.50	255 - 6	263 - 0	7 - 10	97.99	
10	12:00	12:10	.25	2.75	2.50	253 - 6	261 - 12	11 - 6	98.75	
11	12:30	12:40	.125	2.75	2.625	254 - 6	257 - 10	3 - 4	95.20	
12	1:00	1:10	.125	2.75	2.625	255 - 15	259 - 9	3 - 10	95.62	
13	1:30	1:40	.25	2.75	2.50	250 - 2	255 - 2	5 - 0	97.03	
14	2:00	2:10	1.875	4.75	2.875	253 - 14	260 - 3	6 - 5	97.46	
15	2:30	2:40	1.75	4.62	2.875	250 - 11	262 - 0	11 - 5	98.51	
16	3:00	3:10	0.	3.5	3.5	250 - 0	264 - 8	14 - 8	98.52	
17	3:30	3:40	.562	3562	3.00	256 - 13	270 - 14	14 - 1	98.68	
18	4:00	4:10	0.	3.125	3.125	251 - 13	265 - 14	14 - 1	98.63	
19	4:30	4:40	1.00	3.75	2.75	239 - 0	251 - 13	12 - 13	98.69	
20	5:00	5:10	.875	2.75	1.875	252 - 10	259 - 8.5	6 - 14.5	98.22	
21	5:25	5:35	.75	3.75	3.00	263 - 2	272 - 10	10 - 8	98.25	
		TOTAL	13.815	67.985	53.125			185 - 3	2058.	
		AVERAGE	.658	3.237	2.53			8 - 13	98.20	