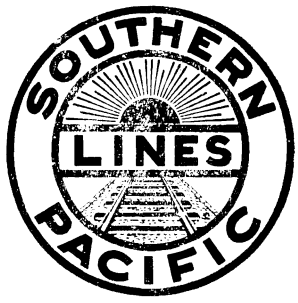

SOUTHERN PACIFIC COMPANY

SPARK ARRESTER TESTS, ENGINE 4401

SACRAMENTO LOCOMOTIVE STANDING TEST PLANT

San Francisco, Calif.,
November 12, 1947.

Report No. ST-1.

RESEARCH PROGRAM

ON

OIL-BURNING

STEAM LOCOMOTIVES

-

SPARK ARRESTER TESTS

-

ENGINE SP 4401

-

LOCOMOTIVE STANDING TEST PLANT

SACRAMENTO, CALIFORNIA

OFFICE GENL. SUPT. MOTIVE POWER
SOUTHERN PACIFIC COMPANY
SAN FRANCISCO, CALIFORNIA

REPORT NO. ST-1
DATED NOVEMBER 12, 1947.

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PURPOSE OF TESTS

Standing Tests on Engine SP 4401 as covered by this report were conducted at Sacramento Locomotive Test Plant to determine the relative performance characteristics and economies of cylindrical basket type spark arrester netting arrangement as shown by Drawing GO-E-5520, page 38, and photographs, pages 9 to 11, inclusive, as compared with present standard front end spark arrester arrangement (commonly known as Master Mechanic's Front End) and shown by Figure 2, page 7. Tests were also made on locomotive with entire spark arrester removed for comparative purposes. Tests with present spark arrester are designated in this report as Series "A"; without spark arrester, as Series "B" and with basket type netting as Series "C".

CONCLUSIONS AND RECOMMENDATIONS

As a result of these series of tests, it is evident that the cylindrical basket type spark arrester is superior to the Master Mechanic's Front End presently used. The use of the basket design will result in maintenance and operating economies including potential saving in fuel oil consumption. Based on information obtained from these standing tests, fuel consumption over the operating range of indicated horse power output can be reduced by approximately 3.5% with basket type netting as indicated by graph on page 32. This fuel saving will result from the fact that removal of restrictions to gas flow in smokebox now existing with Master Mechanic's Front End design including deflecting plates and numerous changes in direction of flow will be eliminated with the basket design. Removal of these restrictions naturally causes

a favorable redistribution of draft relationships between firebox and front end with the consequence that the equivalent volume of air and gas can be removed at a reduced back pressure. This, of course, can result in increased cylinder horse power or the attainment of the same cylinder horse power with reduced fuel consumption as compared with Master Mechanic's Front End. Another resulting advantage from use of cylindrical netting is increased accessibility to flues and superheater units by maintenance forces due to elimination of necessity for removing front end plates and netting.

Series "B" tests conducted without spark arrester showed very slightly better draft conditions than Series "C" with basket type arrangement. However, both Series "B" and Series "C" showed much improvement over Series "A" as represented graphically on Figure 4, page 30, showing draft differential between exhaust nozzle and firebox at various back pressures.

It is recommended as result of this investigation that cylindrical basket type spark arrester be adopted as standard for oil burning steam locomotives in place of Master Mechanic's Front End in view of economies that would result from its use. The basket arrangement offers only slightly higher resistance to flow of air and gases than the front end without spark arrester and until further study has been made of other spark arresters both at Battelle Memorial Institute and Sacramento Locomotive Test Plant, the basket type is the most desirable design yet considered.

With the removal of Master Mechanic's Front End and substitution of the basket type netting therefore, and the resultant ability to move a larger volume of gas and air through the boiler

for a given back pressure, it is further recommended that additional consideration be given to modification in nozzle diameter and cross split design and also to modification of exhaust pipe and stack relationships which can now be accomplished account removal of table plate in smokebox. It is possible that further fuel economies can be obtained by this means.

DESCRIPTION OF LOCOMOTIVE AND TEST PLANT

Spark arrester tests covered by this report form a part of the general research program on oil burning steam locomotives being conducted by Southern Pacific Company in conjunction with the Texas & New Orleans R.R. and Battelle Memorial Institute. Engine SP 4401 has been selected for tests incident to this research program inasmuch as it is representative of 4-8-4 type locomotives Class GS-1 operated on both Southern Pacific and T&NO lines. Locomotive was built by Baldwin Locomotive Works and first placed in service in August 1930. Principal dimensions and data on this locomotive are shown by Figure 1, page 4.

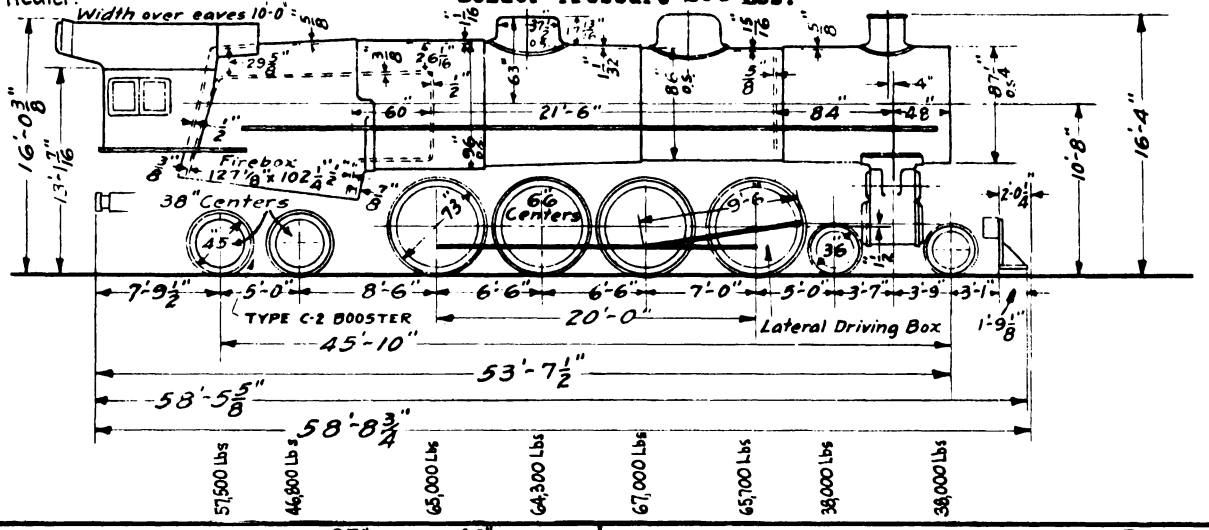
The engine has two simple cylinders using steam at 250 pounds per square inch, boiler pressure. The 12" diameter piston valves are controlled by a Walschaert valve motion and by an ALCO power reverse gear. The piston valve maximum travel is 7-1/4"; steam lap, 1-3/4"; lead, 1/4"; exhaust clearance, 3/16"; maximum cutoff, 73½% of stroke.

The boiler is a conical, radial stayed type, with sloping back head, inside dry pipe, type "E" superheater with end of units located 24" from the back tube sheet, and a multiple front end throttle. The boiler is supplied by a Worthington

Equipped with Nº 5 S Worthington Feedwater Heater.

Class G5-1, G5-73 $\frac{27}{30}$ $\frac{262}{8-104}$-SF

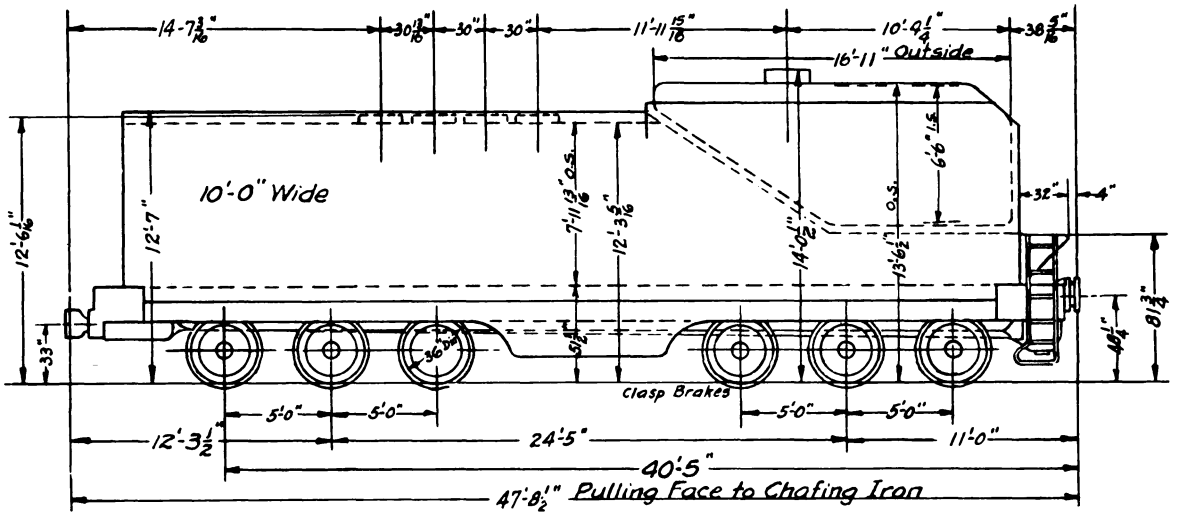
Boiler Pressure 250 Lbs.



Cylinders	27" Dia. X 30" Stroke
Weight on Drivers	262,000 Lbs
Weight on Front Truck	76,000 Lbs
Weight on Trailing Truck	104,300 Lbs
Weight on Engine-Loaded	442,300 Lbs
Driving Axle Journals-Main	13" X 14"
Driving Axle Journals-Front	12" X 14"
Driving Axle Journals-Others	12" X 14"
Engine Truck Journals	7" X 14"
Trailing Truck Journals	Front 7"x14" Back 9"x14"
Boiler Tubes-Length of	21'-6"
Boiler Tubes-No. of	49-2 1/4" & 198-3 1/2"

Heating Surface of Boiler Tubes	4502 Sq.Ft
Heating Surface of Firebox	356 Sq.Ft
Heating Surface-Evaporating	4858 Sq.Ft
Heating Surface of Superheater	2565 Sq.Ft
Heating Surface-Combined	7423 Sq.Ft
Boiler Capacity	96.1 %
Tractive Effort to Adhesive Wt.	.237
Tractive Effort-(M.E.P. 83 %)	62,200 Lbs
Tractive Effort of Booster	13,710 Lbs
Total Tractive Effort	75,910 Lbs

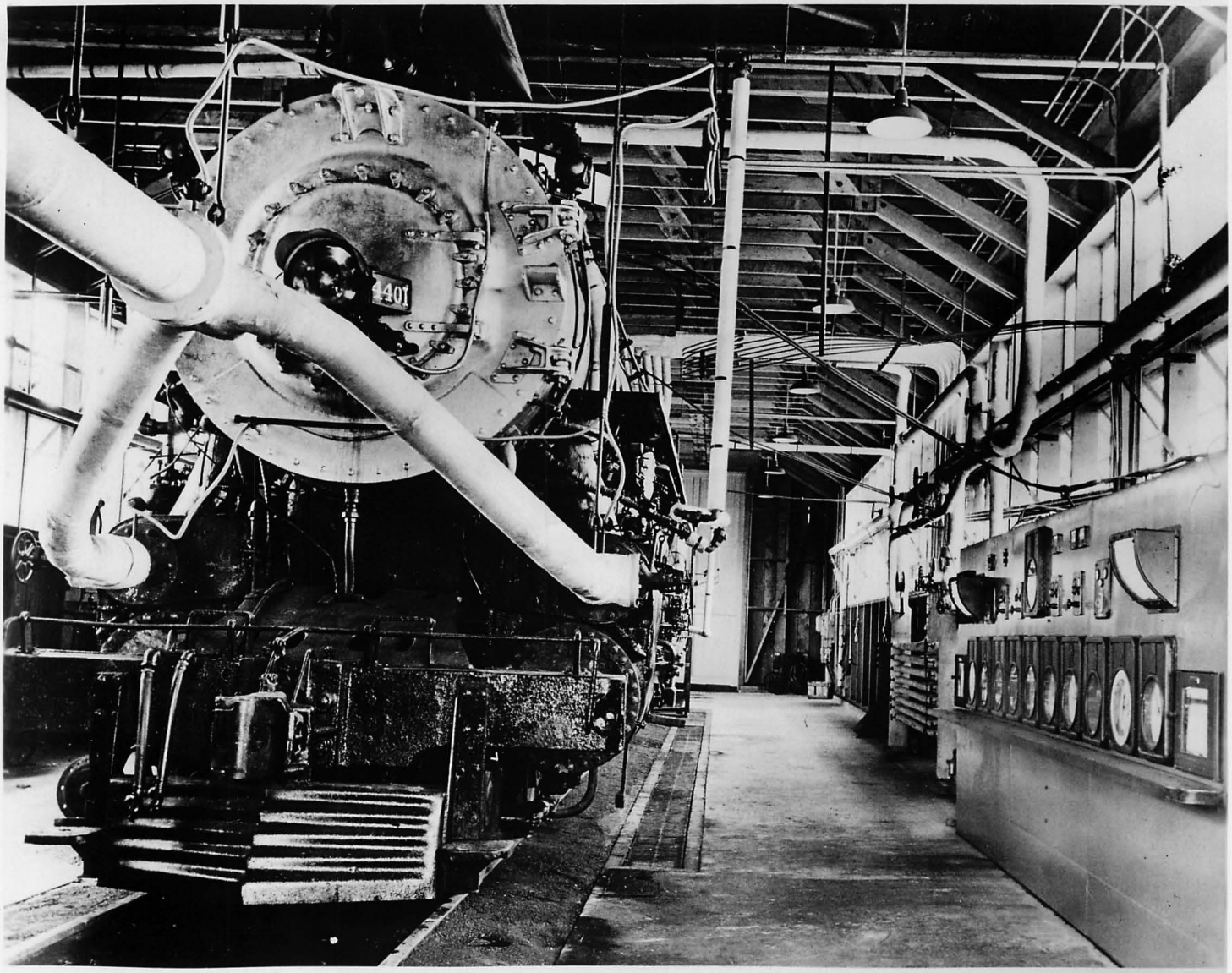
Tender Class 220-R-1



DIMENSIONS AND WEIGHTS FOR LOADED TENDER.

CAPACITY OF OIL TANK	6,275 GALS.	SIZE OF TRUCK JOURNAL	7"x 14"
GALLONS OF OIL TO MARKER BAR	6,062 GALS.	WEIGHT OF TRUCK	26,950 LBS.
CAPACITY OF WATER TANK	21,600 GALS.	WIDTH OVER FRONT STEPS	10'-1 1/8"
WEIGHT OF TENDER, EMPTY	145,000 LBS.	WIDTH OVER BACK STEPS	9'-10"
WEIGHT OF 21,600 GALLONS OF WATER	180,000 LBS.	EXTREME WIDTH (over Front Steps)	10'-1 1/8"
WEIGHT OF 6,062 GALLONS OF FUEL OIL	50,500 LBS.	Width over end sills	9'-10"
WEIGHT OF TENDER, LOADED	375,500 LBS.		
JOURNAL PRESSURE IN POUNDS PER SQUARE INCH OF PROJECTED AREA			300 lbs.

FIG. 1



Lab. No. ST-16-2

General view in test plant prior to installation of some platforms and apparatus but showing Wye pipe, for removal of "surplus" steam, connected to exhaust steam end of chest by special steam chest heads.

type 5-S feedwater heater, capacity 9,000 gallons per hour, and a Nathan non-lifting injector, capacity 7,500 gallons per hour. The feedwater hot pump has an SA type steam valve gear.

Spark arrester tests were conducted in Standing Test Plant at Sacramento Laboratory which was designed and constructed for the general research program. Test plant is completely equipped with necessary instruments and automatic controls to insure most accurate results and uniform operation of locomotive boiler. Photograph of locomotive SP 4401 as installed in Locomotive Test Plant is shown on page 5.

DESCRIPTION OF SPARK ARRESTER DESIGNS

1. Present Arrangement:

The present standard front end spark arrester arrangement used on Pacific Lines is commonly known as Master Mechanic's Front End. This design is based on that originally developed at Purdue University Locomotive Laboratory in cooperation with Locomotive Railway Master Mechanic's Association many years ago and recommended as standard front end by that committee. This arrangement as modified for use in Pacific Lines' locomotives is shown by Figure 2, page 7. As can be noted from Figure 2, this front end arrangement consists of a deflecting plate inclined toward front tube sheet, a small section of which consists of spark arrester netting. A so-called "table plate" is installed under the exhaust nozzle and is attached to a section of netting inclined toward the smokebox door. At the front of this table plate is a deflecting plate extending downward and forward at an angle. The entire arrangement of plates and netting extends across the smokebox so that the major portion of gases emitted from front tube sheet is necessarily drawn under the table plate

Diagram of Smokebox Arrangement Standing Test, Series "A", SP Standard Arrangement Showing Points of Measurement of Drafts, Temperatures and Pressures

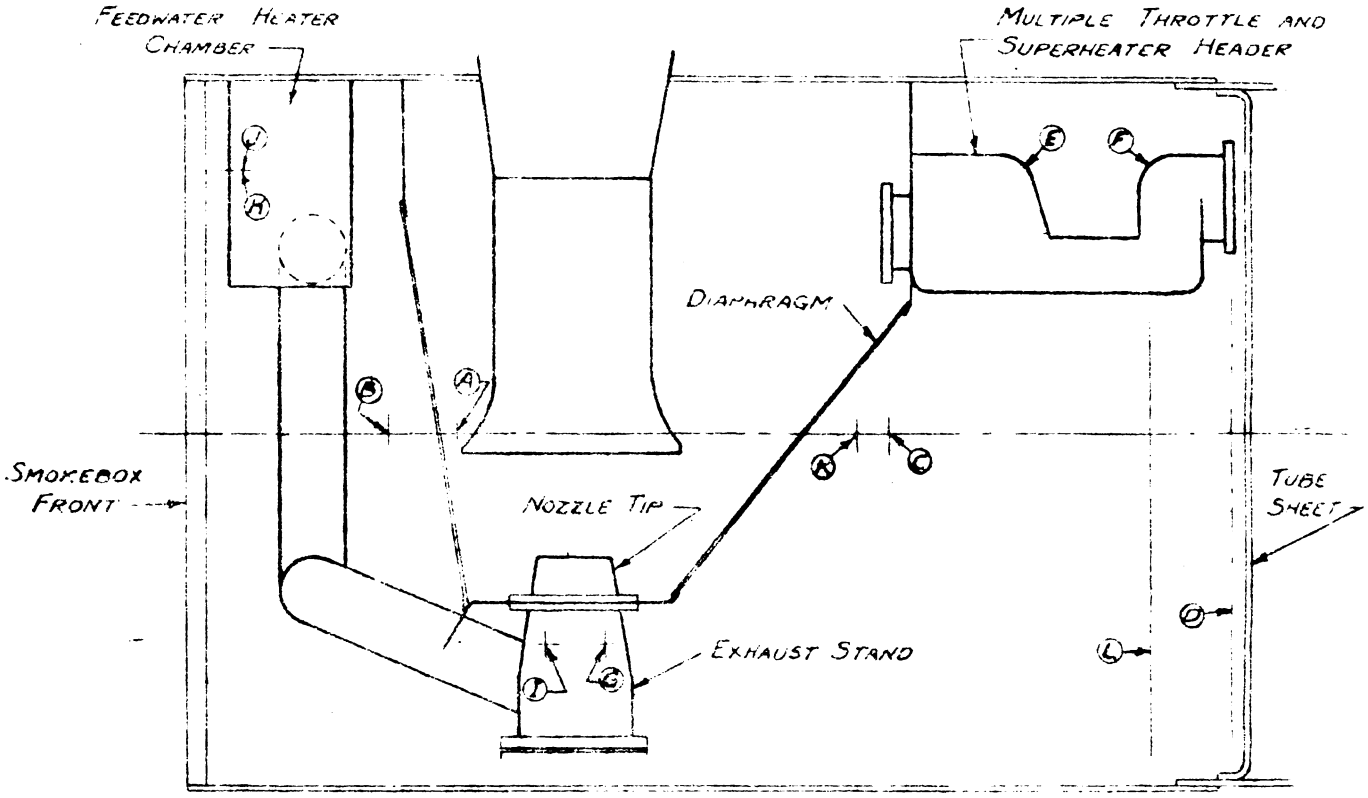


Figure 2

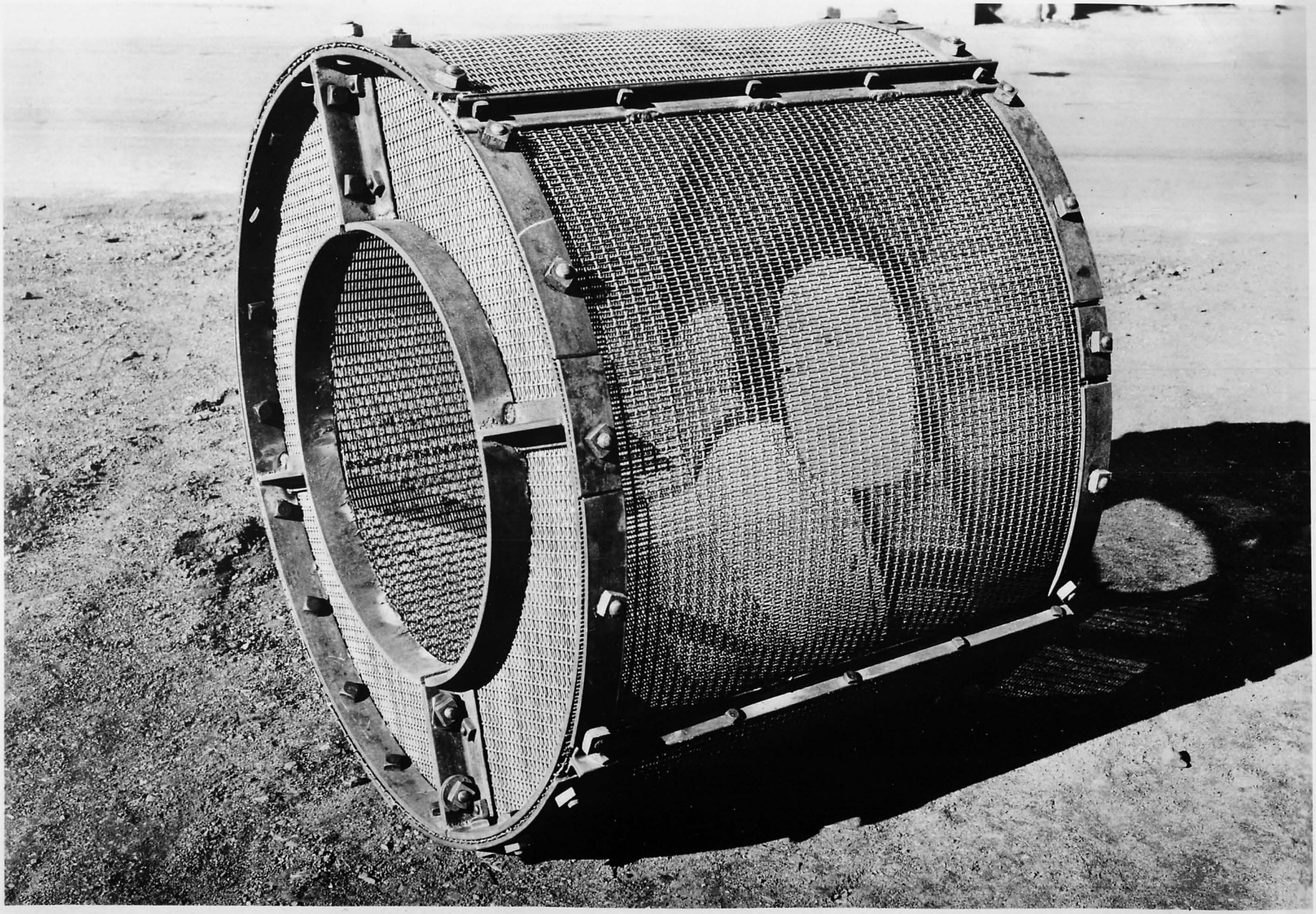
- (A) Draft, Position No. 1, Inside Netting.
- (B) Draft, Position No. 2, Front of Netting.
- (C) Draft, Position No. 3, Back of Diaphragm.
- (D) Drafts, Position Nos. 4-10, 2" Ahead Front Tube Sheet.
- (E) Pressure, Superheated Steam.
- (F) Pressure, Saturated Steam.
- (G) Pressure, Exhaust Steam to Nozzle.
- (H) Pressure, Exhaust Steam to FWH.
- (I) Temperature, Exhaust Steam to Nozzle.
- (J) Temperature, Exhaust Steam to FWH.
- (K) Temperature, Position No. 1, Flue Gases.
- (L) Temperatures, Position Nos. 2-8, Flue Gases, 12" Ahead Front Tube Sheet.

Standing Test Plant, Sacramento — October 31, 1947

and around through front section of netting, with a lesser portion being short-circuited through narrow section of netting in back deflecting plate. The resistance to air and gas flow caused by this arrangement is self-evident when considering the path which exhaust gases must travel to escape from stack. A high draft at exhaust nozzle must be induced by the exhaust steam jet from the nozzle in order to draw the gases through this front end arrangement.

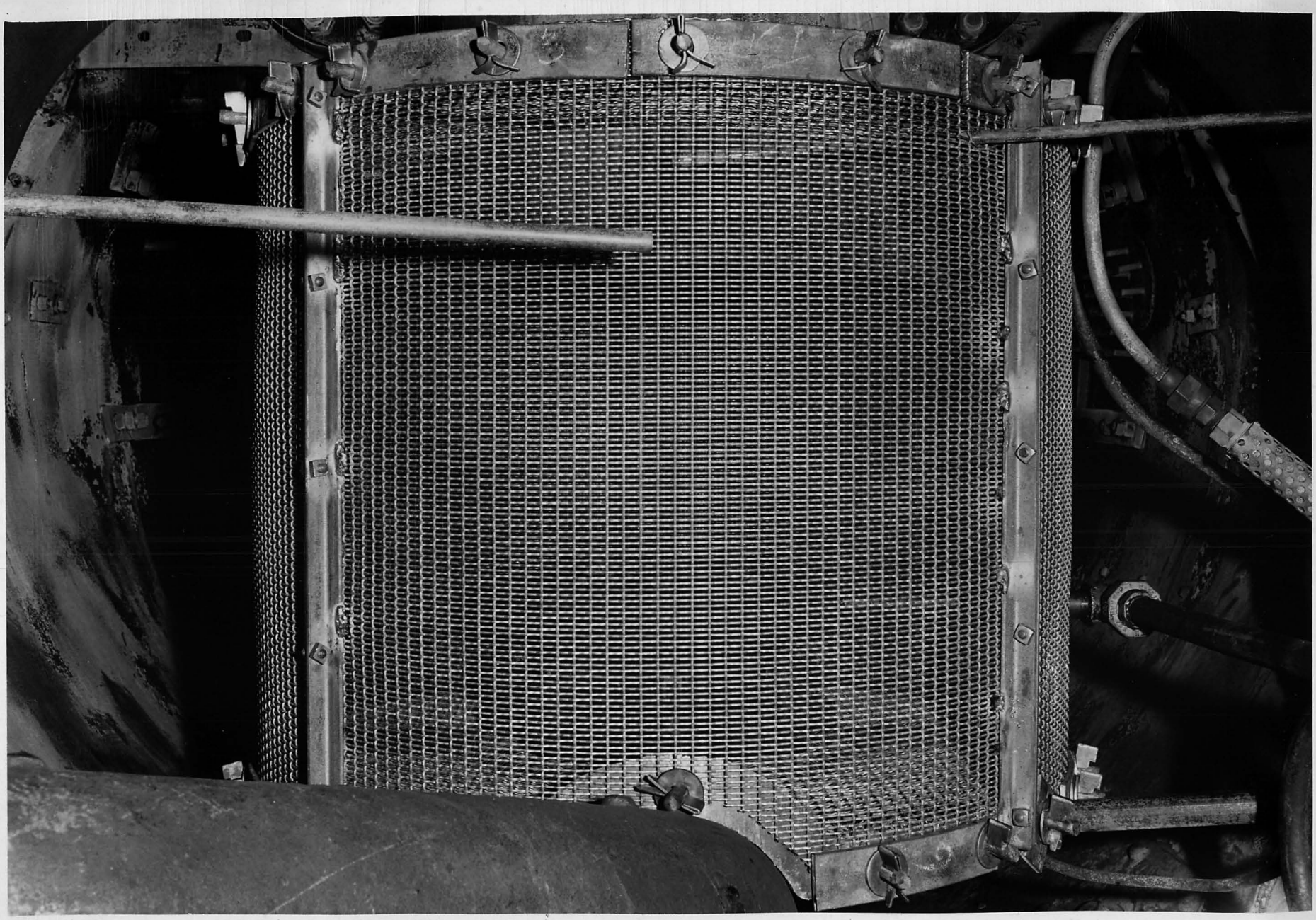
2. Cylindrical Basket Type Netting Arrangement:

About the simplest type spark arrester netting arrangement that can be designed to reduce resistance to gas flow is the basket type arrester which is applied between lower portion of stack extension and upper flange of exhaust stand. For simplicity of design and structural strength, the circular construction was chosen for test purposes. Details of construction of this test spark arrester are shown on Drawing GO-E-5520 on page 38 and photographs showing netting before and after application are shown on pages 9 to 11, inclusive. Spark arrester screen used both in the Master Mechanic's Front End and Basket Type Netting was present standard Tyler No. 363 "Draftac" Steel Wire Netting.

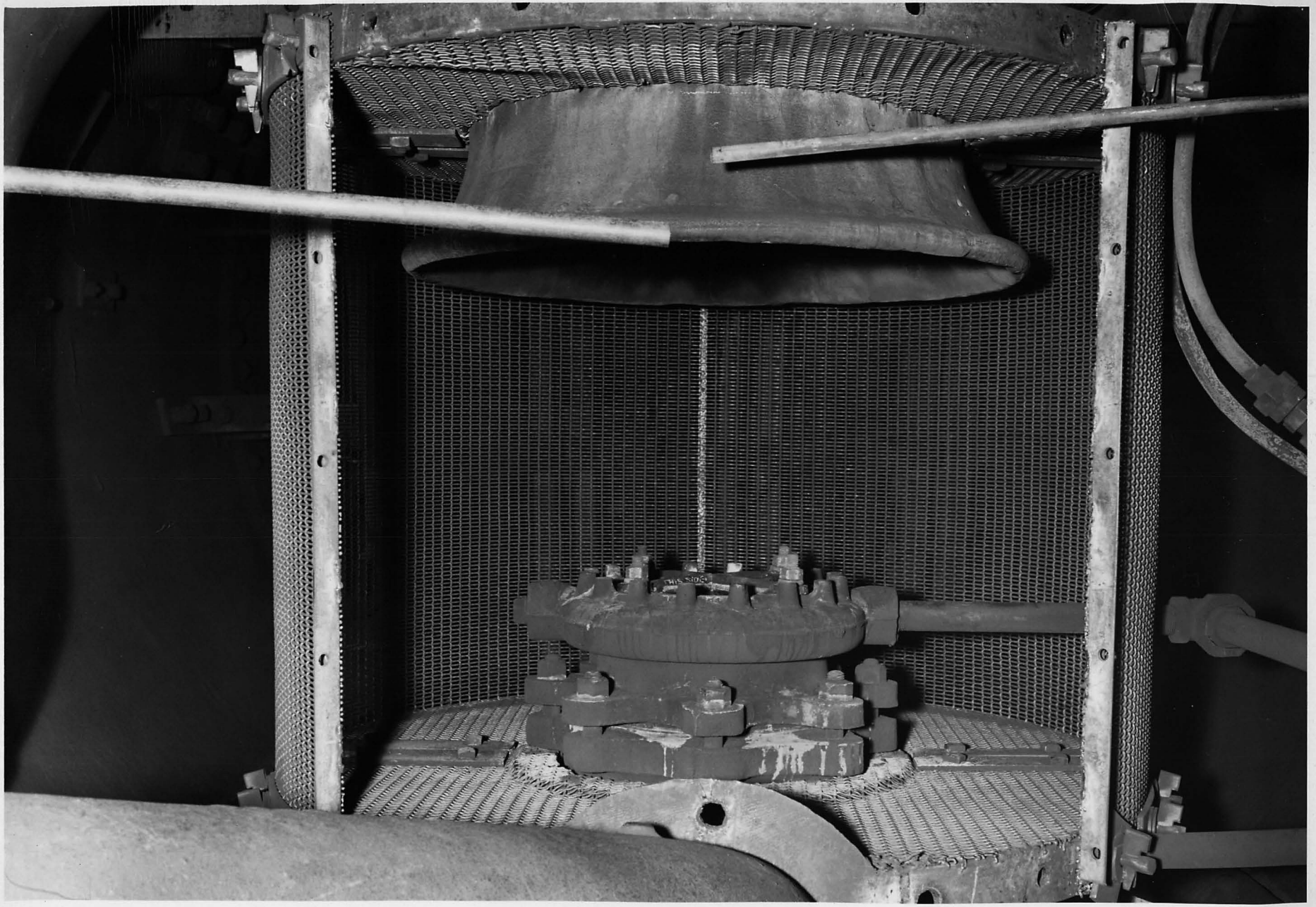


Lab. No. ST-28-2

Cylindrical, Basket Type Spark Arrester, showing removable front section for access to nozzle and cross split.



Lab. No. ST-28-3: Test Installation of Cylindrical, Basket-Type Spark Arrester. Shows cut-out made for pipe to feedwater heater, and removable section for access to nozzle; also, tubes for measurement of draft, and to right, flue gas sampling tubes.



Lab. No. ST 28-4

Cylindrical, Basket Type Spark Arrester. Front section removed to show nozzle.

DATA SHEETS

Three series of test runs were made as the basis for this study and are designated in data sheets, photographs, graphs and discussions as follows:

Series "A": Locomotive equipped with present standard Master Mechanic's Front End (pages 13 to 17, incl.)

Series "B": Locomotive without spark arrester (pages 18 to 22, incl.)

Series "C": Locomotive equipped with cylindrical basket type spark arrester (pages 23 to 27, incl.)

The following data sheets show results of test runs.

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES A, No. 1, RUN NO. ____

Operator's Name ADOLPH A PYLE

Date OCT 23, 1947

	Test No.	203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
		PRESSURES, Lbs. Sq In., Gage				DRAFTS, INCHES OF WATER										
	Time	Boiler at Dome	Exh. Steam in F. W. H.	Steam in "Y" Pipe	Exh. Stm. at Nozzle	Firebox	In side Netting	Front of Netting	Back of Diaphragm	5 SMOKE BOX 12" from Smokebox Tube Sheet - Top Center	Left Top	Right top	Left ½ up	Right ½ up	Bottom Center	Centr ½ up
		A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1	2:20	240	8.25	10	9	10	17	16.8	15.7	15.5	15.5	15	14.8	15.2	15	15
2	2:25	240	9	9.5	9	8.8	16.6	16.1	14.6	14.6	14.6	14.8	15	15.1	14.9	14.9
3	2:30	240	8.75	9.5	9	9.6	16.5	16	14.5	14.5	14.5	14.5	14.9	15	14.8	14.7
4	2:35	240	8.5	9.5	9	9.8	16.3	16	14.6	14.5	14.6	14.8	15.2	14.8	14.9	14.9
5	2:40	240	8.75	9.5	9	9.6	16.3	16	14.5	14.5	14.3	14.4	14.8	14.9	14.8	14.7
6	2:45	240	8.75	10	9	9.8	16.8	16.2	14.5	14.4	14.5	14.5	14.9	14.6	14.8	14.7
7	2:50	240	8.5	9.5	9	9.8	16.4	16.3	14.7	14.6	14.5	14.5	14.7	14.8	14.7	14.6
8	Average	240	8.64	9.64	9.0	9.63	16.56	16.20	14.72	14.66	14.64	14.64	14.90	14.91	14.84	14.79
9																
10																
11																
12	12:55	240	5	5	5	6.5	11	11	9.5	9.5	9.5	9.5	10	10	10	10
13	1.00	240	5.25	5	5	6	10.5	10.5	9.5	9	9.5	9.5	10	10	10	10
14	1:05	240	5	5	5	6	10	10.5	10	10	10	10	10	10	10	10
15	1:10	240	4.3	5	5	6	10	10	9	9.5	9.5	9.5	9.8	9.8	9.8	9.5
16	1:15	240	6	7	6	6.5	11.2	9.9	9.6	9.5	9.6	9.8	9.9	9	9	8.5
17	1:20	240	5.1	5	5	6	10.2	9.8	8.8	9	9	9.2	9.2	9	9	9
18	1:25	236	5	6	5	5.3	9.8	9.7	8.7	8.9	9	9.1	9.3	9	9	8.9
19	Average	239.4	5.09	5.29	5.14	6.04	10.39	10.20	9.30	9.34	9.44	9.52	9.74	9.54	9.54	9.41
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STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES A, No. 1, RUN NO. ____

Operator's Name ADOLPH A PICE

Date OCT. 28, 1947

ITEM No.		203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
		PRESSURES, LBS. Sq. In. Gage				DRAFTS, INCHES OF WATER										
										SMOKE BOX						
										12" from Smokebox Tube Sheet						
LINE No.	Time	Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Stm. at Nozzle	Firebox	Inside Netting	Front of Netting	Back of Diaphragm	Top Center	Left Top	Right Top	Left Bot	Right Bot	Bottom Center	Center Bot
		A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1	11:40	238	14	15.5	14.5	14.2	25.2	25	22.4	22.5	23.4	22.6	22.8	23	22.5	23
2	11:45	236	14.75	16	15.5	14.4	25.8	24.9	22	22	22.5	22.2	23	23	22.7	22.5
3	11:50	236	14.75	16	15	14	25.4	24.5	22	21.8	22.1	22.1	22.5	22.3	22	21.8
4	11:55	236	14	16	15	14.2	25.2	24.6	22.6	22.2	22.4	22.5	22.7	22.7	22	22
5	12:00	238	14.5	15.5	15	14	24.8	25	22.3	22.1	22.8	23	23.3	22.8	22.7	22.6
6	12:05	237	14.25	15.75	15.25	14	25.2	25	22.5	22.5	22.5	22.6	23	23.1	22.5	22.3
7	12:10	238	145	16.0	15	14.5	25.2	25	22.4	22.4	22.8	22.5	22.8	22.8	22.7	22.4
8	Average	237	14.39	15.82	15.03	14.19	25.2	24.86	22.31	22.21	22.46	22.50	22.87	22.81	22.44	22.23
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STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES A, No. 1, RUN No. ____

Operators Name ALVIN M REISS JR Date ____

ITEM No.			303	313	314	304	303A	308B	309	312	307	307A	316	314	
		TEMPERATURES, DEGREES F.											L Cyl	R Cyl	Tempo
Time Int. No.	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. Stm at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Steam Pipe	Right Main Steam Pipe	Dummy Calorimeter	Dry Pipe Calorimeter	At Junction of Y & Pipe
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	2:20		65	167	169	221	231	306	327	485	673	695	276	243	329
2	2:25		65	166	167	230	229	308	325	480	674	696	270	242	327
3	2:30		65	165	167	230	229	303	323	480	674	694	270	243	326
4	2:35		65	164	166	229	229	301	324	469	677	693	273	243	325
5	2:40		65	163	165	230	229	311	325	464	673	695	268	243	323
6	2:45		65	163	165	230	229	311	327	462	674	697	268	243	323
7	2:50		65	162	164	229	228	314	329	463	678	699	275	244	326
8	Average		65	163.3	166.1	228.4	229.1	307.7	325.7	471.9	674.7	695.6	271.4	243.0	325.6
9															
10															
11															
12	12:55		66	152	154	220	219	243	300	220	653	667	224	223	290
13	1:00		65	152	155	220	219	234	298	219	649	667	232	233	293
14	1:05		65	153	154	220	219	262	301	219	649	668	236	234	291
15	1:10		65	153	155	219	218	246	297	219	648	668	234	233	294
16	1:15		65	153	156	220	220	231	297	219	650	669	234	233	294
17	1:20		65	154	156	219	219	220	299	219	645	665	233	231	292
18	1:25		65	154	158	219	218	244	299	299	648	667	233	231	290
19	Average		65	153.0	155.4	219.6	218.9	240.0	298.7	219.1	648.9	667.3	232.3	231.1	292.0
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32															
33															
Time Int. No.															
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2A															
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4A															
5A															
6A															
7A															
8A															

STANDING TEST PLANT - SACRAMENTO

ENGINE No. 4401, TEST SERIES A, No. 1, RUN No. ____

Operators Name A.M. Reiss Jr Date Oct. 28, 1947

ITEM No.			303	313	314	304	303A	308B	309	312	307	307A	311	311A	
		TEMPERATURES, DEGREES F.											"Y" PIPE TEMPS		
Line No.	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. Stm at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Steam Pipe	Right Main Steam Pipe	Aft. L. Cyl. Bonnet Calorimeter	Aft. Cyl. Drip Pipe Calorimeter	At Junction of Y Pipe
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	11:40	64	65	167	169	243	240	396	400	349	705	712	404	391	399
2	11:45	64	65	168	169	244	243	392	397	346	707	715	397	385	395
3	11:50	64	65	169	170	244	243	389	394	345	703	715	395	385	391
4	11:55	63	64	169	170	243	243	403	403	347	699	713	406	399	401
5	12:00	63	64	169	171	243	243	403	405	339	705	717	410	401	404
6	12:05	63	64	169	170	243	243	403	405	339	704	717	409	400	403
7	12:10	63	64	169	170	243	242	404	405	340	700	717	406	401	402
8	Average	63.4	64.4	168.6	169.9	243.0	242.4	398.6	401.2	342.6	703.3	715.1	403.9	394.6	399.3
9															
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Line No.															
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5A															
6A															
7A															
8A															

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES A NO. ___ RUN NO. ___

DATE _____

	10-23-47			10-28-47
OIL	No. 1	No. 2		No. 3
A. Meter Reading Start	20587.70	21201.44		29780.5
B. Meter Reading Finish	20785.39	21459.48		30106.9
C. Gallons Difference (B-A)	197.69	258.04		326.4
D. Length of Run - Min.	30	30		30
E. Flow Rate - GPM (C/D)	6.59	8.60		10.88
F. Meter Factor (from curve)	.9825	.9754		.9708
G. Ave. Temperature at Meter	153	164		169
H. Temperature Correction Factor	.9680	.9643		.9627
I. Moisture Content - %	0.33	0.33		0.16
J. Dry Oil at 60°F. - Gals. (CxFxHx(1-I/100))	187.39	241.91		304.56
K. Density - Lbs./Gal.	8.382	8.382		8.340
L. Heat Value, Dry - BTU/Lb.	18165	18165		18270
M. Oil Burned - Lbs. (JxK)	1570.7	2027.7		2540.0
N. Oil Burned per Hour - Lbs. (Mx60/D)	3141.4	4055.4		5080.0
HOT WATER				
A. Meter Reading Start	252720	259384		290872
B. Meter Reading Finish	254899	262267		294129
C. Gallons Difference (B-A)	2179	2883		3257
D. Length of Run - Min.	30	30		30
E. Flow Rate - GPM (C/D)	72.6	96.1		108.6
F. Meter Factor (from curve)	-	-		-
G. Corrected Gallons (CxF)	-	-		-
H. Average Temperature	219	230		237
I. Density - Lbs./Gal.	-	-		-
J. Hot Water - Lbs. (GxI)	18969	25072		31903
K. Hot Water - Lbs. per Hour (Jx60/D)	37938	50144		63806
COLD WATER				
A. Meter Reading Start	200797	206897		243989
B. Meter Reading Finish	202797	209513		247293
C. Gallons Difference (B-A)	2000	2616		3304
D. Length of Run - Min.	30	30		30
E. Flow Rate - GPM (C/D)	66.7	87.2		110.1
F. Meter Factor (from curve)	.9883	.9875		.9870
G. Corrected Gallons (CxF)	1976.6	2583.3		3261.1
H. Average Temperature	65	65		63
I. Density - Lbs/Gal.	8.330	8.330		8.333
J. Cold Water - Lbs. (GxI)	16465	21519		27175
K. Cold Water - Lbs. per Hour (Jx60/D)	32930	43038		54350
CONDENSATE FACTOR				
Lbs. Hot Water/Lbs. Cold Water				

S.T. SHEET No. 2

STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES B, No. 1, RUN No. ____

Operators Name AL MARION Date NOV. 8, 1947

ITEM No.			303	313	314	304	303A	308B	309	312	307	307A	311	311A	
Line No.	Time		TEMPERATURES, DEGREES F.												
		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. Stm. at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Steam Pipe	Right Main Steam Pipe	Dome Calorimeter	Dry Pipe Calorimeter	
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	8:45	62	67	157	158	252	252	403	397	322	718	727	408	410	405
2	8:50	62	63	157	159	252	251	405	397	314	718	730	410	414	408
3	8:55	62	63	158	160	251	251	404	398	300	719	720	410	412	408
4	9:00	63	63	158	160	251	251	404	397	297	720	730	410	410	406
5	9:05	62	62	158	160	250	250	404	398	290	721	730	414	412	410
6	9:10	62	62	158	160	252	251	403	398	287	718	729	414	410	409
7	9:15	62	62	158	160	252	251	400	397	285	719	727	412	406	408
8	Average	62	63	158	160	251.4	251.0	403	397	299	719	728	411	411	408
9															
10															
11															
12	9:45	62	63	160	164	240	240	376	374	222	698	703	382	374	382
13	9:50	62	63	160	164	242	241	374	372	221	695	701	379	376	381
14	9:55	62	62	160	165	240	240	378	374	221	697	706	379	378	381
15	10:00	62	63	161	166	241	240	378	374	221	696	703	381	377	381
16	10:05	62	63	167	169	240	240	380	376	221	699	704	383	378	383
17	10.10	62	63	167	170	241	240	378	375	232	696	704	380	377	382
18	10.15	62	62	166	169	240	240	376	372	232	695	700	375	369	379
19	Average	62	63	163	167	240.6	240.1	377	374	224	697	703	380	376	381
20															
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Line No.															
1A															
2A															
34															

STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES B, No. 1, RUN NO. ____

Operators Name R. ELLIOTT Date Nov. 8, 1947

ITEM No.		303	313	314	304	303A	308B	309	312	307	307A	311	311A	
		TEMPERATURES, DEGREES F.												
No.	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. Stm at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Steam Pipe	Right Main Steam Pipe	Dome Calorimeter	Dry Pipe Calorimeter	
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	10:50	63	63	165	169	231	231	328	328	395	672	678	294	285	332
2	10:55	63	63	164	169	231	231	327	327	395	672	678	296	285	331
3	11:00	62	63	166	171	231	230	325	327	398	675	679	292	283	331
4	11:05	62	63	165	171	231	230	326	326	394	674	675	290	276	
5	11:10	62	63	166	172	231	231	324	326	377	677	676	294	276	
6	11:15	63	63	164	169	231	230	322	325	373	678	677	297	278	
7	11:20	62	63	162	167	231	231	320	324	342	678	676	284	270	
8	Average	62	63	165	170	231	230.5	325	326	382	675	677	292	279	
9															
10															
11															
12	12:10	63	64	166	168	214	212	277	283	347	619	624	232	232	282
13	12:15	63	63	164	168	213	214	281	280	343	621	626	232	231	285
14	12:20	63	63	164	168	214	215	281	290	343	620	624	231	231	284
15	12:25	63	64	164	167	214	214	282	290	346	622	625	232	231	284
16	12:30	63	64	164	168	215	214	284	290	372	623	625	232	231	285
17	12:35	63	64	165	168	214	214	281	289	379	620	623	231	231	283
18	12:40	63	64	165	167	214	214	282	287	378	620	622	232	231	285
19	Average	63	64	165	168	214.0	213.9	281	287	358	621	624	232	231	284
20															
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S.T. SHEET NO 1

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B, No. 1, RUN NO. ____

Operator's Name ADOLPH A PYLE

Date Nov. 8, 1947

ITEM No.		203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
		PRESSURES, Lbs. Sq In., Gage				DRAFTS, INCHES OF WATER										
										SMOKE BOX						
										12" From Smokebox Tube Sheet						
Line No	Time	Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Stm at Nozzle	Firebox	Ins. Jo Netting	Front of Netting	Back of Diaphragm	Top Center	Left Top	Right Top	Left ½ up	Right ½ up	Bottom Center	Centr ½ up
		A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1	8:45	244	19.25	21.5	20	17.1	27.4	27.3	27.3	27.1	27.2	27.3	27.7	27.8	28	27.1
2	8:50	244	19	21	19.5	16.9	27.2	27.1	27.1	26.9	27	27	27.6	27.6	27.8	26.8
3	8:55	244	19	21	19.5	16.8	27	27	26.7	26.9	26.9	27.4	27.4	27.7	27.9	26.7
4	9:00	244	18.7	21	19.5	17	27.2	27.2	27.2	26.9	26.9	27.2	27.7	27.7	27.6	27
5	9:05	244	18.7	21	19.5	16.6	26.1	26.9	26.8	26.6	26.8	26.8	27.3	27.3	28	26.5
6	9:10	244	19	21	19.5	17	27.3	27.3	27.3	27.1	27.2	27.2	27.8	27.8	27.8	27.1
7	9:15	244	19.25	21.5	20	16.9	27.1	27.1	27.1	26.9	27.2	27	27.5	27.5	27.8	26.8
8	Average	244	18.99	21.14	19.64	16.90	27.16	27.13	27.07	26.91	27.03	27.13	27.57	27.63	27.84	26.86
9																
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11																
12	9:45	245	13.25	14.5	14	13.9	21.8	21.8	21.6	21.8	21.6	21.8	22.1	22.0	22.9	21.5
13	9:50	245	14.25	15	14.25	14.3	22.2	22.2	22.2	22.5	22.5	22.2	22.6	22.5	22.9	22
14	9:55	245	13.5	15	14.25	14.2	22.3	22.3	22.3	22.1	22.1	22.2	22.6	22.6	22.9	22
15	10:00	245	14	15	14.25	14.3	22.4	22.3	22.3	22.1	22.2	22.3	22.7	22.7	23	22.1
16	10:05	245	13.5	15	14	14	22.1	22	22	21.8	22	22	22.4	22.4	22.7	21.8
17	10:10	245	14	15	14.25	14.4	22.5	22.5	22.5	22.3	22.4	22.4	22.8	22.8	23.1	22.2
18	10:15	245	13.5	15	14	14.5	22.4	22.4	22.4	22.2	22.2	22.4	22.8	22.8	23	22.2
19	Average	245	13.71	14.93	14.14	14.23	22.24	22.21	22.19	22.11	22.14	22.19	22.57	22.54	22.93	21.97
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S.T. SHEET NO. 1

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B, No. 1, RUN NO. ____

Operator's Name ADOLPH A PYLE

Date Nov. 8, 1947

ITEM No.		203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
LINE	Time	PRESSURES, LBS, Sq In., Gage				DRAFTS, INCHES OF WATER										
		Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Stm. at Nozzle	Firebox	Inside Netting	Front of Netting	Back of Diaphragm	SMOKE BOX 12" from Smokebox Tube Sheet — Top Center	Left Top	Right Top	Left ¼ up	Right ¼ up	Bottom Center	Centr ¼ up
		A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1	10:50	245	9.7	10.5	10	11	16.8	16.8	16.8	16.7	16.8	16.9	17.1	17.1	17.3	16.6
2	10:55	245	10	10.5	10	11	17	17	17	16.8	16.8	16.9	17.2	17.2	17.4	16.8
3	11:00	245	10	10.5	10	11	16.8	16.8	16.8	16.7	16.8	16.8	17.1	17.1	17.3	16.7
4	11:05	245	9.5	10.5	9.7	10.9	16.7	16.6	16.7	16.5	16.6	16.7	16.9	16.9	17.1	16.5
5	11:10	244	10	10.5	10	11.1	17.1	17.1	17.1	17	17	17.1	17.4	17.4	17.5	17
6	11:15	244	9.5	10.5	9.7	10.7	16.5	16.5	16.5	16.4	16.5	16.5	16.7	16.7	17	16.4
7	11:20	245	10	10.5	10	11.1	17	17	17	16.9	17	17	17.3	17.3	17.4	16.9
8	Average	245	9.81	10.50	9.91	10.97	16.84	16.83	16.84	16.71	16.79	16.84	17.10	17.10	17.29	16.70
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10																
11																
12	12:10	245	5.25	4.9	5.3	6.5	8.6	8.5	8.3	8.5	8.5	8.6	8.6	8.6	8.8	8.2
13	12:15	244	4.9	4.5	5.3	6.5	9.3	9.9	9.4	9.2	9.3	9.3	9.5	9.5	9.4	9.0
14	12:20	244	4.9	4.6	5.3	6.1	8.9	8.8	8.8	8.7	8.9	8.9	8.9	9.0	9.0	8.5
15	12:25	246	5.1	4.8	5.5	6.0	9.1	9.0	9.1	8.9	9.1	9.0	9.2	9.2	9.2	8.8
16	12:30	245	4.9	4.7	5.4	6.4	9.2	9.2	9.2	9.1	9.2	9.3	9.3	9.4	9.3	9.0
17	12:35	245	4.9	4.8	5.3	6.5	9.4	9.3	9.3	9.2	9.3	9.4	9.5	9.5	9.4	9.1
18	12:40	244	4.9	4.8	5.4	6.5	9.4	9.4	9.4	9.2	9.4	9.4	9.5	9.5	9.4	9.1
19	Average	245	4.98	4.73	5.36	6.36	9.11	9.16	9.07	8.97	9.10	9.13	9.21	9.24	9.24	8.81
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STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES B NO. 1 RUN NO. ___

DATE 11-8-47

OIL	# 1	# 2	# 3	# 4
A. Meter Reading Start	40238.36	40964.62	41631.21	42218.94
B. Meter Reading Finish	40617.36	41286.52	41903.62	42399.72
C. Gallons Difference (B-A)	385.0	321.9	272.41	180.78
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	12.83	10.73	9.08	6.03
F. Meter Factor (from curve)	.9710	.9710	.9740	.9847
G. Ave. Temperature at Meter	158	163	165	165
H. Temperature Correction Factor	.9664	.9647	.9640	.9640
I. Moisture Content - %	0.33	0.33	0.33	0.33
J. Dry Oil at 60°F. - Gals. (CxFxHx(1-I/100))	360.28	300.54	254.93	171.04
K. Density - Lbs./Gal.	8.352	8.352	8.352	8.352
L. Heat Value, Dry - BTU/Lb.	18255	18255	18255	18255
M. Oil Burned - Lbs. (JxK)	3007.39	2510.11	2129.[illegible]	1428.53
N. Oil Burned per Hour - Lbs. (Mx60/D)	6014.8	5020.2	[illegible]	2857.1
HOT WATER				
A. Meter Reading Start	405116	413895	421855	428890
B. Meter Reading Finish	409695	417732	425058	431026
C. Gallons Difference (B-A)	4579	3837	3203	2136
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	152.63	127.90	106.76	71.2
F. Meter Factor (from curve)				
G. Corrected Gallons (CxF)				
H. Average Temperature	251	240	231	214
I. Density - Lbs./Gal.				
J. Hot Water - Lbs. (GxI)	37135	31245	26205	17621
K. Hot Water - Lbs. per Hour (Jx60/D)	74270	62490	52410	35242
COLD WATER				
A. Meter Reading Start	339047	346336	353119	359188
B. Meter Reading Finish	342859	349622	355845	361049
C. Gallons Difference (B-A)	3812	3236	2729	1860
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	127.1	127.9	91.0	62.0
F. Meter Factor (from curve)	.9866	.9870	.9878	.9893
G. Corrected Gallons (CxF)	3761	3194	2694	1840
H. Average Temperature	62	62	67	63
I. Density - Lbs/Gal.	8.333	8.333	8.333	8.331
J. Cold Water - Lbs. (GxI)	31340	26616	22449	15329
K. Cold Water - Lbs. per Hour (Jx60/D)	62680	53232	44898	30658
CONDENSATE FACTOR				
Lbs. Hot Water/Lbs. Cold Water				

STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES C, No. 1, RUN No. ____

Operators Name ALVIN M. REISS JR Date NOV. 10, 1947

ITEM No.			303	313	314	304	303A	308B	309	312	307	307A	311	311A	
			TEMPERATURES, DEGREES F.												
No.	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. Stm at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Stm Pipe	Right Main Stm Pipe	Dome Calorimeter	Dry Pipe Calorimeter	
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	9:15	63	64	160	161	251	250	407	391	255	737	744	410	410	408
2	9:20	63	63	161	162	250	250	406	398	257	737	744	407	406	405
3	9:25	63	64	162	162	252	252	404	397	253	733	739	407	403	405
4	9:30	63	63	164	162	251	251	409	399	317	733	741	408	412	406
5	9:35	63	63	165	163	251	251	410	401	330	733	740	413	424	408
6	9:40	63	63	166	164	252	252	411	400	335	730	740	405	419	405
7	9:45	63	63	167	165	250	251	404	394	335	731	740	409	409	407
8	Average	63	633	1636	162.7	251.0	251.0	407.3	398.1	301.7	733.4	741.7	410.4	411.4	406.3
9															
10															
11															
12	10:17	63	63	173	173	240	241	380	372	393	694	709	361	365	384
13	10:22	63	63	170	172	240	240	383	373	395	694	710	364	370	384
14	10:27	62	63	170	170	240	240	382	373	394	694	708	360	363	382
15	10:32	63	63	167	167	240	240	382	374	394	699	711	363	364	383
16	10:37	63	63	167	169	240	241	378	371	393	697	707	360	354	380
17	10:42	63	63	167	169	240	240	380	373	394	700	710	362	356	382
18	10:47	63	63	167	169	241	241	378	371	393	695	707	358	350	380
19	Average	62.9	63.0	168.7	170.1	240.1	240.4	380.4	372.4	393.7	696.1	708.9	361.1	360.3	382.1
20															
21															
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1A															
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STANDING TEST PLANT-SACRAMENTO

ENGINE No. 4401, TEST SERIES C, No. 1, RUN No. ____

Operators Name ALVIN M. REISS JR. Date NOV. 10, 1947

ITEM No.			303	313	314	304	303A	308B	309	312	307	307A	311	311A	
			TEMPERATURES, DEGREES F.												
Line No.	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. Stm at Stand	Steam in F.W.H.	Atomizer Steam	Left Main Stm Pipe	Right Main Stm Pipe	Dome Calorimeter	Dry Pipe Calorimeter	
		1	2	3	4	5	6	7	8	9	10	11	12-A	12-B	
1	11:16	63	63	168	170	229	229	337	331	387	663	665	266	254	328
2	11:21	63	63	168	170	229	229	336	330	387	664	666	265	251	328
3	11:26	63	63	168	171	228	228	338	329	387	663	675	266	254	327
4	11:31	63	63	168	171	227	227	341	331	385	663	675	286	269	329
5	11:36	63	63	168	173	228	228	337	330	385	661	673	283	270	329
6	11:41	63	63	169	172	229	228	340	331	384	660	670	291	263	331
7	11:46	63	63	170	173	229	228	331	325	385	660	667	267	253	326
8	Average	63.0	63.0	168.4	171.4	228.4	228.1	337.1	329.6	385.7	662.0	670.1	274.9	259.1	328.3
9															
10															
11															
12	12:50	63	64	174	176	213	214	279	288	230	621	626	230	230	279
13	12:55	63	64	175	175	213	214	280	288	246	619	626	231	230	281
14	1:00	63	64	177	178	213	210	281	289	248	623	628	231	230	280
15	1:05	63	64	175	178	213	213	281	286	247	623	628	231	230	283
16	1:10	64	64	176	178	213	213	275	286	248	622	628	230	230	279
17	1:15	64	64	174	178	213	213	282	288	244	624	627	231	230	274
18	1:20	63	64	174	176	213	213	280	287	239	624	627	230	230	279
19	Average	63.3	64.0	175.0	177.0	213	212.8	279.7	287.4	243.1	621.4	627.1	230.6	230.0	279.3
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
Line No.															
1A															
2A															
3A															
4A															
5A															
6A															
7A															
8A															

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES C, NO. ___, RUN NO. ___

Operator's Name ADOLPH A. PYLE

Date NOV. 10, 1947

ITEM No.		203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
		PRESSURES, LBS. Sq In., Gage				DRAFTS, INCHES OF WATER										
LINE NO.	Time	Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Stm at Nozzle	Firebox	Inside Netting	Front of Netting	Back of Diaphragm	SMOKEBOX 12" from Smokebox Tube Sheet: Top Center	Left Top	Right Top	Left ½ up	Right ½ up	Bottom Center	Centr ½ up
		A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1	9:15	242	18.7	21	19.5	17.2	28.2	27.8	27.8	27.6	27.7	27.2	28.3	28.3	28.9	27.1
2	9:20	242	18.5	21	19.5	17.5	28.4	28	28	27.8	27.9	28	28.6	28.5	29	27.8
3	9:25	242	19.5	21.5	20	17.9	28.8	28.5	28.5	28.2	28.4	28.5	29	29	29.5	28.2
4	9:30	243	18.7	21.5	19.6	17.7	28.7	28.3	28.4	28.1	28.2	28.2	28.8	28.8	29.3	28.1
5	9:35	242	19	21.5	19.6	17.7	28.7	28.3	28.4	28.1	28.3	28.3	28.9	28.8	29.3	28.1
6	9:40	243	19.5	21.5	20	17.9	28.9	28.5	28.6	28.3	28.5	28.5	29.1	29.1	29.5	28.3
7	9:45	243	18.5	21	19.6	17.8	28.7	28.4	28.5	28.2	28.4	28.3	29	28.9	29.3	28.2
8	Average	242.4	18.91	21.29	19.69	17.67	28.63	28.26	28.31	28.04	28.20	28.14	28.81	28.77	29.26	27.97
9																
10																
11																
12	10:17	244	14	15	14.5	14.4	22.7	22.4	22.4	22.3	22.4	22.4	22.8	22.8	23.2	22.2
13	10:22	244	13.5	15	14	14.1	22.3	22	22	21.9	21.9	22	22.4	22.4	22.7	21.8
14	10:27	243	14	15	14.3	14.2	22.8	22.5	22.6	22.4	22.5	22.6	23	22.9	23.2	22.4
15	10:32	243	13.5	15	14	14	22.3	22	22.1	21.9	22	22.1	22.5	22.4	22.7	21.9
16	10:37	244	14	15	14.2	14.4	22.7	22.4	22.5	22.3	22.3	22.5	22.9	22.8	23.2	22.3
17	10:42	244	13.5	15	14	14.1	22.5	22.1	22.2	22	22.1	22.2	22.5	22.5	22.9	22
18	10:47	242	14	15	14.2	14.3	22.7	22.4	22.5	22.3	22.4	22.5	22.9	22.9	23.2	22.3
19	Average	243.4	13.79	15	14.17	14.21	22.57	22.26	22.33	22.16	22.33	22.33	22.71	22.67	23.01	22.13
20																
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

S.P. SHEET NO. 1

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES C, NO. ___, RUN NO. ___

Operator's Name JOSEPH A. PYE

Date NOV. 10, 1947

ITEM No	203	208	—	207	222	223	220A	220	—	—	—	—	—	—	—
	PRESSURES, LBS. SQ. IN., GAGE				DRAFTS, INCHES OF WATER										
Time	Boiler at Dome	Exh. Steam in F.W.H.	Steam in "Y" Pipe	Exh. Stm at Nozzle	Firebox	Inside Netting	Front of Netting	Back of Diaphragm	SMOKE BOX Top Center	12" From Smokebox Tube Sheet Left Top	Right Top	Left ½ up	Right ½ up	Bottom Center	Center ½ up
	A	B	C	D	FB	1	2	3	4	5	6	7	8	9	10
1 11:16	244	9.25	10	9.5	10.7	16.5	16.3	16.3	16.2	16.2	16.3	16.6	16.6	16.8	16.2
2 11:21	243	9.5	10	9.5	10.6	16.5	16.2	16.3	16.1	16.3	16.3	16.5	16.5	16.8	16.1
3 11:26	243	8.5	9.5	9	10.2	15.7	15.5	15.5	15.4	15.6	15.5	15.8	15.8	16	15.4
4 11:31	243	8.25	9.4	9	10.2	15.7	15.5	15.5	15.5	15.5	15.6	15.8	15.8	16	15.4
5 11:36	242	8	9.5	9.2	10.6	16.3	16.1	16.2	16	16.1	16.2	16.4	16.4	16.5	16
6 11:41	243	7.75	9.5	9.2	10.3	15.7	15.7	15.7	15.6	15.7	15.8	16	16	16.3	15.6
7 11:46	244	8.5	9.4	9	9.9	15.5	15.2	15.3	15.2	15.3	15.3	15.5	15.5	15.8	15.1
8 Average	243.0	8.54	9.61	9.06	10.36	16.01	15.74	15.83	15.71	15.81	15.86	16.09	16.09	16.31	15.69
9															
10															
11															
12 12:50	242	4.75	4.5	5	6.5	9.5	9.4	9.5	9.4	9.3	9.4	9.5	9.5	9.6	9.3
13 12:55	242	4.75	4.5	5	6.4	9.3	9.2	9.2	9.2	9.2	9.3	9.3	9.4	9.5	9.1
14 1:00	244	4.75	4.5	5	6.2	9.3	9.2	9.2	9.1	9.2	9.3	9.3	9.4	9.4	9.1
15 1:05	243	4.75	4.5	5	6.3	9.4	9.3	9.3	9.2	9.3	9.3	9.4	9.5	9.5	9.2
16 1:10	243	4.75	4.5	5	6.2	9.3	9.2	9.2	9.2	9.2	9.2	9.3	9.4	9.4	9.1
17 1:15	242	4.6	4.5	5	6.4	9.3	9.3	9.3	9.2	9.3	9.3	9.4	9.5	9.4	9.2
18 1:20	243	4.5	4.2	5	6.2	9.1	9	9	8.9	9	9	9.1	9.2	9.2	8.9
19 Average	242.7	4.69	4.46	5.00	6.31	9.31	9.23	9.21	9.17	9.21	9.26	9.33	9.41	9.43	9.13
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

STANDING TEST PLANT - SACRAMENTO

ENGINE NO. 4401, TEST SERIES C NO. 1 RUN NO. —

DATE 11-10-47

OIL	# 1	# 2	# 3	# 4
A. Meter Reading Start	42778	43526	44127	44793
B. Meter Reading Finish	43170	43853	44386	44972
C. Gallons Difference (B-A)	392	327	259	179
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	13.07	10.90	8.63	5.97
F. Meter Factor (from curve)	.9713	.9707	.9754	.9848
G. Ave. Temperature at Meter	164	169	168	175
H. Temperature Correction Factor	.9643	.9627	.9630	.9606
I. Moisture Content - %	1.2	1.2	1.2	1.2
J. Dry Oil at 60°F. - Gals. (CxFxHx(1-I/100))	362.75	301.91	240.36	167.80
K. Density - Lbs./Gal.	8.364			
L. Heat Value, Dry - BTU/Lb.	18245			
M. Oil Burned - Lbs. (JxK)	3034.04	2525.19	2010.37	1399.30
N. Oil Burned per Hour - Lbs. (Mx60/D)	6068.08	5050.36	4020.74	2798.60
HOT WATER				
A. Meter Reading Start	434954	443760	450756	458761
B. Meter Reading Finish	439552	447576	453798	461942
C. Gallons Difference (B-A)	4598	3816	3042	2181
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	153.27	127.20	101.40	72.70
F. Meter Factor (from curve)				
G. Corrected Gallons (CxF)				
H. Average Temperature	251	240	228	213
I. Density - Lbs./Gal.				
J. Hot Water - Lbs. (GxI)	36878	30854	24879	18043
K. Hot Water - Lbs. per Hour (Jx60/D)	73756	61708	49758	36086
COLD WATER				
A. Meter Reading Start	364387	371742	377687	384619
B. Meter Reading Finish	368216	374978	380290	386521
C. Gallons Difference (B-A)	3829	3216	2603	1902
D. Length of Run - Min.	30	30	30	30
E. Flow Rate - GPM (C/D)	127.63	107.20	86.77	63.40
F. Meter Factor (from curve)	.9756	.9806	.9858	.9914
G. Corrected Gallons (CxF)	3735.57	3153.61	2566.04	1885.64
H. Average Temperature	63	63	63	63
I. Density - Lbs/Gal.	8.333	8.333	8.333	8.333
J. Cold Water - Lbs. (GxI)	31128.5	26279.0	21382.8	15713.0
K. Cold Water - Lbs. per Hour (Jx60/D)	62257.0	52558.0	42765.6	31426.0
CONDENSATE FACTOR				
Lbs. Hot Water/Lbs. Cold Water				

GRAPHICAL RESULTS

Information obtained from foregoing data sheets which has been correlated and presented graphically on subsequent pages is as follows:

Figure 3: Draft vs Exhaust Nozzle Pressure, Series "A", "B" and "C" (page 29).

Figure 4: Draft Differential between Exhaust Nozzle and Firebox vs Exhaust Nozzle Pressure, Series "A", "B" and "C" (page 30).

Figure 5: Fuel Rate vs Exhaust Nozzle Pressure, Series "A" (page 31).

Figure 6: Fuel Rate vs Approximate Indicated Horse Power Output, Series "A" and "C", showing calculated fuel saving with Series "C" arrangement (page 32).

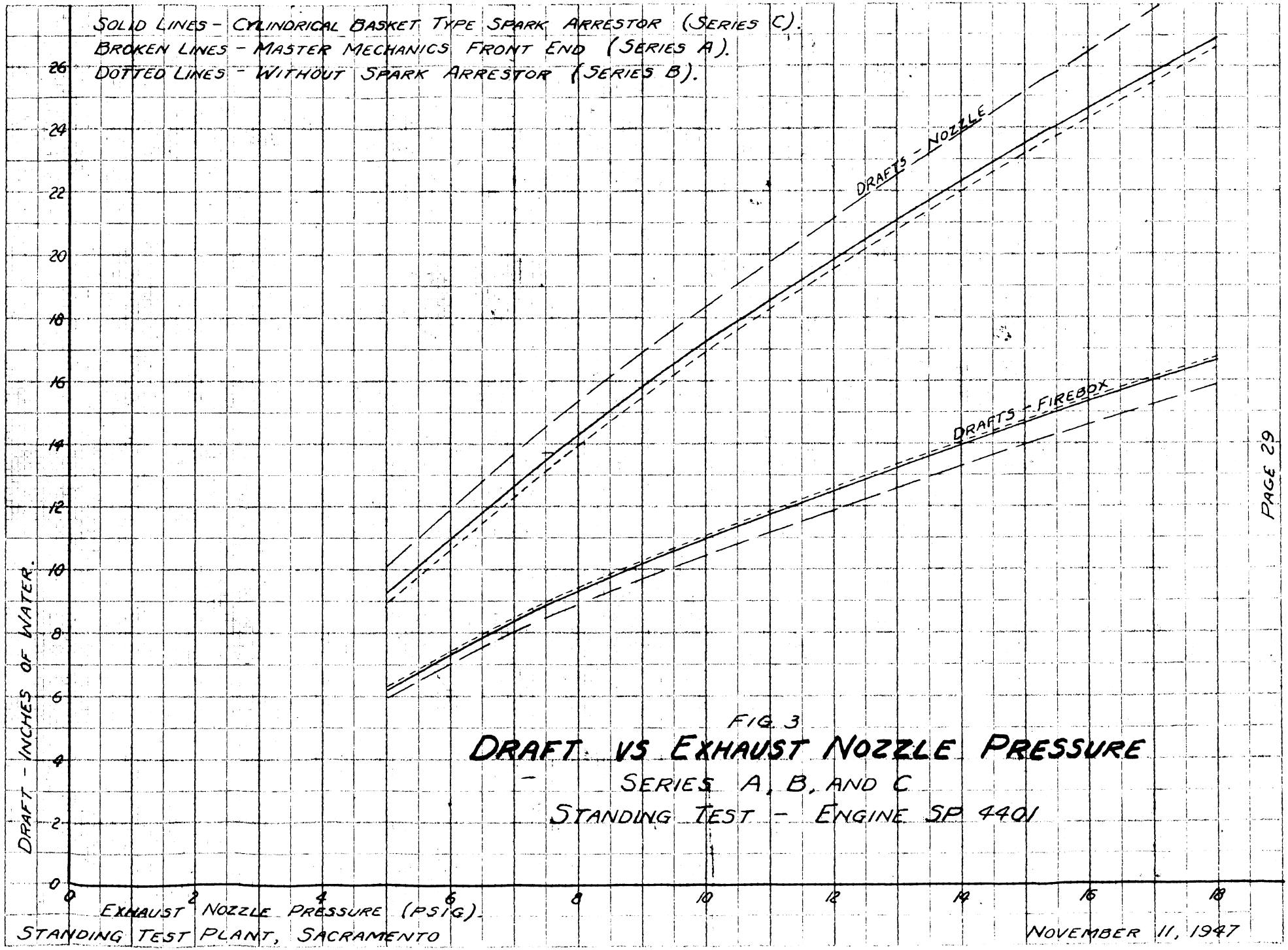


FIG. 3

DRAFT VS EXHAUST NOZZLE PRESSURE

SERIES A, B, AND C

STANDING TEST - ENGINE SP 4401

STANDING TEST PLANT, SACRAMENTO

NOVEMBER 11, 1947

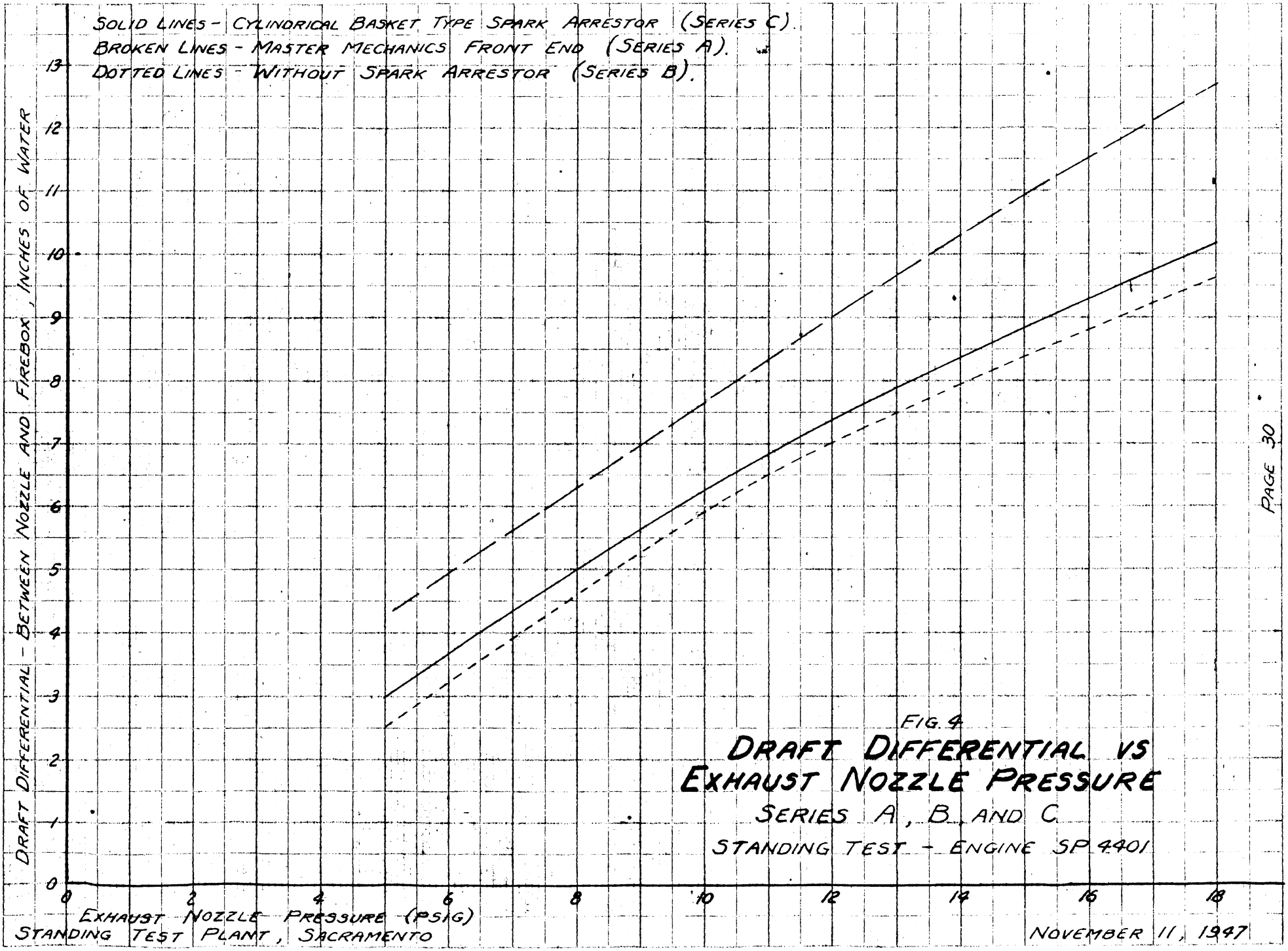


FIG. 4

DRAFT DIFFERENTIAL VS EXHAUST NOZZLE PRESSURE

SERIES A, B AND C

STANDING TEST - ENGINE SP 4401

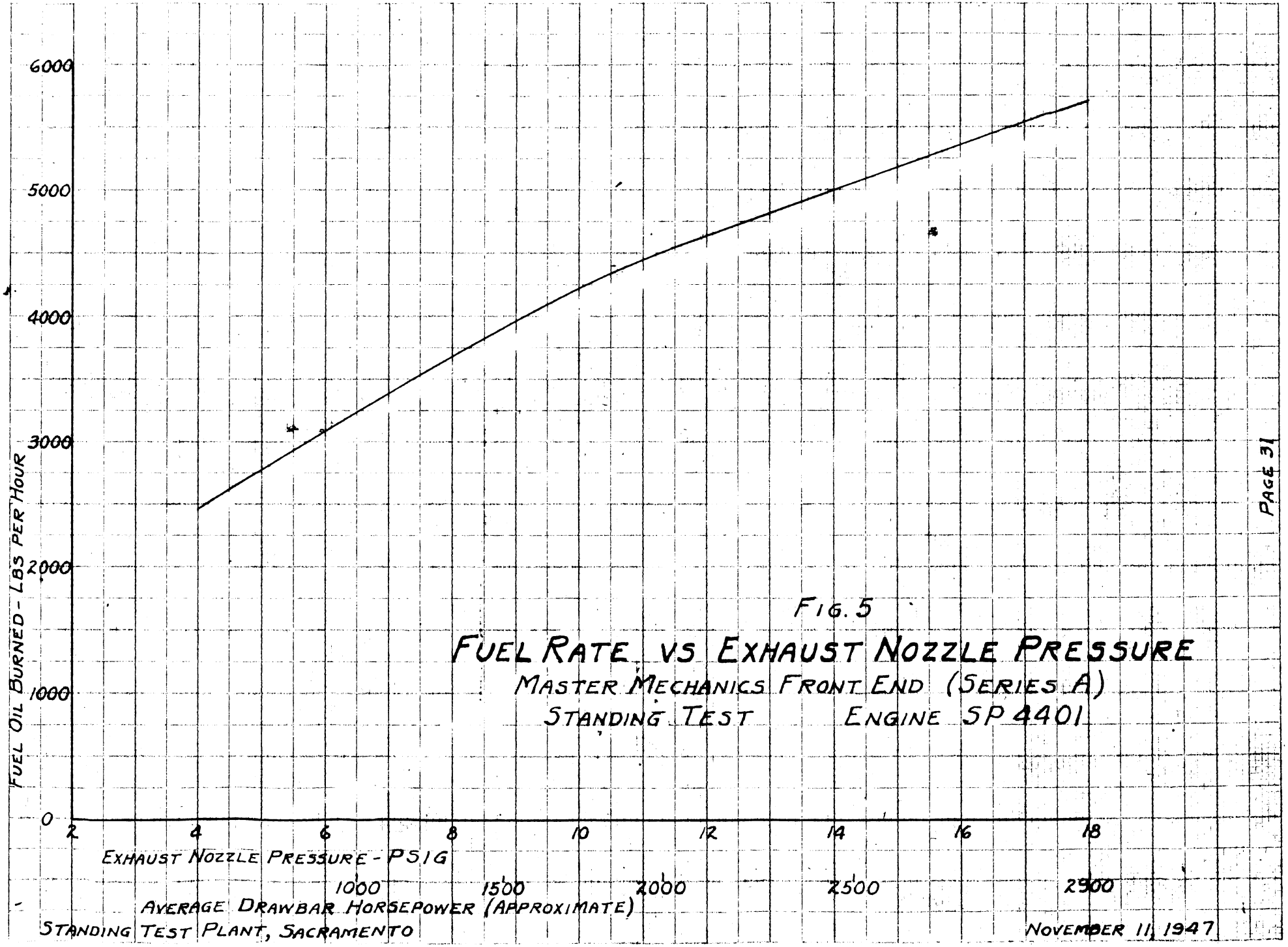


FIG. 5

FUEL RATE VS EXHAUST NOZZLE PRESSURE

MASTER MECHANICS FRONT END (SERIES A)

STANDING TEST ENGINE SP 4401

STANDING TEST PLANT, SACRAMENTO

NOVEMBER 11, 1947

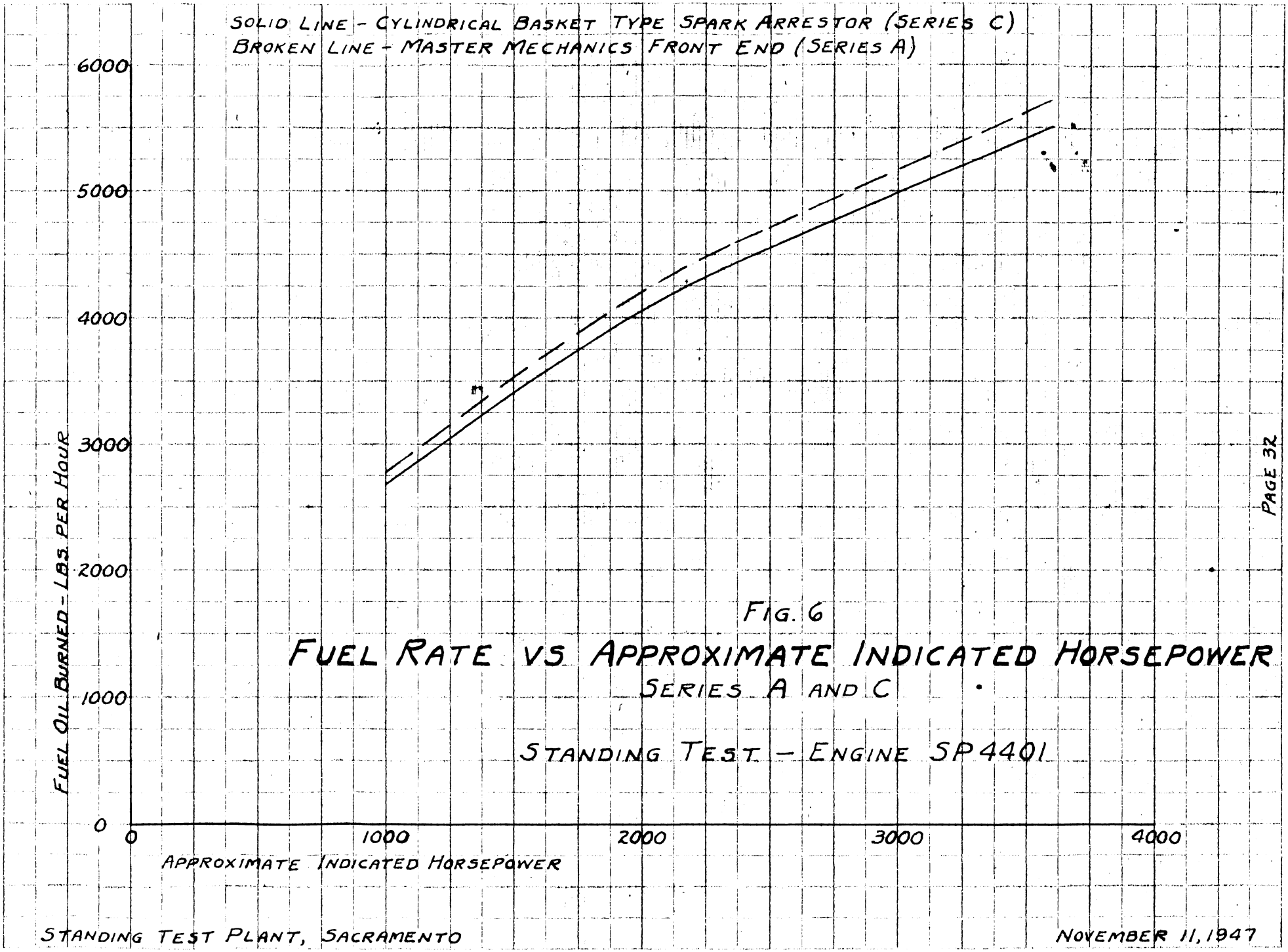


FIG. 6

FUEL RATE VS APPROXIMATE INDICATED HORSEPOWER

SERIES A AND C

STANDING TEST - ENGINE SP4401

STANDING TEST PLANT, SACRAMENTO

NOVEMBER 11, 1947

DISCUSSION OF DATA AND RESULTS

As result of tests and based on analysis of data and results obtained, it is evident that the basket type spark arrester used in Series "C" will result in operating economies when compared with present Master Mechanic's design used in Series "A". The primary reason for these economies is the improved air and gas flow conditions that can be obtained by removal of present restrictions caused by plates and netting and the substitution of the simple basket netting arrangement which offers minimum resistance to flow of air and gases.

Reduction of front end resistances in Series "B" and "C" as compared with Series "A" are shown on Figure 3, page 29 and Figure 4, page 30. By referring to these graphs, it can be seen that with Series "A" arrangement higher drafts are obtained at exhaust nozzle account restrictions to flow caused by deflecting plates and netting. With removal of all netting and diaphragm plates in Series "B", the smoke box draft equalized at a value below maximum obtained with Series "A" and firebox draft showed an increase for any given exhaust nozzle pressure in range considered. The draft differential between nozzle and firebox was accordingly reduced as shown on Figure 4, page 30. In Series "C", with basket netting arrangement, draft at nozzle was very slightly higher than with Series "B" due to presence of netting, but firebox drafts were practically the same as with Series "B".

Increase in firebox draft for a given back pressure with Series "B" and "C" arrangements is due to the removal of front

end restrictions and means that a larger volume of air and gases can be moved at a given back pressure over the range considered. Conversely, this means that the same amount of air and gases can be moved in Series "B" and "C" at a lower back pressure. This decrease in back pressure can result in increased cylinder horse power or for a given cylinder horse power the fuel rate can accordingly be reduced by operating locomotive at shorter cutoffs than necessary with present arrangement. As a result of ability to move larger volume of air and gas with a given back pressure, further study should be made into the desirability of enlarging nozzle diameter or modifying cross split to permit operation of locomotive at lower back pressure, with resultant increase in cylinder horse power.

Removal of table plate will also permit greater latitude in further consideration of desirability of changing nozzle and stack relationships.

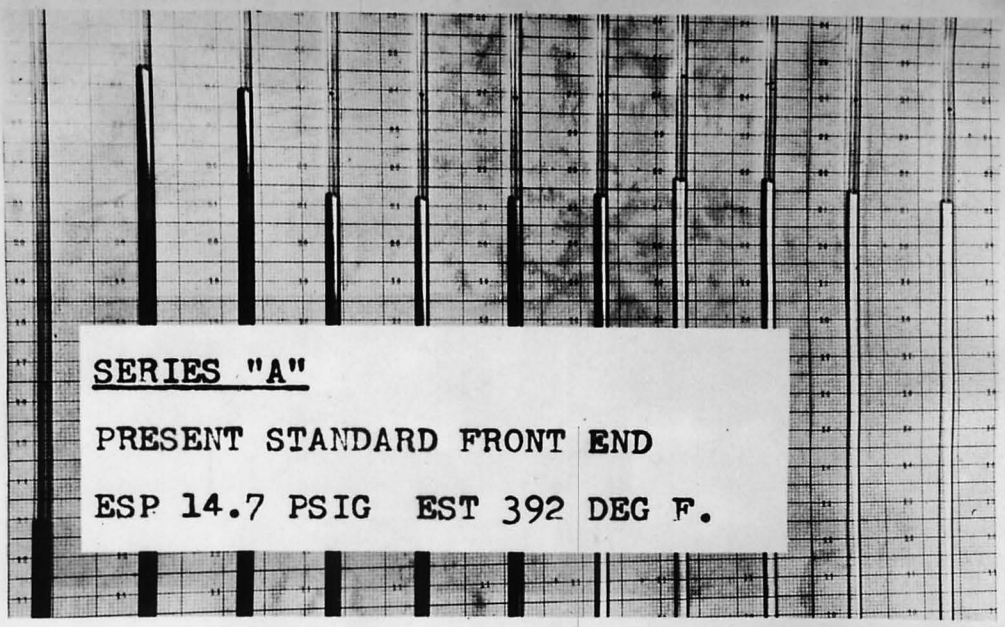
To illustrate further the effect of draft redistribution with the three test arrangements, photograph is included on page 35 which is a composite of actual photographs of multiple draft manometers taken during test operations. This composite photograph shows high draft differential between firebox and inside of netting with Series "A"; the reduced differential, equalized smokebox draft and higher firebox draft with Series "B"; and the slightly higher draft inside netting with Series "C" as compared to Series "B". Photograph, page 36, shows layout of test station

SPARK ARRESTER TESTS - DRAFT RELATIONSHIPS

DRAFTS - INCHES OF WATER

SMOKE BOX

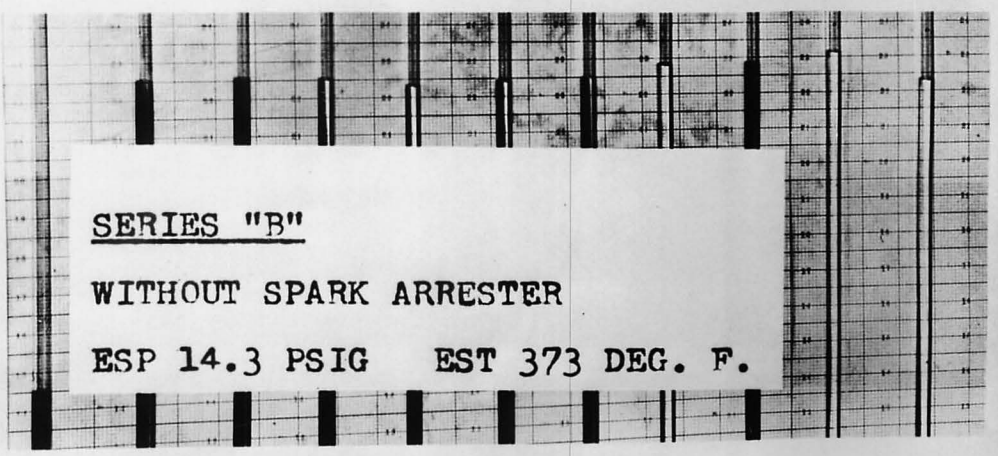
FIREBOX	12 INCHES FROM TUBE SHEET								
	INSIDE NETTING	FRONT OF NETTING	BACK OF DIAPHRAGM	TOP CENTER	TOP LEFT	TOP	RIGHT 1/2 UP	LEFT 1/2 UP	BOTTOM CENTER	RIGHT 1/2 UP



SERIES "A"

PRESENT STANDARD FRONT END

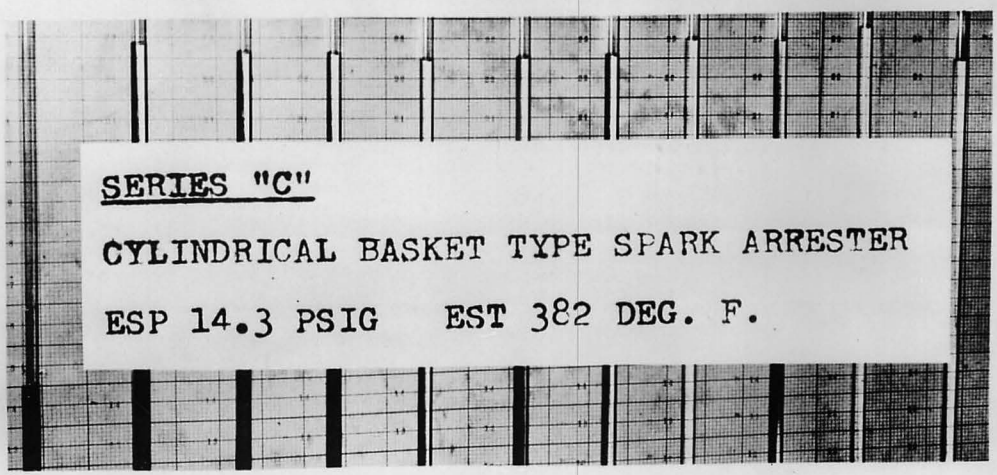
ESP 14.7 PSIG EST 392 DEG F.



SERIES "B"

WITHOUT SPARK ARRESTER

ESP 14.3 PSIG EST 373 DEG. F.



SERIES "C"

CYLINDRICAL BASKET TYPE SPARK ARRESTER

ESP 14.3 PSIG EST 382 DEG. F.

Lab. No. ST 30-A

TEST ARRANGEMENT

ESP= Exhaust Steam Pressure: EST= Exhaust Steam Temperature

Lab. No. ST-26-6

Supplementary data desk-panel showing (top pair) test gages for auxiliary-steam metering orifices; (middle pair) boiler pressure and feedwater heater chamber; and (lowest pair) Wye pipe and exhaust nozzle pressures. On right, Brown electronic pyrometer with extra multipoint switch below. Single tube manometers for drafts, at left.

for draft measurement.

Saving in fuel oil which can be obtained with Series "C" basket type netting as compared with Series "A" arrangement is presented on Figure 6, page 32. This saving was determined by taking firebox drafts for Series "A" as indicated on Figure 3, page 29 and determining on this graph the reduced back pressure at which the same firebox draft could be obtained with Series "C". By this means a reduced exhaust nozzle pressure was obtained for a given firebox draft. This reduction in exhaust nozzle pressure was applied to fuel rate vs exhaust pressure curve, Figure 5, page 31 and the effective fuel reduction determined. By obtaining the indicated fuel reduction at various exhaust pressures, the fuel rate curve for Series "C" was established as shown on Figure 6, page 32. Approximate indicated horsepower outputs for Series "A" as shown on abscissa of Figure 6 were obtained from horse power-exhaust pressure relationships available from Dynamometer car data obtained with Engine SP 4401. On the above basis, the fuel oil savings available by changing from Master Mechanic's Front End, Series "A", to basket type netting arrangement, Series "C", will amount to approximately 3.5% over the operating range considered.

Information developed from these tests indicated that draft inside of basket netting, Series "C" was only slightly higher than draft at exhaust nozzle without netting, and that firebox drafts with both arrangements were practically the same, being slightly higher with Series "B" than with Series "C". Therefore, the available fuel oil saving with Series "C" and Series "B" would be essentially the same.