

SOUTHERN PACIFIC COMPANY

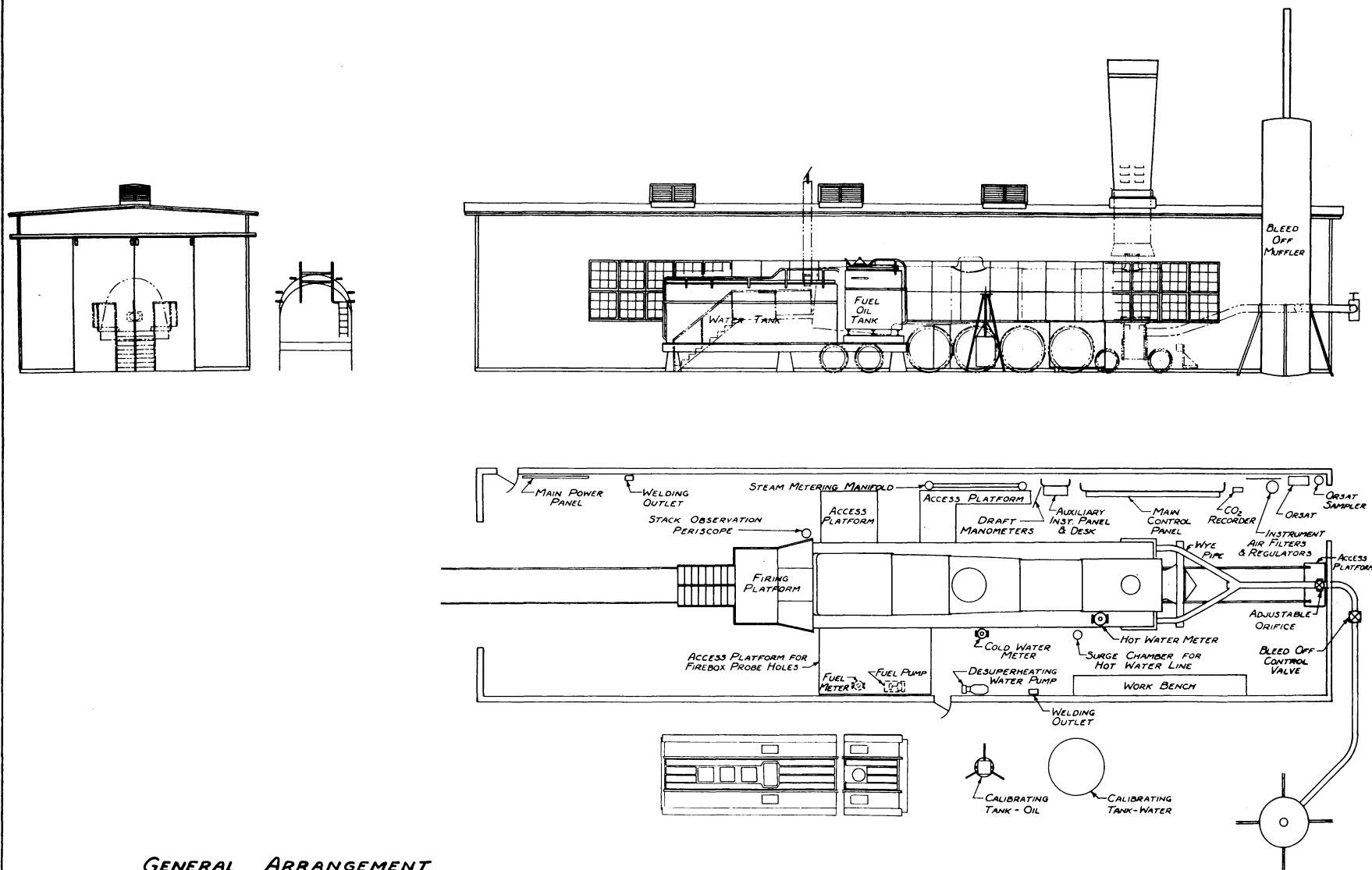
DESCRIPTION OF SACRAMENTO LOCOMOTIVE STANDING TEST PLANT

SACRAMENTO, CALIFORNIA

**San Francisco, Calif.
November 15, 1950.**

Report No. ST

Fig. 1



GENERAL ARRANGEMENT
OF
STANDING LOCOMOTIVE TEST PLANT
SACRAMENTO, CALIF.

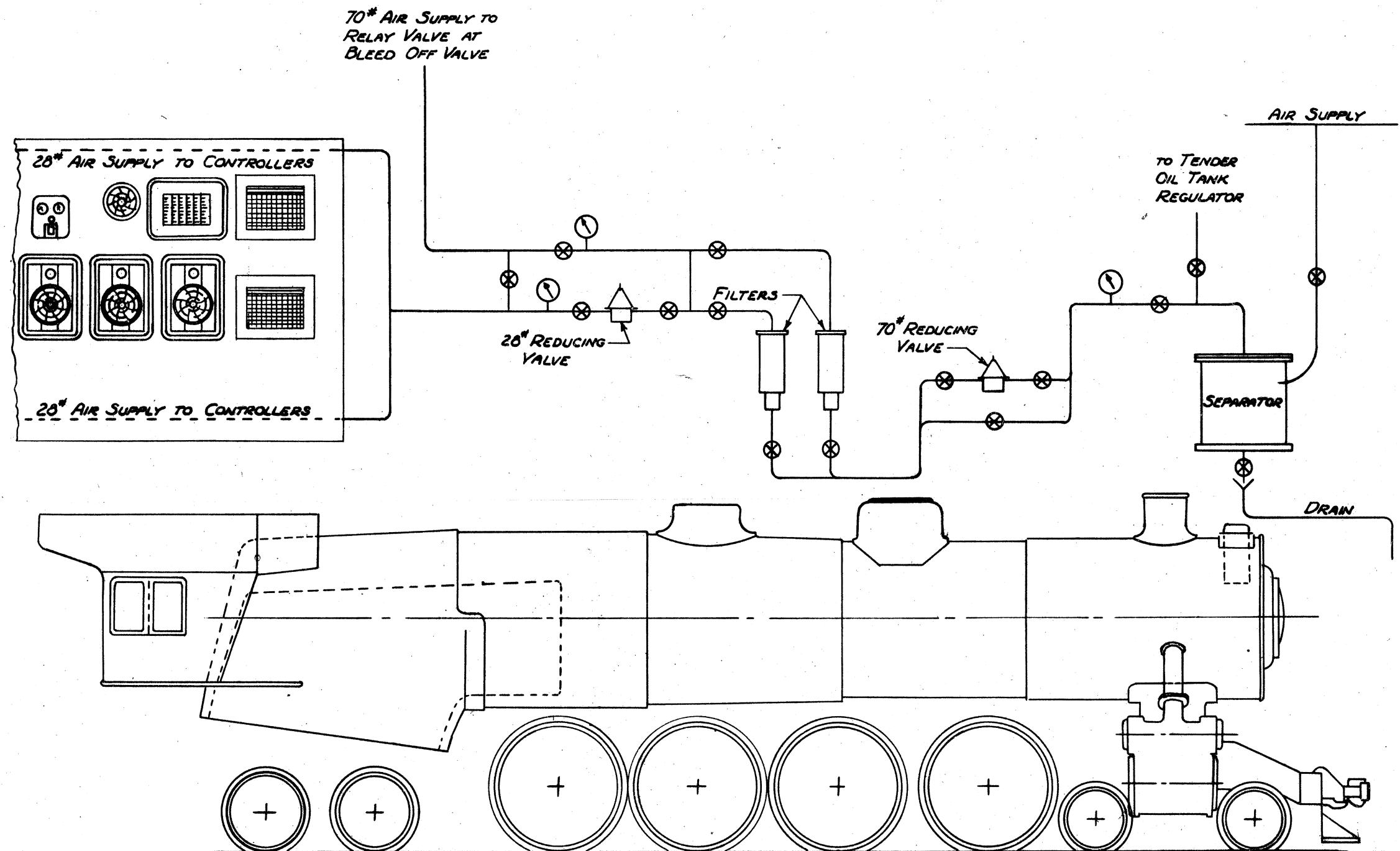


FIG.2A AIR SUPPLY FOR CONTROL INSTRUMENTS

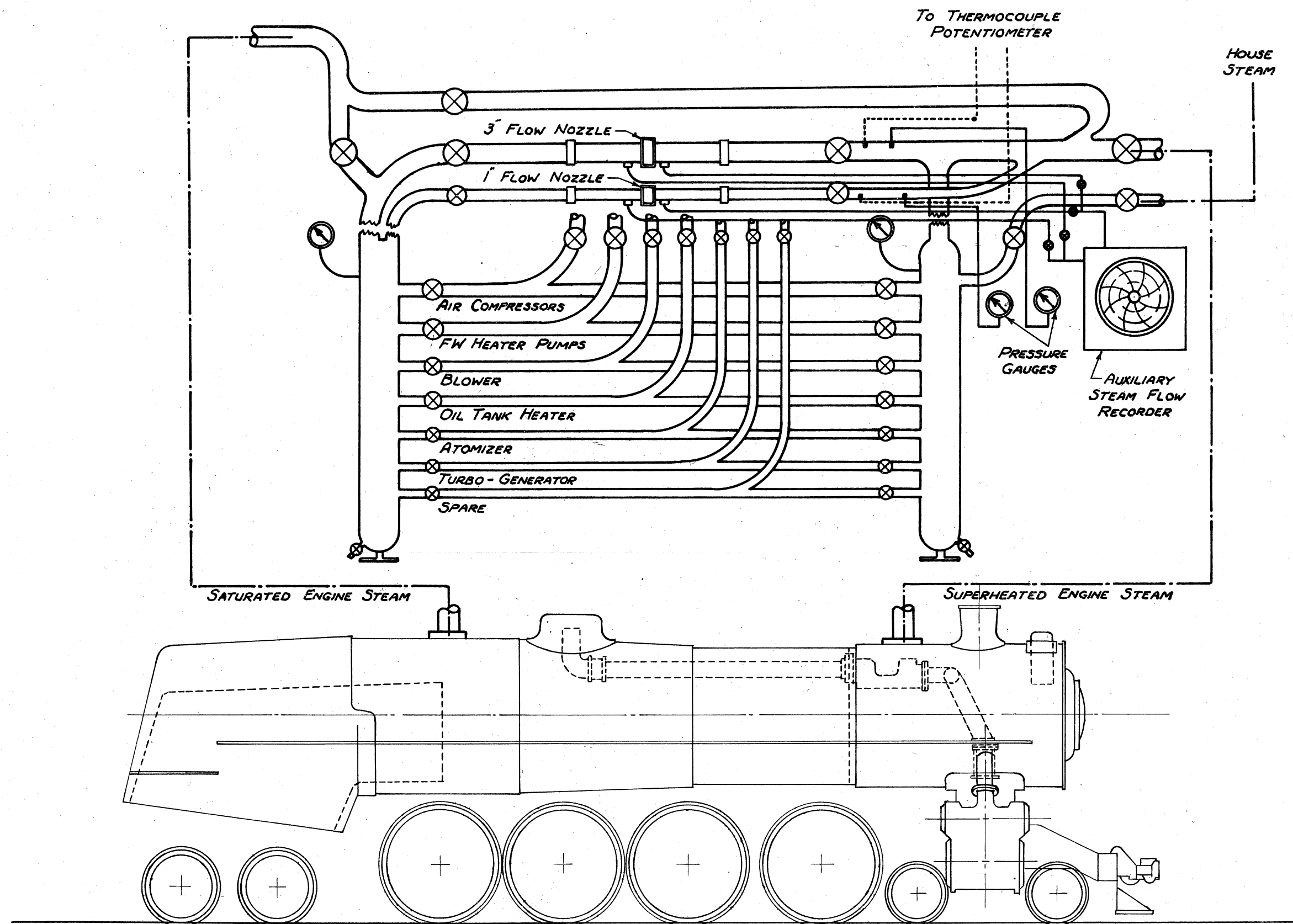


FIG. 3 AUXILIARY STEAM METERING MANIFOLD

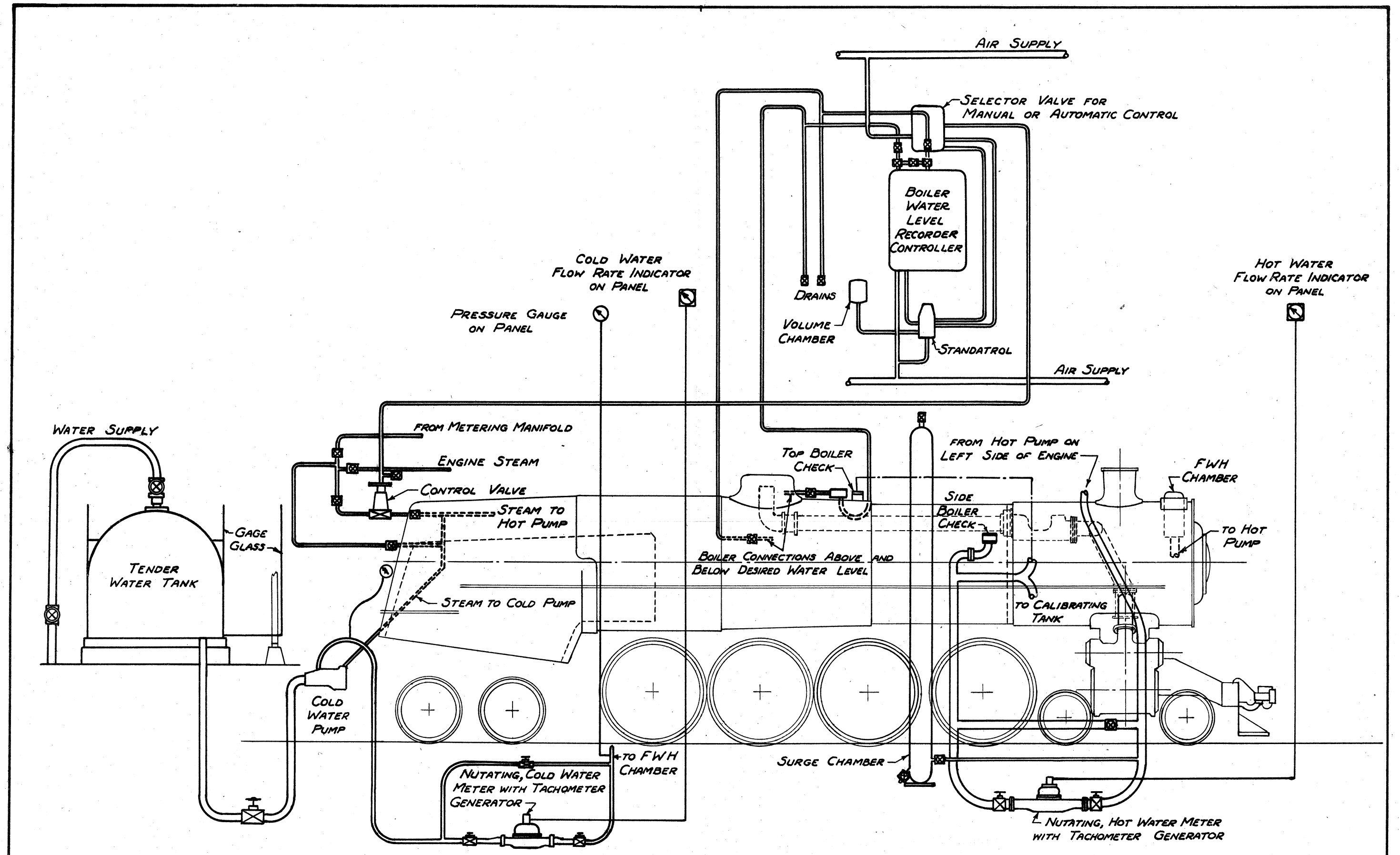


FIG. 4 WATER LEVEL & FEEDWATER CONTROL SYSTEM

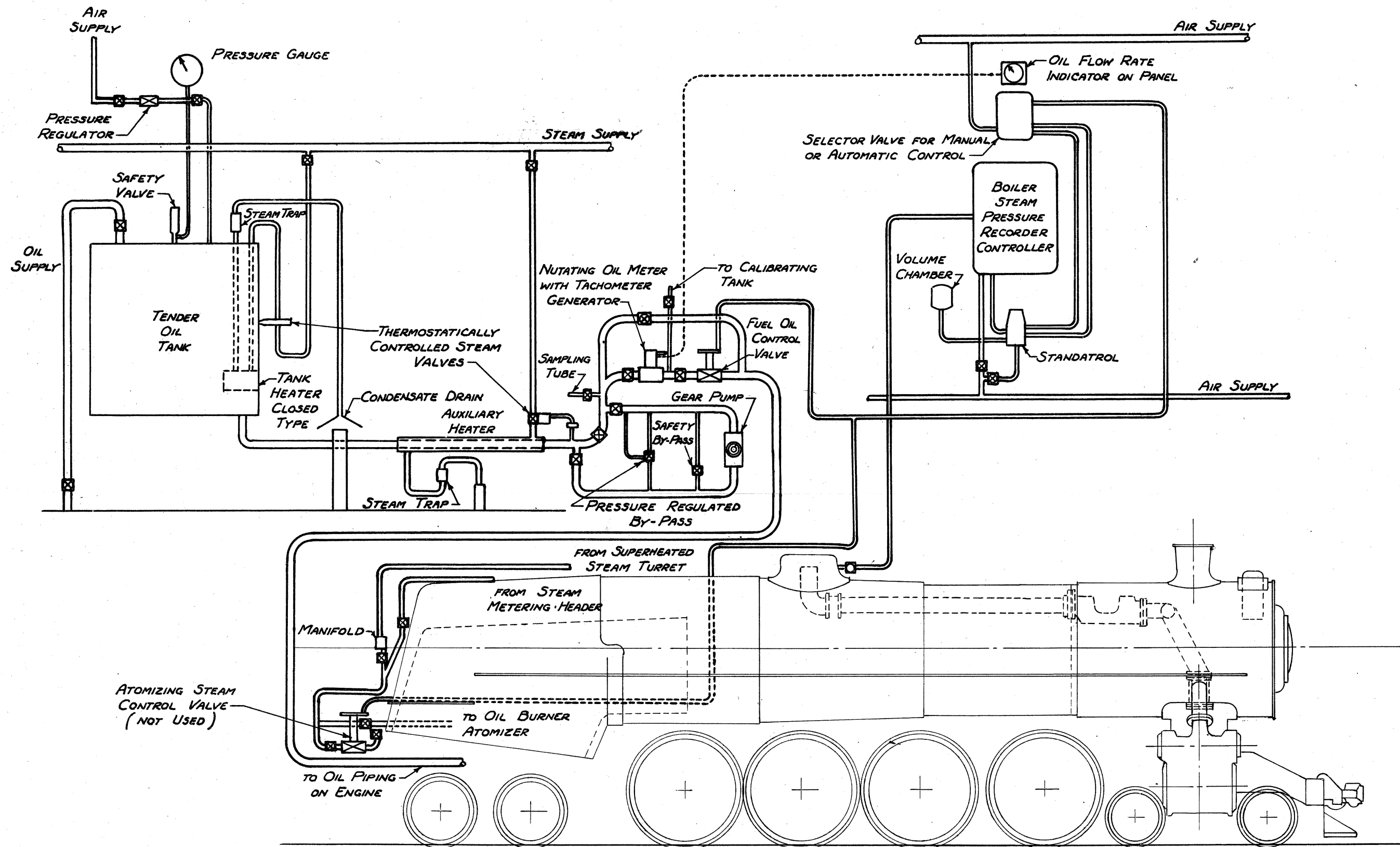


FIG.5 FUEL OIL CONTROL SYSTEM

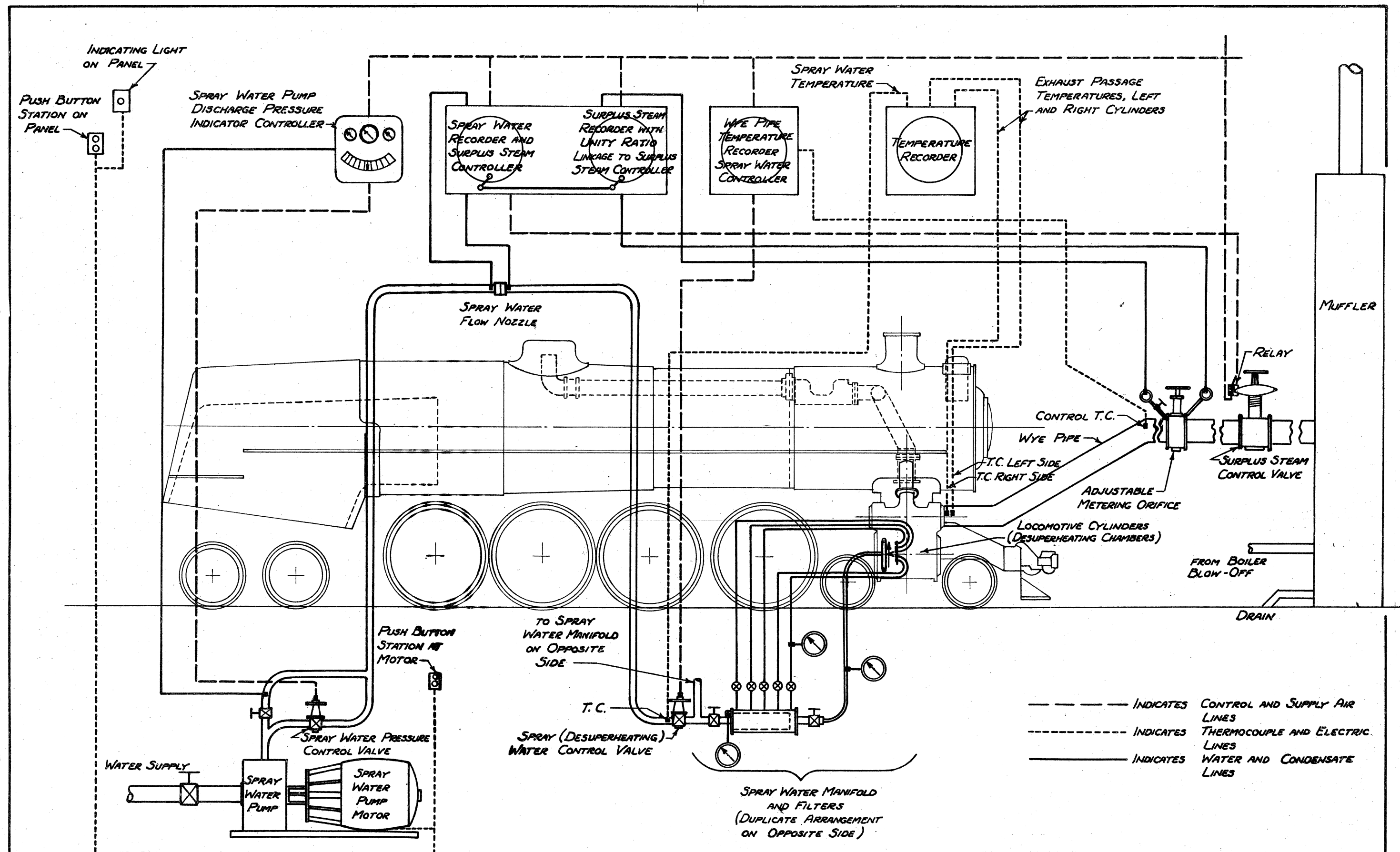
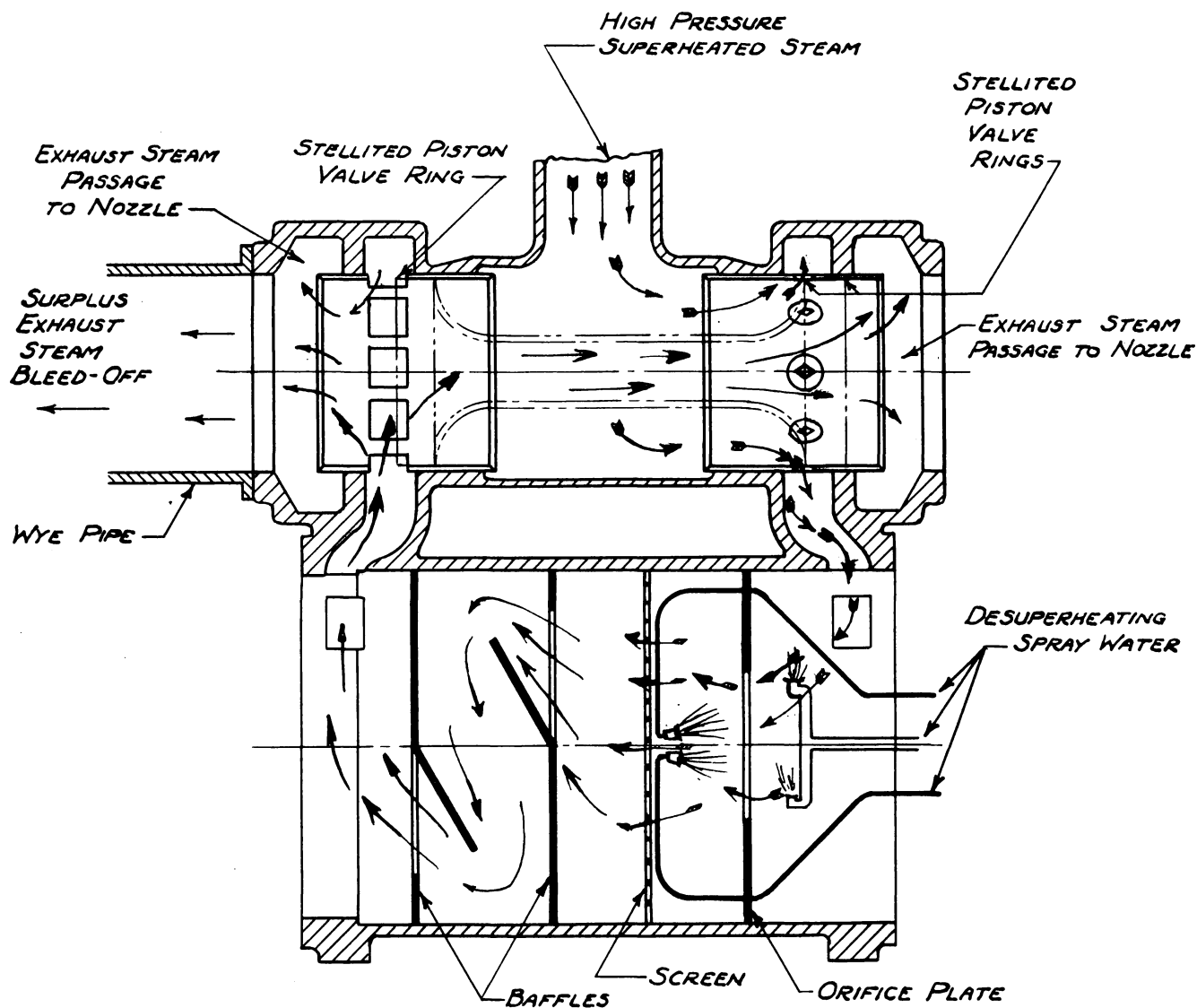


FIG. 6 EXHAUST STEAM CONTROL SYSTEM



**FIG. 6A STEAM FLOW THROUGH
DESUPERHEATING SYSTEM**

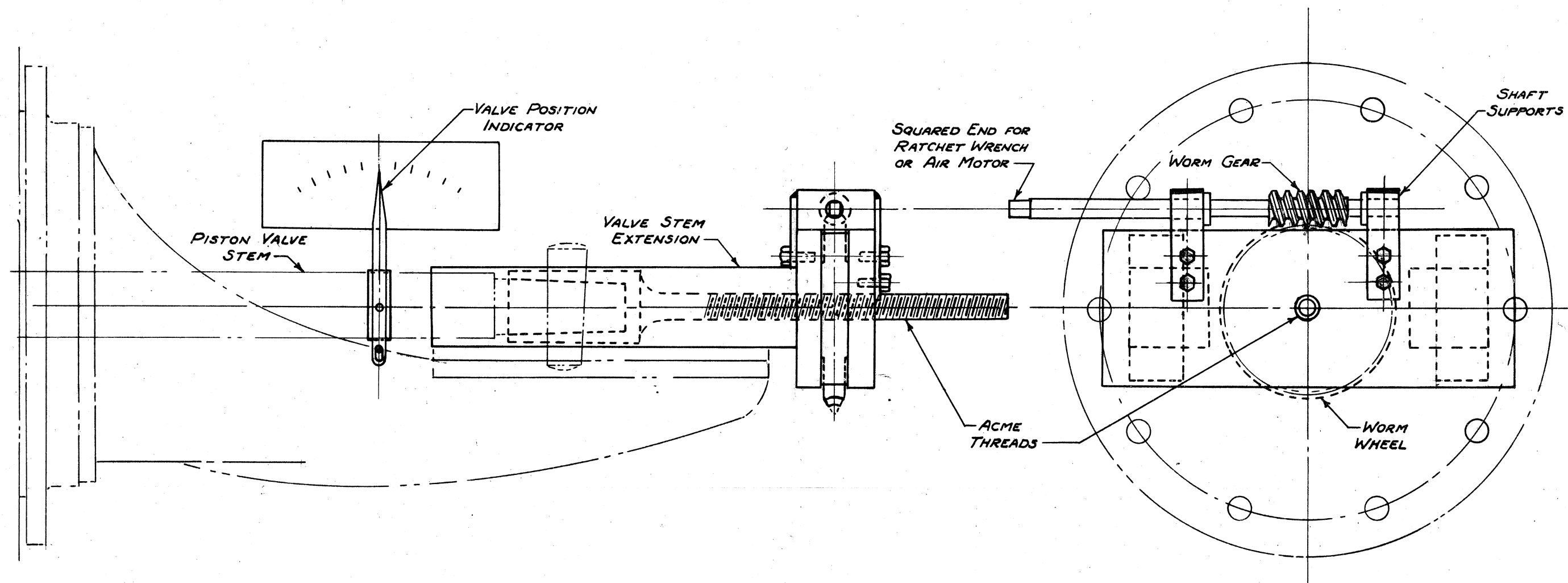


FIG. 6B MAIN VALVE POSITIONING DEVICE

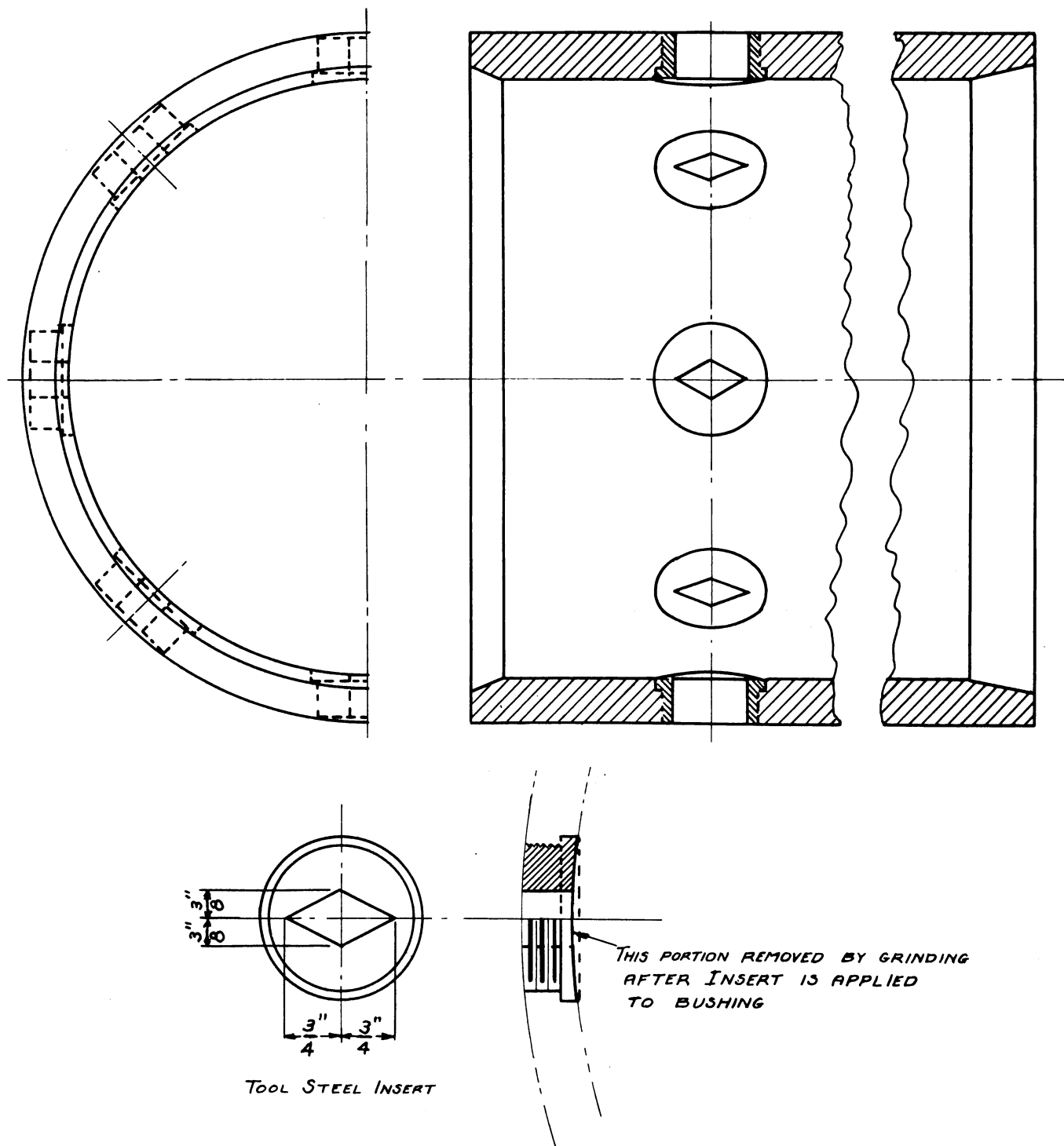


FIG. 6c SPECIAL REAR MAIN VALVE BUSHING

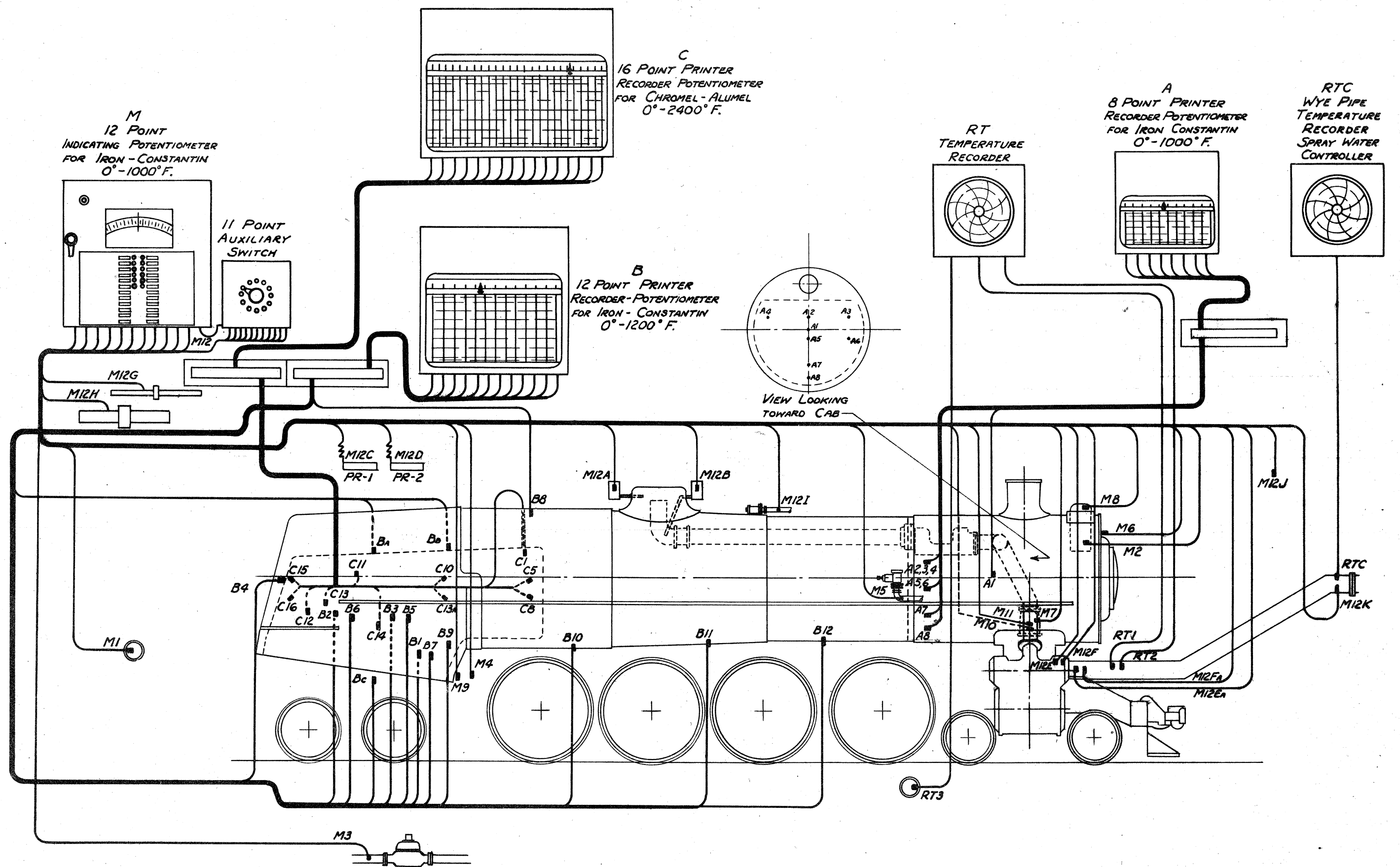


FIG. 7 TEMPERATURE MEASURING ARRANGEMENT

8 Point, Brown Elektronik, Flue Gas Temperature Recorder

A-1 In smokebox, on boiler center line near nozzle
A-2 to) In smokebox, near front tube sheet as shown on
A-8 incl) sketch

12 Point, Brown Elektronik, Boiler Sheet Temperature Recorder

B-1 Fireside Left Side Sheet behind Firebrick
B-2 Water Side Left Side Sheet, Rear
B-3 " " " " " , Front
B-4 " " Door Sheet, Center line above Door
B-5 " " Right Side Sheet, Front
B-6 " " " " " , Rear
B-7 Fireside Right Side Sheet, behind Firebrick
B-8 Shell, Top Centerline, Third Course (Main Ref. Point)
B-9 Fireside, Centerline Throat Sheet behind Firebrick
B-10 Shell, Bottom Centerline, Third Course
B-11 " " " " , Second Course
B-12 " , " " " , First Course

B-a (Alternate) Water Side, Crown Sheet, Forward
B-b (") " " " " , Rear
B-c (") Continuous Blow-down Pipe Line

16 Point, Brown Elektronik Firebox Temperature Recorder

C-1 14" Combustion Chamber Probe, Top, near Tube Sheet
C-2, C-3, C-4 - Spares
C-5 14" Combustion Chamber Probe, Left Side, near Tube Sheet
C-6, C-7 - Spares
C-8 14" Combustion Chamber Probe, Right Side, near Tube Sheet
C-9 - Spares
C-10 Fireside of Left Side Sheet, Front
C-11 Fireside of Left Side Sheet, Rear
C-12 " " " " " " ,
C-13 " " " " " " ,
C-13-A " " " " " " , Front
C-14 " " " " " " , Center
C-15 Fireside of Door Sheet above Door
C-16 Fireside of Door Sheet left of Door

Brown Elektronik, Push button Type Indicating Pyrometer.

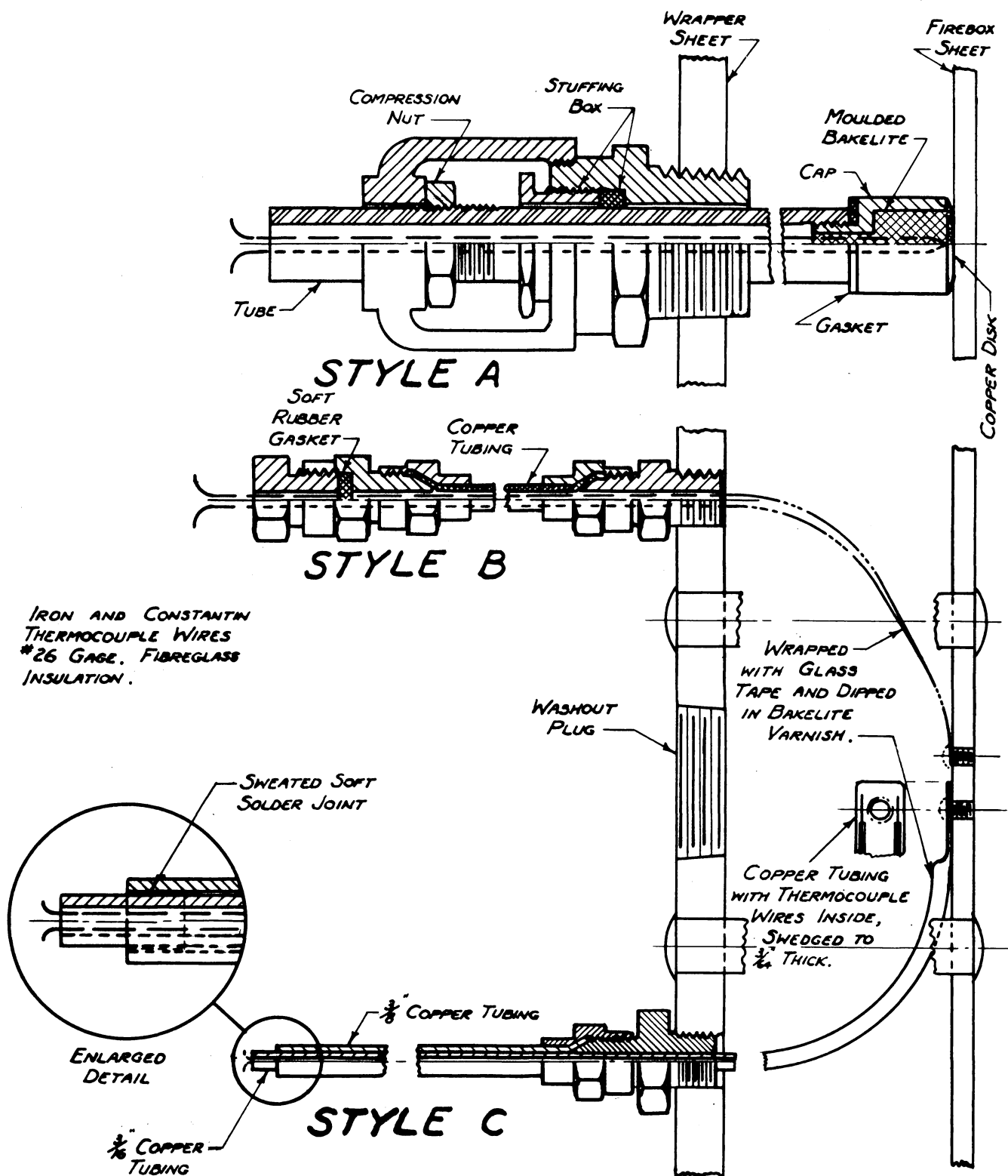
<u>Designation</u>	<u>Purpose & Location</u>
M-1	Tender Water
M-2	Water to FWH Chamber
M-3	Fuel Oil at Meter
M-4	Fuel Oil at Burner
M-5	Feedwater at Side Check
M-6	Hot Water from FWH Chamber
M-7	Exhaust Steam at Nozzle
M-8	Exhaust Steam in FWH Chamber
M-9	Atomizer Steam at Burner
M-10	Left Steam Pipe
M-11	Right Steam Pipe
M-12	To Auxiliary Selector Switch
M-12-A	Calorimeter at Dome
M-12-B	Calorimeter at Dry Pipe
M-12-C	Aspirating Probe at Firebox PR-1, Platinum - Platinum 10% Rhodium
M-12-D	Aspirating Probe at Firebox PR-2, Pt-Pt, 10%Rh
M-12-E	Exhaust Passage - Left Side
M-12-EA	Wye Pipe - Left Side (Alternate)
M-12-F	Exhaust Passage - Right Side
M-12-FA	Wye Pipe - Right Side (Alternate)
M-12-G	1" Steam Flow Nozzle
M-12-H	3" Steam Flow Nozzle
M-12-I	Feedwater at Top Check
M-12-J	Spare
M-12-K	Bleed-Off Steam in Wye Pipe

3 Pen Bailey Pyrotron Temperature Recorder

RT-1	Steam in Right Leg of Wye Pipe
RT-2	Steam in Left Leg of Wye Pipe
RT-3	Water to Desuperheating Sprays

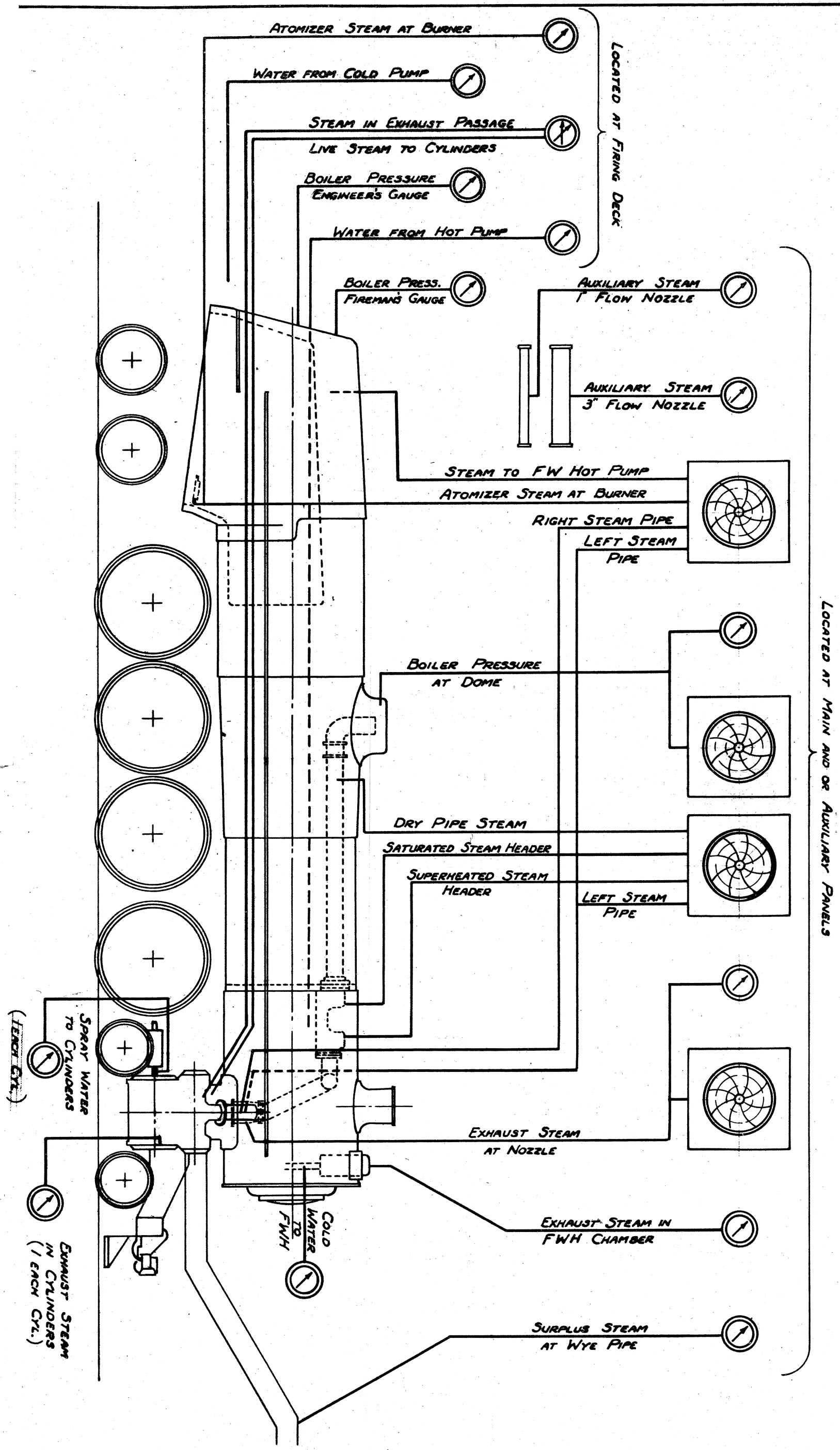
1 Pen Bailey Pyrotron Temperature Recorder - Controller

RT-C	Steam in Wye Pipe at Junction
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**FIG. 7B THERMOCOUPLE DESIGNS
FOR FIREBOX SHEET TEMPERATURES**

FIG. 8 PRESSURE MEASURING ARRANGEMENT



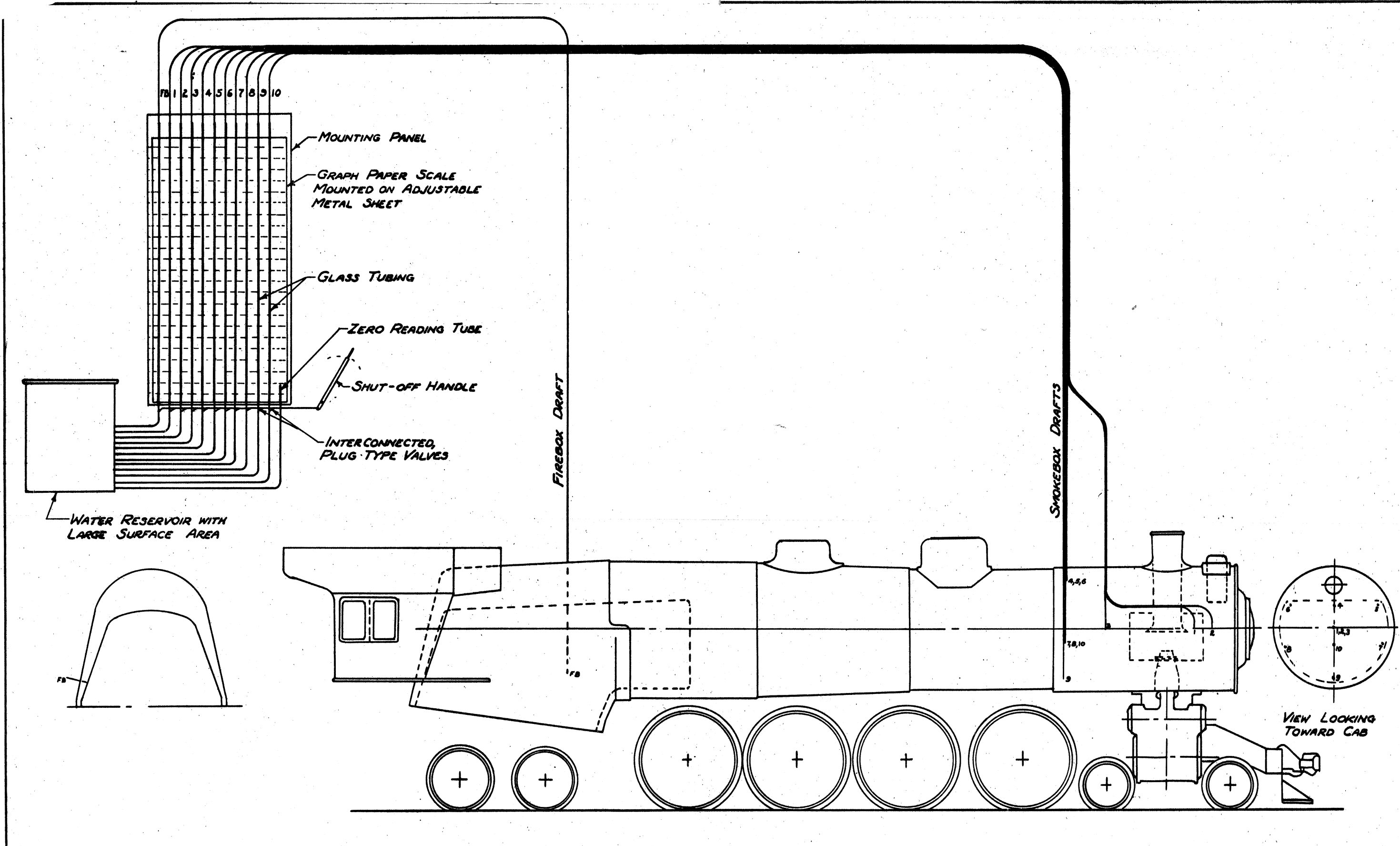


FIG.9 DRAFT MEASUREMENT ARRANGEMENT

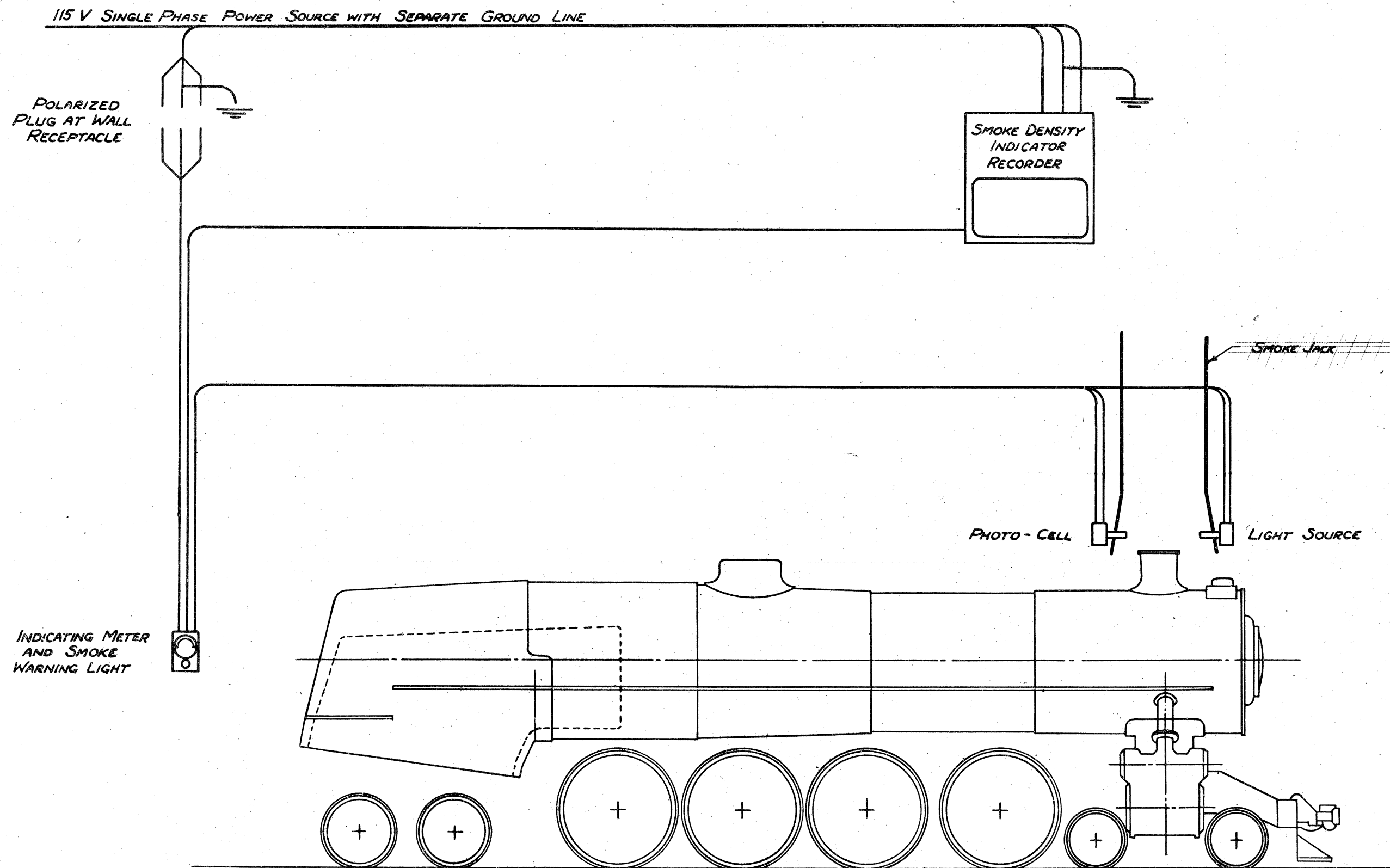


FIG. 10 SMOKE MEASURING ARRANGEMENT

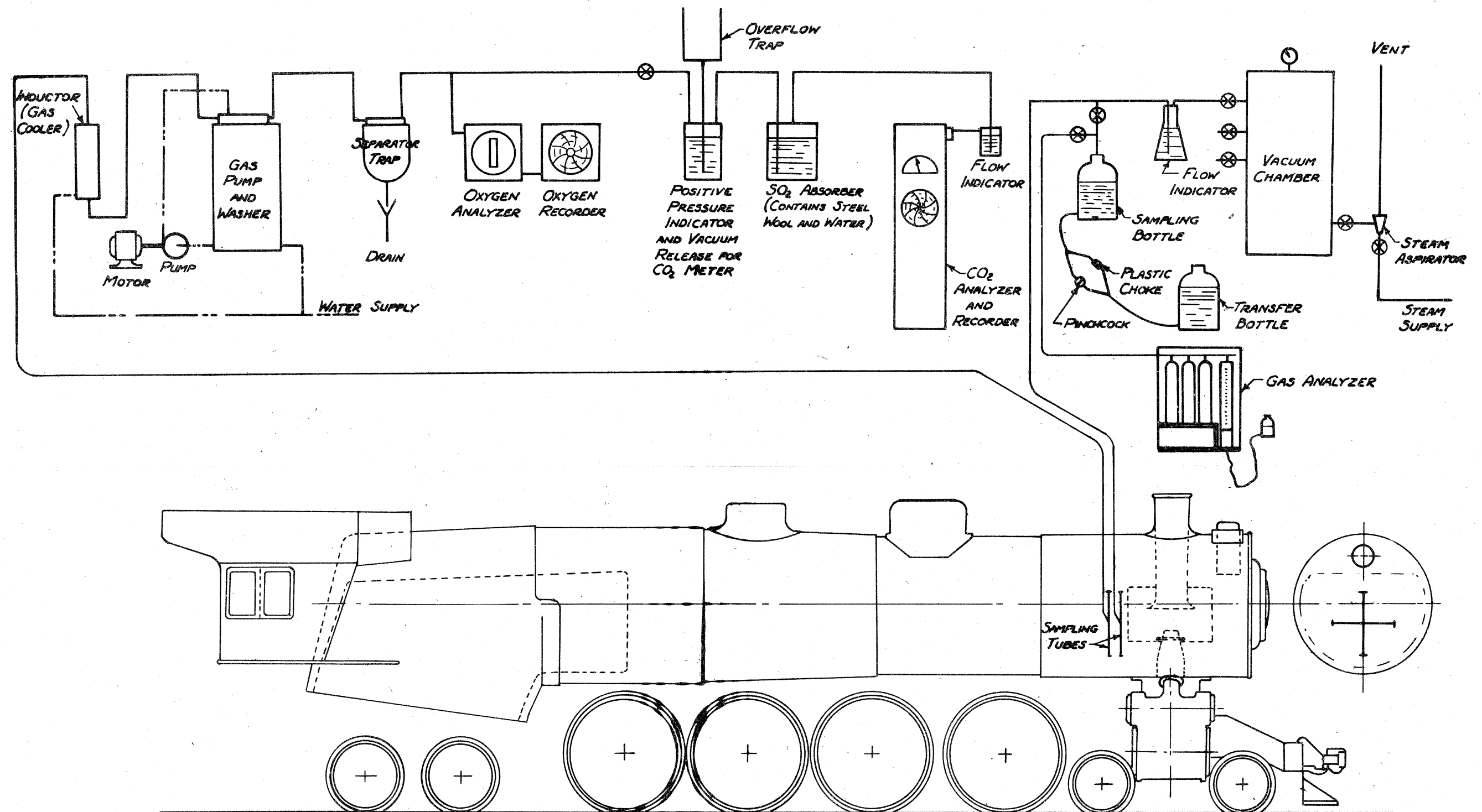


FIG. 11 GAS ANALYSIS ARRANGEMENT

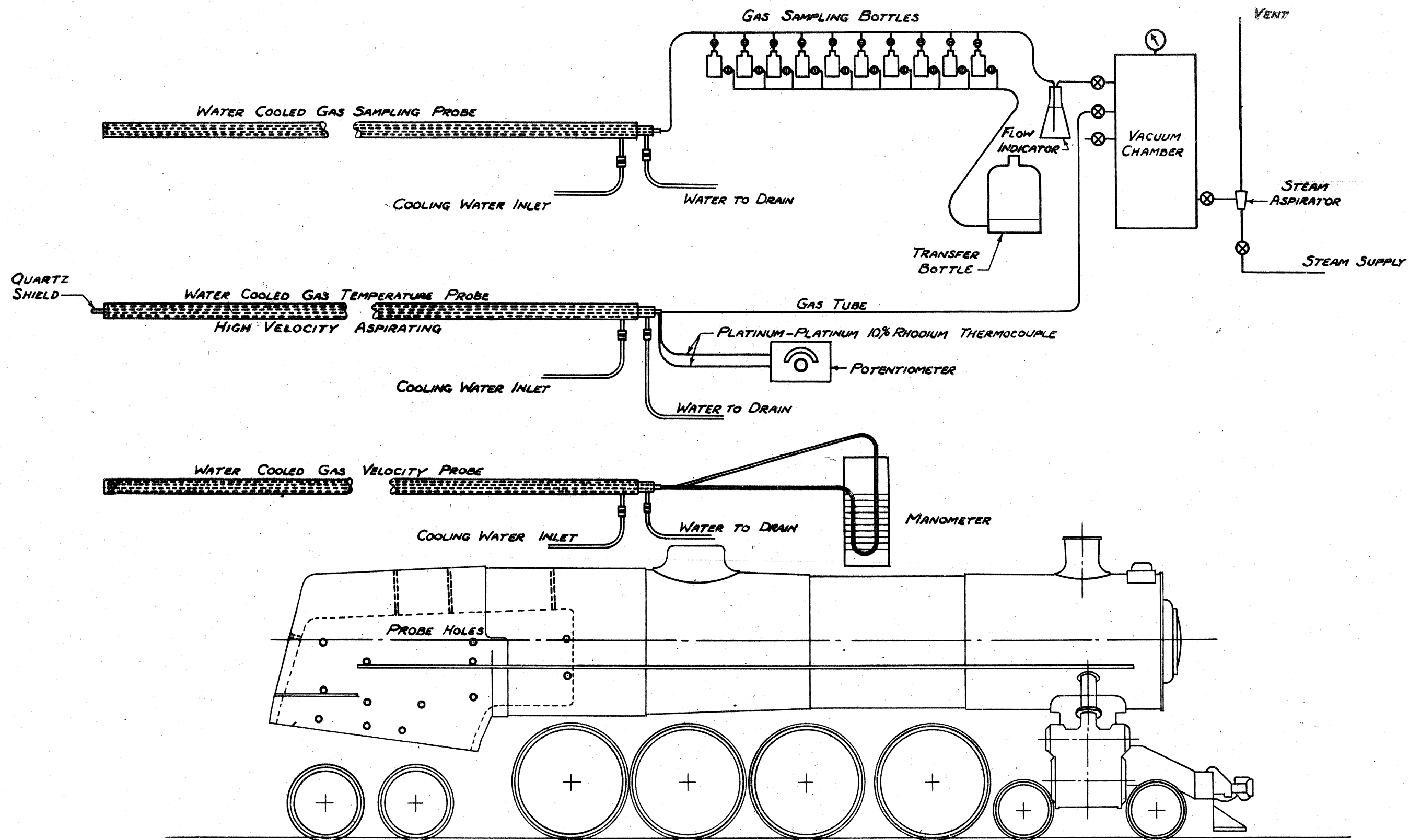


FIG. 12 FIREBOX SURVEY EQUIPMENT

1-50

LABORATORY REPORT

L-4371

Analysis No. _____ Date Recd. **5-18-49** Assigned **E.B. St.C.**

Material **Fuel oil from Standing Tests**

From **Engine 4401** Reqn. & Order No. _____

Insp. Rept. No. _____ Car No. _____ Date Completed **5-18-49**

Analysis shows: **Gravity °API** **9.0**

Moisture, % **1.26**

Density, lbs/gal. **8.388**

Heat Value dry, BTU/lb. **18,220**

Note: Heat Value calculated from: $17680 \div (60 \times ^\circ\text{API})$

Fig. 13

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES BI-T10-D RATE 4 PSIGLog Kept by L. S. B.DATE MAY 18, 1944

DESCRIPTION OF TEST ARRANGEMENT

- 1 Nozzle Dia. 8 in. Cross Split 1/2" x 3" BASKET BRIDGE
- 2 Stack Dia. 20 in. Location STANDARD Height 13 1/2 in.
- 3 Spark Arrestor BASKET Sand Exhauster NONE
- 4 Style Fire Pan T + NO Modifications 6 MAIN COEN BURNERS,
- 5 90° CENTRAL L; 2 COEN PILOT BURNERS, 60° CENTRAL L; AND
- 6 BOTTOM DRAFT CHUTE FOR MAIN BURNERS.
- 7 Damper positions and special conditions of this test END DAMPER 3 LINKS =
- 8 1 1/4" OPEN.
- 9
- 10 Other data PEEP HOLES DRILLED IN SIDE PLATES TO CHECK BURNERS.
- 11 TOP BOILER CHECK USED. NO SHIELDS ON MAIN BURNERS.
- 12 Atomizer Pressure 100 LBS. - MAIN; 100 LBS. - PILOT Fuel Oil Pressure 90 LBS AT PUMP

FUEL AND WATER DATA

Time	FUEL OIL		HOT WATER		COLD WATER	
	Observer	L. S. B.	Observer	L. F. B.	Observer	H. Q.
	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.
1 10:10	558549.19		683126		701935	
2 10:25	558653.00	103.81	684457	1331	703114	1179
3 10:40	558755.18	102.18	685759	1302	704265	1151
4 10:55	558858.17	102.99	687082	1323	705437	1172
5		308.98		3956		3502
6						
7						
8						
9						
10						

11 Fuel Oil Data: Lbs./gal. at 60° _____ Heat Value _____ B.T.U./lb. Moisture _____ %

12 Observations during tests:

13 Stack color CLEAR = 0.05 RINGELMANN.14 Fire, (drumming etc.) QUIET. CLEAR FIRE.

15 Carbon _____

16 Others _____

17 _____

18 _____

19 _____

20 _____

21 _____

22 _____

23 _____

24 _____

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27 _____

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29 _____

STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES B1-T10-D RATE 4 PSIG

Operators Name ELLIOTTDate MAY 18, 1949

ITEM No.		303	313	314	304	303A	3088	309	312	307	307A	311	311A		
		TEMPERATURES, DEGREES F.													
Time		Water from Tender	Water into F.W.H.	Fuel oil at Meter	Fuel oil at Burner	Boiler Feed at Check	Water from F.W.H.	Exh. Sm at Stand	Steam in F.W.H.	Atom-izer Steam	Left Main Steam Pipe	Right Main Steam Pipe	Exh. Pass. Left	Exh. Pass. Right	Y Pipe
		1	2	3	4	5/12A	6	7	8	9	10	11	12-E	12-F	12-K
1	10:10	65	66	175	177	200	198	280	281		587	590	270	290	282
2	10:15	66	66	177	179	197	195	284	283		582	586	275	294	286
3	10:20	66	66	177	179	197	193	284	284		582	586	274	294	286
4	10:25	66	66	175	178	199	199	283	283		581	584	272	292	285
5	10:30	65	65	174	177	200	197	283	284		580	583	276	294	285
6	10:35	65	65	174	176	198	199	284	284		579	582	275	294	285
7	10:40	65	65	173	175	198	200	283	284		578	582	273	293	285
8	10:45	65	65	175	177	198	201	288	287		578	582	285	293	287
9	10:50	65	66	175	177	197	196	289	288		580	583	284	292	287
10	10:55	65	65	172	175	199	199	289	288		580	583	285	292	287
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13	Ave	65	66	175	177	198	198	285	285		581	584	277	293	286
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34	Nozzle	30	#	-286°											
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FIG. 15

STANDING TEST PLANT - SACRAMENTO

ENGINE No. 4401, TEST SERIES BI-TIO-D RATE 4 PSIG

Operator's Name M. MANNERINGDate MAY 18, 1949

ITEM No.	203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—	—
Time	PRESSURES, LBS. Sq. In., Gage				DRAFTS, INCHES OF WATER											
	Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Steam at Nozzle	Firebox	Inside Arrester	Ahead of Arrester	Behind Arrester	SMOKE BOX							
	A	B	C	D	FB	1	2	3	Top Center	Left Top	Right Top	Left Top	Right Top	Bottom Center	Center 1/2 UP	
1 10:10	246	2.5	3.2	3.0	5.5	7.5	7.5	7.6	7.4	7.4	7.6	7.5	7.5	7.6	7.7	
2 10:15	246	2.5	4.2	3.0	5.8	7.7	7.5	7.7	7.7	7.7	7.8	7.6	8.0	7.9	7.8	
3 10:20	246	2.5	4.2	3.2	5.8	7.8	7.8	7.8	7.8	7.9	7.8	7.8	8.0	7.9	7.8	
4 10:25	246	2.5	4.2	3.2	5.8	7.8	7.8	7.7	7.7	7.7	7.8	7.7	7.8	7.8	7.8	
5 10:30	244	2.5	4.2	3.2	5.8	7.7	7.7	7.7	7.7	7.6	7.8	7.6	7.7	7.7	7.7	
6 10:35	244	2.5	4.2	3.2	5.7	7.6	7.0	7.6	7.6	7.6	7.7	7.6	7.7	7.6	7.7	
7 10:40	242	2.2	4.2	3.0	5.6	7.6	7.0	7.0	7.0	7.6	7.6	7.6	7.7	7.6	7.6	
8 10:45	244	2.2	4.2	3.2	5.8	7.6	7.7	7.7	7.7	7.7	7.8	7.6	7.8	7.8	7.8	
9 10:50	244	2.0	4.2	3.2	5.8	7.7	7.7	7.7	7.7	7.6	7.8	7.0	7.9	7.8	7.8	
10 10:55	244	2.5	4.2	3.0	5.6	7.7	7.8	7.0	7.4	7.7	7.0	7.6	7.7	7.8	7.8	
11																
12																
13 AVE.	245	2.4	4.1	3.1	5.7	7.7	7.6	7.6	7.6	7.7	7.7	7.6	7.8	7.8	7.8	
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STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B1-T10-D RATE 7 PSIGLog Kept by L. S. B.DATE MAY 18, 1949

DESCRIPTION OF TEST ARRANGEMENT

- 1 Nozzle Dia. 8 in. Cross Split 1/2"x3" BASKET BRIDGE
- 2 Stack Dia. 20 in. Location STANDARD Height 13 1/2 in.
- 3 Spark Arrestor BASKET Sand Exhauster NONE
- 4 Style Fire Pan T & NO Modifications 6 MAIN COEN BURNERS,
- 5 90°L; 2 PILOT BURNERS, 60°L; BOTTOM DRAFT CHUTE & DAMPER FOR
- 6 MAIN BURNERS
- 7 Damper positions and special conditions of this test OPEN 3 LINKS AT START.
- 8 CHANGED TO #4 LINK = 1 1/4" OPEN.
- 9
- 10 Other data OIL PRESSURE TO MAIN BURNERS, 27 LBS.
- 11 TOP BOILER CHECK
- 12 Atomizer Pressure 140 LBS. - MAIN; 80 LBS. - PILOT Fuel Oil Pressure 88 LBS AT PUMP

FUEL AND WATER DATA

Time	FUEL OIL		HOT WATER		COLD WATER	
	Observer	L. S. B.	Observer	L. F. B.	Observer	A. Q.
	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.
1 11:30	559160.57		690756		708652	
2 11:45	559297.02	136.45	692449	1693	710134	1482
3 12:00	559433.26	136.24	694175	1726	711646	1512
4 12:15	559568.78	135.52	695863	1688	713124	1478
5		408.21		5107		4472
6						
7						
8						
9						
10						

11 Fuel Oil Data: Lbs/gal. at 60° _____ Heat Value _____ BTU/lb. Moisture _____ %

12 Observations during tests:

13 Stack color CLEAR = 0.05 RINGELMANN14 Fire, (drumming etc.) QUIET

15 Carbon _____

16 Others _____

17 _____

18 _____

19 _____

20 _____

21 _____

22 _____

23 _____

24 _____

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27 _____

28 _____

29 _____

Date Mar 18, 1949

FIG. 18

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B1-T10-D RATE 7 PSIG

S.T. SHEET NO. 1A

Operator's Name M. MANNERINO

Date MAY 18, 1949

ITEM No.	Time	203	208	—	207	222	223	220A	220	—	—	—	—	—	—
		PRESSURES, LBS. Sq. In., Gage				DRAFTS, INCHES OF WATER									
		Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Steam at Nozzle	Firebox	Inside Arrestor	Ahead of Arrestor	Behind Arrestor	12" from Smokebox Tube Sheet					
		A	B	C	D	EB	1	2	3	Top Center	Left Top	Right Top	Left Top	Right Top	Bottom Center
1	11:30	244	4.5	7.0	5.5	9.7	12.9	12.9	12.8	12.8	12.8	12.9	12.8	12.9	12.9
2	11:35	244	4.5	7.0	5.5	9.6	12.9	12.8	12.8	12.8	12.8	12.9	12.8	13.0	12.9
3	11:40	246	4.5	7.2	5.7	9.9	13.1	13.1	13.1	13.1	13.3	13.2	13.4	13.3	13.3
4	11:45	246	4.5	7.2	5.5	9.8	13.1	13.0	12.9	13.0	13.0	13.1	13.1	13.1	13.0
5	11:50	244	4.5	7.0	5.5	10.0	13.2	13.2	13.1	13.1	13.1	13.2	13.2	13.3	13.3
6	11:55	244	4.5	7.0	5.5	10.2	13.4	13.5	13.3	13.3	13.3	13.4	13.4	13.0	13.1
7	12:00	244	4.5	7.2	5.7	10.5	13.6	13.0	13.0	13.0	13.0	13.1	13.1	13.2	13.1
8	12:05	244	4.5	7.2	5.7	10.4	13.1	13.0	13.0	13.0	13.0	13.1	13.0	13.1	13.0
9	12:10	244	4.5	7.2	5.7	10.3	13.5	13.5	13.4	13.4	13.5	13.5	13.4	13.6	13.5
10	12:15	244	4.5	7.2	5.7	10.3	13.5	13.4	13.4	13.4	13.3	13.5	13.4	13.5	13.5
11															
12															
13	Ave.	244	4.5	7.1	5.6	10.1	13.2	13.1	13.1	13.1	13.1	13.2	13.2	13.2	13.2
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FIG 19

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B1-T10-D RATE 10 PSIGLog Kept by L.S.B.DATE MAY 18, 1949

DESCRIPTION OF TEST ARRANGEMENT

- 1 Nozzle Dia. 8 in. Cross Split 1/2" x 3" BASKET BRIDGE
- 2 Stack Dia. 20 in. Location _____ Height _____ in.
- 3 Spark Arrestor BASKET Sand Exhauster NONE
- 4 Style Fire Pan T & NO Modifications 6 COEN MAIN BURNERS,
- 5 90° CENTRAL L; 2 COEN PILOT BURNERS, 60° CENTRAL L. BOTTOM DRAFT
- 6 CHUTE AND DAMPER FOR 6 MAIN BURNERS
- 7 Damper positions and special conditions of this test #4 LINK ON PER =
- 8 1 1/4" OPEN.
- 9 _____
- 10 Other data OIL PRESSURE 31 LBS AT BURNER (MAIN), 20 LBS ON DECK
- 11 _____
- 12 Atomizer Pressure 157 LBS - MAIN, 97 LBS - PILOT Fuel Oil Pressure 86 LBS. AT PUMP

FUEL AND WATER DATA

	Time	FUEL OIL		HOT WATER		COLD WATER	
		Observer	L. S. B.	Observer	L. F. B.	Observer	A. Q.
		Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.
1	1:00	560046.79		701686		718169	
2	1:15	560213.05	166.26	703763	2077	719961	1792
3	1:30	560379.23	166.18	705859	2096	721769	1808
4	1:45	560544.37	165.14	707947	2088	723569	1800
5			497.58		6261		5400
6							
7							
8							
9							
10							

11 Fuel Oil Data: Lbs/gal. at 60° _____ Heat Value _____ BTU/lb. Moisture _____ %

12 Observations during tests:

13 Stack color CLEAR = 0.05 RINGELMANN14 Fire, (drumming etc.) QUIET. CLEAR.

15 Carbon _____

16 Others _____

17 _____

18 _____

19 _____

20 _____

21 _____

22 _____

23 _____

24 _____

25 _____

26 _____

27 _____

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STANDING TEST PLANT-SACRAMENTO ENGINE No. 4401, TEST SERIES B1-T0-D RATE 10 PSIG

 Operators Name ELWOTT

 Date MAY 18, 1949

ITEM No.		303	313	314	304	303A	3088	309	312	307	307A	311	311A	
TEMPERATURES, DEGREES F.														
Time	Water from Tender	Water into F.W.H.	Fuel oil at Meter	Fuel oil at Burner	Boiler Feed at Check	Water from F.W.H.	Exh. Sm at Stand	Steam in F.W.H.	Atom-izer Steam	Left Main Sm Pipe	Right Main Sm Pipe	Exh. Pass. LEFT	Exh. Pass. RIGHT	Y Pipe
1 1:00	63	64	170	170	214	215	301	301	9	625	633	292	302	307
2 1:05	63	63	170	171	215	214	302	304		627	633	298	303	304
3 1:10	63	64	170	171	215	216	302	303		627	634	292	302	305
4 1:15	63	63	171	171	215	215	300	303		627	634	288	312	304
5 1:20	64	64	172	173	216	217	301	303		626	634	298	303	301
6 1:25	63	63	172	174	214	216	300	302		626	634	300	304	304
7 1:30	64	64	173	175	215	216	302	302		625	632	292	304	306
8 1:35	63	63	172	174	214	215	302	303		626	633	304	305	304
9 1:40	63	63	172	174	215	215	300	305		628	633	289	304	306
10 1:45	63	63	171	173	214	214	303	306		626	633	302	306	306
11														
12														
13 Ave.	63	63	171	173	215	215	301	303		626	633	295	304	305
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FIG. 21

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES 51-710-D RATE 10 PSIG

Operator's Name M. MANNERINO Date May 18, 1938

ITEM No.	203	208	207	222	223	220A	220	INCHES OF WATER				SMOKE BOX				From Smokebox to Sta. Street			
Time	Boiler at Exh. Station Domic	Exh. Station in F.W. Y. Pipe	Steam in Exh. Station	Firebox	Inside Arrester	Ahead of Arrester	Behind Arrester	Top Center	Left Top	Right Top	Left Top	Right Top	Left Top	Right Top	Center	Left Top	Right Top	Center	Left Top
1 1:00	2444	6.5	10.2	8.2	14.1	18.4	18.3	18.3	18.4	18.4	18.4	18.4	18.4	18.4	18.5	18.4	18.5	18.4	18.3
2 1:05	2444	6.5	10.2	8.2	14.2	18.6	18.5	18.5	18.5	18.6	18.5	18.6	18.5	18.7	18.7	18.5	18.7	18.5	18.6
3 1:10	2444	6.5	10.2	8.2	14.4	18.8	18.7	18.6	18.7	18.7	18.7	18.7	18.7	18.7	18.9	18.7	18.9	18.7	18.8
4 1:15	2444	6.5	10.2	8.2	14.3	18.6	18.5	18.5	18.4	18.6	18.6	18.6	18.5	18.5	18.6	18.6	18.6	18.5	18.6
5 1:20	2444	6.5	10.2	8.2	14.0	18.5	18.5	18.3	18.4	18.4	18.4	18.4	18.4	18.5	18.6	18.5	18.6	18.5	18.6
6 1:25	2444	6.5	10.2	8.2	14.2	18.6	18.6	18.4	18.5	18.5	18.5	18.6	18.5	18.6	18.7	18.5	18.7	18.5	18.6
7 1:30	2443	6.5	10.2	8.2	14.2	18.5	18.5	18.3	18.4	18.5	18.5	18.5	18.5	18.5	18.6	18.6	18.6	18.6	18.6
8 1:35	2443	6.5	10.2	8.2	14.2	18.5	18.4	18.4	18.4	18.5	18.5	18.5	18.5	18.5	18.6	18.5	18.6	18.5	18.6
9 1:40	2443	6.5	10.2	8.2	14.4	18.6	18.6	18.5	18.4	18.4	18.4	18.7	18.4	18.5	18.6	18.4	18.5	18.4	18.5
10 1:45	2443	6.5	10.2	8.2	14.2	18.6	18.5	18.5	18.5	18.6	18.5	18.6	18.5	18.6	18.7	18.5	18.7	18.5	18.5
11																			
12																			
13 AVE.	2444	6.5	10.2	8.2	14.2	18.6	18.5	18.4	18.5	18.6	18.5	18.6	18.5	18.6	18.6	18.5	18.6	18.5	18.5
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FIG. 22

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B1-T10-D RATE 13 PSIGLog Kept by L.S.B.DATE MAY 18, 1949

DESCRIPTION OF TEST ARRANGEMENT

- 1 Nozzle Dia. 8 in. Cross Split 1/2" x 3"
 2 Stack Dia. 20 in. Location STD. Height 13 1/2 in.
 3 Spark Arrestor BASKET Sand Exhauster NONE
 4 Style Fire Pan T & NO Modifications 6-COEN MAIN BURNERS
 5 CENTRAL L=90°; 2 COEN PILOT BURNERS L 60°; BOTTOM AIR DUCT & DAMPER FOR
 6 6 MAIN BURNERS, TOP BOILER CHECK
 7 Damper positions and special conditions of this test #6 LINK ON PEG=2 1/8" OPEN
 8
 9
 10 Other data MAIN OIL PRESSURE 36# @ DECK; 43# @ BURNER
 11
 12 Atomizer Pressure 154# 92# Fuel Oil Pressure 86# @ PUMP, 8# TANK

FUEL AND WATER DATA

Time	FUEL OIL		HOT WATER		COLD WATER	
	Observer <u>L.S.B.</u>		Observer <u>L.F.B.</u>		Observer <u>A.Q.</u>	
	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.	Meter Reading	Gals. Diff.
1 2:37	561182.94		715 963		730 434	
2 2:52	561374.36	191.42	718 395	2432	732 506	2072
3 3:07	561565.28	190.92	720 815	2420	734 568	2062
4		382.34		4852		4134
5						
6						
7						
8						
9						
10						

11 Fuel Oil Data: Lbs./gal. at 60° _____ Heat Value _____ BTU/lb. Moisture _____ %

12 Observations during tests:

- 13 Stack color CLEAR (0.25 RINGELMANN)
 14 Fire, (drumming etc.) QUIET - SMOOTH
 15 Carbon NO CARBON FOUND ON CROWN SHEET OR IN FIREPAN
 16 Others BLEW-OFF SOME BOILER WATER PRIOR TO TEST A/C
 17 FOAMING. 2 BUCKETS OF SAND THRU FLUES, AT START
 18
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COLD PUMP PRESSURE 53-55# DECKOIL TEMP. THERMOMETER = 183°

STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES B1-T10-D RATE 13 PSIG

Operators Name ELLIOTTDate MAY 18, 1949

ITEM No.		303	313	314	304	303A	308B	309	312	307	307A	311	311A		
		TEMPERATURES, DEGREES F.													
Time		Water from Tender	Water into F.W.H.	Fuel oil at Meter	Fuel oil at Burner	Boiler Feed at Check	Water from F.W.H.	Exh. Sm at Stand	Steam in F.W.H.	Atom-izer Steam	Left Main Steam Pipe	Right Main Steam Pipe	EXH. PASS. LEFT	EXH. PASS. RIGHT	Y PIPE
		1	2	3	4	5/2-A	6	7	8	9	10	11	12-E	12-F	12-K
1	2:37	62	62	170	174	222	222	318	320		646	658	316	320	317
2	2:42	62	63	170	173	223	221	316	318		645	657	314	319	317
3	2:47	63	63	170	173	223	224	316	320		646	654	317	320	318
4	2:52	62	63	171	174	222	223	317	320		643	655	316	319	317
5	2:57	62	63	171	174	222	222	317	320		642	656	316	320	317
6	3:02	62	62	171	174	222	223	317	320		642	656	315	319	317
7	3:07	62	62	171	174	222	224	317	320		640	656	316	322	316
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9															
10	Ave	62	63	171	174	222	223	317	320		643	656	316	320	317
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NOZZLE	10.8" - 3/4"	Y PIPE	13" - 3/5"	ORIFICE SETTING	2.425"
1A					
2A					
3A		VALVE	PRESSURE		
4A		SETTING	FRONT OF CYL		
5A		L.S.	12.2	26.7	
6A		R.S.	12.5	22.7	
7A					
8A					

PRESSURES

OIL STEAM

PILOT BURNERS

0 90

MAIN BURNERS

35 153

NOZZLE 10.8" - 314" Y PIPE 13" - 315" ORIFICE SETTING 2.425"

VALVE PRESSURE
SETTING FRONT OF CYL

L.S. 12.2 26.7

R.S. 12.5 22.7

STANDING TEST PLANT-SACRAMENTO

ENGINE NO. 4401, TEST SERIES B1-T10-D RATE 13 PSIG

S.T. SHEET NO. 1A

Operator's Name M. MANNERINO

Date MAY 18, 1949

ITEM No.	203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—	—
Time	PRESSURES, LBS. Sq. In., Gage				DRAFTS, INCHES OF WATER											
	Bailer at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Steam at Nozzle	Firebox	Inside Arrester	Ahead of Arrester	Behind Arrester	SMOKE BOX							
	A	B	C	D	FB				Top Center	Left Top	Right Top	Left Top	Right Top	Bottom Center	Center 1/2 UP	
1 2:37	242	8.2	13.2	11.0	15.5	21.4	21.2	21.2	21.3	21.3	21.3	21.5	21.4	21.3	21.4	
2 2:42	241	8.2	13.2	11.0	15.3	21.0	21.1	20.9	20.9	21.2	21.1	21.2	21.4	21.3	21.2	
3 2:47	242	8.2	13.2	11.0	15.5	21.4	21.2	21.1	21.2	21.3	21.3	21.3	21.5	21.4	21.3	
4 2:52	243	8.2	13.2	11.0	15.7	21.6	21.4	21.4	21.5	21.5	21.6	21.5	21.6	21.4	21.5	
5 2:57	242	8.2	13.2	11.0	15.7	21.5	21.4	21.4	21.5	21.3	21.6	21.4	21.5	21.4	21.5	
6 3:02	242	8.2	13.2	11.0	15.7	21.6	21.5	21.5	21.5	21.4	21.6	21.5	21.6	21.5	21.5	
7 3:07	243	8.2	13.2	11.0	15.7	21.5	21.4	21.4	21.5	21.5	21.6	21.5	21.7	21.6	21.5	
8																
9																
10 AVE.	242	8.2	13.2	11.0	15.6	21.4	21.3	21.3	21.3	21.4	21.4	21.4	21.5	21.4	21.4	
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FIG. 25

STANDING TEST PLANT — SACRAMENTO

ENGINE No. 4401, TEST SERIES B1 No. T10-D RUN No. _____DATE. MAY 18, 1949

OIL AND AIR	13 #	10 #	7 #	4 #
1. METER READING START	561,182.94	560,046.79	559,160.57	558,549.19
2. METER READING FINISH	561,565.28	560,544.37	559,568.78	558,858.17
3. GALLONS DIFFERENCE (2-1)	382.34	497.58	408.21	308.98
4. LENGTH OF RUN - MIN.	30	45	45	45
5. FLOW RATE - GPM (3-4)	12.74	11.06	9.07	6.87
6. METER FACTOR (FROM CURVE)	.9676	.9676	.9676	.9676
7. AVE. TEMP. AT METER	171	171	170	175
8. TEMP. CORRECTION FACTOR	.9620	.9620	.9623	.9606
9. MOISTURE CONTENT - %	1.26	1.26	1.26	1.26
10. DRY OIL AT 60°F - GALS. (3×6×8×(1-9/100))	351.41	457.33	373.30	283.57
11. DENSITY - LBS./GAL.	8.388	8.388	8.388	8.388
12. HEAT VALUE, DRY - BTU/LB.	18,220	18,220	18,220	18,220
13. OIL BURNED - LBS. (10×11)	2,948	3,836	3,148	2,379
14. OIL BURNED PER HOUR - (13×60÷4) - LBS./HR.	5,896	5,115	4,197	3,171
15. LBS. AIR PER LB. OF OIL.	15.15	15.06	16.09	16.35
16. AIR FLOW - (15×14) - LBS AIR PER HOUR	89,324	77,032	67,530	51,846
HOT WATER				
17. METER READING START	715,963	701,686	690,756	683,126
18. METER READING FINISH	720,815	707,947	695,863	687,082
19. GALLONS DIFFERENCE (18-17)	4852	6261	5107	3956
20. LENGTH OF RUN - MIN.	30	45	45	45
21. FLOW RATE - GPM (19÷20)	161.73	139.13	113.49	87.91
22. METER FACTOR (FROM CURVE)	.9623	.9600	.9582	.9590
23. CORRECTED GALLONS (19×22)	4669	6011	4894	3794
24. AVE. TEMP.	223	215	206	198
25. DENSITY - LBS./GAL.	7.964	7.990	8.020	8.044
26. HOT WATER - LBS. (23×25)	37,185	48,024	39,246	30,517
27. HOT WATER - LBS. PER HOUR (26×60/20)	74,370	64,032	52,328	40,690
COLD WATER				
28. METER READING START	730,434	718,169	708,652	701,935
29. METER READING FINISH	734,568	723,569	713,124	705,437
30. GALLONS DIFFERENCE (29-28)	4134	5400	4472	3502
31. LENGTH OF RUN - MIN.	30	45	45	45
32. FLOW RATE - GPM (30÷31)	137.80	120.00	99.38	77.82
33. METER FACTOR (FROM CURVE)	.9556	.9546	.9535	.9524
34. CORRECTED GALLONS (30×33)	3950	5155	4264	3335
35. AVE. TEMP.	63	63	64	66
36. DENSITY - LBS./GAL.	8.332	8.332	8.331	8.329
37. COLD WATER - LBS. (34×36)	32,915	42,950	35,524	27,780
38. COLD WATER - LBS. PER HOUR (37×60/31)	65,830	57,267	47,365	37,040
39. STEAM TO FWH - LBS PER HOUR (FROM CURVE)	1359	1280	1189	1099
40. STEAM TO NOZZLE - LBS/HR. (38-39)	64,471	55,987	46,176	35,941
CONDENSATE FACTOR				
41. LBS. HOT WATER / LBS. COLD WATER	1.1297	1.1181	1.1048	1.0985
SMOKEBOX TEMP.	588	570	553	525

STANDING TEST PLANT - SACRAMENTO

ENGINE No. 4401, TEST SERIES B1 No. T10-D RUN No. _____DATE. MAY 18, 1949

BOILER EFFICIENCY	13#	10#	7#	4#
A. TEMP. WATER FROM FWH TO BOILER MINUS 32° - BTU/LB.	190	183	174	166
B. TEMP. WATER INTO FWH MINUS 32° - BTU/LB.	31	31	32	34
C. HEAT ADDED TO WATER BY EXHAUST STEAM (A-B) - BTU/LB.	159	152	142	132
D. PRESSURE EXHAUST STEAM TO FWH - PSIG.	8.2	6.5	4.5	2.4
E. TEMP. EXHAUST STEAM TO FWH - °F.	320	303	298	285
F. HEAT OF EXHAUST STEAM TO FWH - BTU/LB.	1200.8	1192.8	1191.0	1185.5
G. HEAT OF EXHAUST STEAM MINUS HEAT OF FEED WATER - (F-A) - BTU/LB.	1010.8	1009.8	1017.0	1019.5
H. CONDENSATE FACTOR, CALCULATED - (1+C/G)	1.1573	1.1505	1.1396	1.1295
I. CONDENSATE FACTOR FROM WATER METERS OR CURVE.	1.1297	1.1181	1.1048	1.0985
J. COLD WATER TO FWH - LBS PER HOUR	65,830	57,267	47,365	37,040
K. HOT WATER TO BOILER - LBS PER HOUR	74,370	64,032	52,328	40,690
L. STEAM PIPE PRESSURE - PSIG.	209	218	224	230
M. TEMP. OF STEAM AT CYLINDER STEAM PIPES - °F.	650	630	614	582
N. HEAT CONTENT SUPERHEATED STEAM AT STEAM PIPES - BTU/LB.	1346.6	1335.7	1326.7	1312.6
O. HEAT ADDED TO WATER FROM FWH TO MAKE SUPERHEATED STEAM - (N-A) - BTU/LB.	1156.6	1152.7	1152.7	1146.6
P. TOTAL HEAT OF SUPERHEATED STEAM, FROM BOILER - (K+O) - BTU/1000 PER HOUR.	86,016	73,810	60,318	46,655
Q. HEAT CONTENT OF WATER TO FWH - (J+B) - BTU/1000 PER HOUR.	2041	1775	1516	1259
R. HEAT CONTENT OF WATER FROM FWH - (K+A) - BTU/1000 PER HOUR.	14130	11,718	9,105	6,755
S. HEAT ADDED BY FWH - (R-Q) - BTU/1000 PER HOUR.	12,089	9,943	7,589	5,496
T. TOTAL HEAT ADDED BY BOILER PLUS FWH - (P+S) - BTU/1000 PER HOUR.	98,105	83,753	67,907	52,151
U. OIL BURNED - LBS. PER HOUR.	5896	5115	4197	3171
V. HEAT VALUE OF OIL, DRY - BTU/LB.	18,220	18,220	18,220	18,220
W. TOTAL HEAT CONTENT OF OIL - (U×V) - BTU/1000 PER HOUR	107,425	93,195	76,469	57,776
X. BOILER EFFICIENCY LESS FWH $(P \div W) \times 100 - \%$	80.1	79.2	78.9	80.8
Y. BOILER EFFICIENCY INCLUDING FWH $(T \div W) \times 100 - \%$	91.3	89.9	88.8	90.3
Z. EQUIVALENT EVAPORATION OF BOILER - $(P \div 970.3) - \text{LBS PER HOUR.}$	88,649	76,069	62,164	48,083

Southern Pacific Company
Locomotive Boiler Performance Test
Sacramento, California
Locomotive No. 4401 Class GS-1

Air-Fuel Relations From Flue-Gas Analysis

Test No. Bl-T10-D

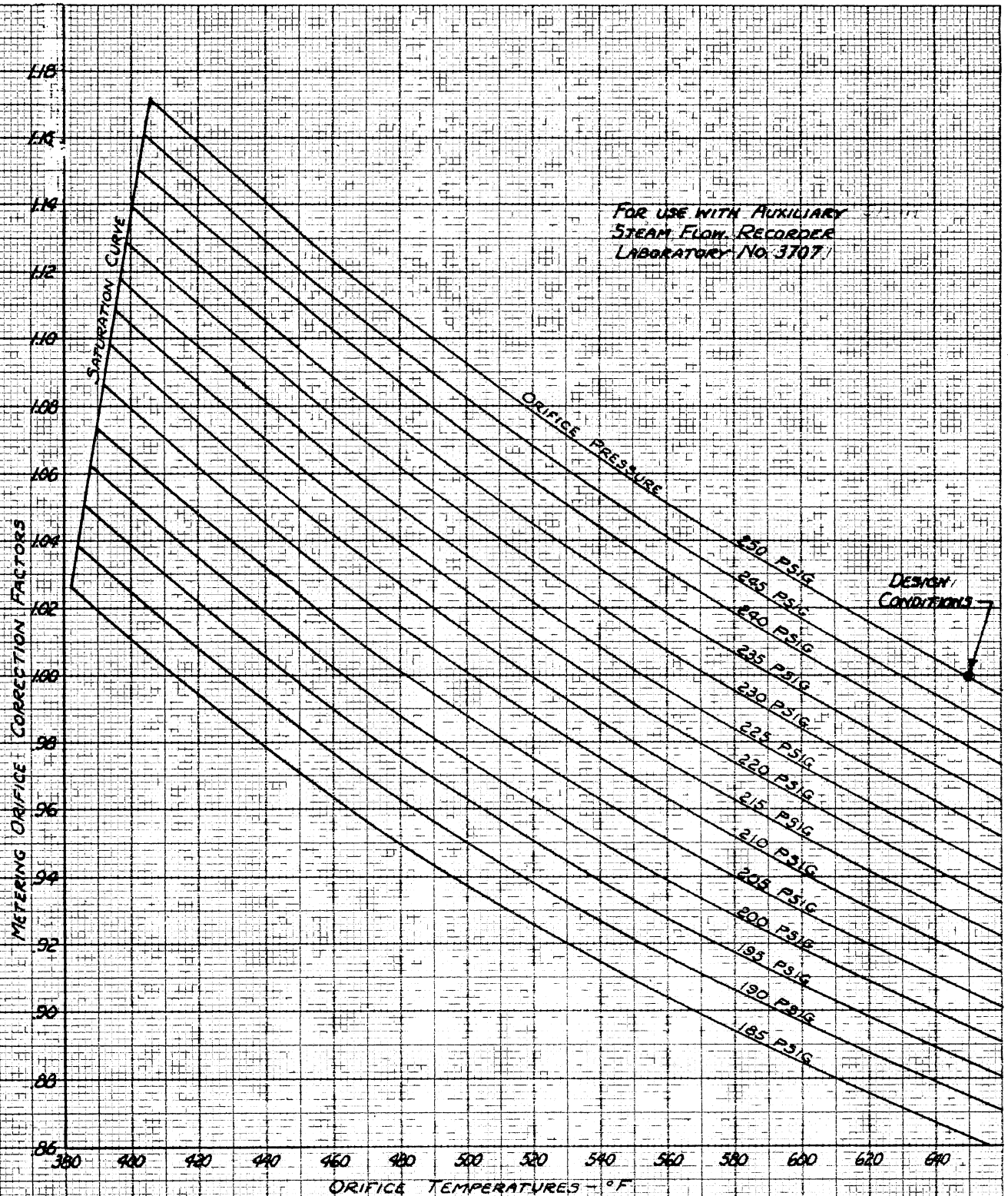
Observer JWK

Date May 18, 1949

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
Nozzle Press.	CO ₂	O ₂	CO	N ₂	18.3 N ₂	34.8 CO	69.6 C ₂	.528 N ₂	5 CO	4 CO ₂	2 O ₂	Denom. i+j+k-l	Air Supplied f/m	Num f+g-h	Theo. Air o/m	Excess Air $\frac{n}{p} - 1$ $\frac{f}{o} - 1$
4Y	13.8	3.0	-	83.2	1522.6	-	208.8	43.93	-	55.2	6.0	93.13	16.35	1313.8	14.11	15.9
7Y	14.0	2.6	-	83.4	1526.2	-	181.0	44.04	-	56.0	5.2	94.84	16.09	1345.2	14.18	13.4
10Y	15.0	1.2	-	83.8	1533.5	-	83.5	44.25	-	60.0	2.4	101.85	15.06	1450.0	14.24	5.8
13Y	14.9	1.3	-	83.8	1533.5	-	90.5	44.25	-	59.6	2.6	101.25	15.15	1443.0	14.25	6.3

Fig. 28

ST-280



METERING ORIFICE CORRECTION FACTORS VS ORIFICE TEMPERATURES FOR VARIOUS ORIFICE PRESSURES

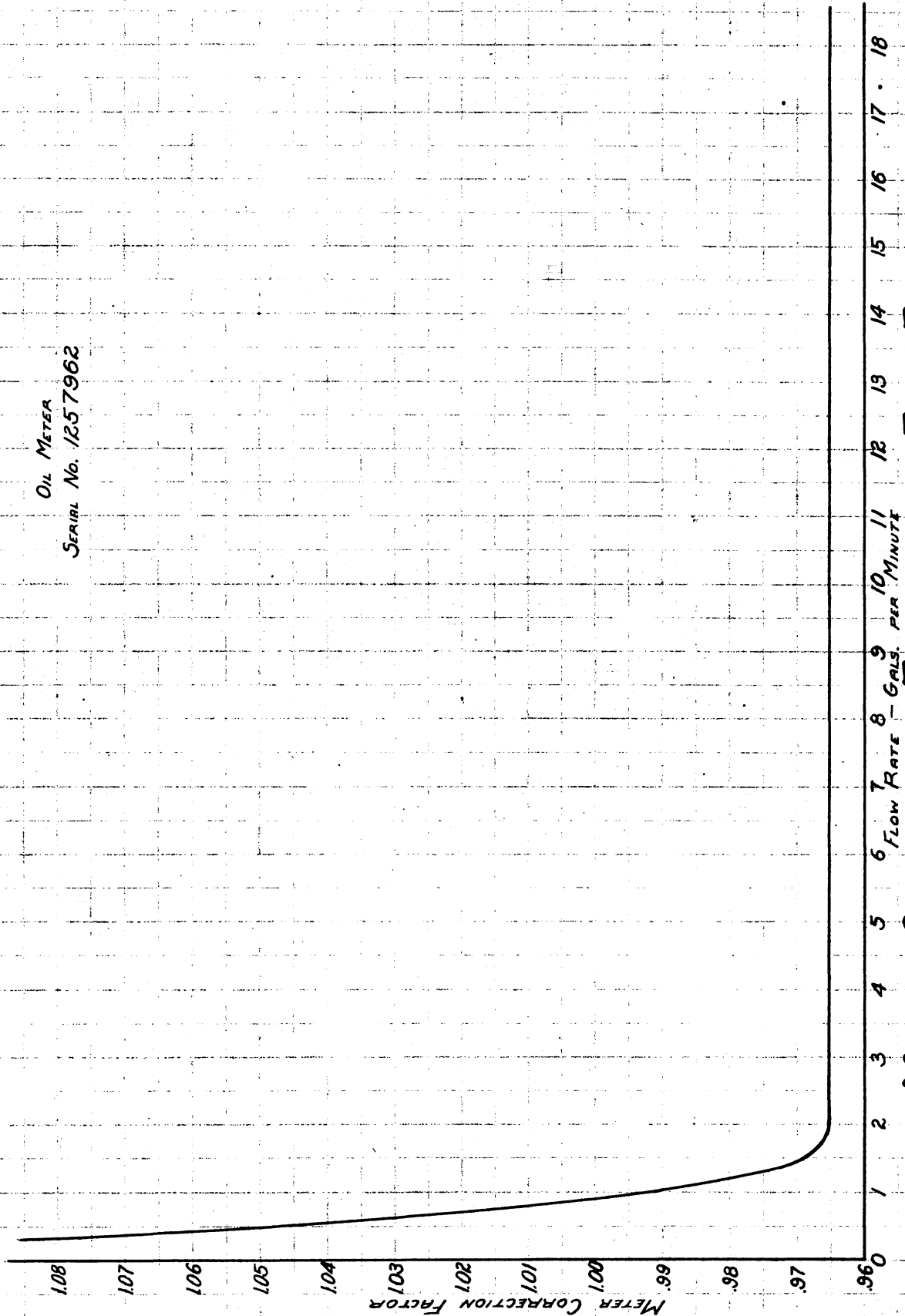
STANDING TEST PLANT, SACRAMENTO

STANDING TEST ENGINE 4401

FEBRUARY 11, 1949

FIG. 29

OIL METER
SERIAL No. 1257962



METER CORRECTION FACTORS VS FLOW RATE

ENGINE 4401

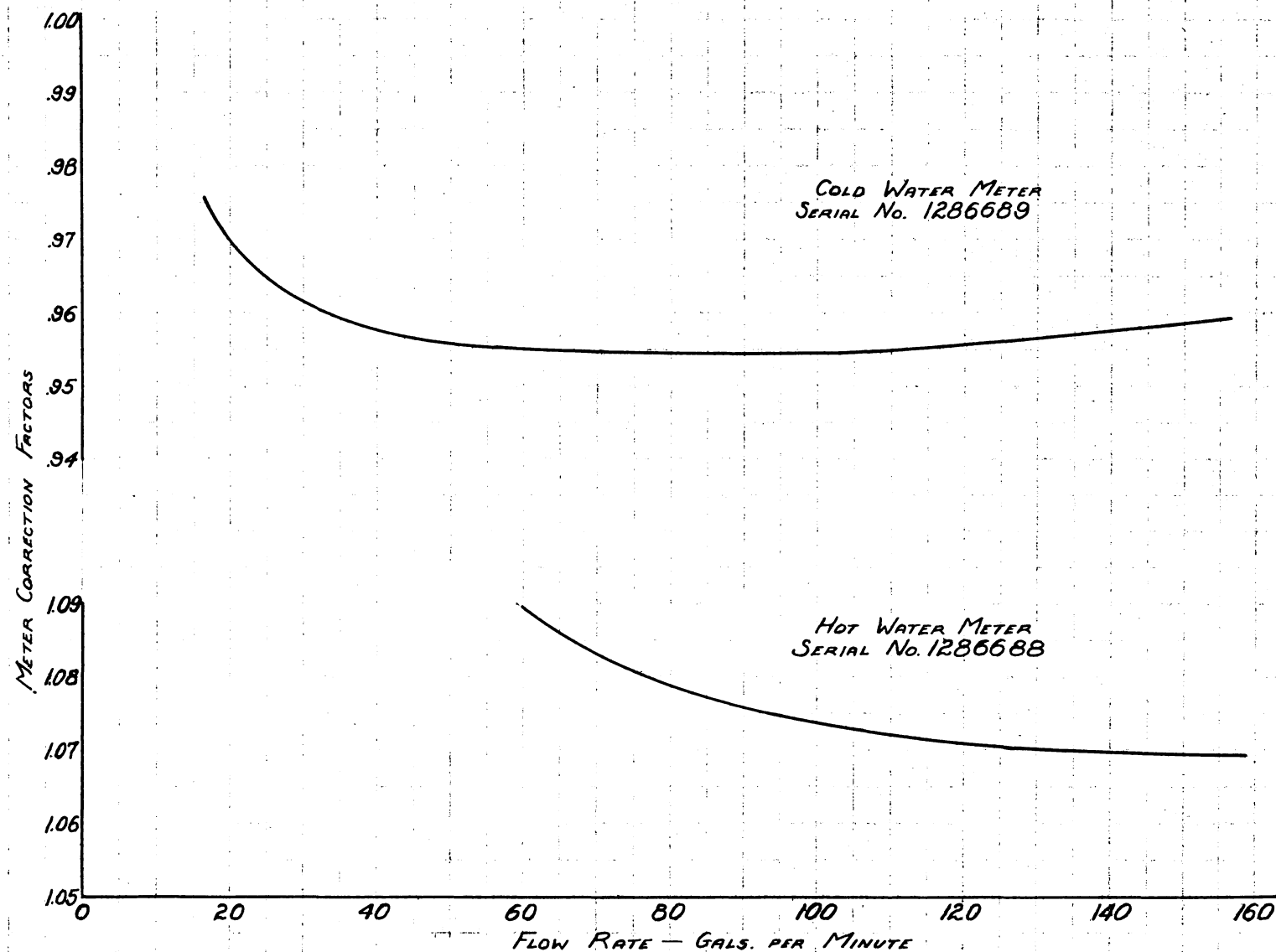
STANDING TEST

STANDING TEST PLANT, SACRAMENTO

SEPTEMBER 1, 1949

FIG. 30

FIG. 31



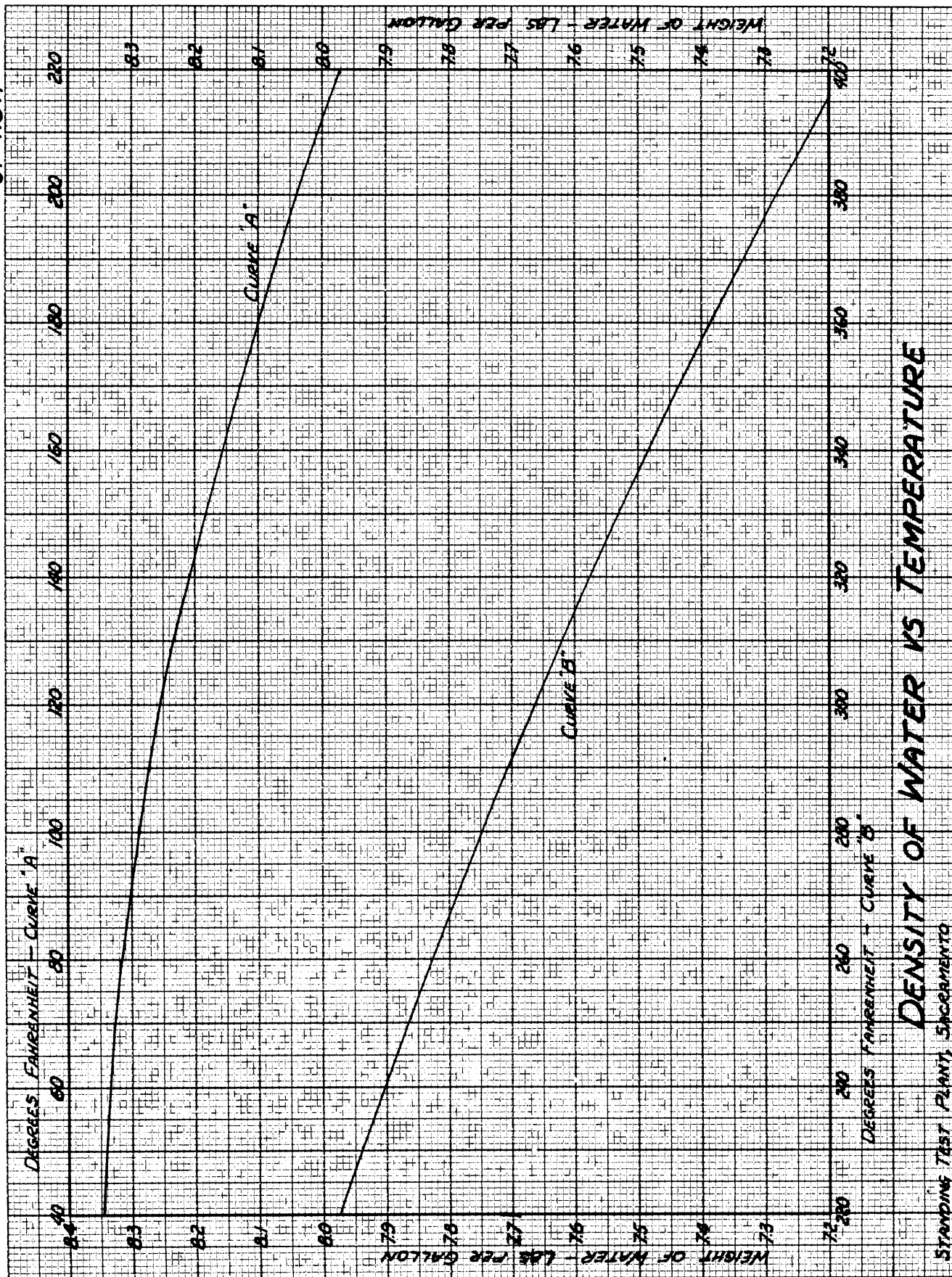
METER CORRECTION FACTORS VS FLOW RATE

STANDING TEST PLANT, SACRAMENTO

STANDING TEST ENGINE 4401

SEPTEMBER 1, 1949

ST-118 A

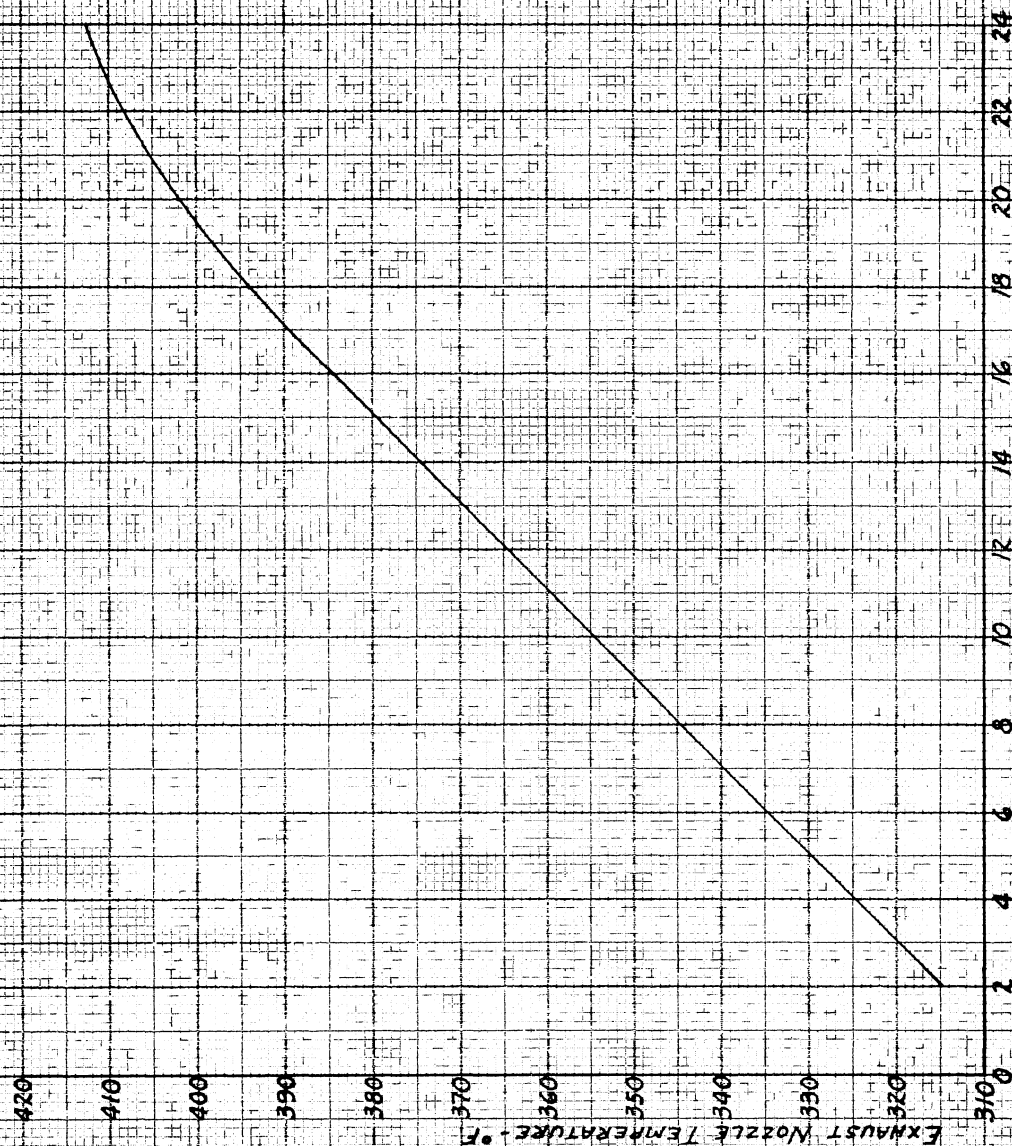


DENSITY OF WATER VS TEMPERATURE

STANDING TEST PLANT, SACRAMENTO

FIG. 32

SI-128



EXHAUST NOZZLE PRESSURE = PSIG

EXHAUST NOZZLE TEMPERATURE VS EXHAUST NOZZLE PRESSURE

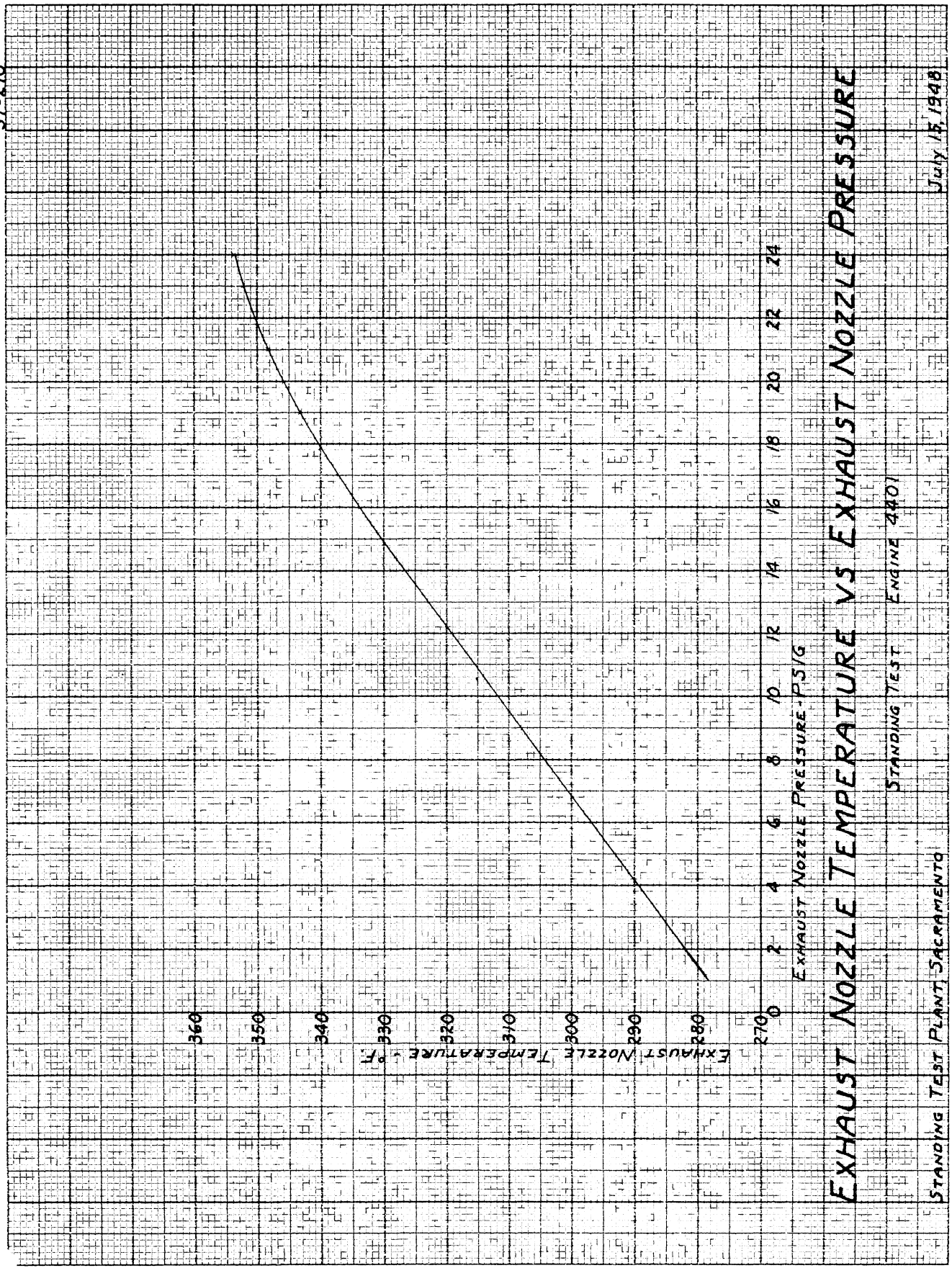
STANDING TEST ENGINE 2401

STANDING TEST PLANT, SACRAMENTO

APRIL 1, 1948

FIG. 33

ST-210



EXHAUST NOZZLE TEMPERATURE VS EXHAUST NOZZLE PRESSURE

STANDING TEST ENGINE 4401

STANDING TEST PLANT SACRAMENTO

JULY 15, 1948

FIG.34

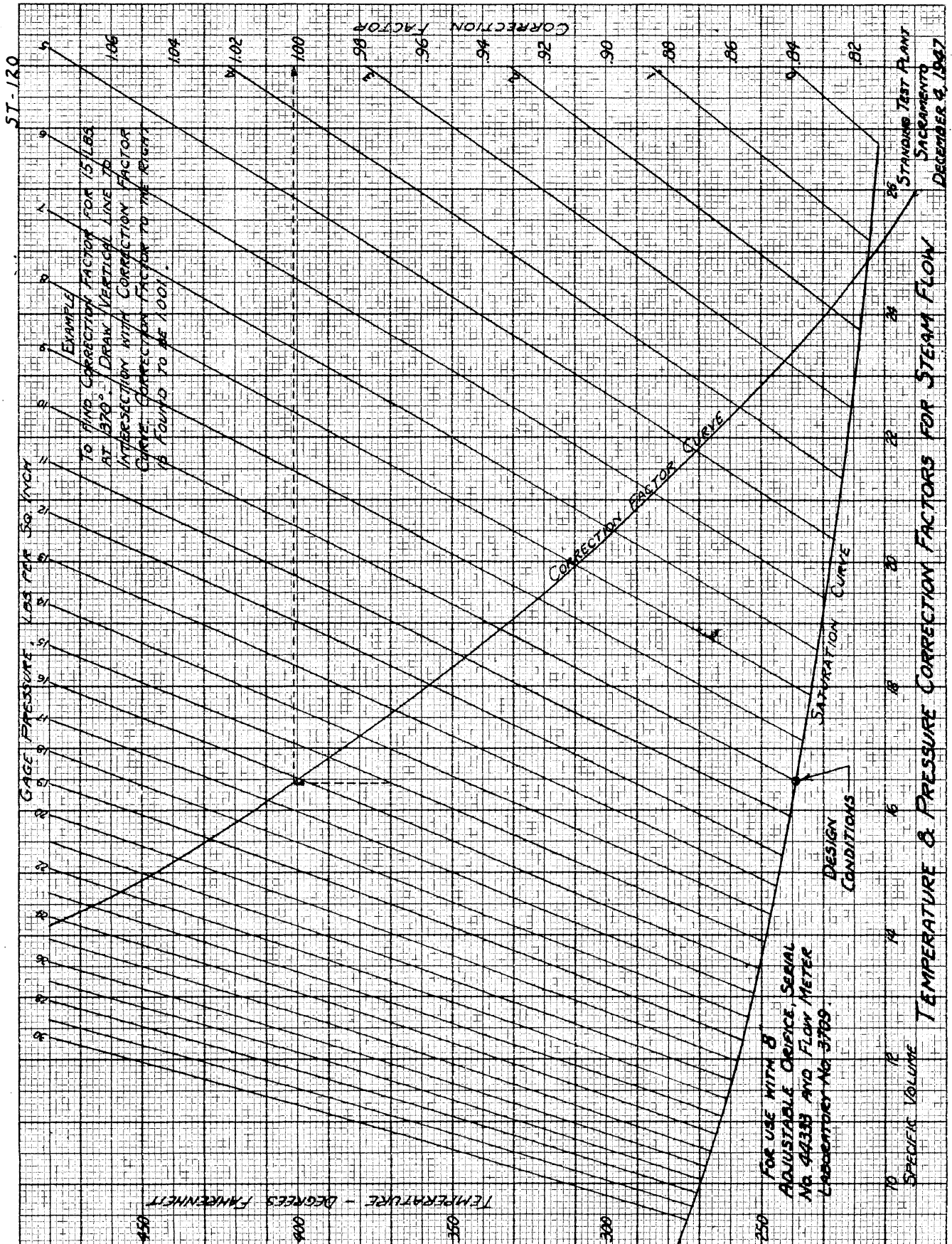
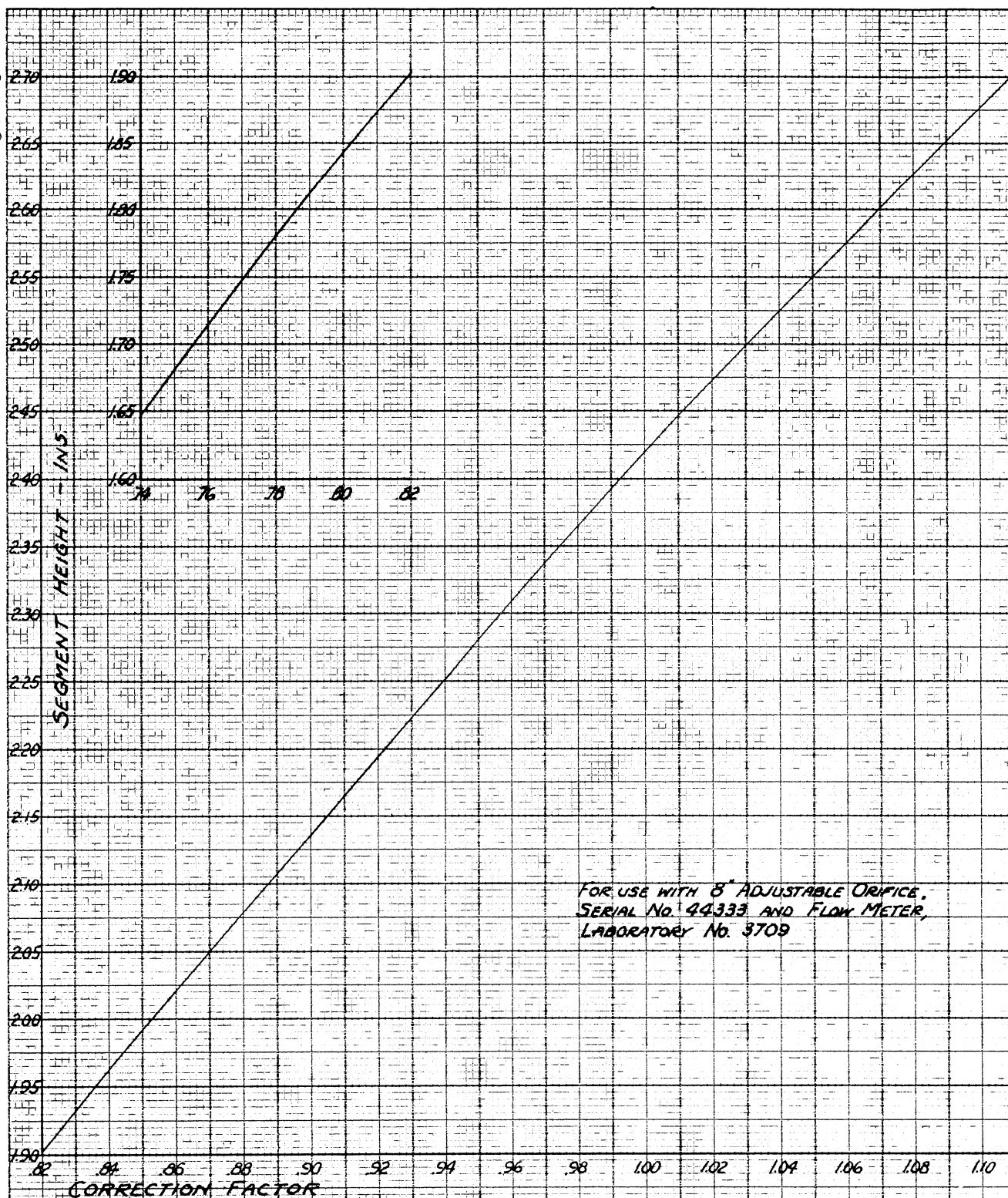


FIG. 35

ST-119



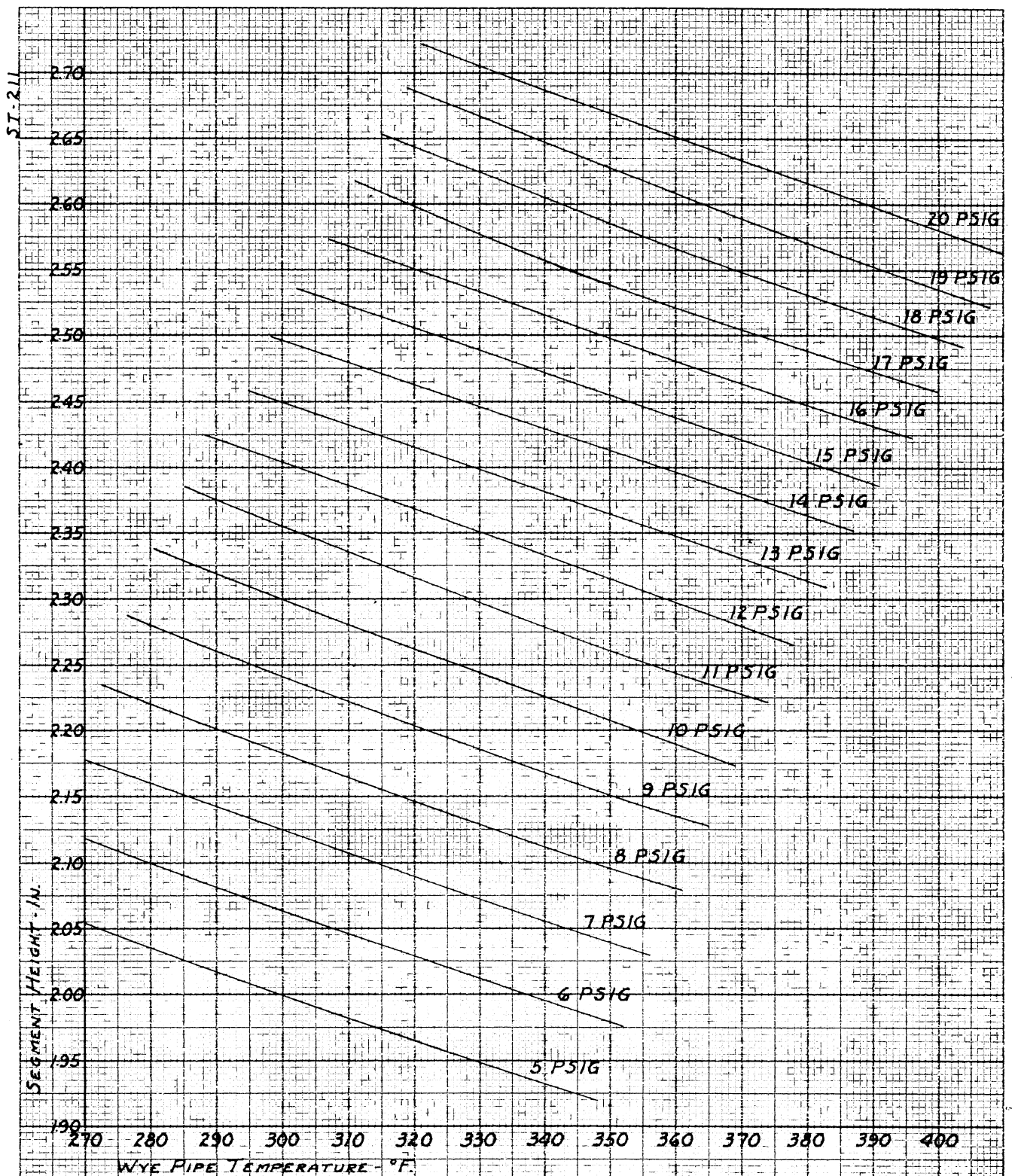
SEGMENT HEIGHTS VS CORRECTION FACTORS

STANDING TEST PLANT, SACRAMENTO

DECEMBER 4, 1947

FIG. 36

ST-119



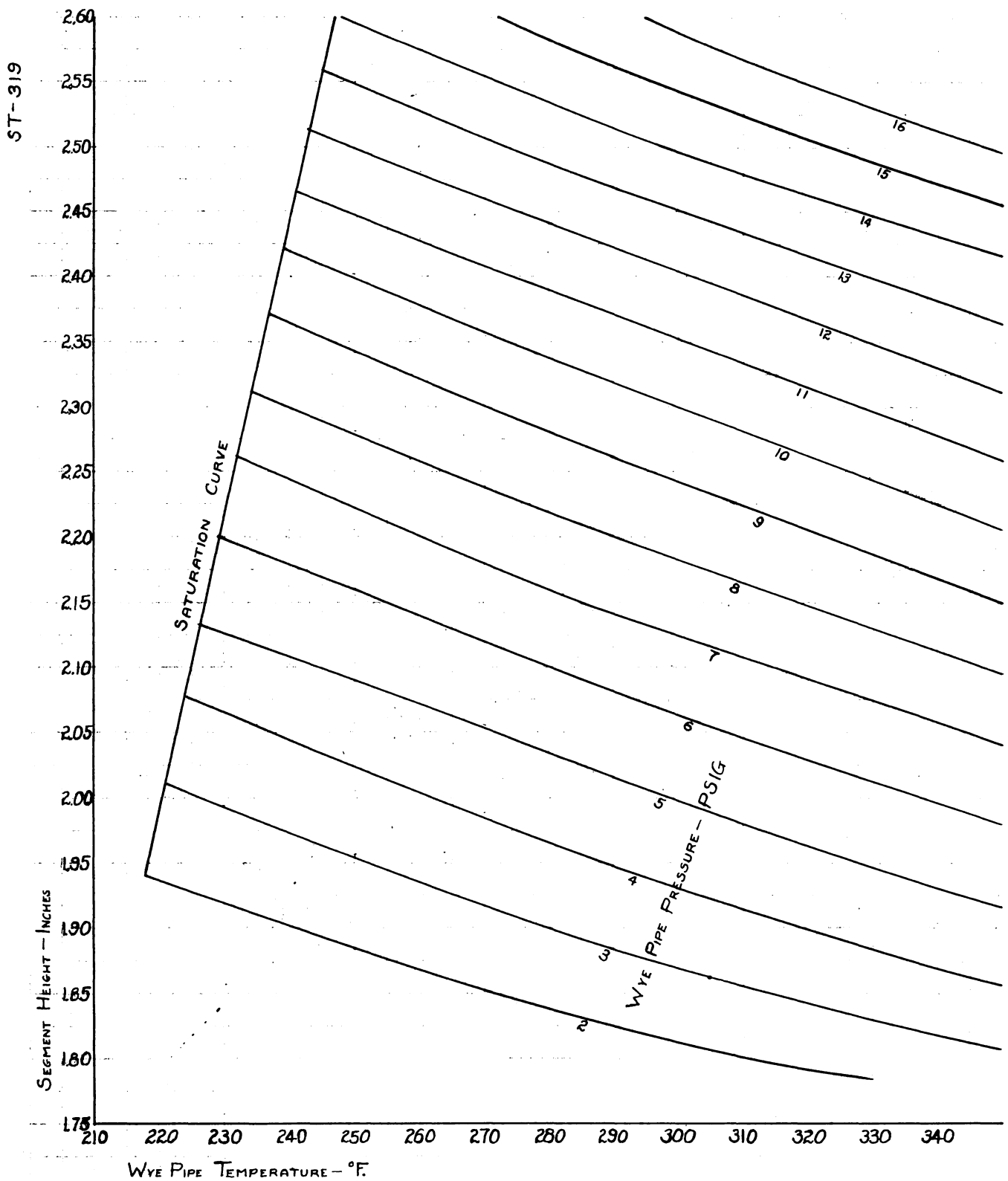
SEGMENT HEIGHT VS WYE PIPE TEMPERATURE FOR VARIOUS WYE PIPE PRESSURES

STANDING TEST ENGINE 4401

STANDING TEST PLANT, SACRAMENTO

JULY 15, 1948

FIG.37



SEGMENT HEIGHT VS WYE PIPE TEMPERATURE

FOR VARIOUS WYE PIPE PRESSURES

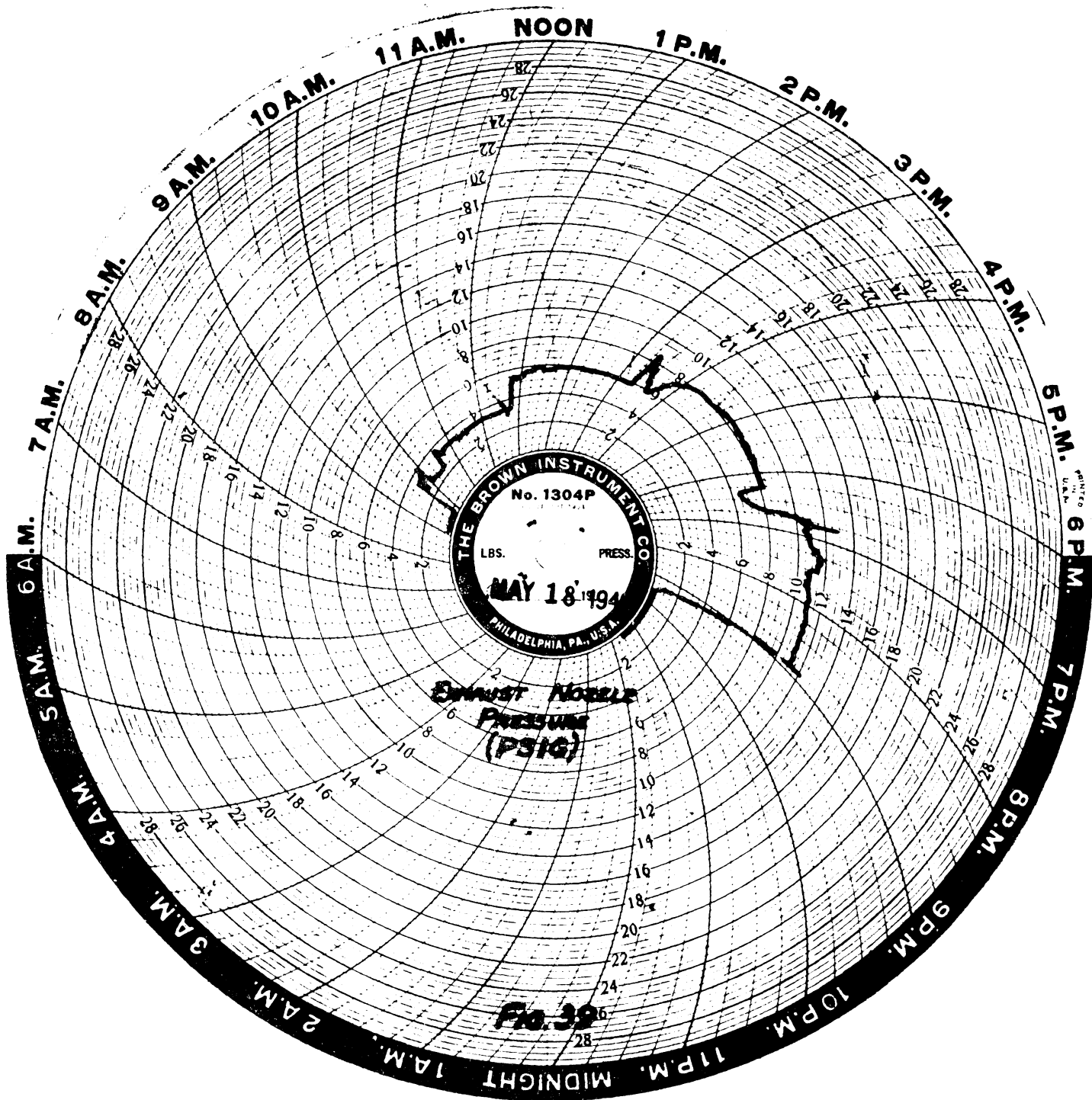
STANDING TEST

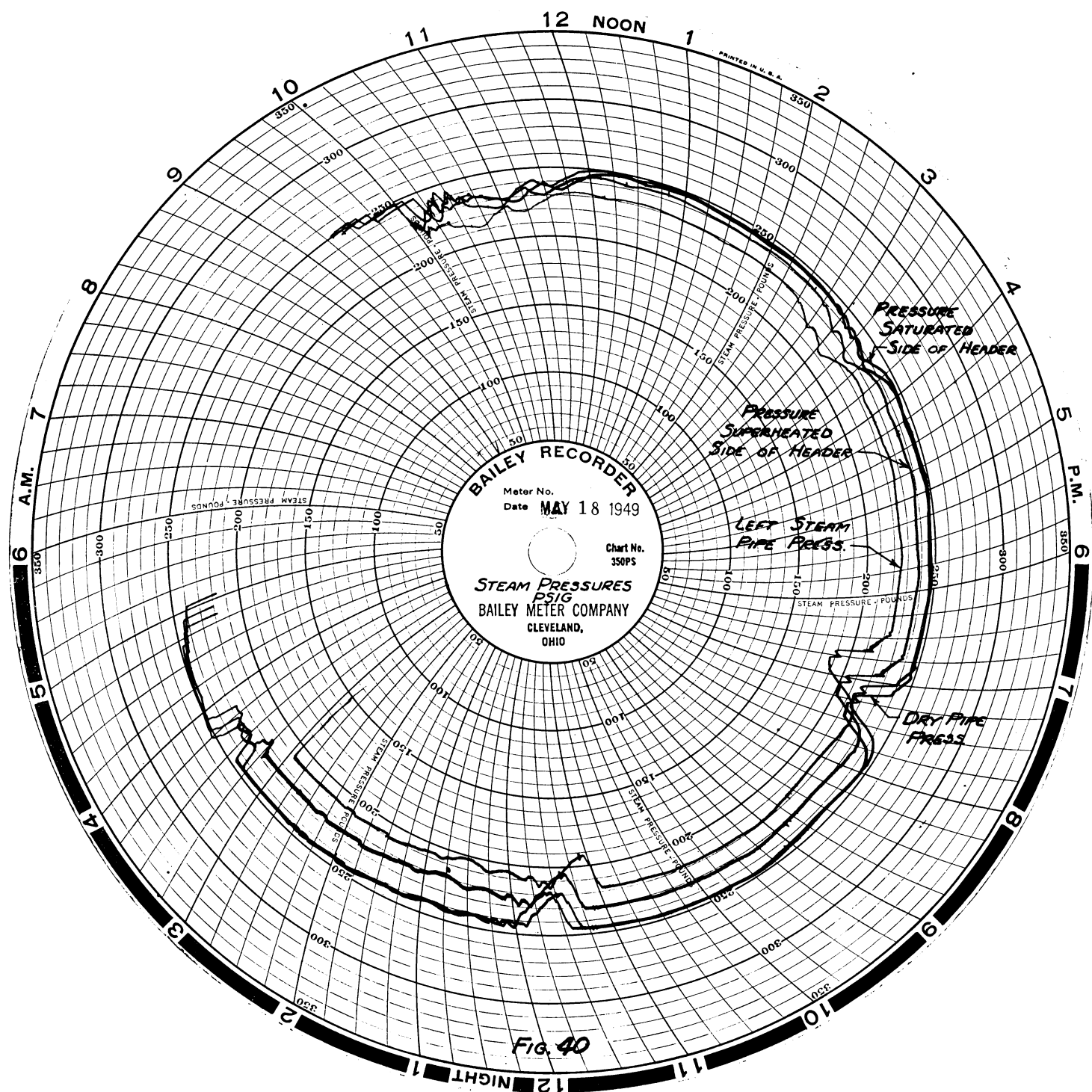
ENGINE 4401

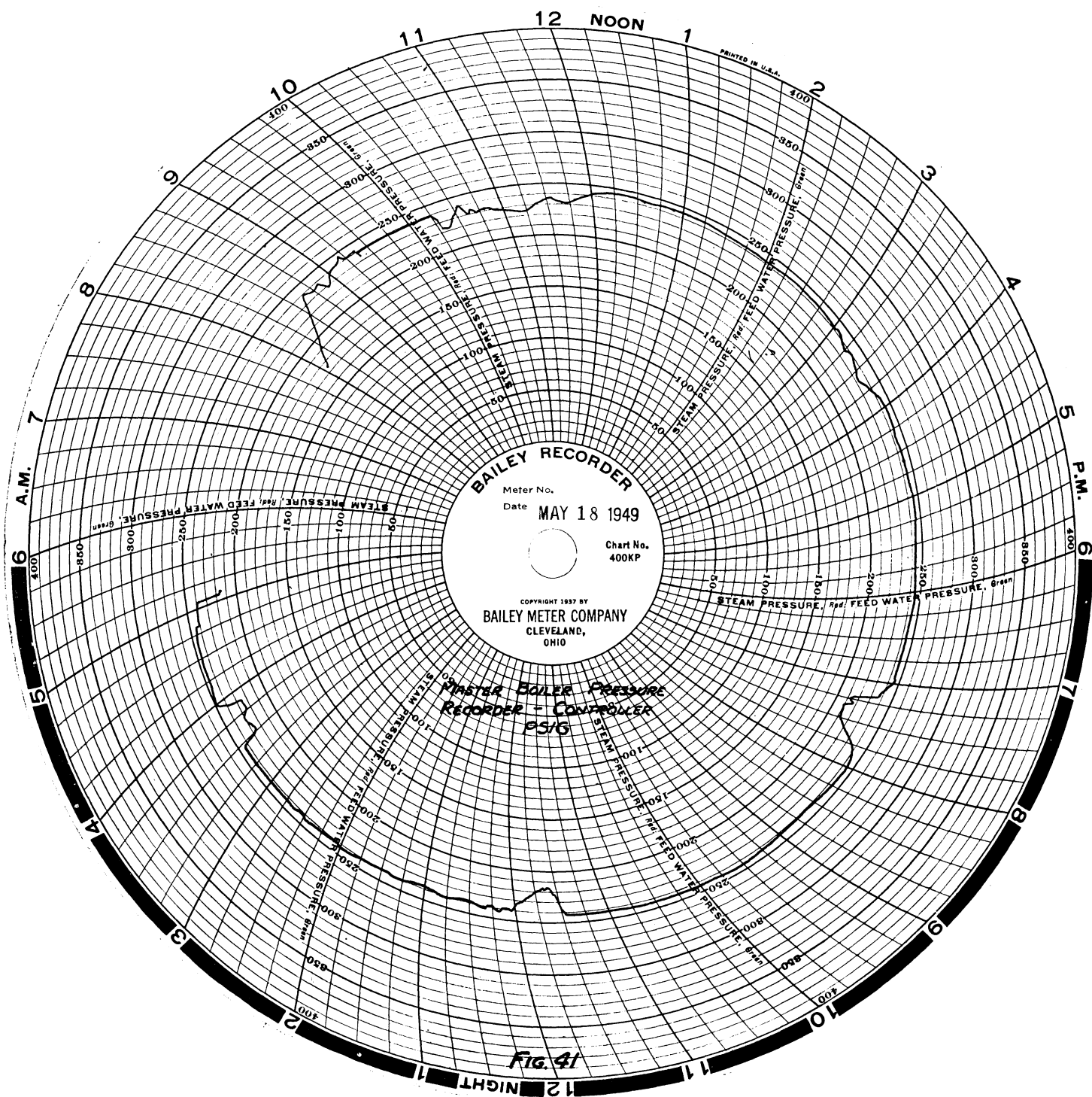
STANDING TEST PLANT, SACRAMENTO

DEC. 28, 1949

FIG. 38







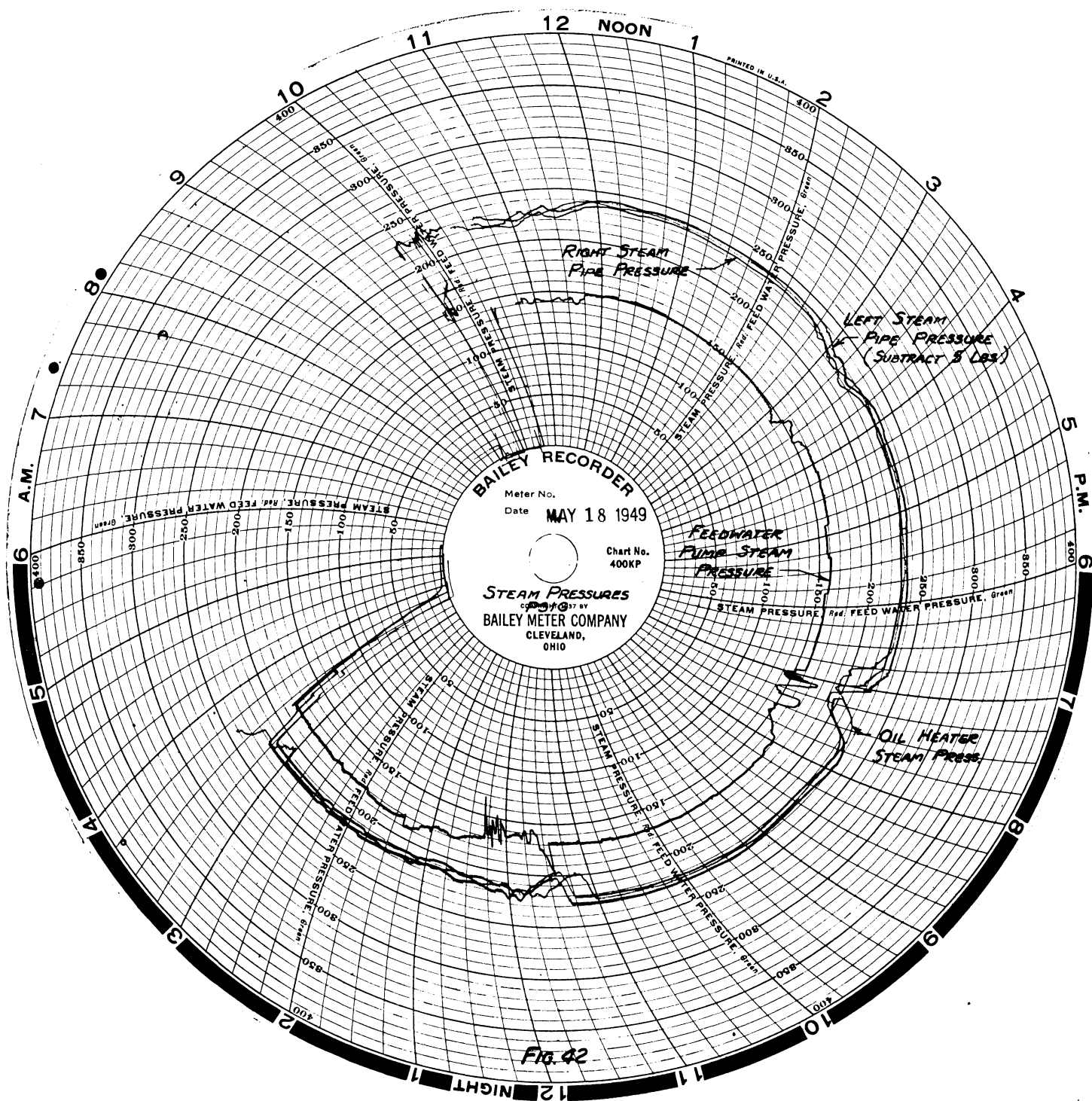
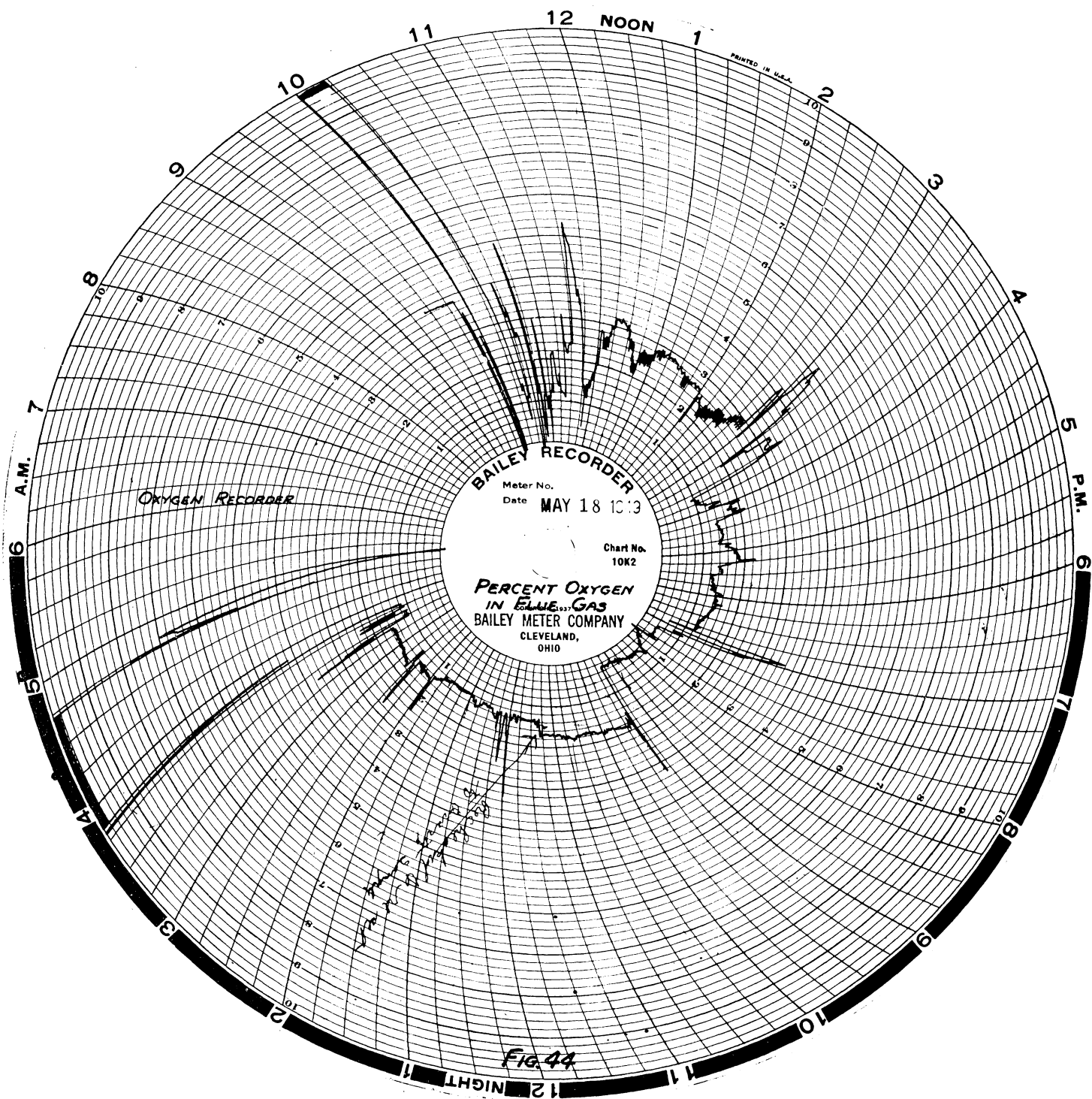
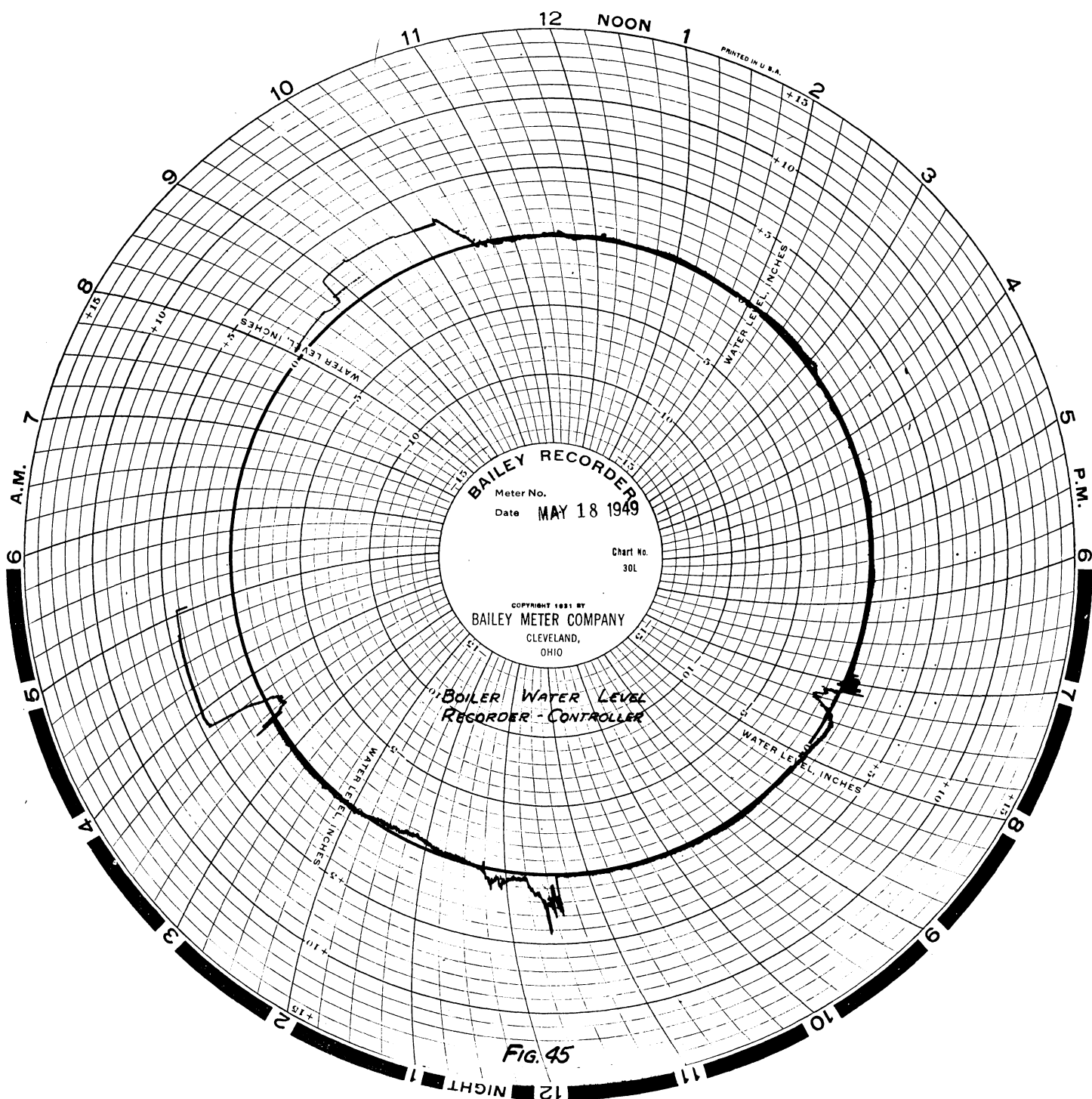
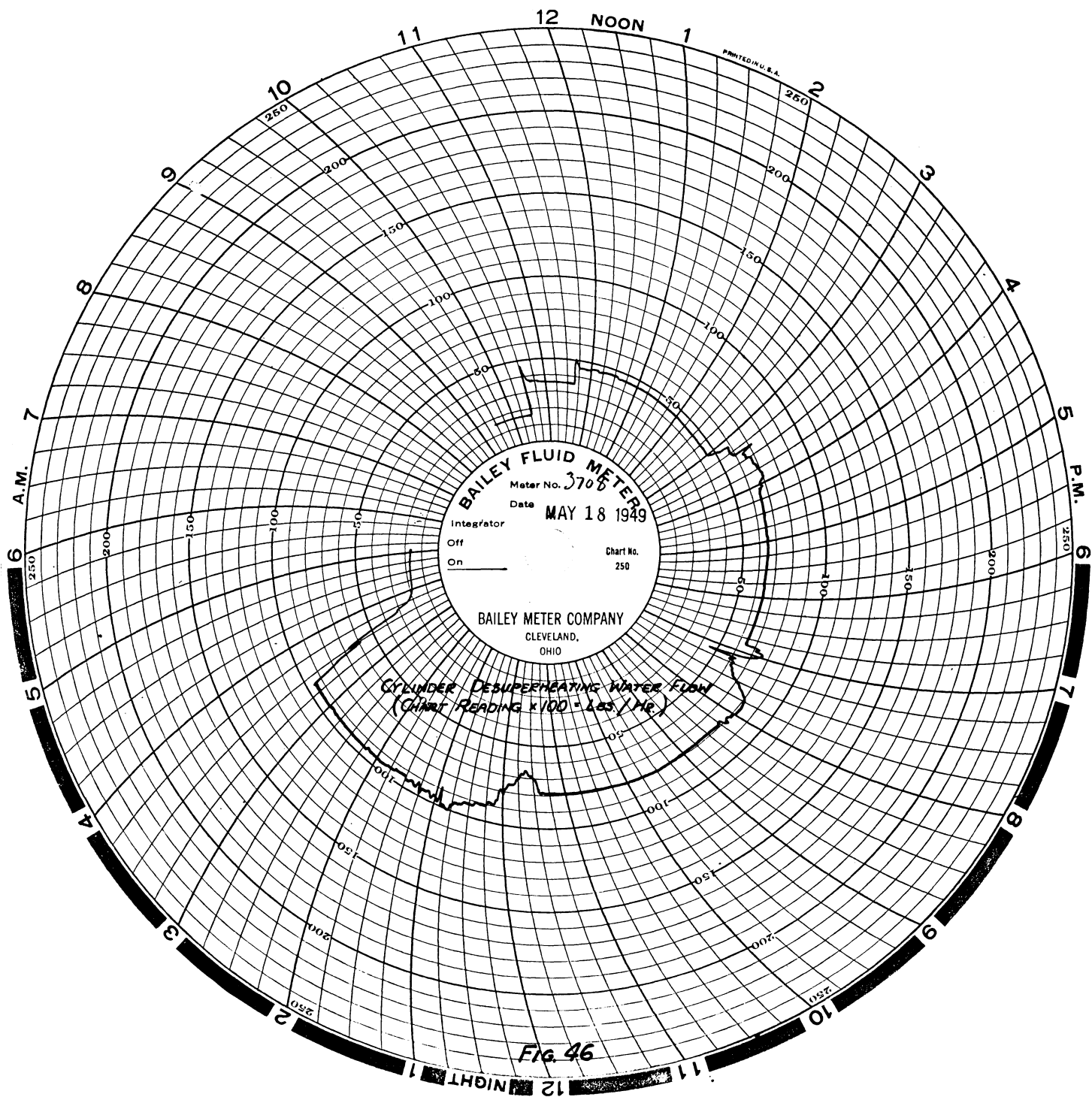


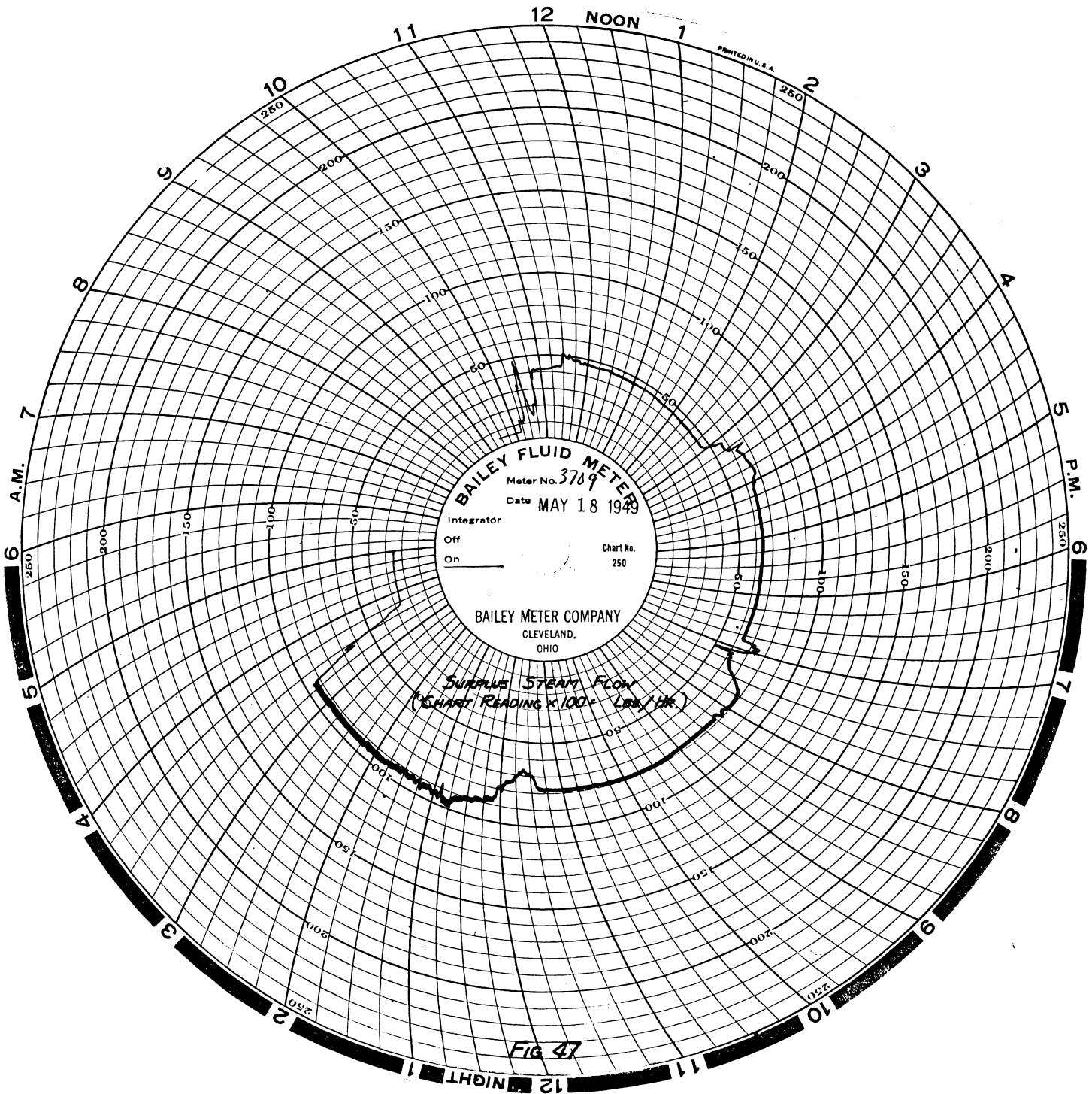


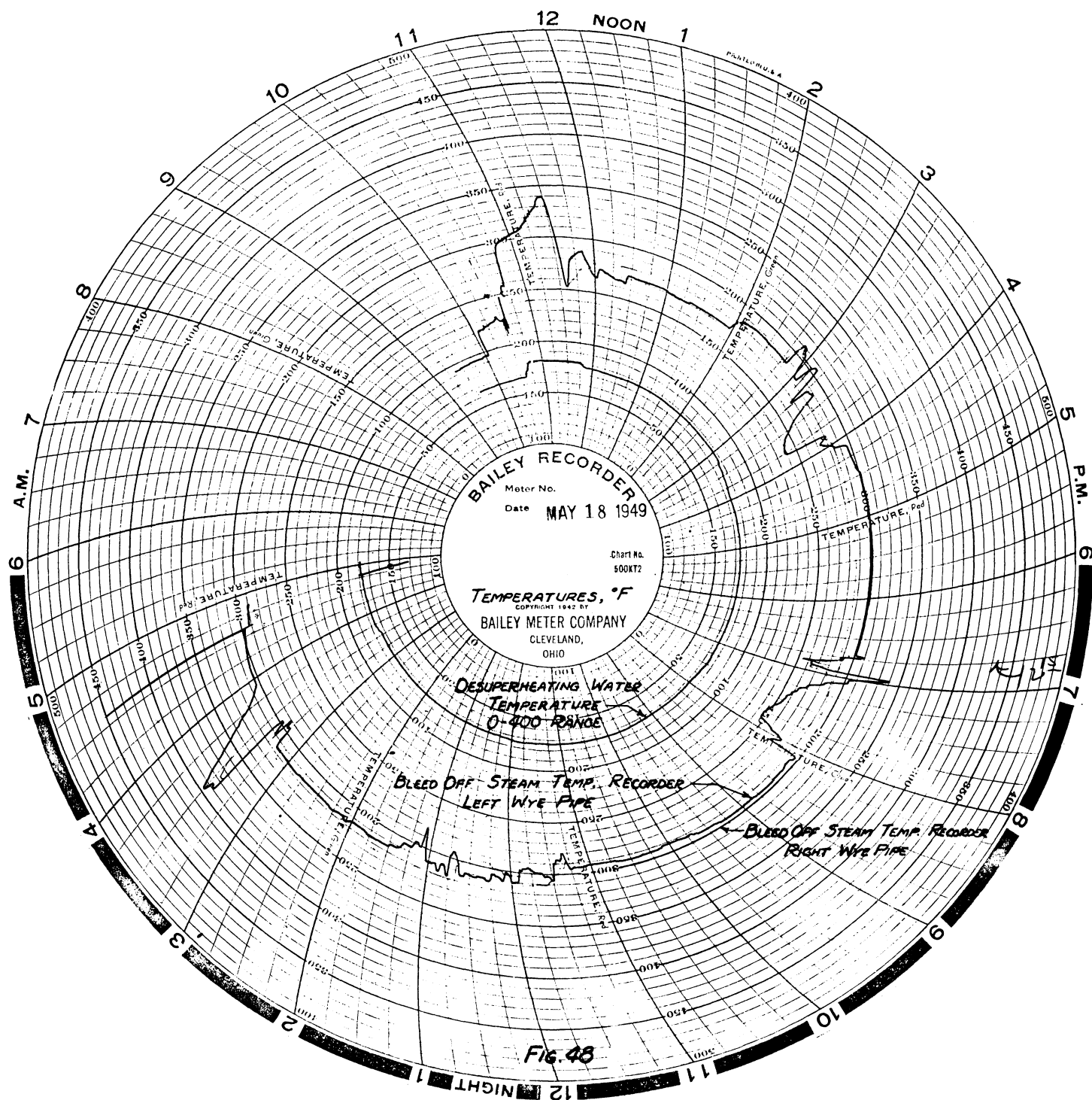
FIG. 43

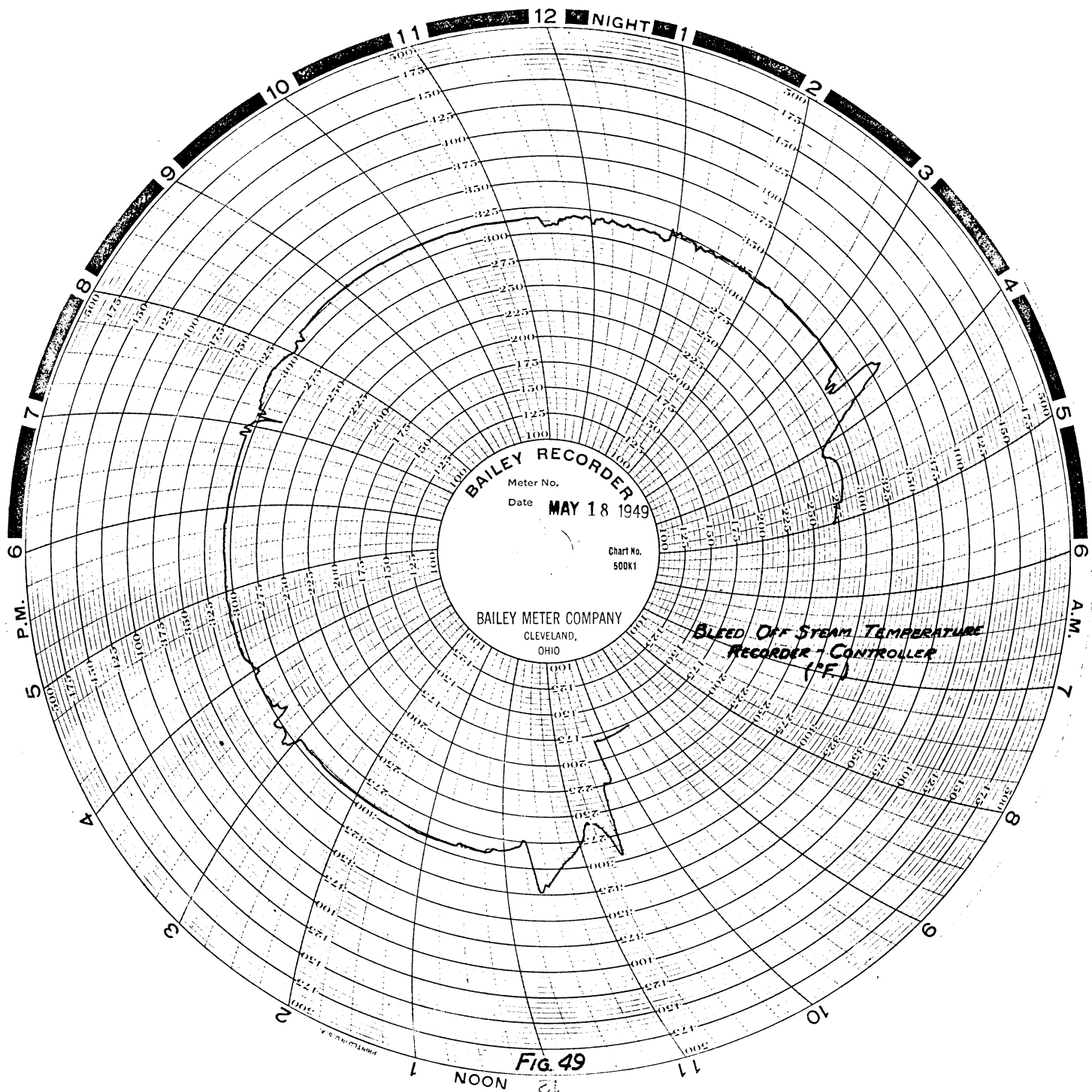












MAY 18 1949

MAY 18 1949

DEGREES FAHRENHEIT

DEGREES FAHRENHEIT

0 100 200 300 400 500 600 700 800 900 1000

13#Y
10#Y

3

2

12

DEGREES FAHRENHEIT

DEGREES FAHRENHEIT

0 100 200 300 400 500 600 700 800 900 1000

10#Y
7#Y

11

8

DEGREES FAHRENHEIT

DEGREES FAHRENHEIT

0 100 200 300 400 500 600 700 800 900 1000

7#Y
4#Y

7

DEGREES FAHRENHEIT

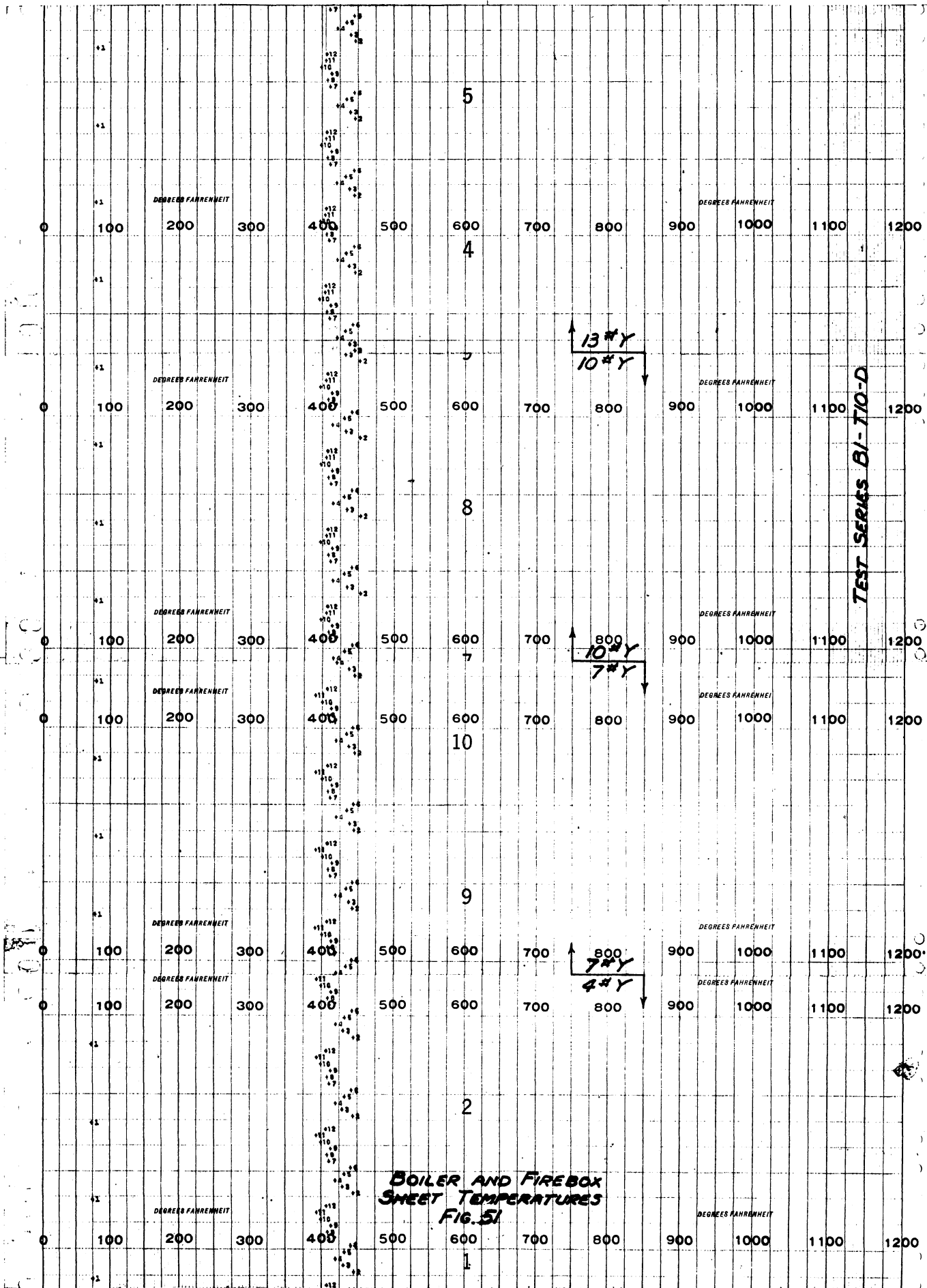
DEGREES FAHRENHEIT

0 100 200 300 400 500 600 700 800 900 1000

TEMPERATURE OF
SMOKEBOX FLUE GASES
FIG. 50

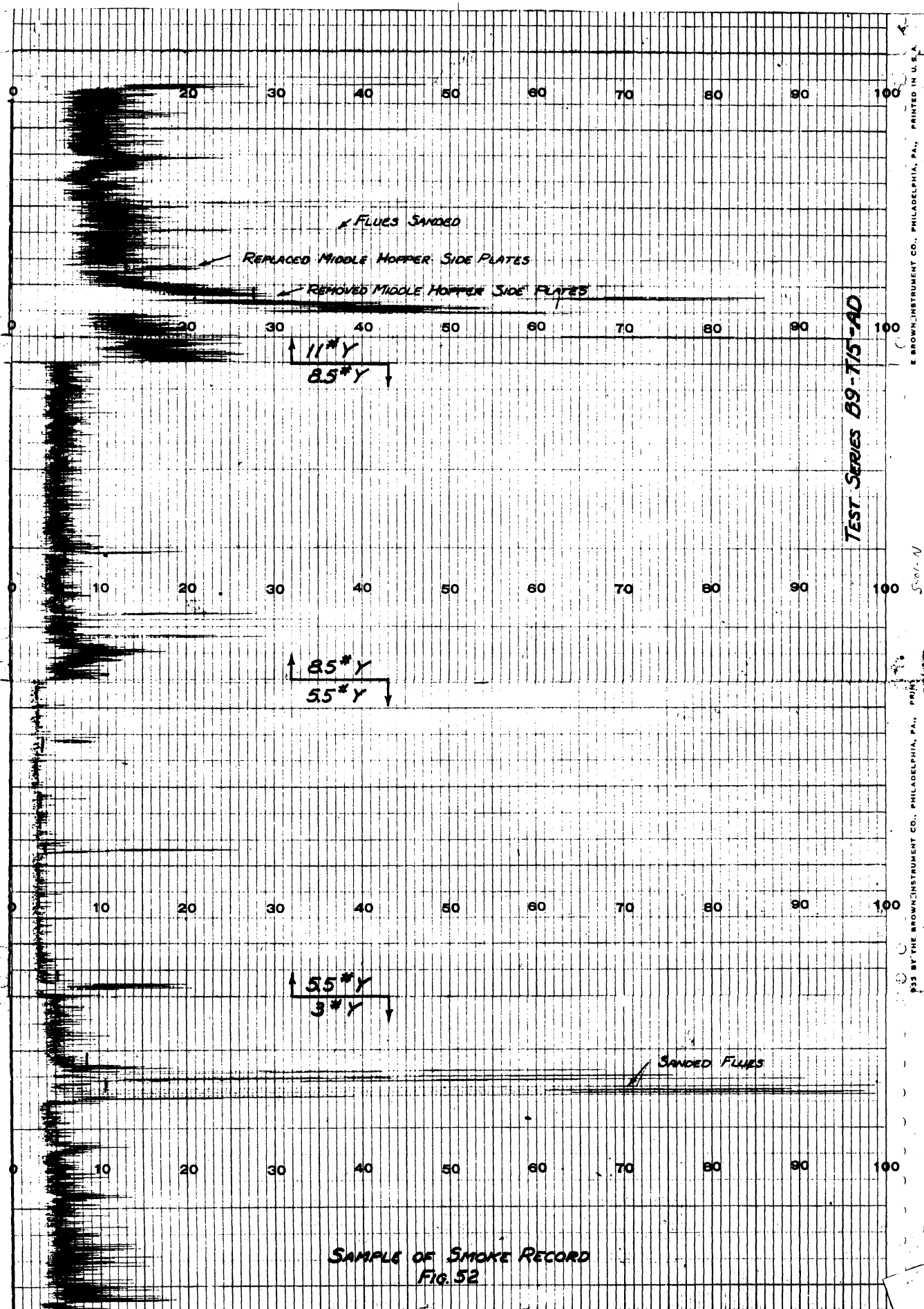
TEST SERIES BI-T10-D

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BOILER AND FIREBOX
SHEET TEMPERATURES
FIG. 51

TEST SERIES B1-T10-D



SAMPLE OF SMOKE RECORD
FIG. 52