THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Sven Alfred Vaule for the degree of Mechanical Engineer They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Mechanical Engineer.

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Date June 3 1922

10-20 5M

CHARACTERISTICS OF A ROTARY PUMP
FOR
OILS OF DIFFERENT VISCOSITIES.

A THESIS SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL,
UNIVERSITY OF MINNESOTA

FOR
THE DEGREE OF MECHANICAL ENGINEER

BY
SVEN A. VAULE
MINNEAPOLIS, MINNESOTA.
1922.

F O R E W O R D.

Much general data on the chemical and physical properties of oils, formulae for the flow through pipes etc. is to be found but practically no information is available bearing directly on the subject of this investigation.

It was because of this lack of available knowledge on the subject that the Northern Fire Apparatus Company of Minneapolis, Minnesota created a Fellowship making this investigation possible.

The tests comprising this report were made in the Experimental Laboratories of the University of Minnesota. The electric dynamometer, and accessories, large weighing scales, tachometer, and other instruments used were furnished by the University. The various oils pumped were purchased by the Northern Fire Apparatus Company.

The writer wishes to express his great appreciation for the splendid cooperation and assistance given

by the Northern Fire Apparatus Company, and by the Pagel Rotary Pump Company.

It has been a great satisfaction to the writer to work under the supervision of Prof. C. F. Shoop, whose advice and criticisms have been very helpful in making this investigation.

Professor F. B. Rowley and Professor B. J. Robertson deserve a great deal of credit for their helpful assistance and cooperation.

The writer is also indebted to Professor J.J. Flather and Professor J. H. Rowen for their helpful suggestions.

Acknowledgements are also extended to include the practical assistance given by Mr. Laurits Clausen, assistant in the Experimental Laboratories.

Sven A. Vaule

June 1922

C O N T E N T S

Characteristics of a Rotary Pump for Oils of Different Viscosities.

I.

INTRODUCTION.

Pumps with revolving pistons are designated as rotary pumps. These machines have been used to pump fluids for nearly three centuries. One of the oldest and also one of the best types of rotary pumps is that which was found among a collection of models belonging to France Grollier de Servieres, a Frenchman born in 1593. There are those who claim that it is the invention of Pappenheim, a German who lived in the early part of the seventeenth century.

This pump employed as rotating pistons two cog wheels or cams, the teeth of which were accurately fitted to work into each other. A highly developed and refined pump of this type is the Northern Rotary Pump, illustrated in figure 2, which was used in this investigation. It differs, principally, from the earlier form in that external gears transmit the driving power and in this way greatly reduce the wear on the cams.

Due to its positive displacement and delivery of a constant stream, and to its compactness, this pump has been found well suited as a fire pump. The rigid

requirements for fire service have forced the manufacturer to make a rotary pump carefully designed and accurately machined.

The same qualities that make this rotary pump desirable as a fire pump are also those required for pumping other liquids. Rotary pumps are today being used in distilleries, breweries, sugar refineries, paper mills and starch factories, salt wells, water works, and in the pumping of petroleum oils.

The immense quantities of oils that must be handled by pumps in an industry which in 1918 marketed 345,896,000 barrels of petroleum crude oil in the United States alone, offer a great field for research in the pumping of viscous liquids.

O B J E C T

It is the purpose of this investigation to furnish information on questions relating to the characteristics of a rotary pump with various rotor clearances, for the pumping of oils of different viscosities.

II

APPARATUS AND CALIBRATIONS.

Figure 1 - General view of Apparatus.

APPARATUS.

The following is an outline and brief description of the equipment used throughout the entire investigation.

A. Rotary Pump.

The pump used is a Northern Rotary Pump, Type K serial #8, manufactured by the Northern Fire Apparatus Company of Minneapolis.

The rotors or cams are driven and timed by external pilot gears. The rotors are of cast bronze and include bronze packing strips which are kept in contact with the cylinder by pressure from small coiled springs. Figure 2 shows the design of the rotor and packing strips. The arrows in this figure show the path taken by the liquid as it is pumped. In the figure the liquid enters at the bottom and is discharged at the top.

The picture following is of the pump as in-

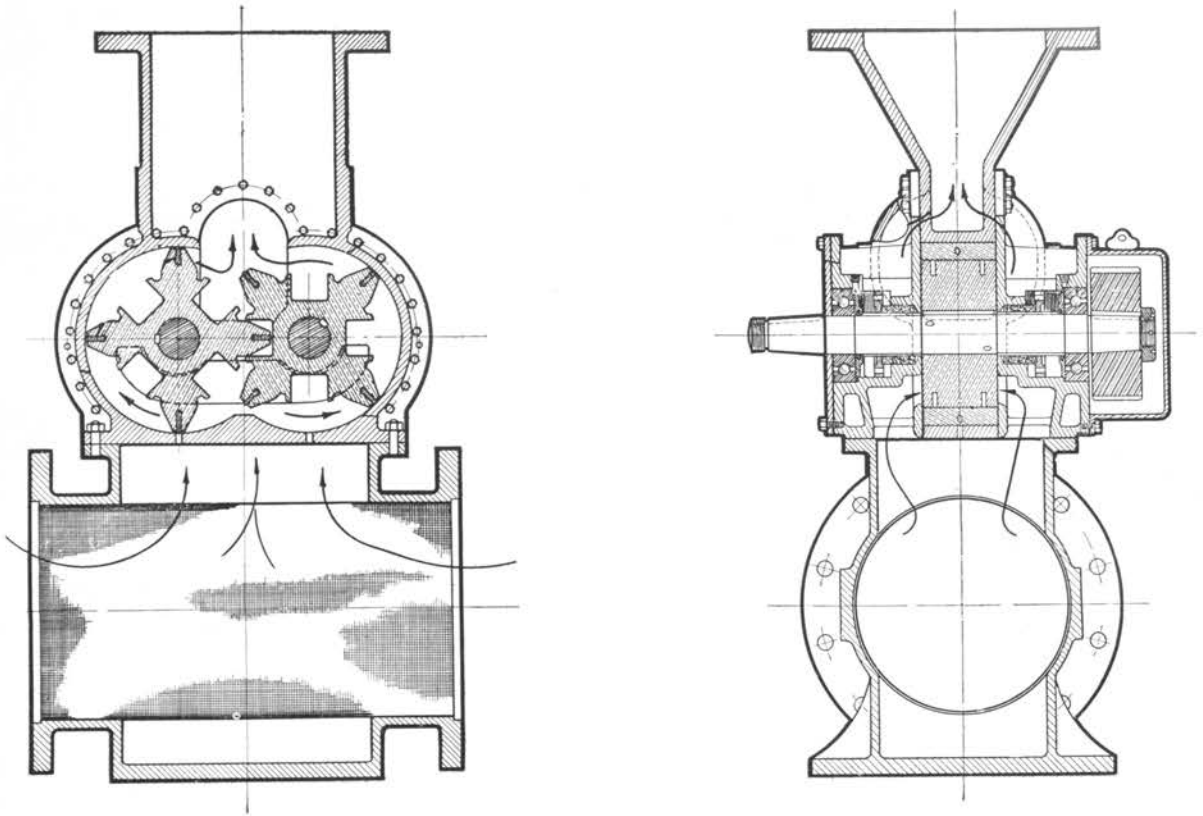


Figure 2 - Cross sections of pump showing rotors, packing strips, ball bearings, stuffing boxes, and external pilot gears.

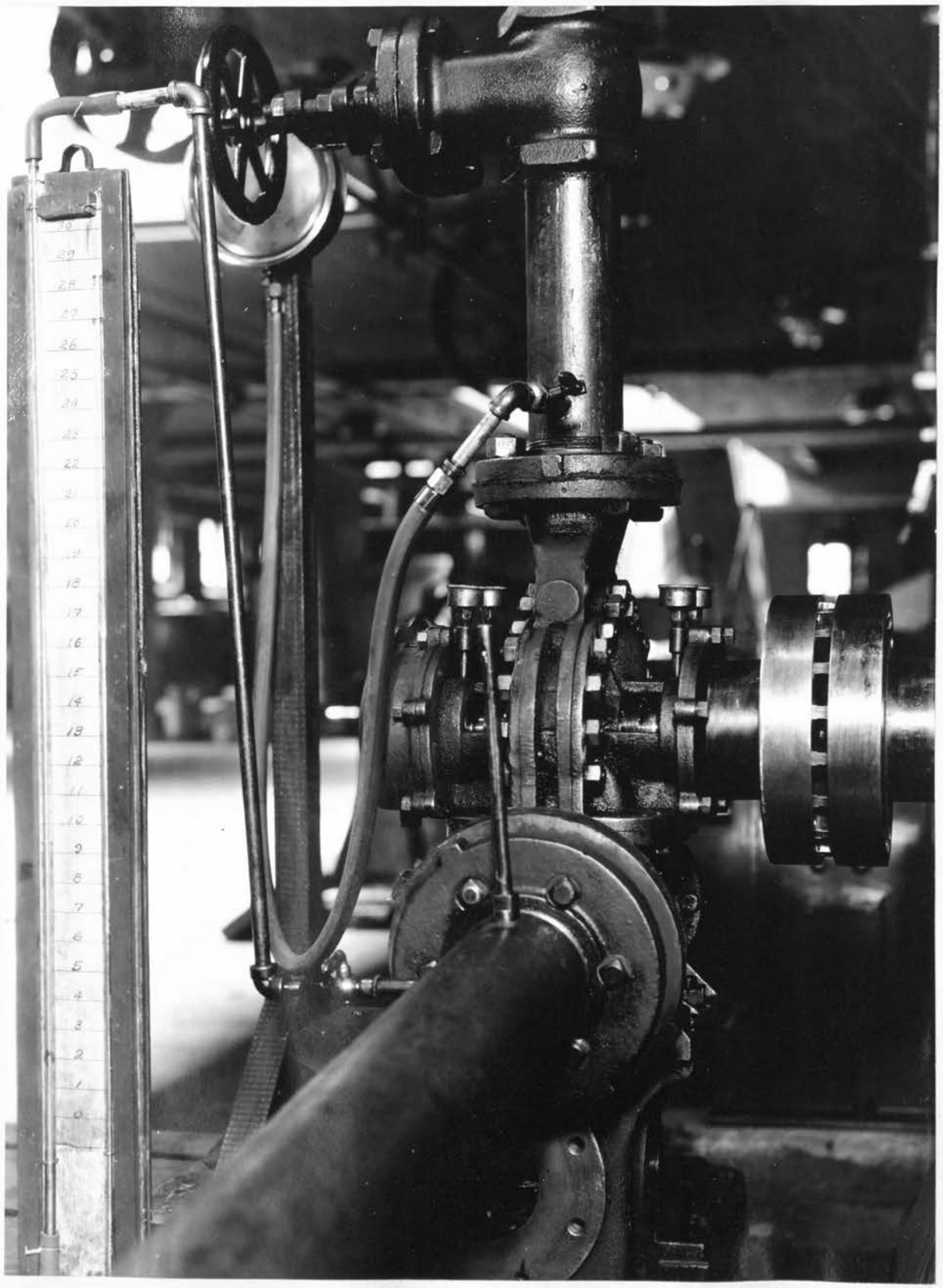


Figure 3 - Rotary pump with pressure gage, and manometer and thermometer in suction line.

stalled and also includes the suction pipe, manometer, discharge pipe and valve, pressure gauge and thermometer in suction pipe. The valve on the suction line is not shown.

B. Dynamometer.

A fifty H. P. Sprague Electric Dynamometer directly connected to the pump by means of a coupling furnished the driving power. See figure 4.

The dynamometer equipment in part includes one John Chatillon & Sons spring scales; one electric tachometer, one Westinghouse voltmeter, one Westinghouse ammeter, two field rheostats, resistance grids, one electrically controlled revolution counter, and electric device for automatically controlling stop watch.

Direct current was supplied to the dynamometer by a 25 K.W. 250 volt General Electric motor generator set. A rheostat in series with the generator field was used for controlling the voltage to the dynamometer.

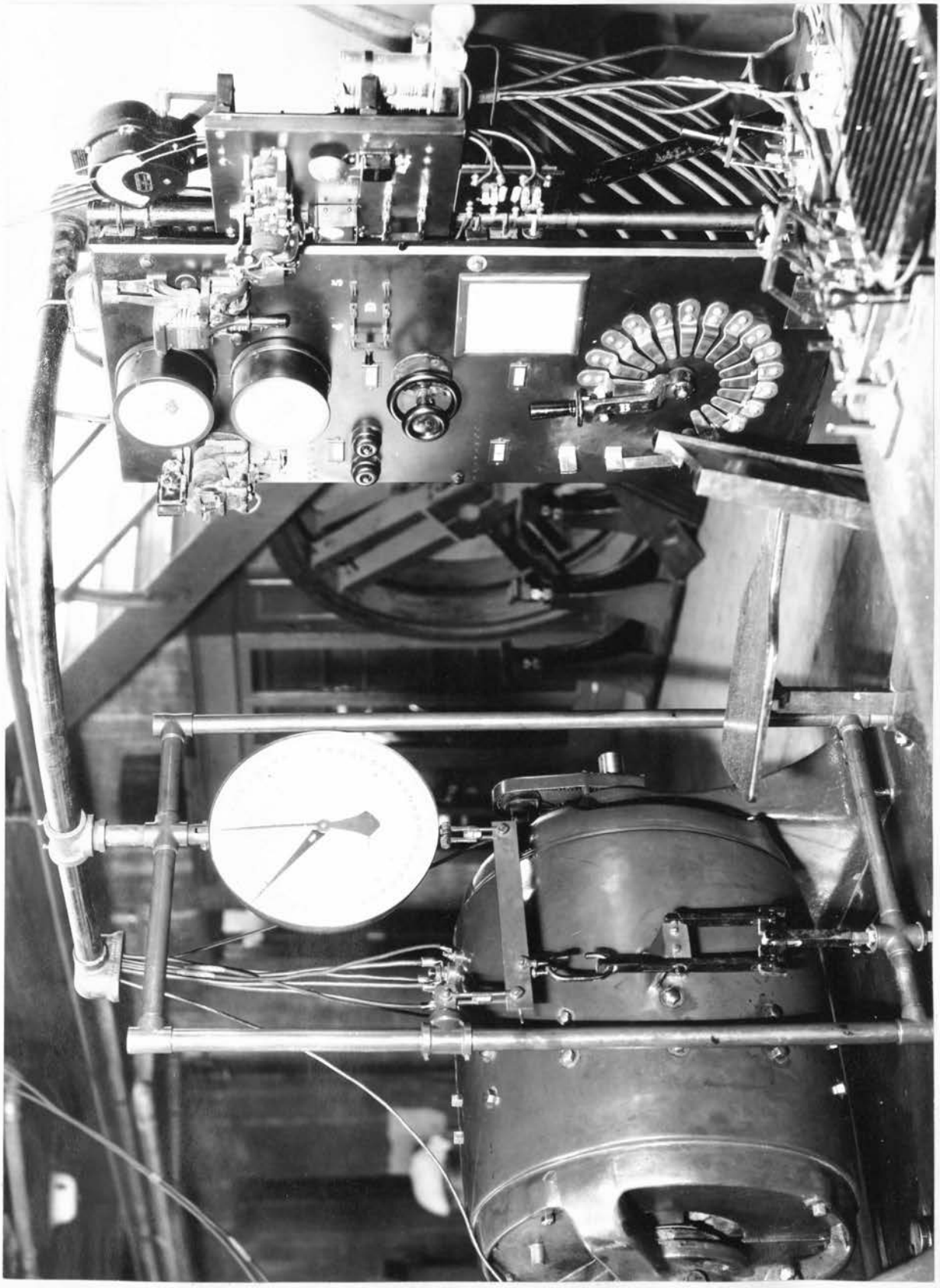


Figure 4 - Dynamometer and Electric Control Board.

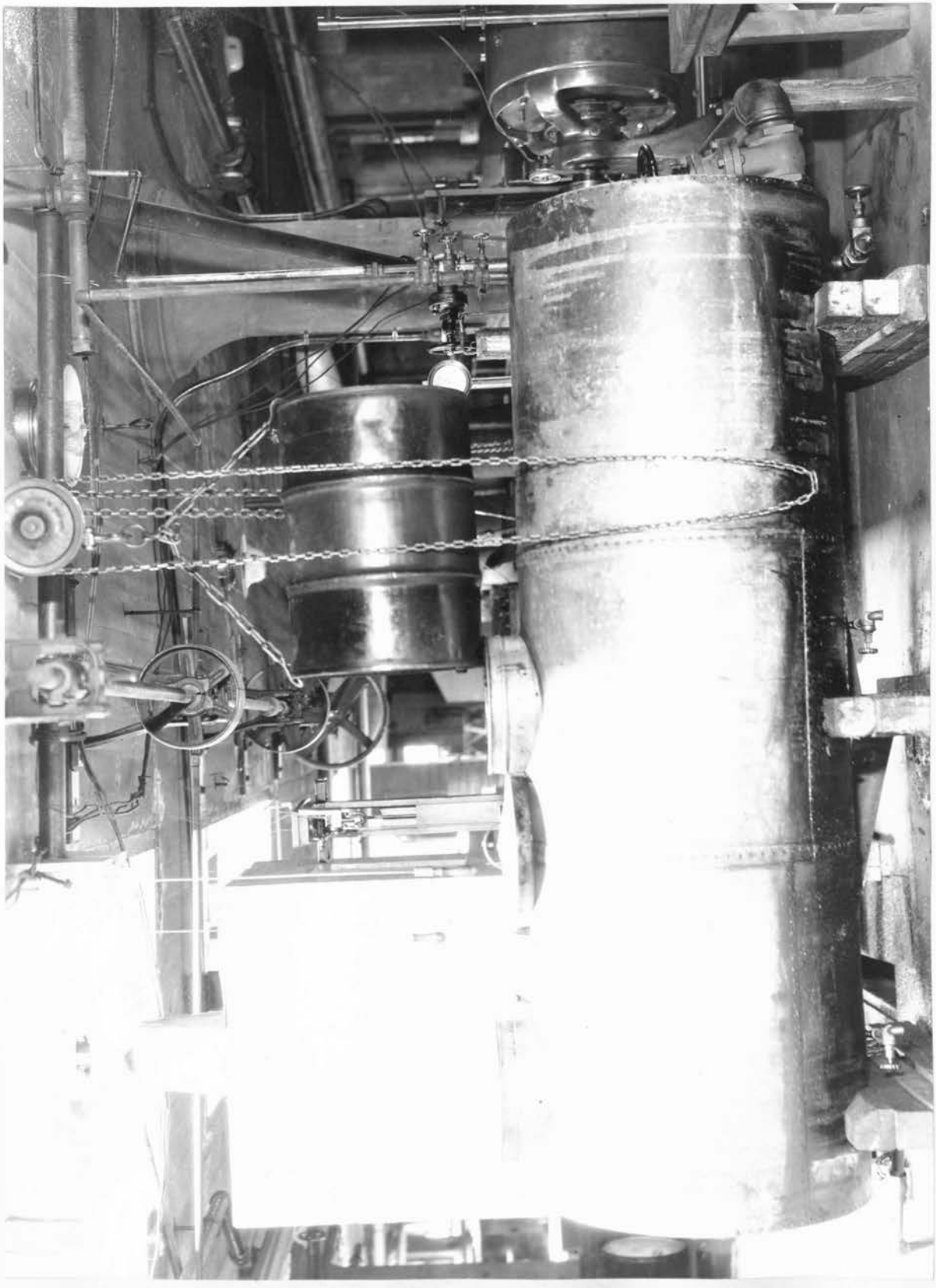


Figure 5 - Sump tank and method of filling.

C. Sump tank.

The sump tank (figure 5) is a 600 gallon galvanized iron tank provided with a coil for use with either steam or water to either heat or cool the liquid as may be desired.

D. Weighing tank.

The weighing tank (figure 8) is of 350 gallons capacity and is equipped with a four inch discharge valve and an automatic float trip (figure 6 and 7) designed by the writer to prevent liquids pumped from overflowing weighing tank. The beam is equipped with an electric switch which closes when beam rises, causing stop watch on instrument board to operate.

E. Hoist.

One pulley hoist of 2000 pounds capacity was used in lifting barrels of oil to be emptied into the sump tank.

F. Pressure gage.

The pressure gage is a six-inch Standard Test Gage of 300 pounds capacity, laboratory number 1105.

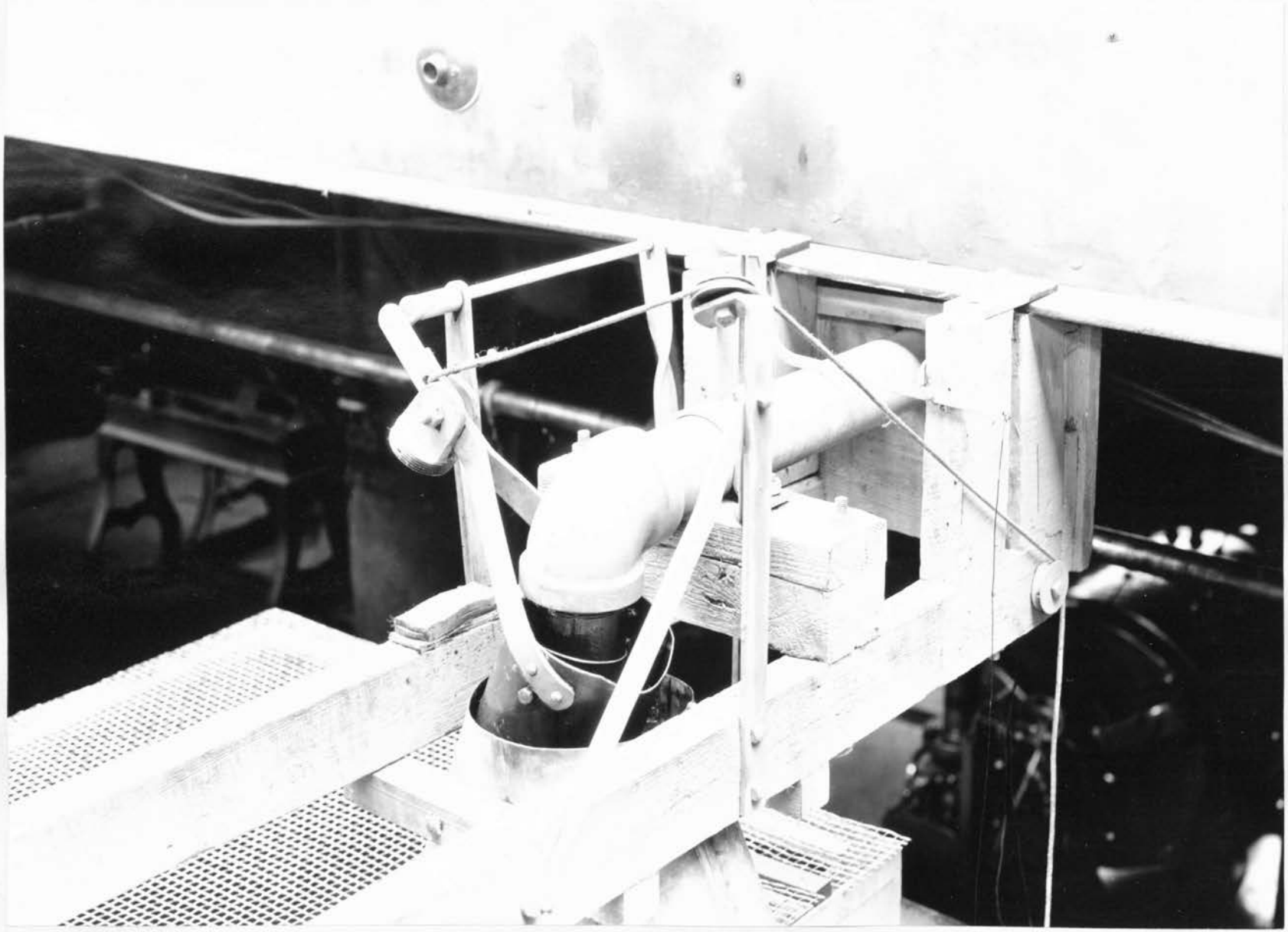


Figure 6 - Position of Automatic Float Trip when liquid is discharged into weighing tank.

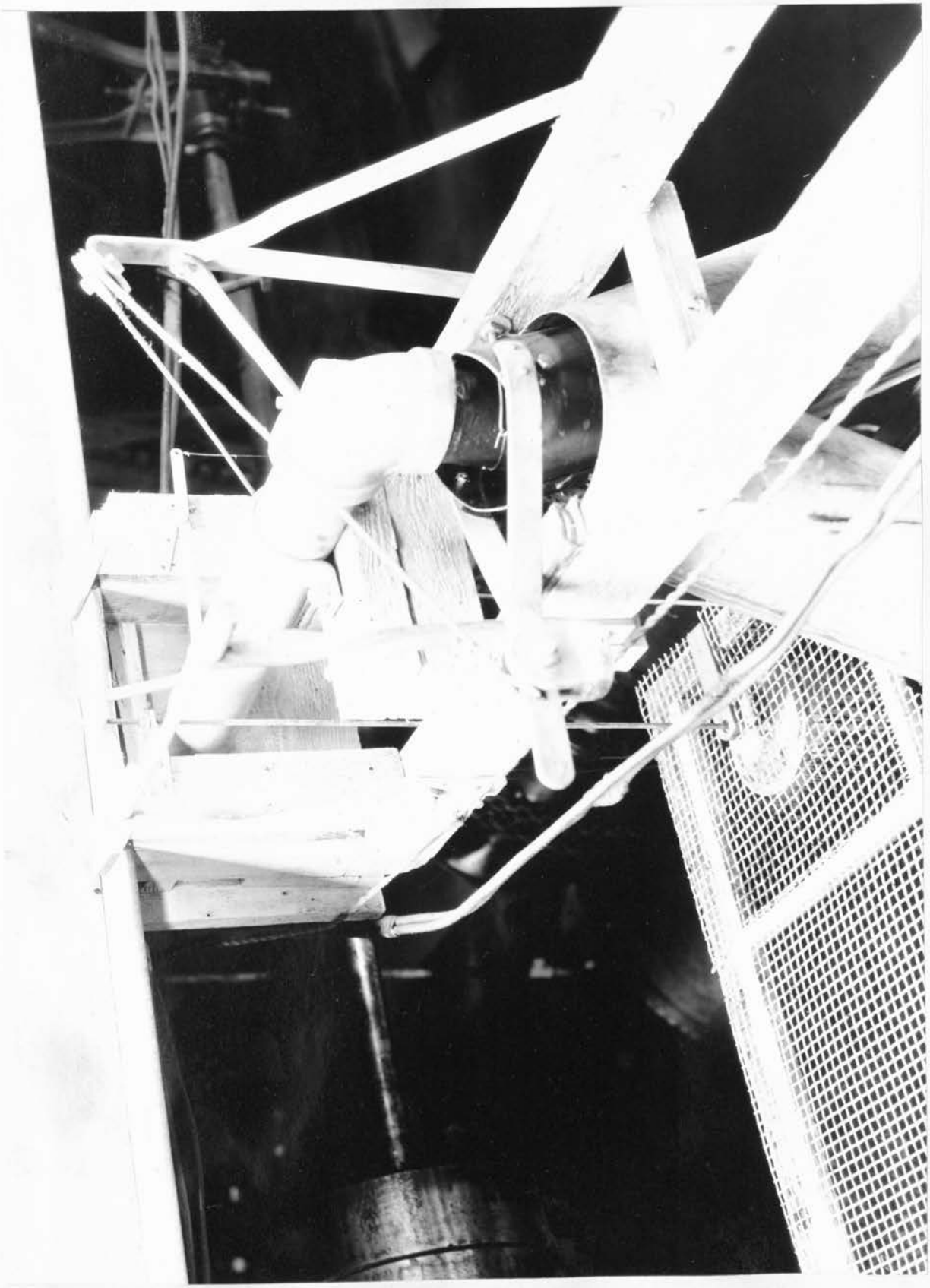


Figure 7 - Position of Automatic Float Trip when liquid is discharged into sump tank.

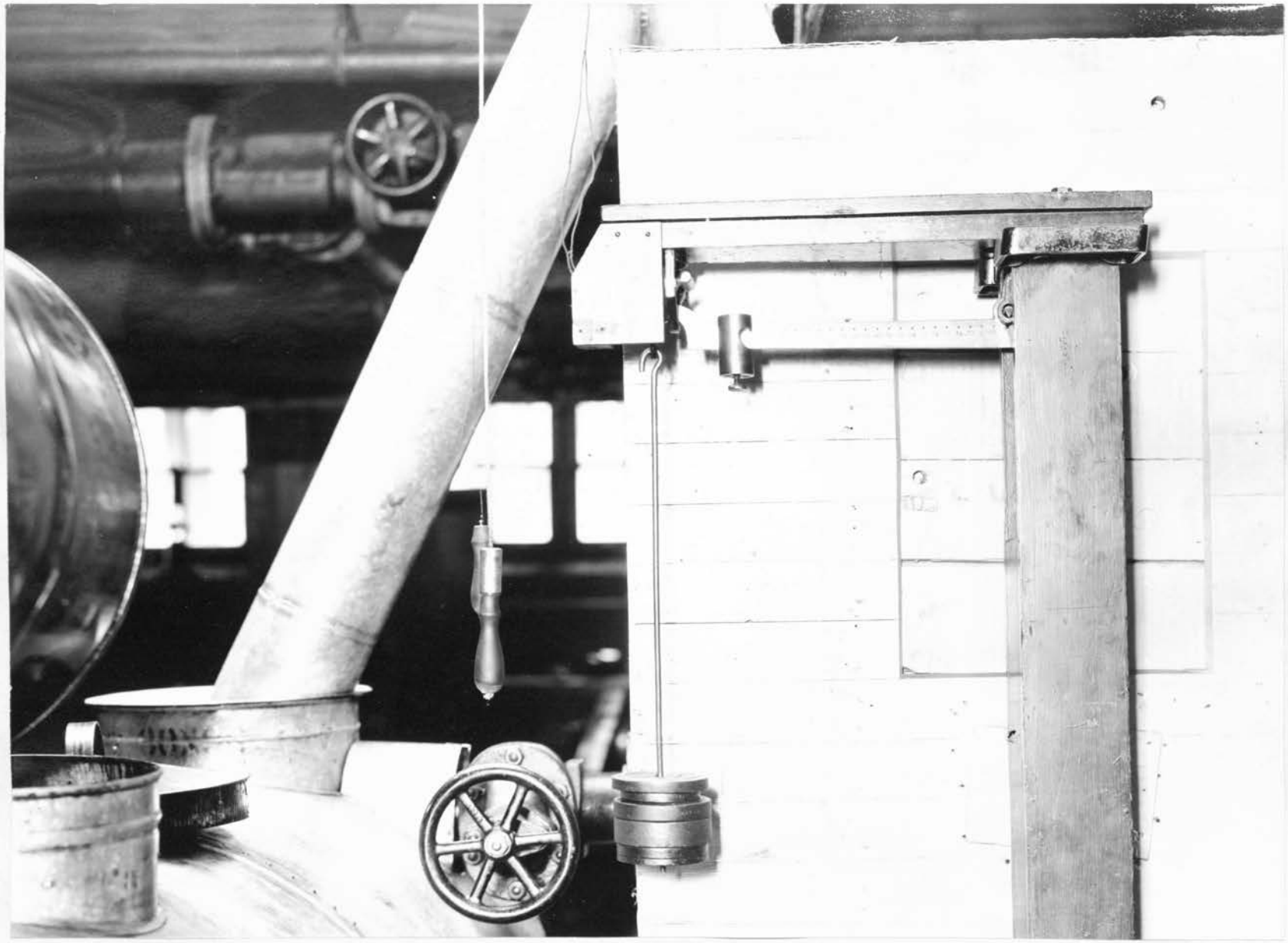


Figure 8 - Weighing Tank with Discharge Valve.

G. Manometer.

A mercury manometer reading in inches of mercury was used.

H. Stop watch.

The stop watch is The Racer, non-magnetic. This watch reads in hundredths of a minute.

I. Tachometer.

One O. Zirnickow hand-tachometer, laboratory number 2835,was used throughout the test.

J. Thermometer.

One thermometer, laboratory number 218, was used in determining the temperature of the liquid as pumped.

K. Viscosimeter.

One Saybolt Universal Viscosimeter, laboratory number 2462, was used in determining the viscosity of all the liquids.

CALIBRATIONS.

All instruments were carefully calibrated, and the calibrations checked from time to time to prevent any errors due to original calibrations having changed. At the close of all the test runs the instrument calibrations were checked and found to be correct. An outline of the instruments calibrated follows:

A. Stop watch.

The stop watch was first regulated very carefully. Later, it was always checked before using.

B. Pressure gage.

Data and curve follow.

C. Dynamometer scale.

Data and curve follow.

D. Hand tachometer.

Data follow.

The tachometer being broken and then repaired accounts for the difference in the two calibrations.

Calibrations of the tachometer in the later test runs varied very slightly from time to time, and

therefore in the later runs the tachometer was calibrated before each time used.

E. Thermometer.

The thermometer was calibrated with a standard and found to be correct at 110 degrees F.

F. Saybolt Universal Viscosimeter.

The viscosimeter was calibrated with a 30 per cent solution of ethyl alcohol and found to agree with values given by the Bureau of Standards.

Calibration Dynamometer Scale

December 8, 1931.

1/2 lb. actual.	1/2 lb. Reading.	1/2 lb. Reading.	Av. Reading.	Correction to be added.
0.0	-.6	-.7	-.65	+.65
2.0	+1.3	+1.3	+1.3	+.70
4.0	3.3	3.3	3.3	+.70
10.0	9.3	9.35	9.32	+.68
20.0	19.35	19.35	19.35	+.65
30.0	29.40	29.35	29.37	+.63
40.0	39.50	39.50	39.50	+.50
50.0	49.55	49.60	49.57	+.43
60.0	59.6	59.6	59.6	+.40
70.0	69.6	69.6	69.6	+.40

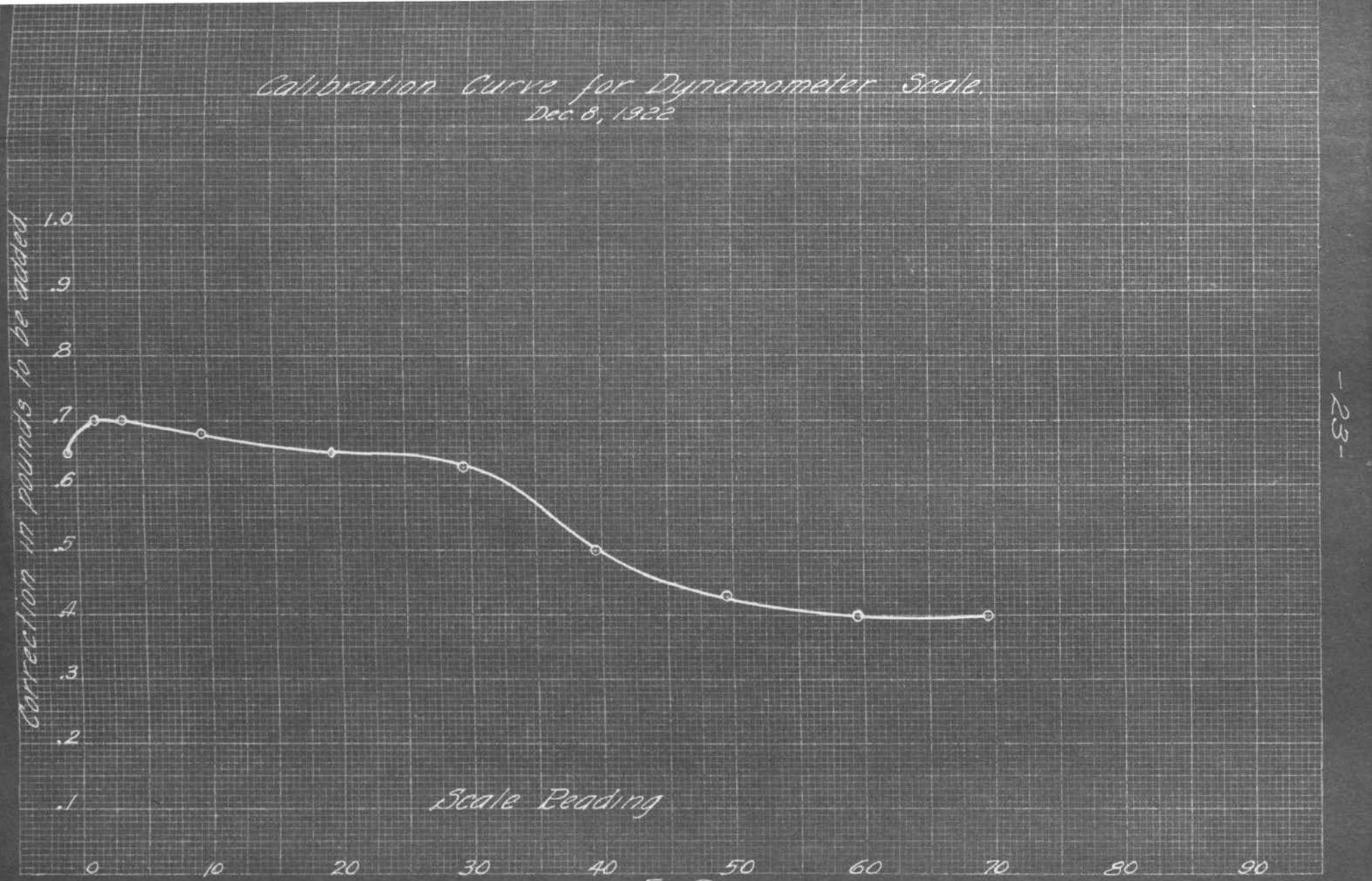

Calibration Curve for Dynamometer Scale.
Dec. 8, 1922
Correction in pounds to be added
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Scale Reading
0
10
20
30
40
50
60
70
80
90

Fig. 9.

Calibration Pressure Gage #1105

December 8, 1921.

Actual Pressure lb.per sq. inch.	Read. Down	Read. Up	Read. Av.	Correction to be added
0	-2.3	-2.3	-2.3	2.3
5	2.5	2.0	2.25	2.75
10	7.5	7.5	7.5	2.50
20	18.0	17.5	17.75	2.25
40	37.5	37.5	37.5	2.50
60	57.5	57.5	57.5	2.50
80	77.0	76.5	76.75	3.25
100	97.0	96.5	96.75	3.25
120	117.5	117.5	117.5	2.25
140	137.0	136.5	136.75	3.25
160	157.0	156.0	156.5	3.5
180	175.5	175.5	175.5	4.5
200	195.0	194.0	194.5	5.5
220	213.5	213.5	213.5	6.5
240	233.5	233.5	233.5	6.5
260	253.0	253.0	253.0	7.0
280	272.0	271.5	271.75	8.25
300	282.0	282.0	282.0	18.0

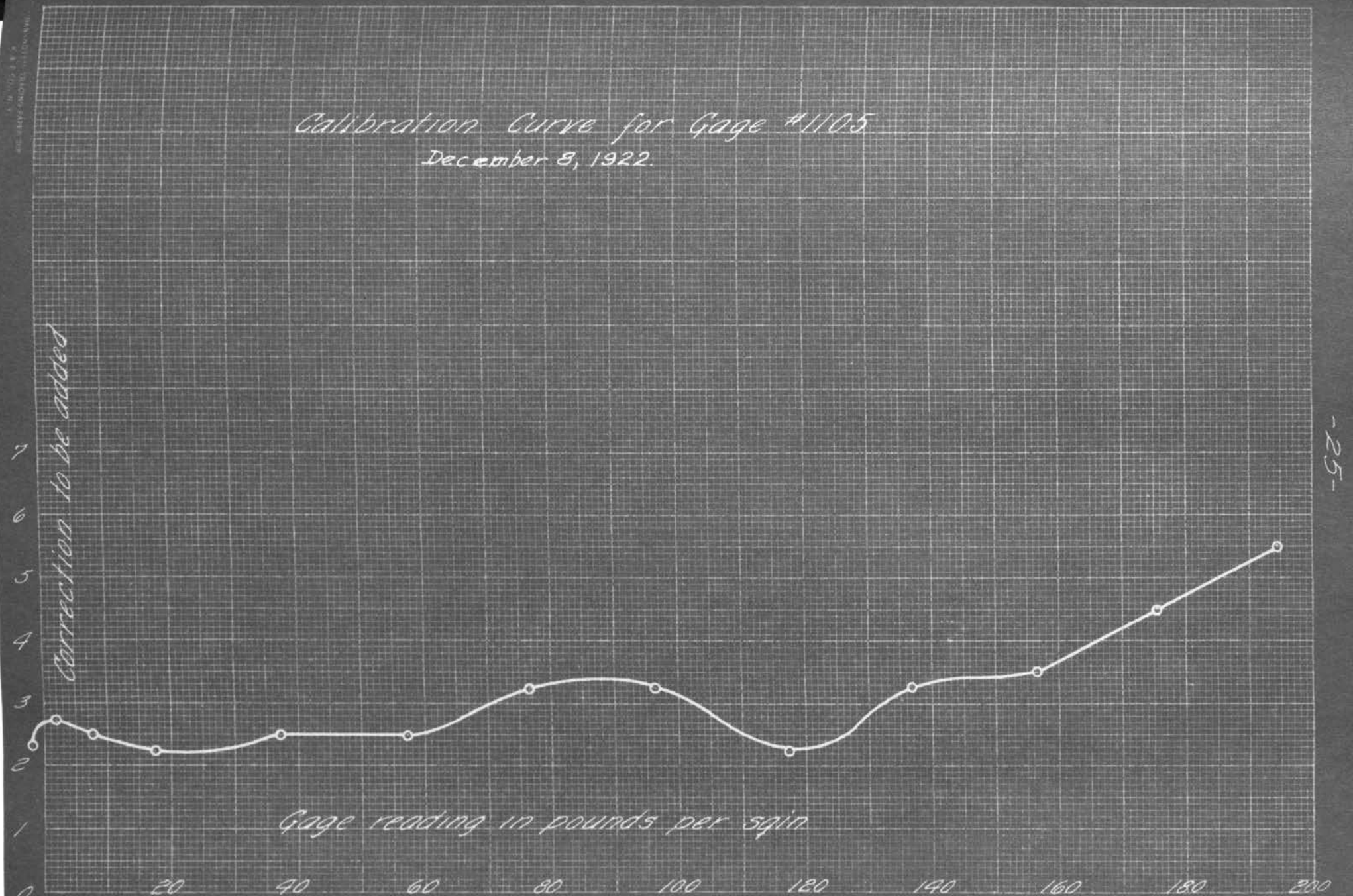

Calibration Curve for Gage #1105
December 8, 1922.
Correction to be added
0
1
2
3
4
5
6
7
20
40
60
80
100
120
140
160
180
200
Gage reading in pounds per sqin.

Fig. 10.

Calibration Hand Tachometer

December 12, 1921.

R. P. M. Actual	Tachometer Reading	Tachometer Reading
1260	1238	1238
1050	1046	1046
840	837	837
630	627	627
420	420	420
210	210	210

Calibration Hand Tachometer
(after repairing)

March 9, 1922.

R. P. M. Actual	Tachometer Reading	Tachometer Reading
210	206	206
420	408	408
630	618	618
840	828	828
1050	1042	1042
1260	1205	1205

III

METHOD OF PROCEDURE.

The following liquids were pumped: water, kerosene, paraffine oil, Trop Artic Auto Oil, 600 Green Cylinder Stock, and Texaco 880 Mexican Fuel Oil. For each liquid the pump was tested at speeds of 210, 420, 630, 840, 1050, and 1260 revolutions per minute. The total pressures pumped against at each speed were at open valve, 15, 35, 50, 80, 100, 120, 140, 160, and 200 pounds per sq. in. except at the higher speeds 160 pounds per sq. in. was the limit. In place of 15, 35, and 50 pounds per sq. in. pressure, 20, 40, and 60 pounds per sq. in. were used in testing the pump with water.

The tests were first made with water since the ability of a rotary pump to handle water is fairly well known and in this way it offered a standard for comparison with the results obtained later for other liquids.

The liquid was pumped from the sump tank and discharged either into the weighing tank or back into the sump tank. Before making a test when pumping oil it was necessary to obtain the desired temperature of the liquid since both viscosity and density of oils

change rapidly with changes in temperature. The temperature at which to pump the oil was chosen as 110° F. It was found that a lower temperature would be very difficult to maintain constant during the runs. The work done on the oil had to be given out in the form of heat and unless the radiation from the pipes, pump, and tanks was great enough the liquid would rise in temperature while being pumped. Forcing steam through the coil in the sump tank aided in bringing the oils up to the temperature desired, and by running water through the same coil it helped to keep the temperature from going higher after the correct temperature had been obtained.

Having obtained the proper temperature, the next step was to obtain the proper speed and pressure, the speed being regulated by two field rheostats on the control board and the pressure by a valve above the pump. To obtain the lower speeds it was necessary to lower the voltage to the dynamometer by increasing the resistance in the field of the generator.

The discharge valve of the weighing tank was then closed and the liquid pumped into the weighing tank.

Time was taken for pumping 1500 pounds with the exception of the 210 R. P. M. readings for which 700 pounds was used. After the desired amount of fluid was pumped into the weighing tank, the liquid was directed back into the sump tank, the discharge valve of the weighing tank opened, and preparations for another run made. During each run the following observations were taken: dynamometer scale reading, revolutions per minute, pressure reading, manometer reading, temperature reading, weight pumped, and time, all being recorded on the data sheets.

The proper lateral rotor clearance for each liquid was found by making runs with various clearances. The proper clearance was taken as the one giving the highest average efficiency. Lateral rotor clearance is the space between the side of the rotor and the casing and was found by inserting thickness gauges or feelers. This clearance was changed by inserting or taking out thin paper gaskets between the pump head and the pump cylinder, and the rotor then centered, making the same clearance on each side. In order to do this it was necessary to take the pump off its suction base and then

to remove the pump head.

The radial clearance between the rotor and the cylinder was .0035 inches and was not changed, it being unnecessary since the packing strips adjusted themselves to the different liquids.

The distance between the pressure gage and the manometer was 2.3 feet. This was added to the sum of the corrected gage pressure and suction, all expressed in pounds per sq. inch. The difference in the velocity heads between the suction and the discharge was so small as to be negligible.

The viscosity and the density were accurately determined from samples which were kept of each oil. The density of water was taken as 1.00 which is very nearly correct for the temperatures at which the liquid was pumped.

FORMULAE.

Hydraulic Horse Power =

$$2.31 \frac{(\text{total press. in lb./sq. in.})\ (\text{lb. per min.})}{33{,}000 \times (\text{density of liquid})}$$

Input horse power =

$$\frac{(\text{dynamometer scale reading})\ (\text{rev. per min.})}{1{,}000}$$

$$\text{Efficiency} = \frac{\text{hydraulic horse power}}{\text{in put horse power}}$$

IV.

DATA AND CURVES.

Density Determination of Kerosene

January 10 and 11, 1923.

Westphal Balance Method.

Read.	Density	Temp. Degrees F.
.8154	.8154	69
.8188	.8188	60

Hydrometer Method.

Degrees Baume'	Density	Temp. Degrees F.
41.0	.8187	60
44.6	.8018	106
44.3	.8032	103
44.1	.8041	100
43.2	.8083	90

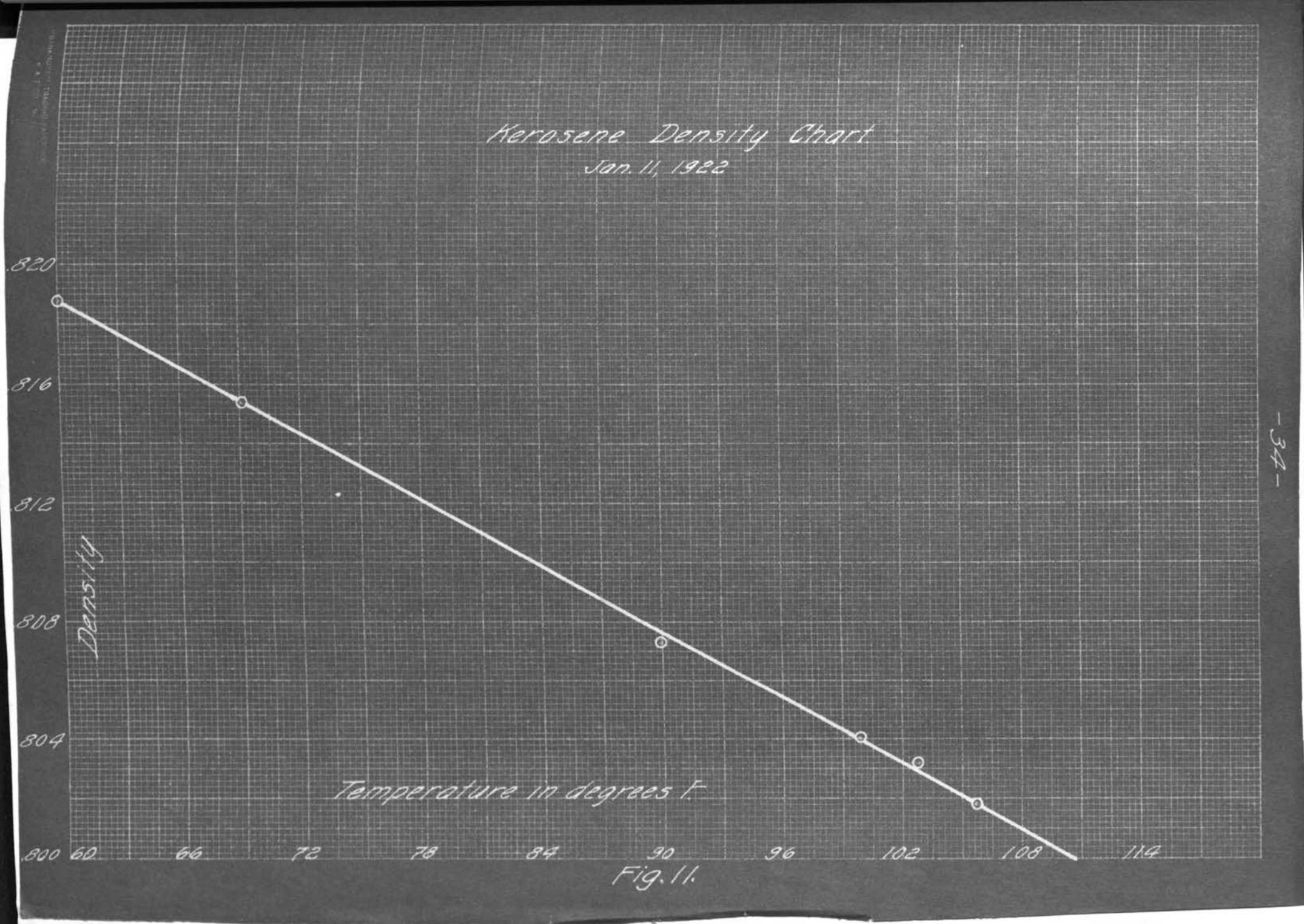

Kerosene Density Chart
Jan. 11, 1922
.820
.816
.812
.808
.804
.800
Density
60
66
72
78
84
90
96
102
108
114
Temperature in degrees F.

Fig. 11.

Density Determination of Paraffine Oil

January 27, 1922.

Before used in pump.

Degrees Baume'	Density	Temp. Degrees F.
30.4	.8728	117½
29.0	.8805	95

After first series of tests.

29.6	.8772	106
30.7	.8712	122

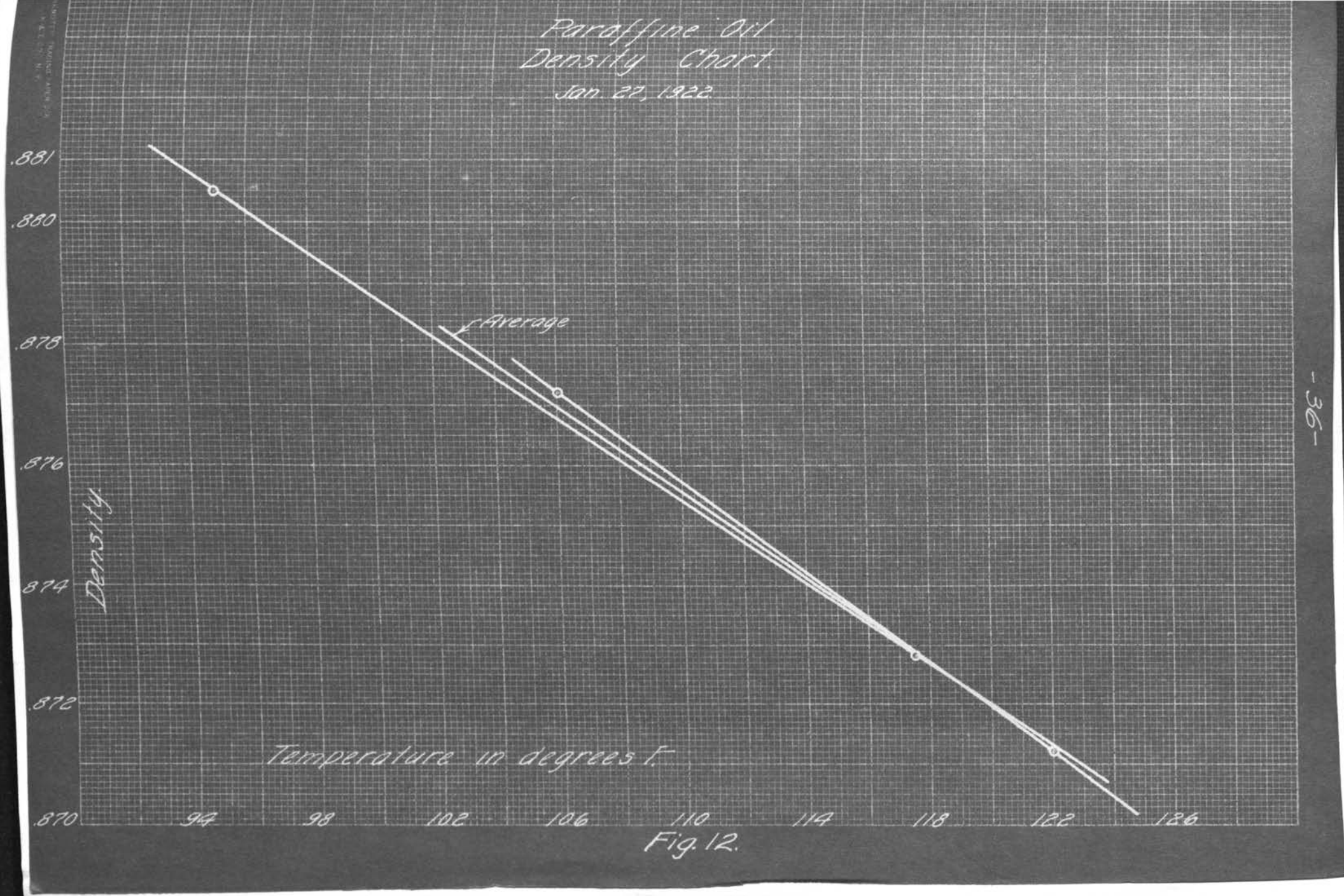

Paraffine Oil
Density Chart
Jan. 22, 1922
.881
.880
.878
.876
.874
.872
.870
Density.
Average
94
98
102
106
110
114
118
122
126
Temperature in degrees f.

Fig. 12.

Density Determination

of

Trop Artic Auto Oil.

February 20, 1922.

Degrees Baume'	Density	Temp. Degrees F.
31.0	.8696	116
30.5	.8723	107
30.0	.8750	97

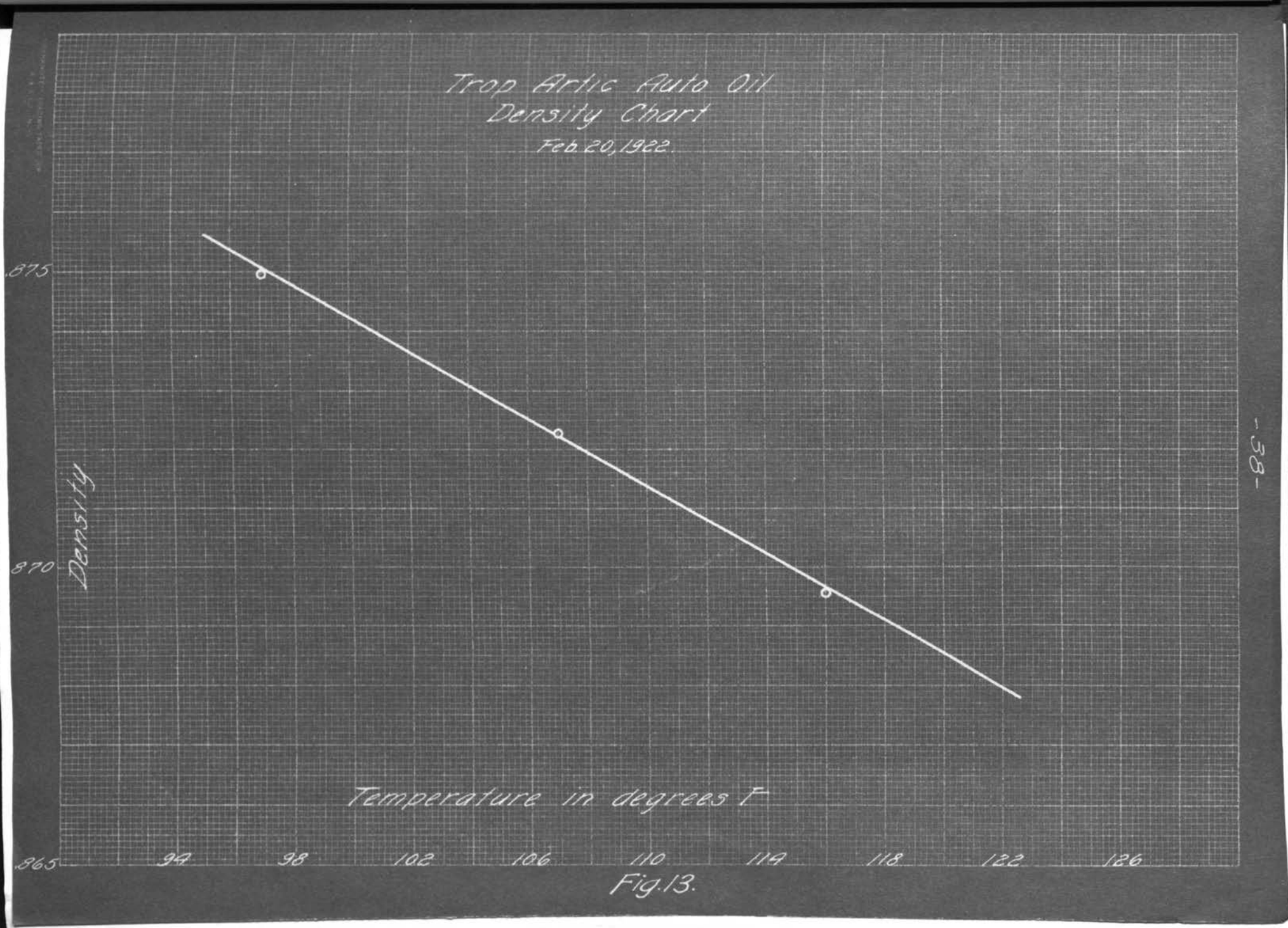

Trop Artic Auto Oil
Density Chart
Feb. 20, 1922.
.875
870
865
Density
94
98
102
106
110
114
118
122
126
Temperature in degrees F

Fig. 13.

Density Determination

600 Green Cylinder Stock

April 3, 1923.

Pycnometer Method.

Weight pycnometer	23.5890	gm.
Weight pycnometer and distilled water at 78 F	41.4830	"
Weight distilled water at 78 F	17.90	"
Density water at 78 F =	.9973	
Volume pycnometer = $\frac{17.90}{.9973}$ c c.		
Weight pycnometer and oil at 110 F	39.7126	gm.
Weight pycnometer	23.5890	"
Weight oil at 110 F	16.1236	"

Density oil at 110 F = $\frac{16.12 \times .9973}{17.90}$ = .898

Density Determination

Texaco 880 Mexican Fuel Oil.

May 2, 1922.

Pycnometer Method.

Weight pycnometer	40.5237 gm.
Weight pycnometer and distilled water at 78 F	65.2010
Weight distilled water at 78 F	24.6783 gm.
Density water at 78 F	.9973 gm.

$$\text{Volume pycnometer} = \frac{24.68}{.9973} \text{ c c.}$$

Weight pycnometer and oil at 110 F	62.3850 gm.
Weight pycnometer	40.5237 gm.
Weight oil at 110 F	21.8623 gm.

$$\text{Density oil at at 110 F} = \frac{21.86 \times .9973}{24.68} = .882$$

The relatively low density found for this oil is due to the formation of gas in the oil in the form of minute bubbles.

Viscosity Determinations

Saybolt Universal Viscosimeter.

Liquid	Temp. Degrees F.	Time of Discharge in seconds.
Tap water	80	30.0
" "	80	30.2
Kerosene	90	33.2
"	90	33.4
Paraffine	111	86.0
"	109	87.2
Trop Artic Auto Oil	111	387.
" " " "	110	394.
600 Green Cylinder Stock	110	3893.
" " " "	111	3403.
Texaco 880 Mexican Fuel Oil	110	18720.
" " " "	110	18000.

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1.0 LB. PER SQ. IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F DATE December 12, 1921

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average	VAC.		READ.	ACTUAL									
840	843	0	2.7	1.4	1.4	0	3.7	3.3	4.0	1.405	1067	1.00	128.0	.276	3.37	8.9		
840	843	0	2.7	1.4	1.4	0	3.7	3.2	3.9	1.400	1071	1.00	128.7	.277	3.29	8.42		
840	843	17.7	20.0	1.4	1.4	0	21.0	4.55	5.25	1.418	1058	1.00	127.0	1.555	4.43	35.1		
840	843	37.5	40.0	1.4	1.4	0	41.0	6.2	6.9	1.423	1053	1.00	126.4	3.02	5.82	51.9		
840	843	57.5	60.0	1.4	1.4	0	61.0	7.65	8.35	1.434	1045	1.00	125.4	4.46	7.04	63.3		
840	843	76.7	80.0	1.4	1.4	0	81.0	9.35	10.05	1.442	1040	1.00	124.8	5.90	8.48	69.6		
840	843	96.7	100.0	1.4	1.4	0	101.0	11.05	11.75	1.451	1033	1.00	124.0	7.31	9.91	73.8		
840	843	117.5	120.	1.4	1.4	0	121.0	12.9	13.55	1.470	1020	1.00	122.4	8.64	11.42	75.6		
840	843	136.7	140.0	1.4	1.4	0	141.0	14.8	15.45	1.491	1005	1.00	120.6	9.92	13.03	76.0		
840	843	156.5	160.0	1.4	1.4	0	161.0	16.4	17.05	1.503	998	1.00	119.7	11.25	14.38	78.3		
840	843	194.5	200.0	1.4	1.4	0	201.0	20.3	20.95	1.560	962	1.00	115.4	13.53	17.69	76.5		

Table Number 1

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1. LB. PER SQ.IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F. DATE December 12, 1921

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average		VAC.		READ.	ACTUAL									
1050	1054	0.0	2.7	1.4		.6	.8	4.1	3.7	4.4	1.125	1333	1.00	160.0	.382	4.63	8.25		
1050	1054	17.7	20.	1.4		.6	.8	21.4	4.95	5.65	1.130	1328	1.00	159.8	1.990	5.96	33.4		
1050	1054	37.5	40.	1.4		.6	.8	41.4	6.65	7.35	1.143	1312	1.00	157.4	3.80	7.75	49.0		
1050	1054	57.5	60.0	1.4		.6	.8	61.4	8.35	9.05	1.150	1304	1.00	156.6	5.61	9.54	58.8		
1050	1054	76.7	80.	1.4		.6	.8	81.4	10.1	10.8	1.158	1297	1.00	155.5	7.39	11.39	64.9		
1050	1054	96.7	100.	1.4		.6	.8	101.4	11.65	12.35	1.168	1284	1.00	154.1	9.12	13.01	70.1		
1050	1054	117.5	120.	1.4		.6	.8	121.4	13.5	14.15	1.177	1275	1.00	153.0	10.85	14.91	72.7		
1050	1054	136.7	140.	1.4		.6	.8	141.4	15.3	15.95	1.190	1260	1.00	151.1	12.48	16.80	74.3		
1050	1054	156.5	160.	1.4		.6	.8	161.4	17.0	17.65	1.198	1252	1.00	150.3	14.17	18.60	76.1		

Table Number 2

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1. LB. PER SQ. IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F. DATE December 13, 1921

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average		VAC.		READ.	ACTUAL									
1238	1260	0	2.7	1.4		-.4	1.8	4.6	4.35	5.05	.948	1582	1.00	190.0	.509	6.36	8.00		
1238	1260	17.7	20.	1.4		-.4	1.8	21.9	5.60	6.30	.950	1580	1.00	189.7	2.42	7.94	30.5		
1238	1260	37.5	40.	1.4		-.4	1.8	41.9	7.30	8.00	.953	1575	1.00	189.0	4.62	10.08	45.8		
1238	1260	57.5	60.	1.4		-.4	1.8	61.9	8.90	9.60	.960	1563	1.00	187.7	6.78	12.10	56.0		
1238	1260	76.7	80.	1.4		-.4	1.8	81.9	10.55	11.25	.963	1558	1.00	187.0	8.93	14.18	63.0		
1238	1260	96.7	100.	1.4		-.4	1.8	101.9	12.40	13.05	.971	1546	1.00	185.5	11.02	16.43	67.0		
1238	1260	117.5	120.	1.4		-.4	1.8	121.9	14.0	14.65	.983	1527	1.00	183.2	13.02	18.46	70.5		
1238	1260	136.7	140.	1.4		-.4	1.8	141.9	15.85	16.50	.993	1511	1.00	181.5	15.01	20.8	72.2		
1238	1260	156.5	160.	1.4		-.4	1.8	161.9	17.6	18.25	1.008	1488	1.00	178.5	16.87	23.0	73.3		

Table Number 3

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1. LB. PER SQ.IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F. DATE December 14, 1921

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average	VAC.		READ.	ACTUAL									
627	630	-1.0	1.7	1.4	1.4	0	2.7	2.35	3.05	1.876	800	1.00	96.0	.1510	1.922	7.8		
627	630	17.7	20.	1.4	1.4	0	21.0	3.70	4.40	1.897	792	1.00	95.1	1.164	2.77	42.0		
627	630	37.5	40.	1.4	1.4	0	41.0	5.50	6.20	1.922	780	1.00	93.7	2.24	3.91	57.3		
627	630	57.5	60.	1.4	1.4	0	61.0	7.20	7.90	1.946	771	1.00	92.6	3.29	4.98	66.1		
627	630	76.7	80.	1.4	1.4	0	81.	8.75	9.45	1.967	763	1.00	91.7	4.33	5.95	72.9		
627	630	96.7	100.	1.4	1.4	0	101.	10.40	11.10	1.986	755	1.00	90.7	5.34	7.00	76.3		
627	630	117.5	120.	1.4	1.4	0	121.	12.50	13.15	2.012	746	1.00	89.6	6.32	8.29	76.3		
627	630	136.7	140.	1.4	1.4	0	141.	14.10	14.75	2.043	735	1.00	88.3	7.25	9.30	78.0		
627	630	156.5	160.	1.4	1.4	0	161.	16.00	16.65	2.070	725	1.00	87.1	8.17	10.50	77.8		
627	630	194.5	200.	1.4	1.4	0	201.	19.60	20.25	2.156	695	1.00	83.4	9.78	12.75	76.6		

Table Number 4

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1. LB. PER SQ. IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F. DATE December 14, 1921

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average	VAC.		READ.	ACTUAL									
420	420	-1.0	1.7	1.4	1.4	0	2.7	2.25	2.95	2.838	528	1.00	63.4	.0998	1.240	8.04		
420	420	17.7	20.	1.4	1.4	0	21.0	3.75	4.45	2.855	526	1.00	63.2	.774	1.870	41.4		
420	420	37.5	40.	1.4	1.4	0	41.0	5.60	6.30	2.943	510	1.00	61.2	1.463	2.650	55.2		
420	420	57.5	60.	1.4	1.4	0	61.0	7.20	7.90	2.950	508	1.00	61.0	2.17	3.32	65.4		
420	420	76.7	80.	1.4	1.4	0	81.	8.60	9.30	3.045	493	1.00	59.2	2.80	3.91	71.6		
420	420	96.7	100.	1.4	1.4	0	101.	10.40	11.10	3.092	485	1.00	58.2	3.43	4.64	73.8		
420	420	117.5	120.	1.4	1.4	0	121.	12.30	12.95	3.120	481	1.00	57.7	4.08	5.44	75.0		
420	420	136.7	140.	1.4	1.4	0	141.	13.80	14.45	3.200	468	1.00	56.2	4.62	6.07	76.0		
420	420	156.5	160.	1.4	1.4	0	161.	15.20	15.85	3.280	457	1.00	54.8	5.15	6.66	77.3		
420	420	194.5	200.	1.4	1.4	0	201.	19.10	19.75	3.420	438	1.00	52.6	6.16	8.30	74.2		

Table Number 5

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1.0 LB. PER SQ. IN.

VISCOSITY LIQUID 30.1 seconds Saybolt at 80 degrees F. DATE December 15, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average	VAC.		READ.	ACTUAL									
208	208	-1.0	1.7	1.4	1.8	-.4	2.5	2.30	3.00	2.690	260.	1.00	31.2	.0455	.624	7.29		
210	210	17.7	20.	1.4	1.8	-.4	20.8	3.85	4.55	2.738	256.	1.00	30.7	.373	.955	39.1		
210	210	37.5	40.	1.4	1.8	-.4	40.8	5.40	6.10	2.832	247.	1.00	29.6	.706	1.281	55.1		
210	210	57.5	60.	1.4	1.8	-.4	60.8	7.05	7.75	2.943	238.	1.00	28.6	1.014	1.628	62.3		
211	211	76.7	80.	1.4	1.8	-.4	80.8	8.20	8.90	3.070	228.	1.00	27.4	1.290	1.879	68.7		
212½	212½	96.7	100.	1.4	1.8	-.4	100.8	10.05	10.75	3.170	221.	1.00	26.5	1.560	2.28	68.4		
206½	206½	117.5	120.	1.4	1.8	-.4	120.8	11.95	12.60	3.426	204.	1.00	24.5	1.725	2.60	66.3		
212	212	136.7	140.	1.4	1.8	-.4	140.8	13.60	14.25	3.430	204.	1.00	24.5	2.01	3.02	66.5		
212	212	156.5	160.	1.4	1.8	-.4	160.8	15.60	16.25	3.652	192.	1.00	23.1	2.16	3.45	62.6		
210-	210	194.5	200.	1.4	1.8	-.4	200.8	19.80	20.45	4.258	164.5	1.00	19.75	2.32	4.30	53.9		

Table Number 6

LIQUID USED Water

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS 1.0 LB. PER SQ. IN.

VISCOSITY LIQUID **30.1 seconds Saybolt at 80 degrees F.** DATE December 15, 1921 - December 21

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ. Average	VAC.		READ.	ACTUAL									
					December 15, 1921 Check Runs													
1238	1260	156.5	160.	1.4	-.4	1.8	161.9	17.55	18.20	1.003	1496	1.00	179.5	16.95	22.9	74.0		
840	843	194.5	200.	1.4	1.4	0	201.0	20.0	20.65	1.560	962	1.00	115.5	13.52	17.40	77.7		
					December 21, 1921													
1050	1054	17.7	20.	1.4	-.3	1.7	21.8	4.60	5.30	1.129	1329	1.00	159.5	2.03	5.59	36.3		

Table Number 7

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .8 LB. PER SQ.IN.

VISCOSITY LIQUID 33.3 seconds Saybolt at 90 degrees F. DATE January 4, 1922

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1238	1260	0.0	2.7	1.3	1.1	.3	.6	3.8	3.2	3.9	1.187	1265	.812	187.0	.415	4.92	8.44		79.
1238	1260	12.4	14.7	1.3	1.1	.3	.6	15.8	4.2	4.9	1.190	1261	.811	186.6	1.722	6.17	27.9		
1238	1260	32.2	34.7	1.3	1.1	.3	.6	35.8	6.0	6.7	1.198	1252	.810	185.5	3.88	8.44	46.0		
1238	1260	47.2	49.7	1.3	1.1	.3	.6	50.8	7.3	8.0	1.215	1234	.809	183.1	5.44	10.08	54.0		
1238	1260	76.4	79.7	1.3	1.1	.3	.6	80.8	9.9	10.6	1.227	1223	.808	185.1	8.57	13.36	64.1		
1238	1260	96.4	99.7	1.3	1.1	.3	.6	100.8	11.7	12.35	1.345	1204	.807	179.0	10.52	15.56	67.6		
1238	1260	117.2	119.7	1.3	1.1	.3	.6	120.8	13.3	13.95	1.260	1191	.806	177.1	12.50	17.59	71.1		
1238	1260	136.4	139.7	1.3	1.1	.3	.6	140.8	15.0	15.65	1.277	1175	.805	175.4	14.38	19.71	72.9		
1238	1260	156.2	159.7	1.3	1.1	.3	.6	160.8	16.7	17.35	1.303	1151	.804	171.8	16.12	21.9	73.6		99.

Table Number 8

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .8 LB. PER SQ. IN.

VISCOSITY LIQUID **33.3 seconds Saybolt at 90 degrees F.** DATE January 4, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1046	1050	0.0	2.7	1.3	1.1	.4	.5	3.7	2.5	3.2	1.421	1056	.804	157.8	.341	3.36	10.14		99.
1046	1050	12.5	14.8					15.8	3.5	4.2	1.429	1050	.804	156.8	1.444	4.41	32.8		
1046	1050	32.3	34.8					35.8	5.3	6.0	1.438	1043	.803	155.8	3.26	6.30	51.8		
1046	1050	47.3	49.8					50.8	6.55	7.25	1.449	1036	.803	154.7	4.58	7.61	60.2		
1046	1050	76.5	79.8					80.8	9.2	9.9	1.461	1027	.802	153.5	7.25	10.40	69.7		
1046	1050	96.5	99.8					100.8	10.95	11.6	1.487	1009	.802	151.0	8.88	12.19	72.9		
1046	1050	117.3	119.8					120.8	12.7	13.35	1.510	993	.801	148.8	10.49	14.01	74.8		
1046	1050	136.5	139.8					140.8	14.25	14.90	1.521	986	.800	147.7	12.15	15.64	77.7		
1046	1050	156.3	159.8	1.3	1.3	.5	.4	160.8	16.2	16.85	1.548	969	.799	145.5	13.65	17.70	77.1		113

Table Number 9

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEFN GAGES 2.3 FT. EQUALS .8 LB. PER SQ. IN.

VISCOSITY LIQUID 33.3 seconds Saybolt at 90 degrees F. DATE January 5, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
627	630	0	2.7	1.3	1.7	.9	0	3.5	1.8	2.5	2.349	638	.804	95.3	.194	1.57	12.4		98.8
627	630	12.7	15.0					15.8	2.95	3.65	2.370	633	.	94.6	.870	2.30	37.8		
627	630	32.5	35.0					35.8	4.65	5.35	2.400	625	.804	93.4	1.950	3.37	57.9		98.5
627	630	47.5	50.0					50.8	5.8	6.50	2.425	619		92.5	2.74	4.09	67.0		
627	630	76.7	80.0					80.8	8.5	9.20	2.485	604	.804	90.2	4.25	5.80	73.3		98.8
627	630	96.7	100.0					100.8	10.4	11.1	2.534	593		88.6	5.21	7.00	74.4		
627	630	117.5	120.0					120.8	12.0	12.65	2.579	582	.804	86.9	6.12	7.97	76.8		100.5
627	630	136.7	140.0					140.8	13.8	14.45	2.620	573		85.6	7.03	9.10	77.3		
627	630	156.5	160.0					160.8	15.8	16.45	2.691	558	.803	83.3	7.83	10.38	75.5		102.6
627	630	184.5	200.0	1.3	1.7	1.0	0	200.8	19.5	20.15	2.828	530	.803	79.2	9.28	12.70	73.1		104.1

Table Number 10

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .8 LB. PER SQ. IN.

VISCOSITY LIQUID 33.3 seconds Saybolt at 90 degrees F. DATE January 5, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
837	840	0	2.7	1.3	1.5	.8	.2	3.6	2.3	3.0	1.753	856	.811	126.8	.266	2.52	10.56		81
837	840	0	2.7					3.6	2.3	3.0	1.751	856	.811	126.8	.266	2.52	10.56		
837	840	12.6	14.9					15.8	3.35	4.05	1.756	854	.811	126.3	1.166	3.40	34.3		
837	840	32.4	34.9					35.8	5.10	5.80	1.783	841	.811	124.3	2.60	4.87	53.3		
837	840	47.4	49.9					50.8	6.4	7.1	1.791	837	.810	123.9	3.68	5.96	61.7		84
837	840	76.6	79.9					80.8	8.8	9.5	1.820	824	.809	122.1	5.76	7.98	72.2		
837	840	96.6	99.9					100.8	10.6	11.25	1.853	809	.808	120.0	7.07	9.45	74.8		
837	840	117.4	119.9					120.8	12.5	13.15	1.880	798	.807	118.5	8.37	11.05	75.8		91.
837	840	136.6	139.9					140.8	14.25	14.90	1.910	785	.807	116.6	9.58	12.52	76.5		
837	840	156.4	159.9					160.8	16.0	16.65	1.945	771	.806	114.6	10.75	14.00	76.8		96
837	840	194.4	199.9	1.3	1.5	.8	.2	200.8	19.95	20.6	2.025	741	.805	110.2	12.95	17.31	74.8		98.

Table Number 11

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .8 LB. PER SQ. IN.

VISCOSITY LIQUID 33.3 seconds Saybolt at 90 degrees F. DATE January 6, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
420	420	0	2.7	1.3	1.2	.6	.4	3.7	1.55	2.25	3.484	431	.808	64.0	.1381	.945	14.6		90.8
420	420	12.5	14.8					15.8	2.55	3.25	3.523	426	.808	63.2	.583	1.365	42.7		89.8
420	420	32.3	34.8					35.8	4.3	5.0	3.579	419		62.2	1.300	2.10	61.9		
420	420	47.3	49.8					50.8	5.75	6.45	3.642	412	.808	61.1	1.812	2.71	66.9		88.8
420	420	76.5	79.8					80.8	8.3	9.00	3.780	397		58.9	2.78	3.78	73.5		
420	420	96.5	99.8					100.8	10.0	10.7	3.840	391	.808	58.0	3.42	4.49	76.1		89.6
420	420	117.3	119.8					120.8	11.8	12.45	3.938	381		56.5	3.99	5.23	76.3		
420	420	136.5	139.8					140.8	13.7	14.35	3.052	370	.808	54.9	4.51	6.02	74.8		90.6
420	420	156.3	159.8					160.8	15.5	16.15	4.188	358		53.1	4.98	6.78	73.5		
420	420	194.3	199.8	1.3	1.5	.7	.2	200.8	19.2	19.85	4.523	332	.807	49.2	5.79	8.34	69.5		93.0

Table Number 12

LIQUID USED Kerosene

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .8 LB. PER SQ. IN.

VISCOSITY LIQUID 33.3 seconds Saybolt at 90 degrees F. DATE January 7, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
210	210	0	2.7	1.3	1.3	1.0	.1	3.5	.85	1.55	3.300	212.	.811	31.4	.0640	.325	19.7		81.0
210	210	12.7	15.0					15.8	2.05	2.75	3.365	208.	.811	30.8	.284	.578	49.2		80.8
210	210	32.5	35.0					35.8	3.9	4.6	3.514	199.	2.811	29.5	.616	.966	63.8		80.8
210	210	47.5	50.0					50.8	5.4	6.1	3.610	194.0		28.7	.850	1.282	66.3		
210	210	76.7	80.0					80.8	8.1	8.8	3.830	182.8	.811	27.1	1.275	1.850	68.9		81.5
210	210,	96.7	100.0					100.8	9.9	10.6	4.060	172.5	.	25.5	1.500	2.23	67.3		
210	210	117.5	120.0					120.8	11.8	12.45	4.310	162.5	.810	24.1	1.696	2.62	64.7		82.9
210	210	136.7	140.0					140.8	13.5	14.15	4.618	151.6	.	23.5	1.844	2.97	62.1		
210	210	156.5	160.0					160.8	15.25	15.90	4.934	141.9	.810	21.0	1.970	3.34	59.0		84.0
210	210	194.5	200.0	1.3	1.3	1.0	.1	200.8	18.95	19.6	5.954	117.5	.809	17.4	2.05	4.12	49.8		85.6

Table Number 13

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE January 23, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1238	1260	1.0	3.7	1.4	-.3	-1.1	2.1	5.6	2.95	3.65	1.087	1380	.875	189.3	.617	4.60	13.4		111
1238	1260	1.0	3.7					5.6	2.95	3.65	1.088	1379	.875	189.2	.617	4.60	13.4		111
1238	1260	1.0	3.7					5.6	2.95	3.65	1.085	1383	.875	189.6	.619	4.60	13.4		111
1238	1260	10.8	13.2					15.1	3.75	4.45	1.089	1377	.875	188.9	1.664	5.61	29.7		110
1238	1260	30.6	33.0					34.9	5.55	6.25	1.094	1371	.875	188.2	3.83	7.88	48.6		110
1238	1260	45.6	48.1					50.0	6.8	7.5	1.092	1378	.875	189.0	5.49	9.45	58.1		111
1238	1260	74.8	78.0					79.9	9.6	10.3	1.100	1364	.875	187.1	8.72	12.99	67.2		112
1238	1260	94.8	98.1					100.0	11.2	11.85	1.103	1359	.875	186.4	10.86	14.93	72.7		110
1238	1260	115.6	117.9					119.8	12.95	13.6	1.109	1352	.875	185.5	12.95	17.14	75.5		111
1238	1260	134.8	138.0					139.9	14.8	15.45	1.115	1345	.875	184.5	15.05	19.48	77.2		112
1238	1260	154.6	158.0	1.4	-.3	-1.1	2.1	159.9	16.5	17.15	1.121	1338	.875	183.5	17.10	21.6	79.1		110

Table Number 14

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE January 23, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.	VAC.		READ.	ACTUAL									
1046	1050	.7	3.4	1.4	.1 -.7	1.7	5.1	2.2	2.9	1.293	1160	.875	159.2	.473	3.04	15.5		109
1046	1050	10.8	13.2				14.9	3.1	3.8	1.295	1159	.875	159.0	1.38	3.99	34.6		109
1046	1050	30.6	33.0				34.7	4.85	5.55	1.298	1156	.875	158.5	3.21	5.83	55.0		109
1046	1050	45.6	48.1				49.8	6.3	7.0	1.303	1151	.875	158.0	4.58	7.35	62.3		110
1046	1050	74.8	78.0				79.7	8.8	9.5	1.318	1138	.875	156.1	7.26	9.97	72.8		110
1046	1050	94.8	98.1				99.8	10.75	11.4	1.318	1138	.875	156.1	9.08	11.98	75.8		110
1046	1050	115.6	117.9				119.6	12.4	13.05	1.337	1122	.875	153.9	10.73	13.70	78.3		112
1046	1050	134.8	138.0				139.7	14.2	14.85	1.349	1112	.875	153.5	12.43	15.60	79.7		113
1046	1050	154.6	158.0	1.4	.1 -.7	1.7	159.7	16.0	16.65	1.350	1111	.875	153.4	14.20	17.49	81.2		113
1046	1050	154.6	158.0				159.7	16.0	16.65	1.343	1117	.875	153.3	14.26	17.49	81.5		113
1046	1050	94.8	98.1	1.4	.1 -.7	1.7	99.8	10.75	11.4	1.320	1137	.875	156.0	9.07	11.98	75.7		110

Table Number 15

LIQUID USED Parafinne Oil

LATERAL CAM CLEARANCE ON A SIDE .001. INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID **86.6 seconds Saybolt at 110 degrees F.** DATE January 24, 1922

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
837	840	.3	3.0	1.4	.2	=.5	1.5	4.6	1.6	3.3	1.607	934	.875	128.0	.344	1.93	17.8		109
837	840	11.0	13.4					15.0	2.4	3.1	1.610	931	.875	127.6	1.118	2.61	42.8		109
837	840	30.8	33.2					34.8	4.2	4.9	1.622	925	.875	126.8	2.57	4.12	62.4		109
837	840	45.8	48.3					49.9	5.6	6.3	1.631	919	.875	126.0	3.66	5.29	69.2		109
837	840	75.0	78.2					79.8	8.2	8.9	1.631	919	.875	126.0	5.87	7.48	78.5		109
837	840	95.0	98.3					99.9	10.1	10.8	1.647	912	.875	125.0	7.28	9.08	80.2		109
837	840	115.8	118.1					119.7	11.8	12.45	1.657	906	.875	124.2	8.68	10.47	83.0		110
837	840	135.0	138.2					139.8	13.55	14.2	1.673	897	.875	123.0	10.03	11.93	84.1		110
837	840	154.8	158.2					159.8	15.35	16.0	1.692	887	.875	121.6	11.34	13.45	84.3		111
837	840	192.8	198.2	1.4	-.2	-.5	1.5	199.8	19.00	19.65	1.725	869	.875	119.1	13.88	16.51	84.0		112

Table Number 16

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE January 24, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
627	630	0	2.7	1.4	.3	-.3	1.4	4.3	.95	1.65	2.142	701	.875	96.2	.241	1.056	22.8		110
627	630	11.1	13.5					15.1	1.9	2.6	2.151	698	.875	95.8	.844	1.665	50.7		109
627	630	30.9	33.3					34.9	3.65	4.35	2.170	691	.875	94.8	1.930	2.78	69.4		109
627	630	45.9	48.4					50.0	5.1	5.8	2.167	691	.875	94.8	2.76	3.71	74.3		109
627	630	75.1	78.3					79.9	7.65	8.35	2.194	685	.875	94.0	4.38	5.34	82.1		109
627	630	95.1	98.4					100.0	9.55	10.25	2.220	676	.875	93.8	5.41	6.56	82.4		109
627	630	115.9	118.2					119.8	11.25	11.90	2.230	673	.875	93.3	6.45	7.62	84.7		109
627	630	135.1	138.3					139.9	13.1	13.75	2.257	663	.875	91.0	7.42	8.80	84.3		109
627	630	154.9	158.3					159.9	14.9	15.55	2.280	658	.875	90.2	8.42	9.95	84.6		110
627	630	192.9	198.3	1.4	.3	-.3	1.4	199.9	18.65	19.30	2.345	638	.875	87.6	10.20	12.36	82.5		111

Table Number 17

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE January 24, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
								Check Runs											
627	630	30.9	33.3	1.4	.3	-.3	1.4	34.9	3.65	4.35	2.166	691	.875	94.8	1.930	2.78	69.4		111
627	630	45.9	48.4					50.0	5.1	5.8	2.180	688	.875	94.4	2.75	3.71	74.1		111
627	630	45.9	48.4					50.0	5.1	5.8	2.180	688	.875	94.4	2.75	3.71	74.1		111
627	630	45.9	48.4	1.4	.3	-.3	1.4	50.0	5.1	5.8	2.180	688	.875	94.4	2.75	3.71	74.1		111

Table Number 18

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE January 25, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
420	420	0	2.7	.4	.6	-.2	1.1	4.1	.55	1.25	3.190	470	.875	64.5	.154	.525	29.4		110
420	420	11.4	13.8					15.2	1.6	2.3	3.203	469	.875	64.3	.570	.966	59.0		108
420	420	31.2	33.6					35.0	3.35	4.05	3.230	464	.875	63.6	1.299	1.700	76.3		111
420	420	46.2	48.7					50.1	4.75	5.45	3.240	463	.875	63.5	1.875	2.29	81.0		111
420	420	75.4	78.6					80.0	7.4	8.10	3.290	456	.875	63.5	2.92	3.40	85.8		111
420	420	95.4	98.7					100.1	9.2	9.9	3.346	448	.875	61.5	3.59	4.16	86.3		111
420	420	116.2	118.5					119.9	11.05	11.70	3.386	443	.875	60.8	4.25	4.92	86.3		111
420	420	135.4	138.6					140.0	12.75	13.4	3.437	436	.875	59.8	4.88	5.63	86.7		111
420	420	155.2	158.6					160.0	14.55	15.2	3.490	430	.875	59.0	5.50	6.38	86.2		111
420	420	193.2	198.6	1.4	.6	-.1	1.1	200.	18.4	19.05	3.600	417	.875	57.3	6.67	8.00	83.4		112

Table Number 19

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F DATE January 26, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 I.B.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
210	210	0	2.7	1.4	.7	.4	.8	4.0	0.15	.85	2.970	236	.875	32.4	.0755	.178	42.5		108
210	210	0	2.7					4.0	0.15	.85	2.975	236	.875	32.4	.0755	.178	42.5		109
210	210	11.7	14.1					15.4	1.2	1.9	3.016	232	.875	31.8	.286	.399	71.7		110
210	210	31.5	33.9					35.2	2.95	3.65	3.090	226	.875	31.0	.636	.767	82.9		109
210	210	46.5	49.0					50.3	4.3	5.0	3.107	225	.875	30.9	.906	1.050	86.3		110
210	210	75.7	78.9					80.2	7.0	7.7	3.213	218	.875	29.9	1.400	1.618	86.5		109
210	210	95.7	99.0					100.3	8.65	9.35	3.280	213	.875	29.2	1.710	1.963	87.0		109
210	210	116.5	118.8					120.1	10.55	11.2	3.368	208	.875	28.5	2.000	2.35	85.0		109
210	210	135.7	138.9					140.2	12.3	12.95	3.446	203	.875	27.8	2.28	2.72	83.8		109
210	210	155.5	158.9					160.2	14.2	14.85	3.566	196.7	.875	27.0	2.52	3.12	80.7		109
210	210	193.5	198.9	1.4		.4		200.2	17.8	18.45	3.836	182.3	.875	25.0	2.92	3.88	75.3		109

Table Number 20

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE February 3, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1238	1260	1.5	4.2	.4	.2	-.4	.5	5.3	2.85	3.55	1.100	1364	.875	187.1	.578	4.47	12.9		110
1238	1260	11.5	13.9					15	3.75	4.45	1.101	1363	.875	186.9	1.636	5.61	29.2		110
1238	1260	31.5	33.9					35	5.6	6.30	1.103	1360	.875	186.4	3.81	7.93	48.1		110
1238	1260	46.4	48.9					50	6.9	7.6	1.111	1350	.875	185.2	5.40	9.58	56.3		110
1238	1260	75.7	78.9					80	9.55	10.25	1.116	1345	.875	184.5	8.61	12.92	66.6		111
1238	1260	95.7	98.9					100	11.2	11.85	1.120	1339	.875	183.6	10.71	14.93	71.7		112

Table Number 21

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE February 4, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1238	1260	116.4	118.7	.3	-.2	-1.0	.0	120	12.9	13.55	1.131	1327	.875	182.0	12.74	17.08	74.6		110
1238	1260	135.4	138.7					140	14.55	15.20	1.140	1316	.875	180.4	14.73	19.16	76.9		112
1238	1260	155.2	158.7					160	16.5	17.15	1.153	1301	.875	178.5	16.65	21.6	77.1		114

Table Number 22

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE February 6, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
837	840	.2	2.9	.4	.1	-.6	-.6	4.1	1.35	2.05	1.611	931	.875	127.6	.306	1.72	17.8		110
837	840	11.4	13.8					15	2.3	3.0	1.617	928	.875	127.2	1.114	2.52	44.2		109 ~~112~~
837	840	31.4	33.8					35	4.05	4.75	1.632	919	.875	126.0	2.57	3.99	64.4		109
837	840	46.3	48.8					50	5.45	6.15	1.643	913	.875	125.2	3.66	5.17	70.8		109
837	840	75.6	78.8					80	8.15	8.85	1.650	909	.875	124.6	5.82	7.43	78.3		109
837	840	95.6	98.8					100	10.00	10.70	1.676	895	.875	122.7	7.16	8.99	79.6		110
837	840	116.5	118.8					120	11.85	12.50	1.684	891	.875	122.2	8.55	10.50	81.4		110
837	840	135.5	138.8					140	13.6	14.25	1.704	880	.875	120.7	9.85	11.97	82.3		110
837	840	155.3	158.8					160	15.45	16.10	1.728	868	.875	119.0	11.12	13.52	82.2		111
837	840	193.4	198.8					200	19.4	20.05	1.780	843	.875	115.6	13.50	16.85	80.1		112

Table Number 23

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE February 6, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
210	210	-.3	2.4	.4	.4	.2	.1	3.3	0.0	.70	2.991	234.	.875	32.1	.0617	.147	42.0		109
210	210	11.7	14.1					15	0.95	1.65	3.060	229.	.875	31.4	.275	.346	79.5		109
210	210	31.7	34.1					35	2.80	3.50	3.150	222.	.875	30.5	.622	.735	84.6		110
210	210	46.6	49.1					50	4.1	4.8	3.244	216.	.875	29.6	.863	1.008	85.6		110
210	210	75.9	79.1					80	6.9	7.6	3.405	206.	.875	28.3	1.319	1.596	82.6		109
210	210	95.9	99.1					100	8.6	9.3	3.580	195.5	.875	26.8	1.564	1.953	80.1		109
210	210	116.8	119.1					120	10.45	11.1	3.770	185.7	.878	25.5	1.784	2.32	76.9		108
210	210	135.9	139.1					140	12.2	12.85	3.931	178.1	.875	24.5	1.996	2.70	73.9		109
210	210	155.6	159.1					160	14.0	14.65	4.156	168.3	.875	23.1	2.16	3.08	70.1		109
210	210	193.6	199.1	.4		.2		200	17.9	18.55	4.895	143.0	.875	19.6	2.29	3.90	58.7		109

Table Number 24

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F. DATE February 9, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1238	1260	1.0	3.7	.4	0.0	-.6	.7	4.9	3.05	3.75	1.097	1368	.875	187.5	.537	4.72	11.4		109
1238	1260	11.4	13.8					15	3.85	4.55	1.099	1366	.875	187.3	1.64	5.73	28.6		109
1238	1260	31.4	33.8					35	5.75	6.45	1.119	1340	.875	184.0	3.75	8.13	46.2		109
1238	1260	46.3	48.8					50	7.1	7.8	1.119	1340	.875	184.0	5.36	9.83	54.5		109
1238	1260	75.6	78.8					80	9.8	10.5	1.130	1328	.875	182.1	8.50	13.23	64.2		110
1238	1260	95.5	98.8					100	11.55	12.20	1.140	1316	.875	180.5	10.53	15.37	68.5		110
1238	1260	116.5	118.8					120	13.05	13.70	1.148	1307	.875	179.4	12.55	17.27	72.6		111
1238	1260	135.6	138.8					140	15.0	15.65	1.166	1287	.875	176.5	14.41	19.72	73.0		112
1238	1260	155.4	158.8			-.5		160	16.7	17.35	1.184	1266	.875	173.6	16.20	21.9	74.0		113

Table Number 25

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F DATE February 9, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
837	840	.7	3.4	.4	.6	-.1	.2	4.4	1.55	2.25	1.614	929.	.875	127.4	.327	1.89	17.3		109
837	840	11.6	14.0					15	2.3	3.0	1.620	926.	.875	127.0	1.112	2.52	44.1		109
837	840	31.6	34.0					35	4.15	4.85	1.649	910.	.875	124.7	2.55	4.07	62.7		109
837	840	46.5	49.0					50	5.55	6.25	1.655	906.	.875	124.3	3.62	5.25	69.0		109
837	840	75.8	79.0					80	8.2	8.9	1.684	890.	.875	122.1	5.69	7.48	76.0		109
837	840	95.8	99.0					100	10.0	10.7	1.718	873.	.875	119.7	6.98	8.99	77.7		109
837	840	116.7	119.0					120	11.8	12.45	1.749	858.	.875	117.7	8.23	10.46	78.7		110
837	840	135.8	139.0					140	13.6	14.25	1.770	848.	.875	116.3	9.50	11.97	79.4		111
837	840	155.5	159.0					160	15.4	16.05	1.795	836.	.875	114.6	10.71	13.49	79.4		111
837	840	193.5	199.0	.4		.0		200	19.3	19.95	1.870	802.	.875	110.0	12.83	16.77	76.5		112

TABLE NUMBER 36

LIQUID USED Paraffine Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 86.6 seconds Saybolt at 110 degrees F DATE February 10, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
210	210	.5	3.3	.4	.4	.1	.1	4.2	0.05	.75	2.999	233.	.875	32.0	.0784	.1575	49.8		109
210	210	11.7	14.1					15	1.0	1.7	3.073	228.	.875	31.3	.274	.357	76.8		109
210	210	31.7	34.1					35	2.8	3.5	3.268	214.	.875	29.3	.600	.737	81.7		109
210	210	46.6	49.1					50	4.15	4.85	3.441	203.	.875	27.9	.811	1.019	79.6		110
210	210	75.9	79.1					80	6.95	7.65	3.813	183.6	.875	25.2	1.176	1.607	73.2		110
210	210	95.9	99.1					100	8.7	9.4	4.103	170.7	.875	23.4	1.365	1.974	69.2		109
210	210	116.8	119.1					120	10.55	11.24	4.483	156.1	.875	21.4	1.500	2.35	63.8		109
210	210	135.9	139.1					140	12.3	12.955	5.090	137.5	.875	18.9	1.540	2.78	56.6		112
210	210	155.6	159.1					160	14.1	14.755	5.840	119.9	.875	16.4	1.535	3.10	49.5		112
210	210	193.6	199.1	.4		.2		200	17.95	18.608	8.170	85.7	.875	11.8	1.372	3.91	35.1		112

TABLE NUMBER 27

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 9, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	.3	3.0	.4	.5	.2	0	3.9	.15	.853	.006	233	.871	32.1	.0731	.1785	40.9		108
206	210	11.7	14.1					15	1.15	1.853	.016	232	.871	31.9	.280	.389	72.0		109
206	210	31.7	34.1					35	2.9	3.6	.027	231	.871	31.8	.650	.756	86.0		110
206	210	46.6	49.1					50	4.35	5.05	.057	229	.871	31.6	.921	1.061	86.7		110
206	210	75.9	79.1					80	7.05	7.75	.120	224	.871	30.9	1.142	1.628	88.6		109
206	210	95.8	99.1					100	8.9	9.6	.170	221	.871	30.4	1.777	2.02	88.0		109
206	210	116.8	119.1					120	10.8	11.153	.215	218	.871	30.0	2.10	2.42	86.7		109
206	210	135.9	139.1					140	13.5	13.153	.277	213	.871	29.3	2.40	2.76	86.9		110
206	210	155.7	159.1					160	14.4	15.05	.344	209	.871	28.8	2.69	3.16	85.2		110
206	210	193.6	199.1					200	17.95	18.60	.515	199	.871	27.4	3.20	3.91	81.8		110

Table Number 28

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN CAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 13, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.	VAC.		READ.	ACTUAL									
408	420	.5	3.2	.3	.4	.2	4.2	.75	1.45	3.193	470	.871	64.8	.159	.609	26.1		109
408	420	11.6	14.0				15	1.7	2.4	3.223	466	.871	64.2	.562	1.007	55.8		110
408	420	31.6	34.0				35	3.55	4.25	3.244	463	.871	63.8	1.303	1.785	73.0		109
408	420	46.5	49.0				50	4.9	5.6	3.250	462	.871	63.7	1.860	2.35	79.1		109
408	420	75.8	79.0				80	7.55	8.25	3.280	457	.871	63.0	2.94	3.46	85.0		109
408	420	95.7	99.0				100	9.3	10.0	3.313	453	.871	62.4	3.64	4.20	86.7		109
408	420	116.7	119.0				120	11.2	11.85	3.356	447	.871	61.6	4.31	4.98	86.4		110
408	420	135.8	139.0				140	13.0	13.65	3.370	445	.871	61.3	5.01	5.73	87.4		110
408	420	155.6	159.0				160	14.8	15.45	3.43	439	.871	60.5	5.65	6.49	8710		111
408	420	193.5	199.0	.3		-.2	200	18.45	19.10	3.523	426	.871	58.7	6.85	8.02	85.4		111

Table Number 29

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .0035 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 13, 1932

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1205	1260	2.0	4.7	.3	-.5	-1.1	1.1	6.1	3.85	4.55	1.083	1385	.871	191.0	.680	5.73	11.9		108
1205	1260	11.2	13.6					15	4.7	5.4	1.096	1368	.871	188.3	1.650	6.80	24.3		108
1205	1260	31.2	33.6					35	6.5	7.2	1.096	1368	.871	188.3	3.85	9.07	42.4		108
1205	1260	46.1	48.6					50	7.7	8.4	1.100	1364	.871	187.9	5.48	10.59	51.8		108
1205	1260	75.4	78.6					80	10.4	11.1	1.103	1360	.871	187.4	8.75	14.00	62.5		109
1205	1260	95.3	98.6					100	12.15	12.80	1.110	1352	.871	186.3	10.87	16.13	67.3		110
1205	1260	116.3	118.6					120	13.9	14.55	1.113	1347	.871	185.6	13.00	18.33	70.9		111
1205	1260	135.4	138.6					140	15.6	16.25	1.116	1344	.871	185.1	15.13	20.5	73.8		113
1205	1260	155.2	158.6	.3		-1.0		160	17.4	18.05	1.127	1331	.871	183.5	17.12	22.8	75.0		113

Table number 30

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 14, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.	VAC.		READ.	ACTUAL									
618	630	.7	3.4	.3	.2	.5	4.5	1.4	2.1	2.161	694	.871	95.6	.251	1.323	18.97		109
618	630	11.5	13.9				15	2.3	3.0	2.161	694	.871	95.6	.837	1.890	44.3		109
618	630	31.5	33.9				35	4.2	4.9	2.165	693	.871	95.5	.950	3.109	63.1		109
618	630	46.4	48.9				50	5.6	6.3	2.180	688	.871	94.8	2.76	3.97	69.5		109
618	630	75.7	78.9				80	8.25	8.95	2.184	687	.871	94.6	4.42	5.64	78.4		109
618	630	95.6	98.9				100	10.05	10.75	2.200	682	.871	94.0	5.48	6.78	80.9		109
618	630	116.6	118.9				120	11.85	12.50	2.210	678	.871	93.4	6.54	7.88	83.0		110
618	630	135.7	138.9				140	13.6	14.25	2.230	672	.871	92.6	7.56	8.98	84.2		110
618	630	155.5	158.9				160	15.3	15.95	2.260	663	.871	91.4	8.53	10.05	84.9		110
618	630	193.4	198.9	.3		.5	200	19.15	19.80	2.301	652	.871	89.9	10.48	12.48	84.0		110

Table Number 31

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 594 seconds Saybolt at 110 degrees F. DATE March 14, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
828	840	.8	3.5	.3	.1	-.6	-.5	4.6	2.2	2.9	1.618	927	.871	127.8	.343	2.44	14.07		108
828	840	11.5	13.9					15	3.05	3.75	1.618	927	.871	127.7	1.119	3.15	35.5		108
828	840	31.5	33.9					35	4.85	5.55	1.620	926	.871	127.5	2.61	4.67	55.9		108
828	840	46.4	48.9					50	6.25	6.95	1.634	917	.871	126.3	3.69	5.84	63.2		108
828	840	75.7	78.9					80	8.8	9.5	1.643	913	.871	125.7	5.88	7.98	73.7		108
828	840	95.6	98.9					100	10.7	11.4	1.648	910	.871	125.3	7.32	9.58	76.4		108
828	840	116.6	118.9					120	12.5	13.15	1.660	904	.871	124.4	8.71	11.05	78.8		109
828	840	135.7	138.9					140	14.2	14.85	1.673	896	.871	123.5	10.09	12.48	80.8		110
828	840	155.5	158.9					160	16.0	16.65	1.682	891	.871	122.7	11.45	14.00	81.7		111
828	840	193.4	198.9	.3		-.5		200	19.6	20.25	1.705	879	.871	121.0	14.14	17.00	83.2		113

Table number 32

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds at Saybolt at 110 degrees F. DATE March 20, 1923.

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1042	1050	1.0	3.7	.3	.1	.8	-.7	4.9	2.9	3.6	1.293	1161	.871	160.1	.457	3.78	12.1		109
1042	1050	11.4	13.8					15	3.75	4.451	.306	1148	.871	158.1	1.385	4.67	29.6		108
1042	1050	31.4	33.8					35	5.6	6.3	1.314	1141	.871	157.3	3.21	6.62	48.5		108
1042	1050	46.3	48.8					50	6.9	7.6	1.314	1141	.871	157.3	4.59	7.98	57.5		109
1042	1050	75.6	78.8					80	9.45	10.15	1.327	1130	.871	155.8	7.26	10.66	68.1		109
1042	1050	95.5	98.8					100	11.25	11.90	1.339	1121	.871	154.5	9.01	12.50	72.1		109
1042	1050	116.5	118.8					120	13.1	13.75	1.341	1119	.871	154.3	10.79	14.45	74.7		110
1042	1050	135.6	138.8					140	14.75	15.40	1.351	1110	.871	153.0	12.50	16.17	77.3		110
1042	1050	155.4	158.8	.3		-.7		160	16.65	17.30	.358	1104	.871	152.1	14.20	18.17	78.1		111

Table number 33

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt a t 110 degrees F. DATE March 23, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	.2	2.9	.3	.5	.2	0	3.8	0.1	0/8	2.982	235	.871	128.9	.0718	.168	42.7		109
206	210	11.7	14.1					15	1.1	1.8	3.014	232	.871	127.5	.280	.378	74.1		108
206	210	31.7	34.1					35	2.9	3.6	3.080	227	.871	126.4	.639	.756	84.5		110
206	210	46.6	49.1					50	4.3	5.0	3.104	226	.871	126.0	.909	1.050	86.5		109
206	210	75.9	79.1					80	7.0	7.7	3.218	217	.871	125.1	1.396	1.616	86.4		109
206	210	95.8	99.1					100	8.85	9.55	3.310	211	.871	124.6	1.695	2.01	84.3		109
206	210	116.8	119.1					120	10.65	11.30	3.396	206	.871	123.6	1.987	2.37	83.8		109
206	210	135.9	139.1					140	12.4	13.05	3.474	201	.871	122.7	2.26	2.74	82.4		109
206	210	155.7	159.1					160	14.2	14.85	3.611	194.0	.871	121.7	2.49	3.12	79.8		109
206	210	193.6	199.1	.3		-.2		200	17.9	18.55	3.974	176.2	.871	118.2 *	2.83	3.90	72.5		110

* Belongs to table number 35.

Table Number 34

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 23, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
828	840	.8	3.5	.3	.2	-.6	.5	4.6	1.95	2.65	1.603	935	.871	* 32.4	.346	2.23	15.5		109
828	840	11.5	13.9					15	2.8	3.5	1.620	926	.871	32.0	1.117	2.94	38.0		108
828	840	31.5	33.9					35	4.6	5.3	1.633	918	.871	31.3	2.58	4.46	57.8		108
828	840	46.4	48.9					50	6.05	6.75	1.640	915	.871	31.2	3.68	5.67	64.9		108
828	840	75.7	78.9					80	8.65	9.35	1.650	909	.871	29.9	5.84	7.85	74.4		108
828	840	95.6	98.9					100	10.5	11.2	1.656	905	.871	29.1	7.28	9.41	77.4		109
828	840	116.6	118.9					120	12.3	12.95	1.670	898	.871	28.4	8.67	10.88	79.7		109
828	840	135.7	138.9					140	14.05	14.70	1.683	891	.871	27.7	10.03	12.35	81.2		110
828	840	155.5	158.9					160	15.85	16.50	1.696	884	.871	26.7	11.37	13.86	82.0		111
828	840	193.4	198.9	.3		-.5		200	19.4	20.05	1.746	859	.871	24.3 *	13.80	16.83	82.0		112

* Belongs to table number 34.

Table number 35

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 23, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1205	1260	2.0	4.7	.3	-.5	-1.1	1.1	6.1	3.7	4.4	1.083	1385	.871	190.9	.679	5.54	12.25		108
1205	1260	11.2	13.6					15	4.45	5.15	1.087	1380	.871	190.0	1.664	6.49	25.6		108
1205	1260	31.2	33.6					35	6.25	6.95	1.100	1364	.871	188.0	3.84	8.76	43.8		108
1205	1260	46.1	48.6					50	7.55	8.25	1.106	1356	.871	186.9	5.45	10.40	52.4		109
1205	1260	75.4	78.6					80	10.25	10.95	1.111	1350	.871	186.0	8.68	13.80	62.9		109
1205	1260	95.3	98.6					100	11.95	12.60	1.119	1340	.871	184.6	10.76	15.88	67.8		110
1205	1260	116.3	118.6					120	13.7	14.35	1.127	1330	.871	183.3	12.81	18.10	70.8		110
1205	1260	135.4	138.6					140	15.45	16.10	1.127	1330	.871	183.3	14.96	20.3	73.7		111
1205	1260	155.2	158.6	.3		-.9		160	17.3	17.95	1.130	1327	.871	182.8	17.06	22.6	75.4		113

Table Number 36

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 25, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	0.0	2.7	.4	.6	.2	.0	3.6	0.35	1.05	2.985	235	.871	32.4	.0680	.221	30.8		109
206	210	11.7	14.1					15	1.4	2.10	3.010	233	.871	32.1	.281	.441	63.8		109
206	210	31.7	34.1					35	3.2	3.9	3.042	230	.871	31.7	.647	.818	79.1		109
206	210	46.6	49.1					50	4.55	5.25	3.040	230	.871	31.7	.925	1.102	83.9		109
206	210	75.9	79.1					80	7.3	8.0	3.096	226	.871	31.2	1.454	1.680	86.5		109
206	210	95.8	99.1					100	9.1	9.8	3.126	224	.871	30.9	1.800	2.06	87.3		109
206	210	116.8	119.1					120	11.0	11.65	3.168	221	.871	30.5	2.13	2.45	87.0		110
206	210	135.9	139.1					140	12.65	13.30	3.215	218	.871	30.1	2.45	2.79	87.7		109
206	210	155.7	159.1					160	14.5	15.15	3.270	214	.871	29.5	2.75	3.18	86.5		110
206	210	193.6	199.1	.4			.3	200	18.05	18.70	3.411	205	.871	28.2	3.29	3.93	83.7		110

Table Number 37

LIQUID USED Manhattan Trop Artic Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 25, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	0 READ.	READ.		VAC.		READ.	ACTUAL									
828	840	.8	3.5	.4	0	-.7	.7	4.7	2.45	3.15	1.609	932	.871	128.4	.352	2.65	13.3		109
828	840	11.4	13.8					15	3.3	4.0	1.617	928	.871	127.7	1.120	3.36	33.3		109
828	840	31.4	33.8					35	5.15	5.85	1.620	926	.871	127.5	2.61	4.91	53.2		109
828	840	46.3	48.8					50	6.9	7.6	1.637	916	.871	126.1	3.68	6.38	57.7		109
828	840	75.6	78.8					80	9.1	9.8	1.648	913	.871	125.7	5.87	8.23	71.3		109
828	840	95.5	98.8					100	11.0	11.65	1.638	915	.871	125.9	7.35	9.80	75.0		110
828	840	116.5	118.8					120	12.8	13.45	1.660	904	.871	124.4	8.72	11.30	77.1		110
828	840	135.6	138.8					140	14.5	15.15	1.661	903	.871	124.3	10.17	12.73	79.8		111
828	840	155.4	158.8					160	16.35	17.00	1.661	903	.871	124.3	11.62	14.29	81.3		111
828	840	193.3	198.8	.4		-.6		200	19.85	20.50	1.691	887	.871	122.2	14.27	17.22	82.8		112

Table Number 38

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 27, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
								Check on run made March 25, 1922											
828	840	46.3	48.8	.4	0	-.7	.7	50.0	6.45	7.15	1.632	919	.871	126.5	3.69	6.01	61.4		110

Table Number 39

LIQUID USED Manhattan Trop Artic Auto Oil

LATERAL CAM CLEARANCE ON A SIDE .001 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 394 seconds Saybolt at 110 degrees F. DATE March 25, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1205	1260	1.8	4.5	.4	-.4	-1.1	1.1	5.9	4.2	4.9	1.083	1385	.871	190.9	.657	6.17	10.65		108
1205	1260	11.2	13.6					15	4.9	5.6	1.090	1375	.871	189.5	1.659	7.06	23.5		109
1205	1260	31.2	33.6					35	6.7	7.4	1.093	1372	.871	189.0	3.86	9.32	41.4		109
1205	1260	46.1	48.6					50	8.0	8.7	1.096	1369	.871	188.5	5.50	10.96	50.2		109
1205	1260	75.4	78.6					80	10.6	11.3	1.107	1355	.871	186.7	8.71	14.24	61.1		110
1205	1260	95.3	98.6					100	12.4	13.05	1.107	1355	.871	186.7	10.89	16.45	66.2		111
1205	1260	116.3	118.6					120	14.05	14.70	1.107	1355	.871	186.7	13.08	18.52	70.6		111
1205	1260	135.4	138.6					140	15.8	16.45	1.110	1351	.871	186.3	15.21	20.7	73.5		113
1205	1260	155.2	158.6			-1.0		160	17.7	18.35	1.111	1350	.871	186.0	17.36	23.1	75.1		114

Table Number 40

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 4, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	1.1	3.8	.4	.5	.1	.1	4.7	1.4	2.1	2.187	244	.898	32.6	.0893	.441	20.2		110
206	210	11.7	14.1					15	2.35	3.05	2.868	244	.898	32.6	.285	.641	44.5		110
206	210	31.7	34.1					35	4.2	4.9	2.903	241	.898	32.2	.657	1.030	63.8		110
206	210	46.6	49.1					50	5.6	6.3	2.906	241	.898	32.2	.938	1.323	70.9		109
206	210	75.9	79.1					80	8.45	9.15	2.933	239	.898	32.0	1.490	1.921	77.5		109
206	210	95.8	99.1					100	10.2	10.9	2.950	237	.898	31.7	1.845	2.29	80.5		109
206	210	116.8	119.1					120	11.9	12.55	2.983	235	.898	31.4	2.20	2.64	83.3		111
206	210	135.9	139.1					140	13.7	14.35	2.990	234	.898	31.3	2.55	3.02	84.5		111
206	210	155.7	159.1					160	15.6	16.25	3.020	232	.898	31.0	2.89	3.41	84.7		111
206	210	193.6	199.1	.4		.2		200	19.25	19.90	3.075	227	.898	30.3	3.54	4.18	84.6		111

Table Number 41

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 4, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
833	840	5.7	8.3	.4	-.7	-1.4	1.4	9.9	5.05	5.75	1.570	955	.898	127.6	.737	4.83	15.3		109
833	840	11.0	13.4					15	5.5	6.2	1.575	952	.898	127.2	1.112	5.21	21.3		109
833	840	31.0	33.4					35	7.25	7.95	1.586	945	.898	126.3	2.57	6.68	38.5		109
833	840	45.9	48.4					50	8.55	9.25	1.587	944	.898	126.2	3.68	7.77	47.4		109
833	840	75.2	78.4					80	11.2	11.85	1.610	932	.898	124.6	5.81	9.95	58.4		109
833	840	95.1	98.4					100	13.0	13.65	1.614	929	.898	124.1	7.24	11.47	63.2		110
833	840	116.1	118.4					120	14.8	15.45	1.620	926	.898	123.7	8.66	12.99	66.7		111
833	840	135.2	138.4					140	16.5	17.15	1.639	915	.898	122.4	9.97	14.41	69.2		112
833	840	155.0	158.4					160	18.3	18.95	1.634	918	.898	122.6	11.43	15.93	71.7		113
833	840	192.9	198.4	.4		-1.0		200	21.7	22.35	1.663	902	.898	120.6	14.05	18.80	74.7		114

Table Number 42

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 4, 1922

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1205	1260	8.7	7.2	.4	-1.7	2.5	2.5	13.5	7.6	8.3	1.056	1420	.898	189.7	.472	10.45	14.1		109
1205	1260	10.5	12.9					15	7.8	8.5	1.060	1415	.898	189.1	1.654	10.7	15.4	3	109
1205	1260	30.5	32.9					35	9.65	10.35	1.055	1421	.898	189.9	3.88	13.05	29.7		110
1205	1260	45.4	47.9					50	10.85	11.5	1.062	1413	.898	189.0	5.50	14.49	38.0		111
1205	1260	74.7	77.9					80	13.35	14.0	1.068	1404	.898	187.9	8.75	17.65	49.6		111
1205	1260	94.6	97.9					100	15.0	15.65	1.083	1385	.898	185.2	10.79	19.7	54.7		112
1205	1260	115.6	117.9					120	16.65	17.3	1.097	1368	.898	182.8	12.79	21.8	58.6		113
1205	1260	134.7	137.9					140	18.5	19.15	1.096	1369	.898	182.9	14.92	24.1	61.9		113

Table Number 43

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .008 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 6, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1200	1260	9.2	11.7	.4	-1.7	-2.5	2.5	13.8	7.0	7.7	1.065	1407	.898	188.2	1.513	9.70	15.6		108
1200	1260	10.5	12.9					15	7.2	7.9	1.070	1403	.898	187.6	1.640	9.96	16.5		110
1200	1260	30.5	32.9					35	8.95	9.65	1.090	1376	.898	184.0	3.75	12.15	30.8		110
1200	1260	45.4	47.9					50	10.2	10.9	1.094	1370	.898	183.1	5.34	13.73	38.9		111
1200	1260	74.7	77.9					80	12.75	13.4	1.096	1368	.898	182.9	8.53	16.89	50.6		111
1200	1260	94.6	97.9					100	14.5	15.5	1.115	1346	.898	179.9	10.49	19.10	54.9		112
1200	1260	134.7	137.9					140	18.1	18.75	1.125	1334	.898	178.4	14.4	23.6	61.6		113

Table Number 44

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .008 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 7, 1923.

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	1.1	3.8	.4	.5	.1	.1	4.7	1.35	2.05	3.883	243	.898	32.5	.0890	.431	20.7		109
206	210	11.7	14.1					15	2.2	2.9	3.898	241	.898	32.2	.282	.609	46.3		109
206	210	31.7	34.1					35	4.0	4.7	3.940	238	.898	31.8	.649	.987	65.8		109
206	210	46.6	49.1					50	5.5	6.2	3.966	236	.898	31.6	.919	1.303	70.5		109
206	210	75.9	79.1					80	8.25	8.95	4.010	233	.898	31.1	1.452	1.880	77.2		109
206	210	95.8	99.1					100	9.9	10.6	4.055	229	.898	30.6	1.784	2.230	80.0		109
206	210	116.8	119.1					120	11.65	12.30	4.162	221	.898	29.6	2.07	2.58	80.3		109
206	210	135.9	139.1					140	13.4	14.05	4.265	214	.898	28.6	2.33	2.95	78.9		109
206	210	155.7	159.1					160	15.2	15.85	4.345	209	.898	27.9	2.61	3.33	78.4		109
206	210	193.6	199.1					200	18.8	19.45	4.610	194.0	.898	25.9	3.02	4.087	74.0		109
206	210	193.6	199.1					200	18.8	19.45	4.620	193.3	.898	25.8	3.01	4.087	73.8		110

Tab;e Number 45

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .008 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 7, 1922

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
833	840	5.8	8.4	.4	-.4	-1.0	1.1	9.8	4.75	5.45	1.567	958	.898	128.0	.732	4.58	16.0		108
833	840	11.2	13.6					15	5.2	5.9	1.572	954	.898	127.5	1.116	4.96	22.5		108
833	840	31.2	33.6					35	7.1	7.8	1.590	943	.898	126.0	2.57	6.55	39.2		108
833	840	46.1	48.6					50	8.35	9.05	1.600	938	.898	125.3	3.66	7.60	48.2		109
833	840	75.4	78.6					80	11.0	11.65	1.618	930	.898	124.3	5.80	9.80	59.2		109
833	840	95.3	98.6					100	12.85	13.50	1.623	924	.898	123.5	7.20	11.34	63.5		109
833	840	116.3	118.6					120	14.6	15.25	1.647	911	.898	121.8	8.52	12.82	66.5		110
833	840	135.4	138.6					140	16.3	16.95	1.655	906	.898	121.1	9.88	14.25	69.3		111
833	840	155.2	158.6					160	18.0	18.65	1.662	902	.898	120.6	11.24	15.68	71.7		112
833	840	193.1	198.6	.4		-.8		200	21.6	22.25	1.702	881	.898	117.8	13.72	18.65	73.5		113

Table Number 46

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 13, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
828	840	6.0	8.6	-.2	-.9	-1.7	1.1	10	4.7	5.4	1.590	943	.898	126.0	.735	4.54	16.2		107
828	840	11.2	13.6					15	5.0	5.7	1.600	938	.898	125.3	1.096	4.79	22.9		108
828	840	31.2	33.6					35	6.9	7.6	1.614	929	.898	124.0	2.53	6.38	39.7		108
828	840	46.1	48.6					50	8.2	8.9	1.621	925	.898	123.7	3.60	7.47	48.2		108
828	840	75.4	78.6					80	10.9	11.55	1.655	906	.898	121.0	5.65	9.70	58.3		108
828	840	95.3	98.6					100	12.65	13.30	1.680	893	.898	119.3	6.95	11.18	62.1		109
828	840	116.3	118.6					120	14.4	15.05	1.690	887	.898	118.4	8.29	12.64	65.6		110
828	840	135.4	138.6					140	16.1	16.75	1.710	877	.898	117.1	9.55	14.07	67.9		110
828	840	155.2	158.6					160	17.9	18.55	1.732	866	.898	115.7	10.79	15.58	69.2		111
828	840	193.1	198.6	-.2		-1.4		200	21.2	21.85	1.788	838	.898	112.0	13.05	18.35	71.2		113

Table Number 47

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 13, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.	VAC.		READ.	ACTUAL									
1200	1260	9.1	11.6	-.2	-2.2 -3.0	2.4	13.7	7.15	7.85	1.065	1408	.898	188.3	1.503	9.88	15.2		108½
1200	1260	10.5	12.9				15	7.20	7.90	1.070	1403	.898	187.6	1.640	9.95	16.5		109
1200	1260	30.5	32.9				35	9.0	9.9	1.088	1379	.898	184.2	3.76	12.46	30.2		109
1200	1260	45.4	47.9				50	10.25	10.95	1.092	1373	.898	183.6	5.34	13.80	38.7		110
1200	1260	74.7	77.9				80	12.8	13.45	1.108	1353	.898	180.9	8.43	16.94	49.8		111
1200	1260	94.6	97.9				100	14.5	15.15	1.120	1340	.898	179.1	10.44	19.10	54.7		111
1200	1260	115.6	117.9				120	16.25	16.90	1.130	1327	.898	177.4	12.40	21.3	58.2		113
1200	1260	134.7	137.9				140	18.1	18.75	1.130	1327	.898	177.4	14.48	23.6	61.3		113

Table Number 48

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 18, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
405	420	2.8	5.5	-.2	-.1	-.3	0	6.4	2.4	3.1	3.177	472	.898	63.1	.236	1.30	18.2		109
405	420	11.7	14.1					15	3.15	3.85	3.177	472	.898	63.1	.551	1.62	34.0		108
405	420	31.7	34.1					35	4.95	5.65	3.190	470	.898	62.8	1.281	2.37	54.1		109
405	420	46.6	49.1					50	6.50	7.20	3.200	468	.898	62.6	1.824	3.02	60.4		109
405	420	75.9	79.1					80	9.1	9.80	3.240	463	.898	62.0	2.88	4.12	69.9		109
405	420	95.8	99.1					100	10.85	11.50	3.258	460	.898	61.5	3.58	4.83	74.1		109
405	420	116.8	119.1					120	12.7	13.35	3.264	460	.898	61.5	4.30	5.61	76.7		110
405	420	135.9	139.1					140	14.4	15.05	3.295	455	.898	60.8	4.97	6.32	78.7		110
405	420	155.7	159.1					160	16.2	16.85	3.315	453	.898	60.6	5.65	7.08	79.8		111
405	420	193.6	199.1					200	19.7	20.35	3.398	441	.898	59.0	6.86	8.55	80.2		112

Table Number 49

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 18, 1922.

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
620	630	4.0	6.6	-.2	-.3	-.1	.5	7.7	3.80	4.50	3.073	724	.898	96.8	.434	2.84	15.3		108
620	630	11.5	13.9					15	4.5	5.2	3.096	714	.898	95.5	.834	3.28	35.4		108
620	630	31.5	33.9					35	6.4	7.1	3.083	721	.898	96.4	1.948	4.48	43.5		108
620	630	46.4	48.9					50	7.65	8.35	3.090	718	.898	96.0	2.80	5.27	53.1		108
620	630	75.7	78.9					80	10.2	10.9	3.092	718	.898	96.0	4.48	6.87	65.3		109
620	630	95.6	98.9					100	11.95	12.6	3.100	714	.898	95.5	5.56	7.94	70.0		109
620	630	116.6	118.9					120	13.7	14.35	3.130	704	.898	94.2	6.58	9.05	72.7		110
620	630	135.7	138.9					140	15.45	16.10	3.160	694	.898	92.7	7.56	10.15	74.5		111
620	630	155.5	158.9					160	17.25	17.90	3.195	683	.898	91.3	8.51	11.29	75.4		111
620	630	193.4	198.9	-.2		-1.0		200	20.7	21.35	3.240	670	.898	89.5	10.44	13.48	77.5		112

Table number 50

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0045 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 18, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1042	1050	6.9	9.4	-.2	-1.4	-2.3	1.6	11.1	6.2	6.9	1.280	1172	.898	156.6	1.013	7.24	14.0		109
1042	1050	10.9	13.3					15	6.5	7.2	1.300	1154	.898	154.2	1.348	7.56	17.85		109
1042	1050	30.9	33.3					35	8.15	8.85	1.306	1149	.898	153.5	3.13	9.29	33.7		109
1042	1050	45.8	48.3					50	9.35	10.05	1.318	1138	.898	152.1	4.43	10.55	42.0		110
1042	1050	75.1	78.3					80	11.9	12.55	1.350	1111	.898	148.6	6.93	13.18	52.6		110
1042	1050	95.0	98.3					100	13.6	14.25	1.363	1101	.898	147.3	8.58	14.97	57.3		111
1042	1050	116.0	118.3					120	15.4	16.05	1.370	1095	.898	146.3	10.24	16.85	60.8		112
1042	1050	135.1	138.3					140	17.05	17.70	1.388	1080	.898	144.4	11.78	18.59	63.4		113
1042	1050	154.9	158.3	-2.0		-2.0		160	18.95	19.60	1.400	1072	.898	143.4	13.39	20.6	65.0		114

Table Number 51

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0150 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 22, 1922

R. P. M.		GAGE LB. SQ.IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1300	1260	9.1	11.6	-.3	-2.3	-3.0	2.4	13.7	7.15	7.85	1.058	1417	.898	189.4	1.511	9.89	15.3		108
1200	1260	10.5	12.9					15	7.3	7.9	1.063	1410	.898	188.5	1.648	9.95	16.6		108
1200	1260	30.5	32.9					35	8.6	9.3	1.085	1383	.898	184.9	3.77	11.71	32.3		109
1200	1260	45.4	47.9					50	9.95	10.65	1.104	1358	.898	181.6	5.28	13.41	39.4		110
1200	1260	74.7	77.9					80	12.55	13.20	1.108	1354	.898	181.0	5.44	16.63	50.8		111
1200	1260	94.6	97.9					100	14.2	14.85	1.122	1336	.898	178.6	10.41	18.71	55.6		111
1200	1260	115.6	117.9					120	15.9	16.55	1.132	1325	.898	177.1	12.38	20.9	59.2		113
1200	1260	134.7	137.9	-.3		-2.7		140	17.6	18.25	1.150	1304	.898	174.4	14.33	23.0	61.8		114

Table Number 52

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0150 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 21, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	1.1	3.8	-.2	+.1	-.5	.1	4.7	1.0	1.7	2.920	240	.898	32.1	.0878	.357	24.6		109
206	210	11.7	14.1					15	1.95	2.65	2.986	234	.898	31.3	.273	.557	49.0		110
206	210	31.7	34.1					35	3.75	4.45	3.037	230	.898	30.8	.627	.934	67.2		109
206	210	46.6	49.1					50	5.2	5.9	3.111	225	.898	30.1	.876	1.239	70.6		110
206	210	75.9	79.1					80	7.95	8.65	3.283	213	.898	28.5	1.327	1.816	73.0		109
206	210	95.8	99.1					100	9.7	10.4	3.398	206	.898	27.5	1.603	2.185	73.4		110
206	210	116.8	119.1					120	11.5	12.15	3.580	195.6	.898	26.3	1.829	2.55	71.6		110
206	210	135.9	139.1					140	13.2	13.85	3.867	181.0	.898	24.2	1.973	2.91	67.7		110
206	210	155.7	159.1					160	15.0	15.65	4.280	163.5	.898	21.9	2.04	3.29	62.0		110
206	210	193.6	199.1					200	18.5	19.15	5.551	126.1	.898	16.9	1.963	4.02	48.8		110

Table Number 53

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .0150 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 22, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
828	840	5.8	8.4	-.2	-.9	-1.7	1.1	9.8	4.35	5.05	1.570	956	.898	127.8	.730	4.24	17.2		109
828	840	11.2	13.6					15	4.8	5.5	1.571	955	.898	127.6	1.115	4.62	24.1		109
828	840	31.2	33.6					35	6.70	7.4	1.595	940	.898	125.6	2.56	6.22	41.2		108
828	840	46.1	48.6					50	8.00	8.7	1.606	934	.898	124.8	3.64	7.31	49.8		108
828	840	75.4	78.6					80	10.7	11.4	1.630	920	.898	123.0	5.73	9.58	59.8		109
828	840	95.3	98.6					100	12.45	13.10	1.653	908	.898	121.3	7.08	11.00	64.3		110
828	840	116.3	118.6					120	14.3	14.95	1.678	894	.898	119.4	8.36	12.57	66.5		110
828	840	135.4	138.6					140	15.95	16.60	1.714	875	.898	116.9	9.54	13.94	68.4		111
828	840	155.2	158.6					160	17.75	18.40	1.742	861	.898	115.0	10.73	15.46	69.4		112
828	840	193.1	198.6					200	21.2	21.85	1.795	836	.898	111.7	13.01	18.35	70.9		113

Table Number 54

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 28, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.			TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DENSITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.	VAC.		READ.	ACTUAL									
828	840	5.8	8.4	-.2	-.9	1.8	1.1	9.8	4.15	4.85	1.596	940	.898	125.7	.718	4.08	17.6		108
828	840	11.2	13.6					15	4.55	5.25	1.610	932	.898	124.6	1.089	4.42	24.7		108
828	840	31.2	33.6					35	6.4	7.1	1.660	904	.898	120.8	2.47	5.96	41.4		108
828	840	46.1	48.6					50	7.65	8.35	1.685	889	.898	118.7	3.47	7.02	49.4		109
828	840	75.4	78.6					80	10.35	11.05	1.758	853	.898	114.0	5.32	9.29	57.2		109
828	840	95.3	98.6					100	12.1	12.75	1.830	820	.898	109.6	6.39	10.72	59.6		109
828	840	116.3	118.6					120	13.85	14.50	1.910	785	.898	104.9	7.34	12.19	60.2		110
828	840	135.4	138.6					140	15.55	16.2	1.986	755	.898	101.0	8.23	13.61	60.4		111
828	840	155.2	158.6					160	17.3	17.95	2.096	715	.898	95.6	8.92	15.09	59.1		112
828	840	193.1	198.6					200	20.7	21.35	2.363	636	.898	85.0	9.91	17.95	55.3		113

Table Number 55

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 3893 seconds Saybolt at 110 degrees F. DATE April 27, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	1.0	3.7	-.2	-.1	-.5	.1	4.6	.75	1.45	2.958	237	.898	31.7	.0849	.305	27.8		110
206	210	11.7	14.1					15	1.7	2.4	3.030	231	.898	30.9	.270	.504	53.6		110
206	210	31.7	34.1					35	3.6	4.3	3.300	212	.898	28.3	.578	.902	64.1		110
206	210	46.6	49.1					50	4.95	5.65	3.560	196.6	.898	26.3	.765	1.186	64.5		109
206	210	75.9	79.1					80	7.65	8.35	4.160	168.5	.898	22.5	1.050	1.753	59.9		109
206	210	95.8	99.1					100	9.5	10.4	5.146	136.0	.898	18.2	1.060	2185	48.5		110
206	210	116.8	119.1					120	11.25	11.90	6.430	108.9	.898	14.6	1.018	2.50	40.8		109
206	210	135.9	139.1					140	12.9	13.55	9.730	71.9	.898	9.6	.784	2.84	27.6		109
				160 lb./ sq. in - not obtainable - valve closed.															

Table Number 56

LIQUID USED 600 Green Cylinder Stock

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 3893 seconds Saybolt a t 110 degrees F. DATE April 27, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1200	1260	9.1	11.6	-.2	-2.2	-3.0	2.4	13.7	6.95	7.65	1.060	1415	.898	189.2	1.512	9.64	15.7		107
1200	1260	10.5	12.9					15	7.05	7.75	1.060	1415	.898	189.2	1.655	9.76	17.0		102
1200	1260	30.5	32.9					35	8.4	9.1	1.081	1387	.898	185.4	3.78	11.47	32.9		107
1200	1260	45.4	47.9					50	9.65	10.35	1.100	1364	.898	183.3	5.31	13.05	40.7		108
1200	1260	74.7	77.9					80	12.15	12.80	1.142	1313	.898	175.5	8.18	16.12	50.7		108
1200	1260	94.6	97.9					100	13.95	14.60	1.164	1289	.898	172.3	10.04	18.40	54.5		109
1200	1260	115.6	117.9					120	15.7	16.35	1.192	1258	.898	168.2	11.76	20.6	57.1		111
1200	1260	134.7	137.9	-.2	-2.7			140	17.45	18.10	1.221	1229	.898	164.3	13.40	22.8	58.7		112

Table Number 57

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360. seconds Saybolt at 110 degrees F. DATE May 3, 1928

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	7.0	9.5	-.2	-1.1	1.3	1.0	10.9	3.1	3.8	3.822	248	.882	33.7	.214	.798	26.8		109
206	210	7.0	9.5					10.9	3.1	3.8	3.822	248	.882	33.7	.214	.798	26.8		110
206	210	11.2	13.6					15	3.5	4.2	3.840	247	.882	33.6	.294	.882	33.3		110
206	210	31.2	33.6					35	5.4	6.1	3.886	242	.882	32.9	.672	1.281	52.4		110
206	210	46.1	48.6					50	6.9	7.6	3.960	237	.882	32.2	.940	1.595	58.9		110
206	210	75.4	78.6					80	9.6	10.3	3.068	228	.882	31.0	1.446	2.16	67.0		109
206	210	95.3	98.6					100	11.35	12.0	3.137	223	.882	30.3	1.767	2.52	70.1		109
206	210	116.3	118.6					120	13.2	13.85	3.330	210	.882	28.6	2.00	2.91	68.7		110
206	210	135.4	138.6					140	14.85	15.50	3.500	200	.882	27.2	2.22	3.25	68.3		109
206	210	155.2	158.6					160	16.65	17.30	3.785	185	.882	25.2	2.34	3.63	64.5		109
206	210	193.1	198.6					200	20.0	20.65	4.830	144.8	.882	19.7	2.29	4.34	52.8		109

Table Number 58

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 3, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
830	840	21.1	23.3	-.2	-6.0	6.9	6.2	27.3	8.8	9.5	1.605	935	.882	127.3	2.02	7.98	25.3		110
830	840	28.6	31.0					35	9.0	9.7	1.641	914	.882	124.3	2.54	8.15	31.2		111
830	840	43.5	46.0					50	10.2	10.95	1.685	890	.882	121.0	3.52	9.20	38.3		111
830	840	72.9	76.0					80	12.7	13.35	1.746	859	.882	116.9	5.45	11.20	48.7		112
830	840	92.6	96.0					100	14.4	15.05	1.800	833	.882	113.3	6.60	12.63	52.3		112½
830	840	113.7	116.0					120	16.4	17.05	1.810	829	.882	112.8	7.89	14.33	55.1		112½
830	840	132.9	136.0					140	18.1	18.75	1.820	824	.882	112.1	9.15	16.75	58.1		112½
830	840	152.6	156.0			-6.5		160	19.7	20.35	1.860	806	.882	109.5	10.23	17.10	59.8		113½

Table Number 59

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .027 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 4, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1200	1260	30.3	32.7	-.2	-9.2	11.7	10.	238.6	12.35	13.00	1.106	1355	.882	184.4	4.14	16.38	25.3		108
1200	1260	41.6	44.1					50	12.9	13.55	1.130	1338	.882	180.6	5.26	17.07	30.8		110
1200	1260	71.1	74.1					80	15.35	16.00	1.155	1298	.882	176.5	8.25	20.2	40.8		111
1200	1260	90.8	94.1					100	17.0	17.65	1.170	1283	.882	174.5	10.18	22.2	45.8		112
1200	1260	111.7	114.1					120	18.7	19.35	1.196	1255	.882	170.8	11.94	24.4	48.9		113
1200	1260	131.1	134.1					140	20.2	20.85	1.210	1240	.882	168.7	13.75	26.3	52.3		113
1200	1260	150.8	154.1		-9.0			160	21.8	22.45	1.240	1210	.882	164.6	15.35	28.3	54.3		114

Table Number 60

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 10,1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
830	840	21.5	23.7	+.2	-6.6	6.8	6.2	27.7	9.5	10.2	1.610	931	.882	126.7	3.04	8.57	23.8		109
830	840	38.6	31.0					35	10.1	10.8	1.648	910	.882	123.8	3.53	9.07	27.9		108½
830	840	43.5	46.0					50	11.1	11.75	1.685	890	.882	121.2	3.53	9.88	35.7		109
830	840	72.9	76.0					80	13.8	14.45	1.714	875	.882	119.0	5.55	12.13	45.7		109½
830	840	92.6	96.00					100	15.45	16.10	1.730	868	.882	118.1	6.88	13.52	50.9		109½
830	840	113.7	116.					120	17.2	17.85	1.746	859	.882	116.8	8.17	15.00	54.4		110½
830	840	132.9	136.					140	18.8	19.50	1.763	850	.882	115.7	9.44	16.39	57.6		111½
830	840	152.6	156.					160	20.6	21.35	1.790	838	.882	114.0	10.63	17.85	59.5		112
830	840	190.7	196.		-5.5			200	23.9	24.55	1.813	827	.882	112.5	13.11	20.6	63.6		113½

Table Number 61

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 21, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	6.8	9.3	-.2	-1.1	1.3	1.0	10.7	3.2	3.9	3.920	240	.882	32.6	.204	.819	24.9		110
206	210	11.3	13.6					15	3.75	4.45	3.958	237	.882	32.2	.282	.935	30.2		109
206	210	31.2	33.6					35	5.65	6.35	3.900	241	.882	32.8	.668	1.334	50.1		110
206	210	46.1	48.6					50	7.05	7.75	3.870	244	.882	33.2	.967	1.629	59.3		111
206	210	75.4	78.6					80	9.75	10.45	3.878	243	.882	33.1	1.540	2.19	70.3		111
206	210	95.3	98.6					100	11.45	12.10	3.900	241	.882	32.8	1.910	2.54	75.2		110
206	210	116.3	118.6					120	13.25	13.90	3.918	240	.882	32.7	2.28	2.93	78.0		111
206	210	135.4	138.6					140	14.85	15.50	3.937	238	.882	32.4	2.64	3.26	80.9		111
206	210	155.2	158.6					160	16.75	17.40	3.978	235	.882	32.0	2.98	3.66	81.4		110
206	210	193.1	198.6		-1.2			200	20.3	20.95	3.010	233	.882	31.7	3.69	4.40	83.9		111

Table Number 62

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ.IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 21, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
407	420	11.8	14.2	-.2	-3.6	3.3	2.7	16.4	5.1	5.8	3.310	453	.882	61.6	.589	2.43	24.2		110
407	420	12.5	14.9					17.1	5.4	6.1	3.320	452	.882	61.5	.612	2.56	23.9		109
407	420	30.4	32.8					35	7.1	7.8	3.310	453	.882	61.6	1.257	3.27	38.4		109
407	420	45.3	47.8					50	8.45	9.15	3.310	453	.882	61.6	1.800	3.84	46.8		109
407	420	74.6	77.8					80	11.1	11.75	3.303	454	.882	61.8	2.88	4.93	58.4		110
407	420	94.5	97.8					100	12.65	13.30	3.360	446	.882	60.7	3.53	5.58	63.3		111
407	420	115.5	117.8					120	14.45	15.10	3.372	445	.882	60.5	4.23	6.34	66.7		111
407	420	134.6	137.8					140	16.20	16.85	3.390	443	.882	60.3	4.92	7.07	69.5		111
407	420	154.4	157.8					160	18.0	18.65	3.400	441	.882	60.0	5.59	7.83	71.4		112
407	420	192.3	197.8		-3.1			200	21.42	23.05	3.491	430	.882	58.5	6.82	9.25	73.8		112

Table Number 63

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0115 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 22, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
1200	1260	32.3	34.7	-.2	-9.2		11.7	10.2	40.6	13.40	14.05	1.090	1376	.882	187.1	4.43	17.70	25.0	110
1200	1260	41.6	44.1						50	14.1	14.75	1.100	1364	.882	185.6	5.40	18.60	29.0	110
1200	1260	71.1	74.1						80	16.8	17.45	1.130	1328	.882	180.6	8.43	22.0	38.3	111
1200	1260	90.8	94.1						100	18.35	19.00	1.150	1304	.882	177.5	10.34	23.9	43.3	111
1200	1260	111.7	114.1						120	19.75	20.40	1.170	1283	.882	174.5	12.20	25.7	47.5	112
1200	1260	131.1	134.1						140	21.1	21.75	1.186	1265	.882	172.1	14.05	27.4	51.3	114
1200	1260	150.8	154.1		-9.0				160	22.85	23.50	1.186	1265	.882	172.1	16.03	29.6	54.1	115

Table Number 64

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 26, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 700 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
206	210	7.8	10.3	+.2	-1.1		1.0	11.7	5.4	6.1	3.850	246	.882	33.5	.238	1.282	17.8		110
206	210	7.7	10.2					11.6	5.3	6.0	3.850	246	.882	33.5	.236	1.260	17.9		110
206	210	11.2	13.6					15	5.6	6.3	3.856	245	.882	33.3	.291	1.323	22.0		110
206	210	31.2	33.6					35	7.4	8.1	3.860	245	.882	33.3	.680	1.700	40.0		110
206	210	46.1	48.6					50	8.6	9.3	3.862	245	.882	33.3	.972	1.953	49.8		110
206	210	75.4	78.6					80	11.2	11.85	3.875	243	.882	33.1	1.540	2.49	61.8		109
206	210	95.3	98.6					100	12.85	13.5	3.900	241	.882	32.8	1.910	2.83	67.5		110
206	210	116.3	118.6					120	14.65	15.3	3.920	240	.882	32.6	2.29	3.21	71.4		109
206	210	135.4	138.6					140	16.35	17.0	3.980	235	.882	32.0	2.61	3.57	73.1		109
206	210	155.2	158.6					160	18.05	18.70	3.058	229	.882	31.2	2.91	3.93	74.0		109
206	210	193.1	198.6					200	21.50	22.15	3.166	221	.882	30.1	3.50	4.65	75.3		108

Table Number 65

LIQUID USED Texaco 880 Mexican Fuel Oil

LATERAL CAM CLEARANCE ON A SIDE .0025 INCH.

DISTANCE BETWEEN GAGES 2.3 FT. EQUALS .9 LB. PER SQ. IN.

VISCOSITY LIQUID 18360 seconds Saybolt at 110 degrees F. DATE May 30, 1922

R. P. M.		GAGE LB. SQ. IN.		SUCTION IN. HG.				TOTAL PRESS LB.	DYNAMOMETER		TIME FOR 1500 LB.	LB. PER. MIN.	DEN-SITY	G.P.M.	HYD. H.P.	INPUT H.P.	EFF. o/o	o/o VOL. EFF.	TEMP. LIQ.
READ.	ACTUAL	READ	ACTUAL	O READ.	READ.		VAC.		READ.	ACTUAL									
830	840	25.3	27.6	-.2	-7.8	.2	7.4	32.2	12.0	12.65	1.573	954	.882	129.7	2.44	10.63	22.9		110
830	840	113.1	115.4					120	19.55	20.20	1.683	891	.882	121.2	8.47	16.98	49.9		110
830	840	190.1	195.4					200	26.4	27.05	1.820	824	.882	112.1	13.05	22.7	57.5		109

Table Number 66

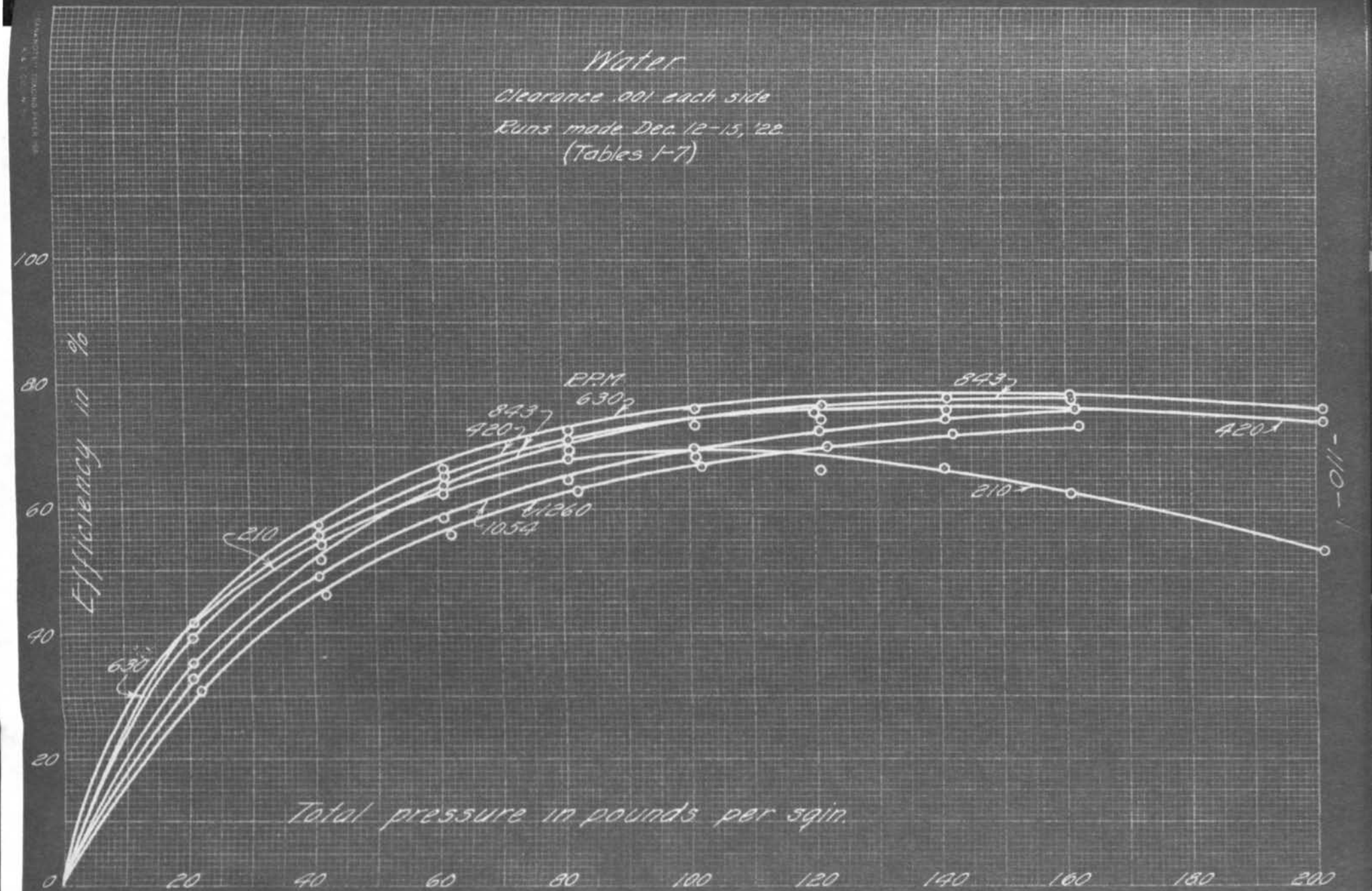

Water
Clearance .001 each side
Runs made Dec. 12-15, '22.
(Tables 1-7)
Efficiency in %
100
80
60
40
20
0
R.P.M.
630
843
420
210
1260
1054
Total pressure in pounds per sq in.
20
40
60
80
100
120
140
160
180
200

Fig. 14.

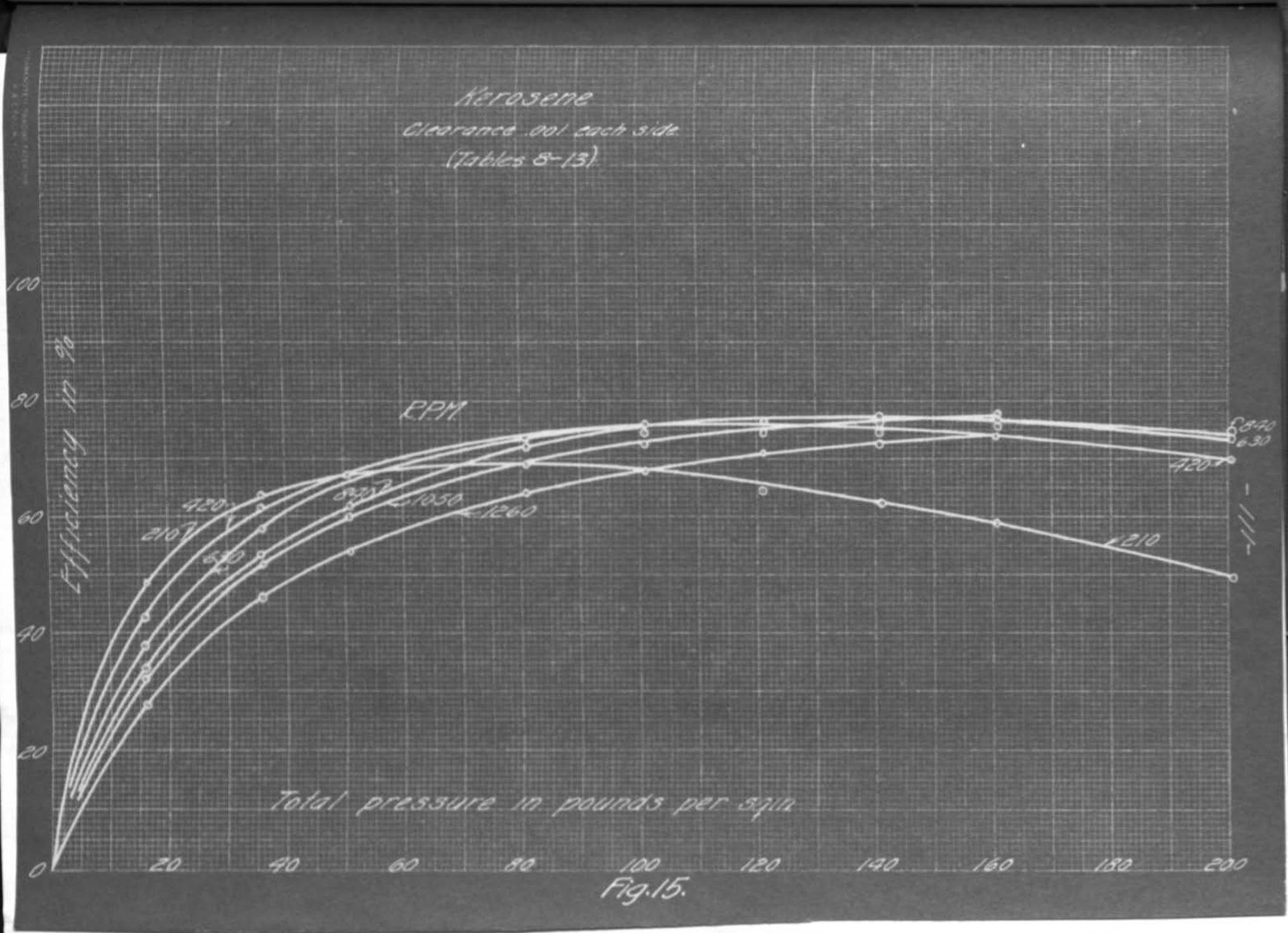

Kerosene
Clearance .001 each side
(Tables 8-13)
R.P.M.
Efficiency in %
100
80
60
40
20
0
420
210
630
1050
1260
840
Total pressure in pounds per sq.in
20
40
60
80
100
120
140
160
180
200

Fig.15.

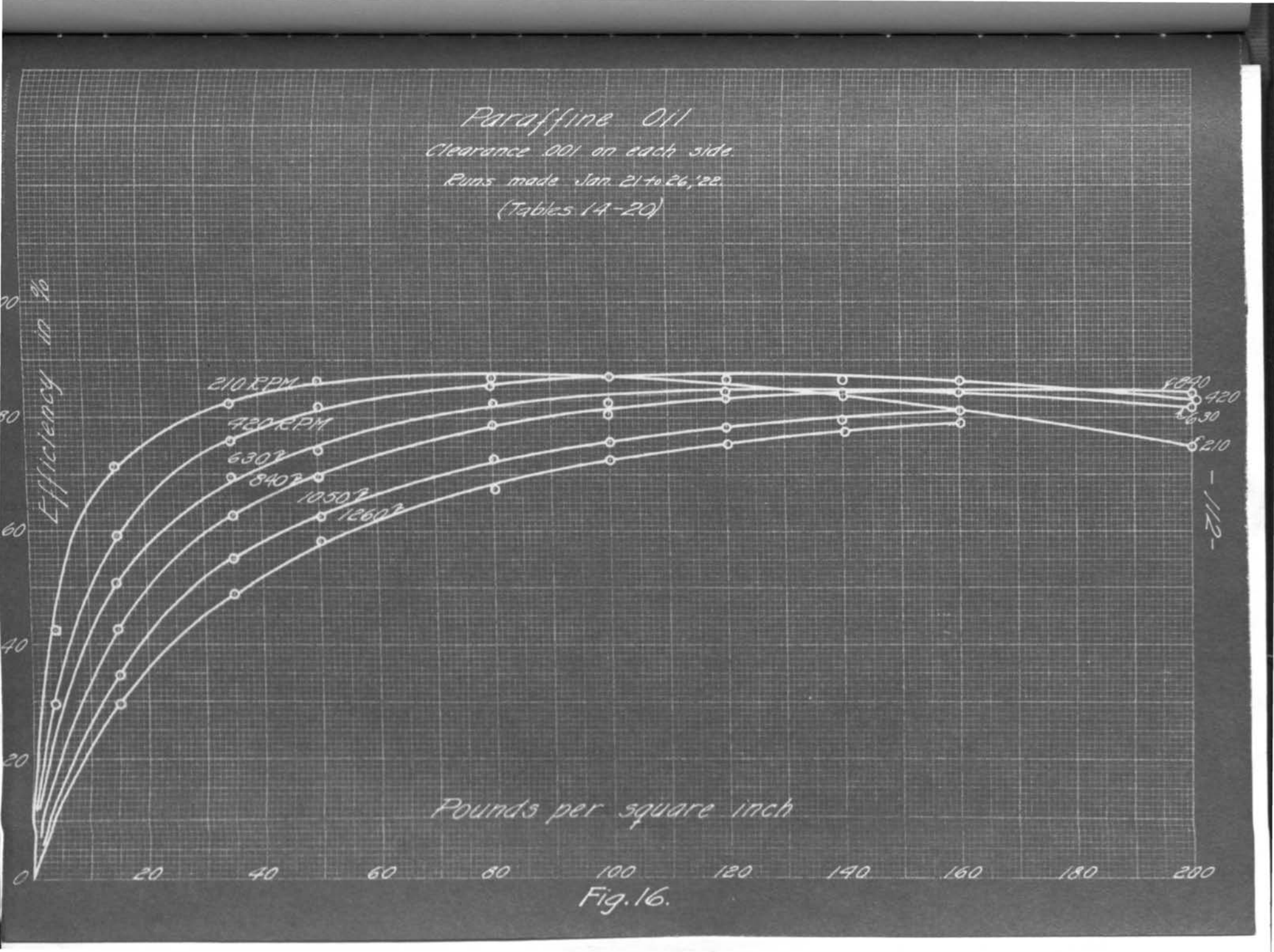

Paraffine Oil
Clearance .001 on each side.
Runs made Jan. 21 to 26, '22.
(Tables 14-20)
Efficiency in %
210 RPM
420 RPM
630
840
1050
1260
630
420
210
Pounds per square inch
0
20
40
60
80
100
120
140
160
180
200
- 112 -

Fig. 16.

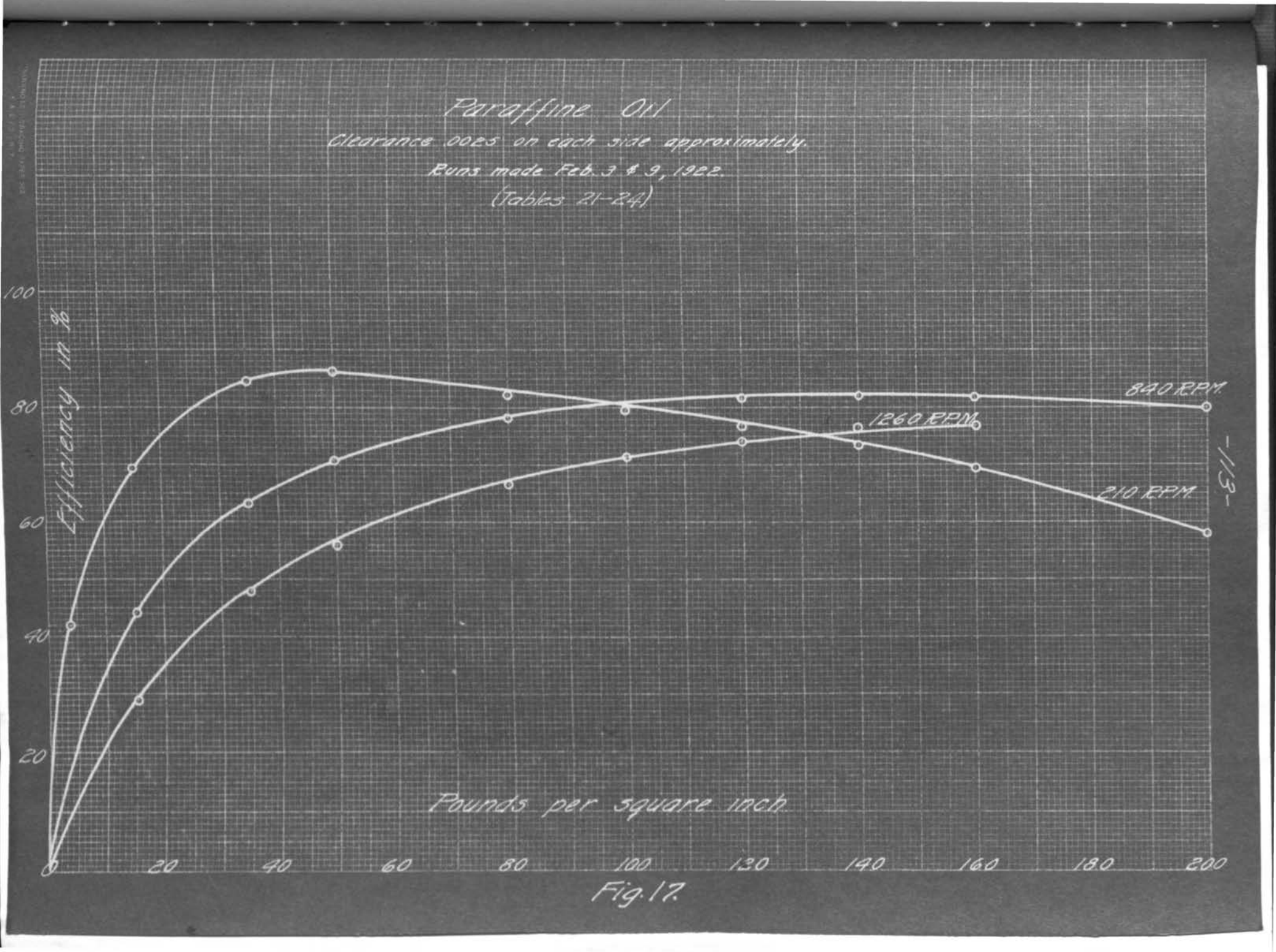
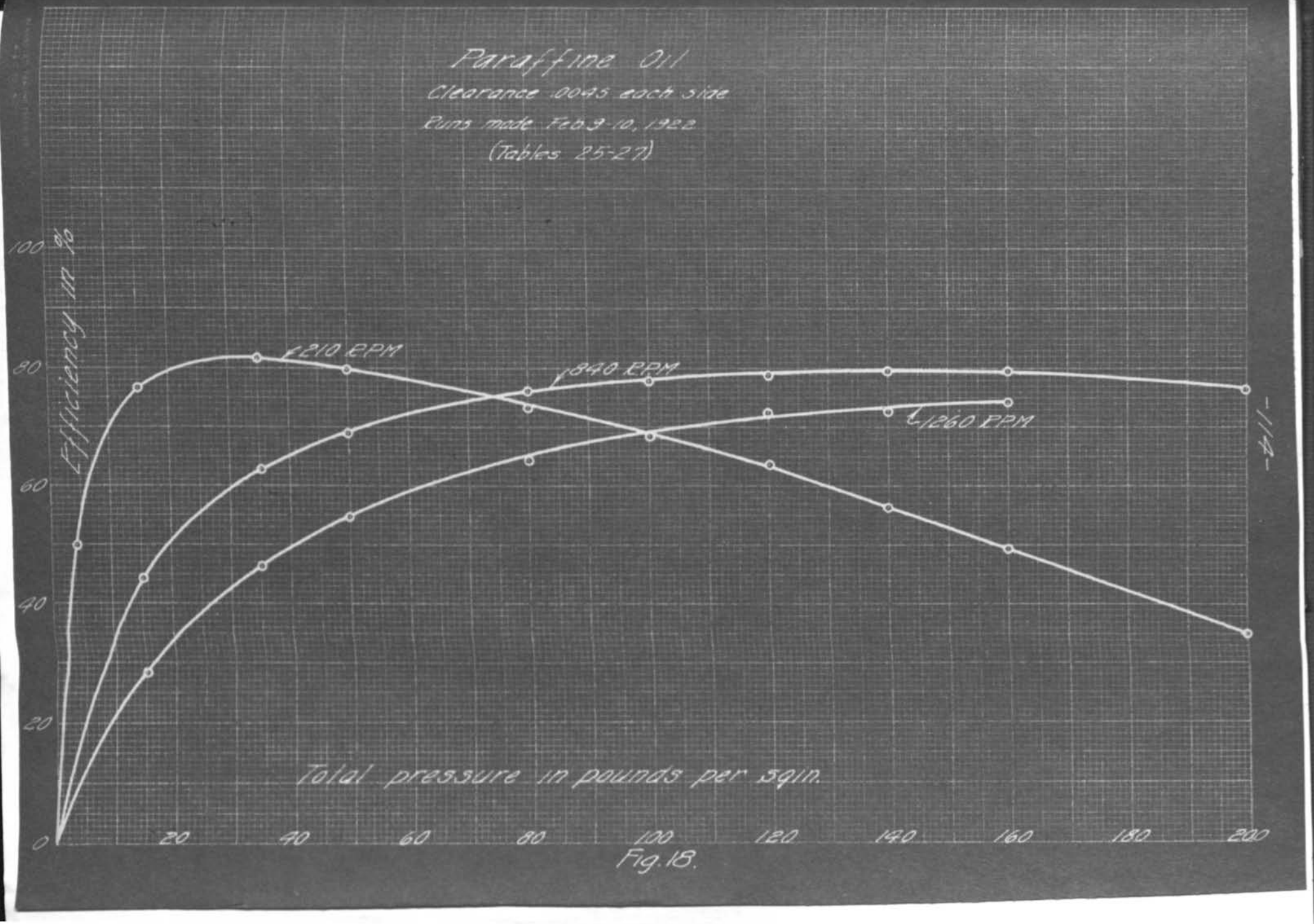

Paraffine Oil
Clearance .0023 on each side approximately.
Runs made Feb. 3 & 9, 1922.
(Tables 21-24)
Efficiency in %
100
80
60
40
20
840 R.P.M.
1260 R.P.M.
210 R.P.M.
Pounds per square inch.
0
20
40
60
80
100
120
140
160
180
200

Fig. 17.


Paraffine Oil
Clearance .0045 each side
Runs made Feb 9-10, 1922
(Tables 25-27)
Efficiency in %
100
80
60
40
20
0
1210 RPM
1840 RPM
1260 RPM
Total pressure in pounds per sq in.
20
40
60
80
100
120
140
160
180
200
Fig. 18.

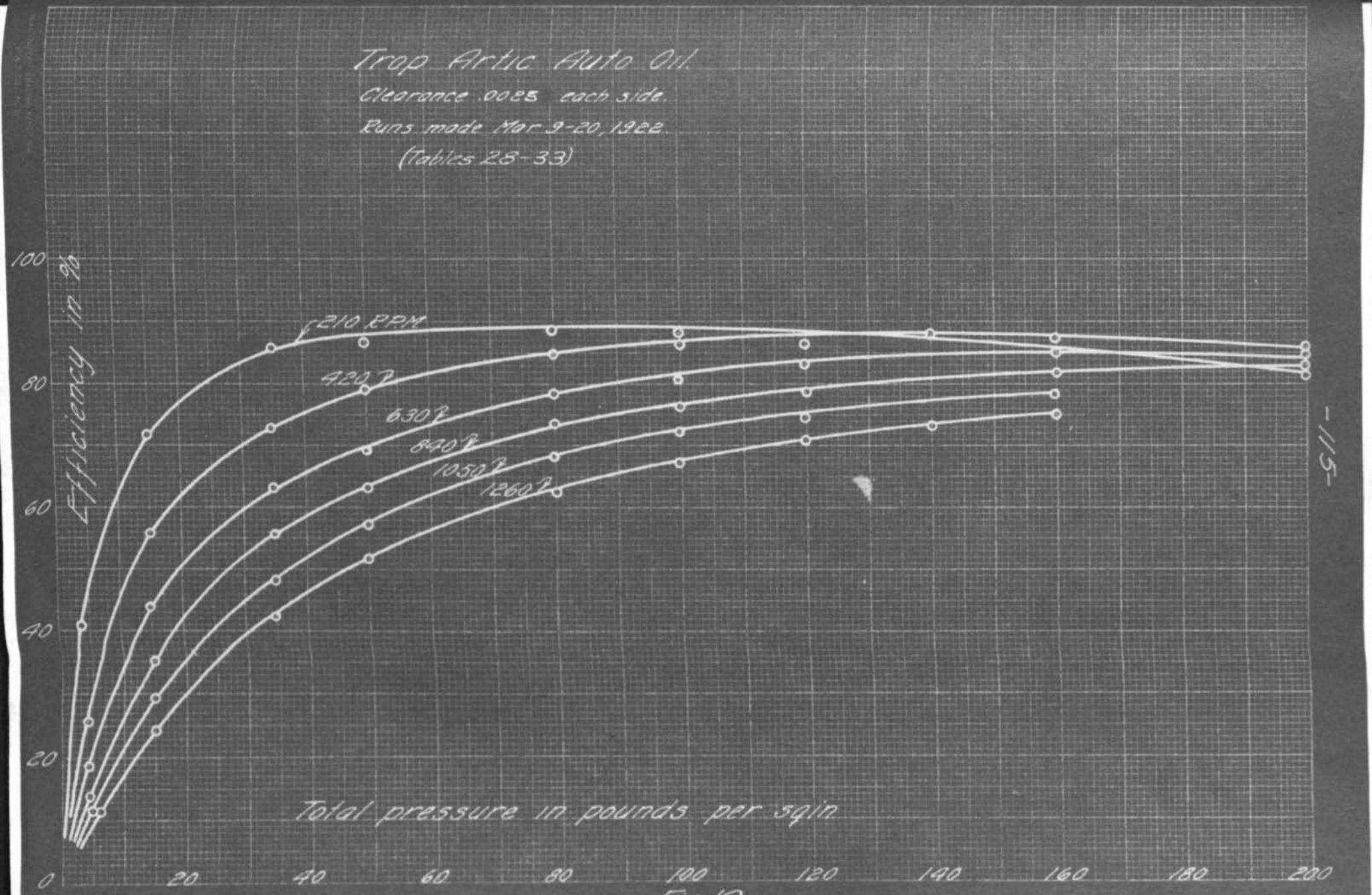

Trop Artic Auto Oil.
Clearance .0025 each side.
Runs made Mar 9-20, 1922.
(Tables 28-33)
Efficiency in %
100
80
60
40
20
0
210 RPM
420 "
630 "
840 "
1050 "
1260 "
20
40
60
80
100
120
140
160
180
200
Total pressure in pounds per sq in

Fig. 19.

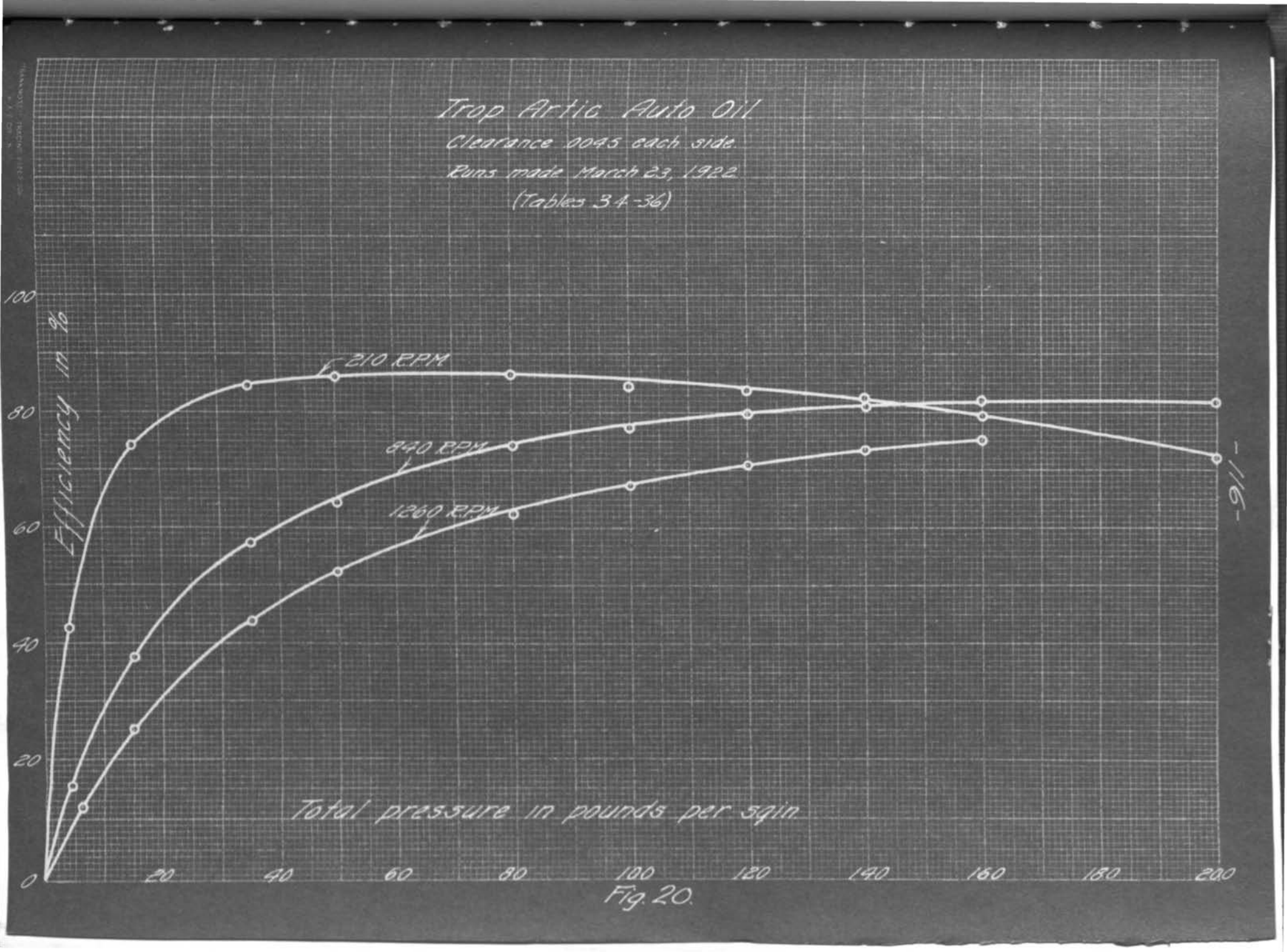
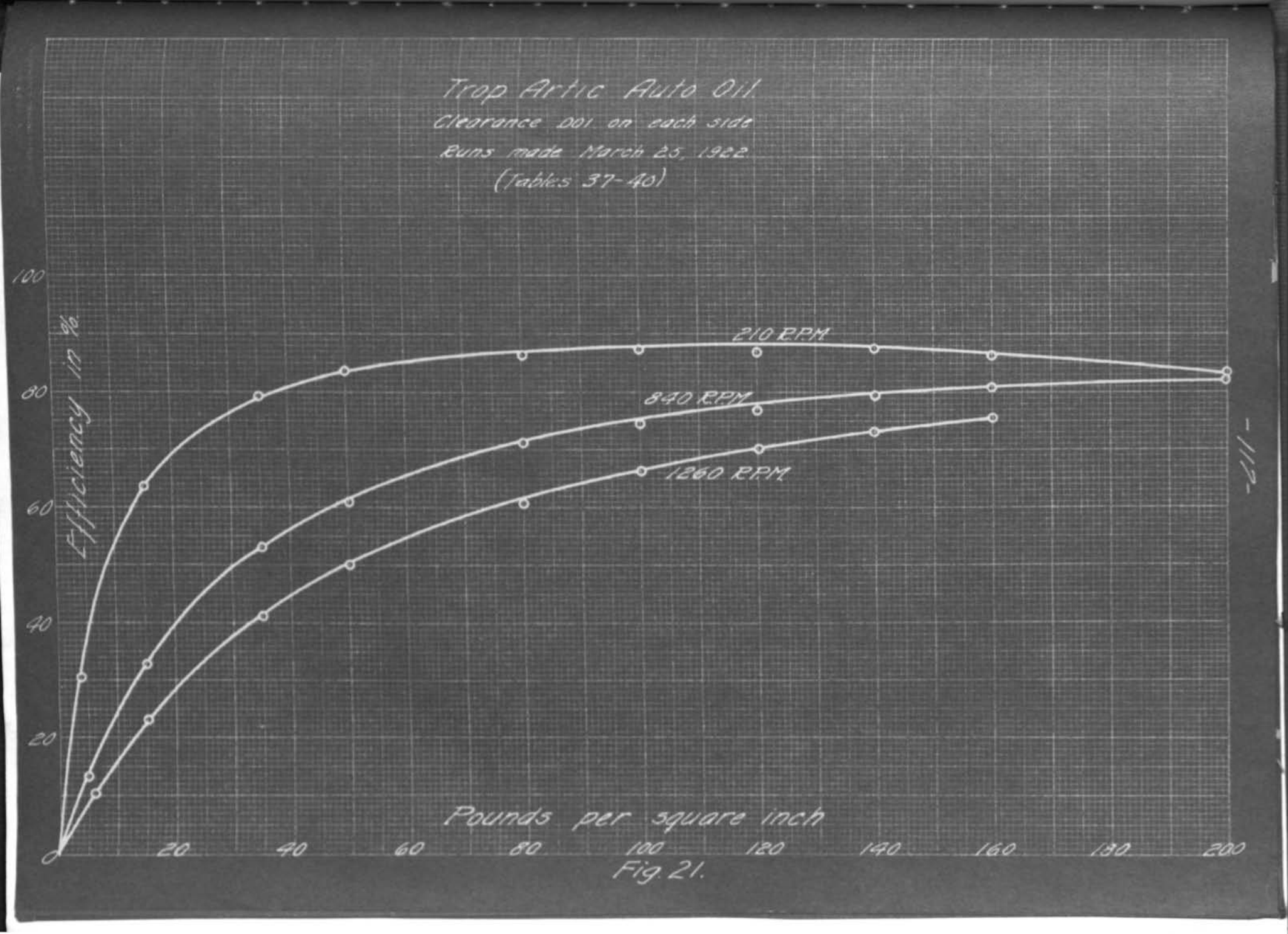

Trop Artic Auto Oil
Clearance .0045 each side
Runs made March 23, 1922
(Tables 34-36)
Efficiency in %
100
80
60
40
20
0
210 R.P.M.
840 R.P.M.
1260 R.P.M.
Total pressure in pounds per sq.in.
20
40
60
80
100
120
140
160
180
200
-116-

Fig. 20.


Trop Artic Auto Oil
Clearance .001 on each side
Runs made March 25, 1922
(Tables 37-40)
Efficiency in %
100
80
60
40
20
0
210 R.P.M.
840 R.P.M.
1260 R.P.M.
20
40
60
80
100
120
140
160
180
200
Pounds per square inch
Fig. 21.

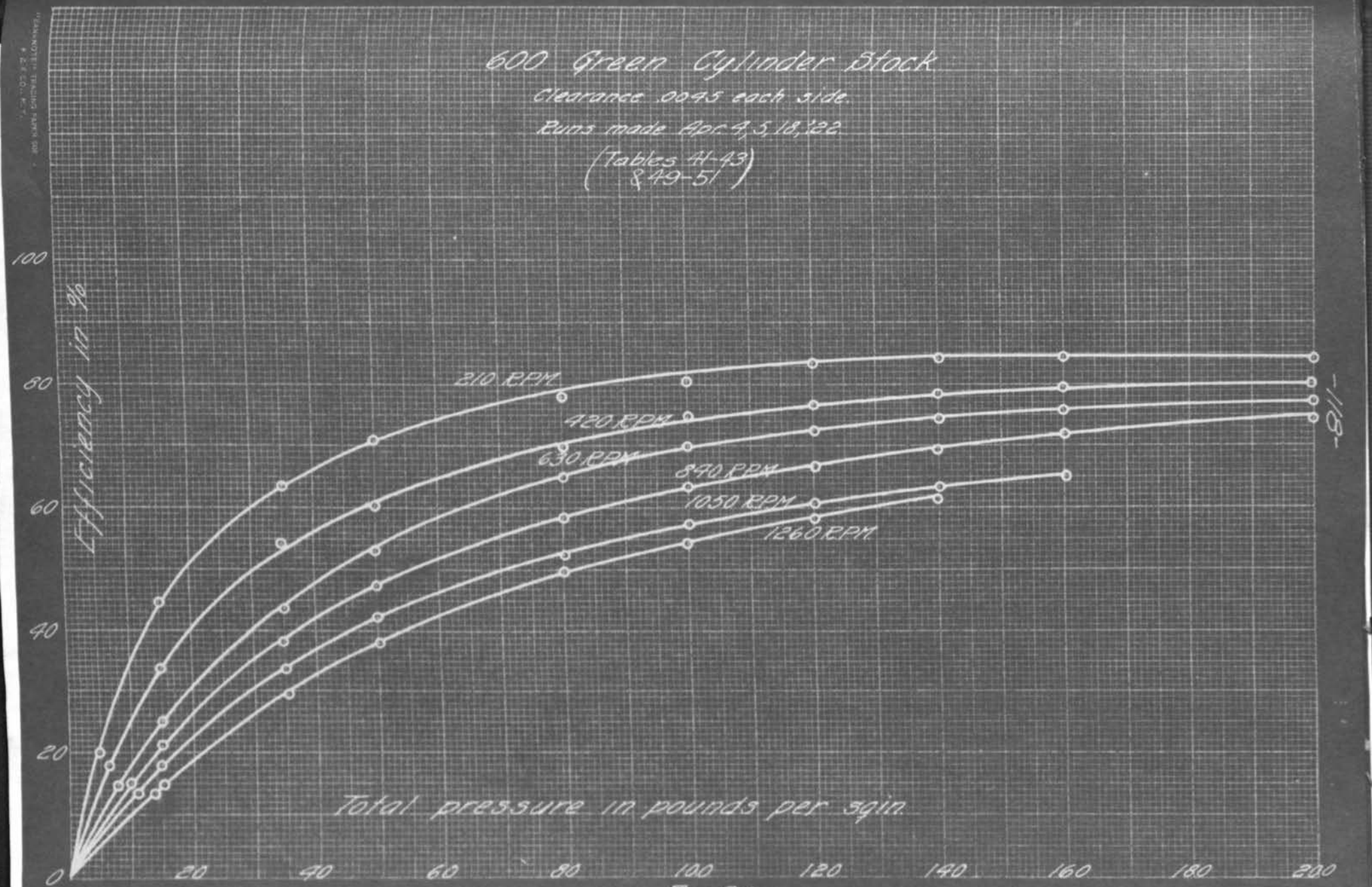

600 Green Cylinder Stock
Clearance .0045 each side.
Runs made Apr. 4, 5, 18, 22.
(Tables A-43 & 49-51)
210 R.P.M.
420 R.P.M.
630 R.P.M.
840 R.P.M.
1050 R.P.M.
1260 R.P.M.
Efficiency in %
Total pressure in pounds per sq.in.
0
20
40
60
80
100
120
140
160
180
200

Fig. 22.

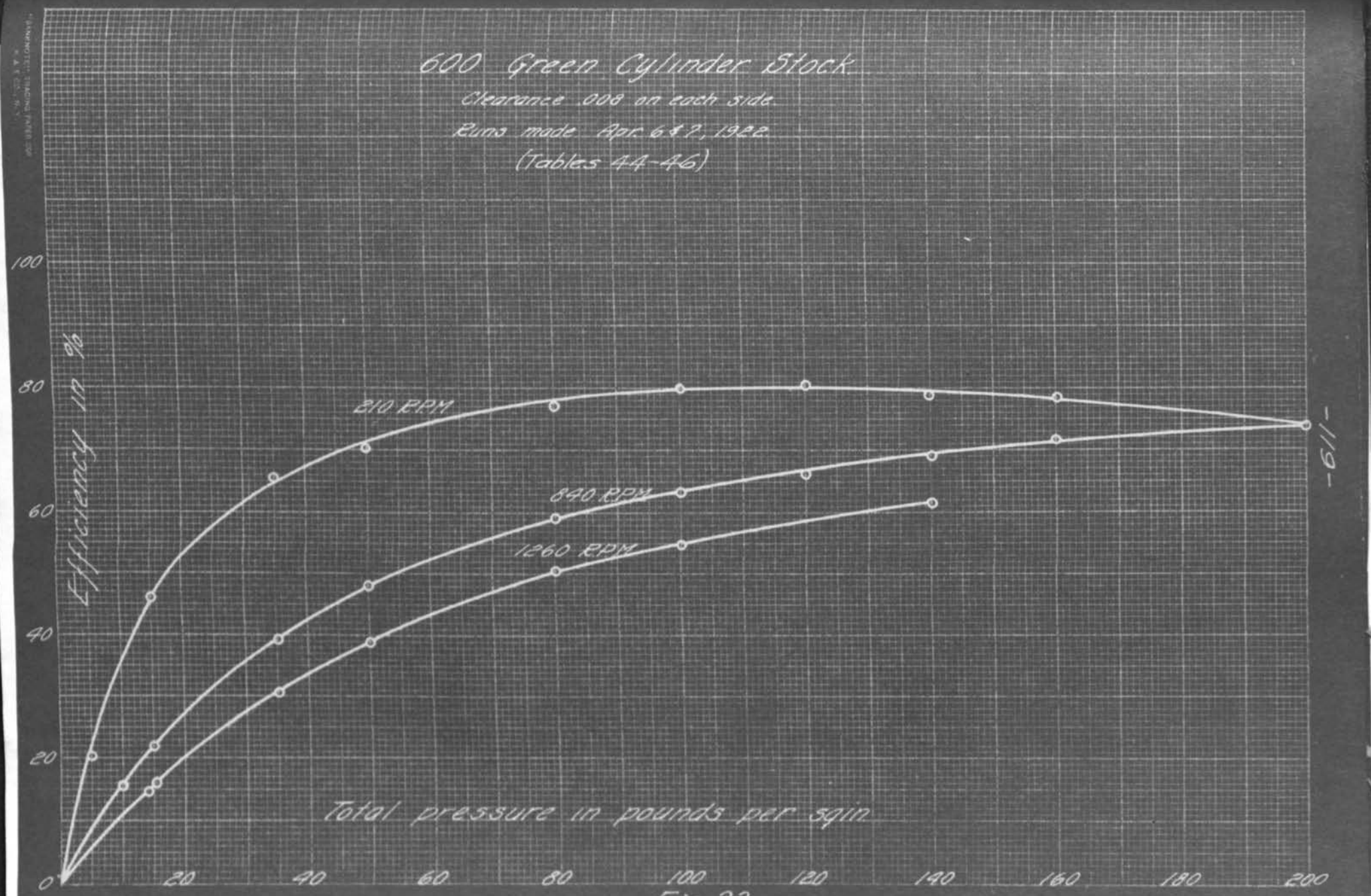

600 Green Cylinder Stock
Clearance .008 on each side.
Runs made Apr. 6 & 7, 1922.
(Tables 44-46)
Efficiency in %
210 R.P.M.
840 R.P.M.
1260 R.P.M.
Total pressure in pounds per sqin.
0
20
40
60
80
100
120
140
160
180
200

Fig. 23.

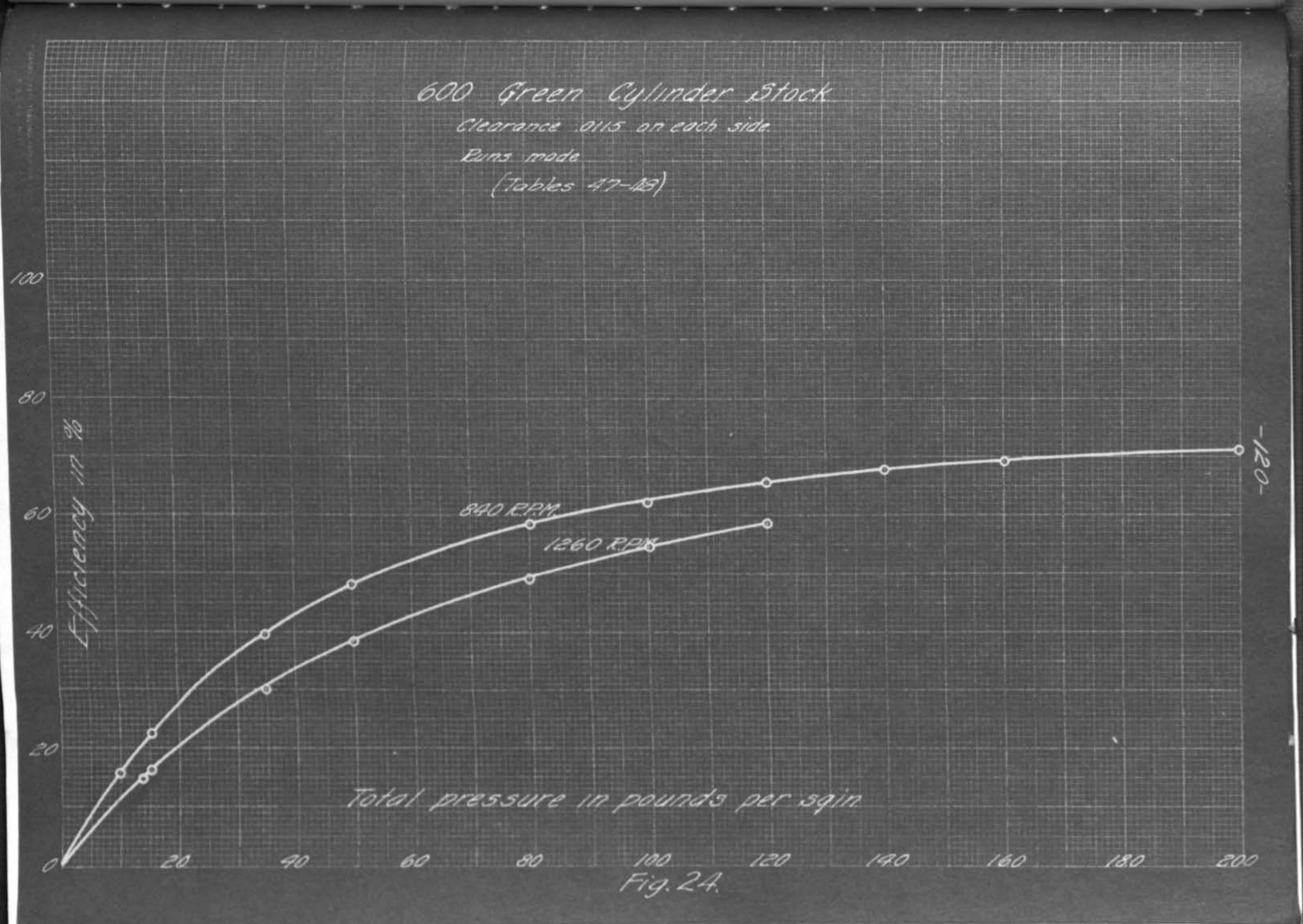

600 Green Cylinder Stock
Clearance .0115 on each side.
Runs made
(Tables 47-48)
100
80
60
40
20
0
Efficiency in %
840 R.P.M.
1260 R.P.M.
-120-
Total pressure in pounds per sqin.
20
40
60
80
100
120
140
160
180
200

Fig. 24.

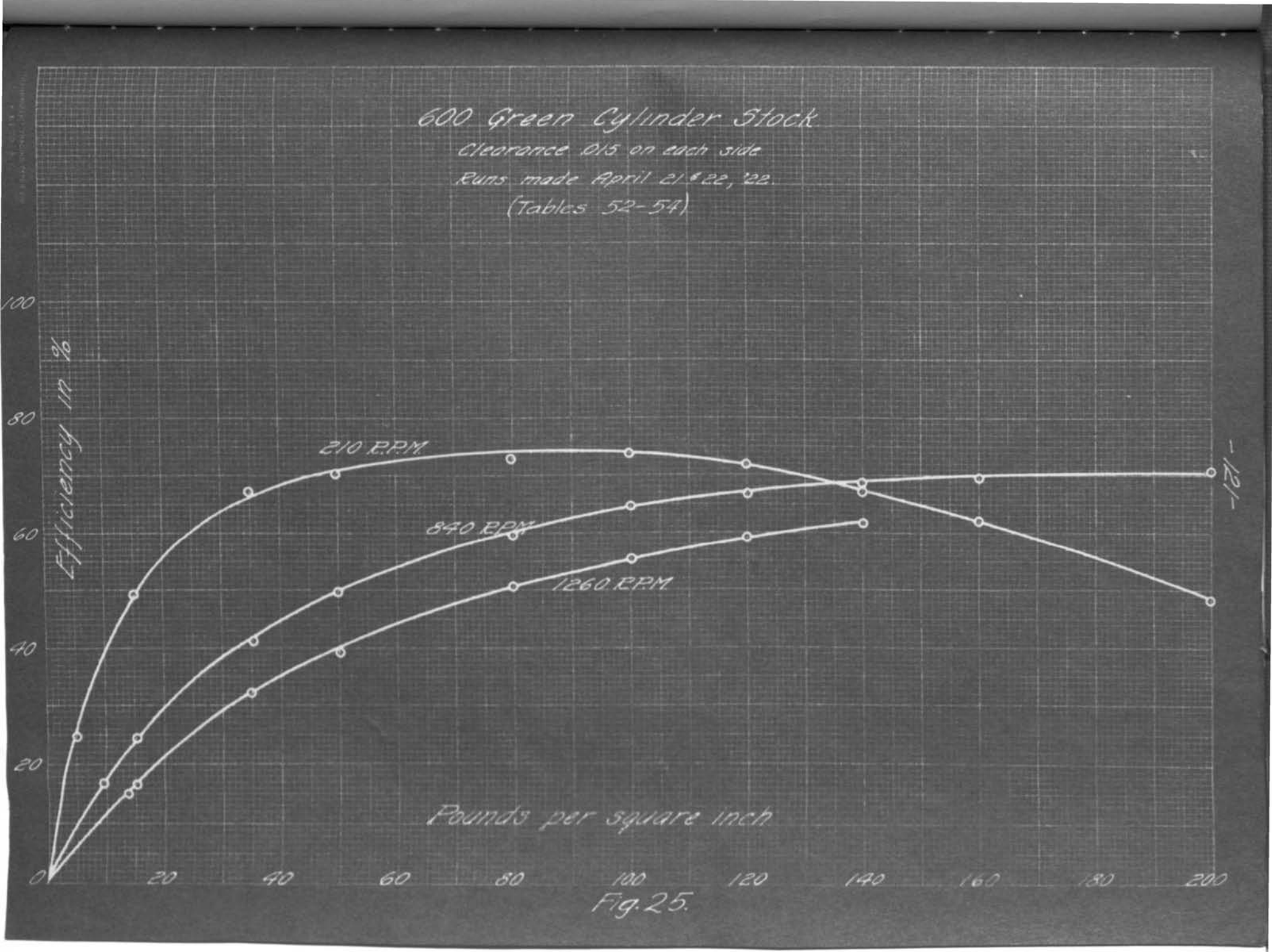

600 Green Cylinder Stock
Clearance .015 on each side
Runs made April 21 & 22, '22.
(Tables 52-54)
Efficiency in %
100
80
60
40
20
0
210 R.P.M.
840 R.P.M.
1260 R.P.M.
Pounds per square inch
20
40
60
80
100
120
140
160
180
200

Fig. 25.

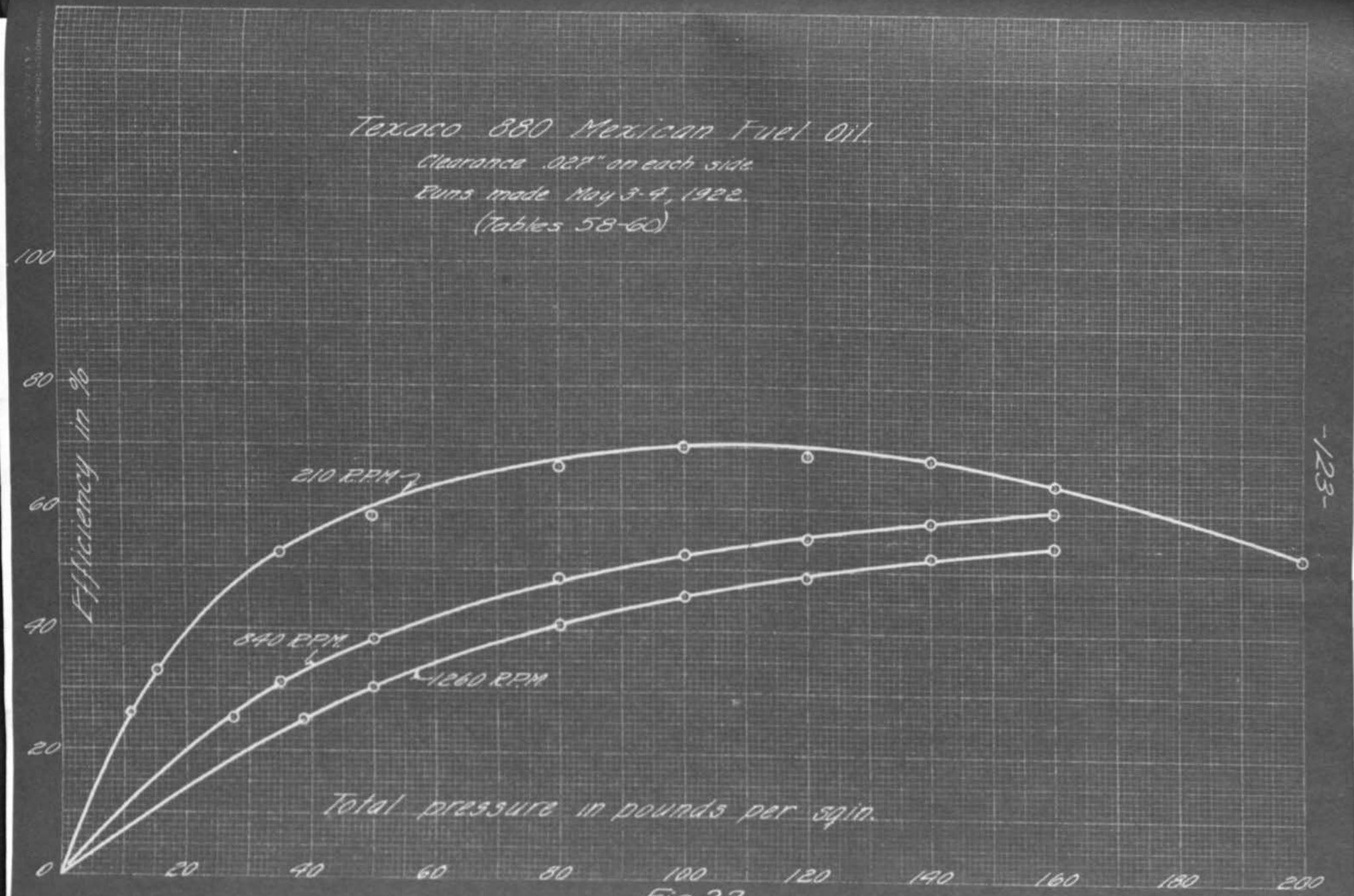

Texaco 880 Mexican Fuel Oil.
Clearance .027" on each side.
Runs made May 3-4, 1922.
(Tables 58-60)
Efficiency in %
100
80
60
40
20
0
210 R.P.M.
840 R.P.M.
1260 R.P.M.
Total pressure in pounds per sq.in.
0
20
40
60
80
100
120
140
160
180
200

Fig. 27.

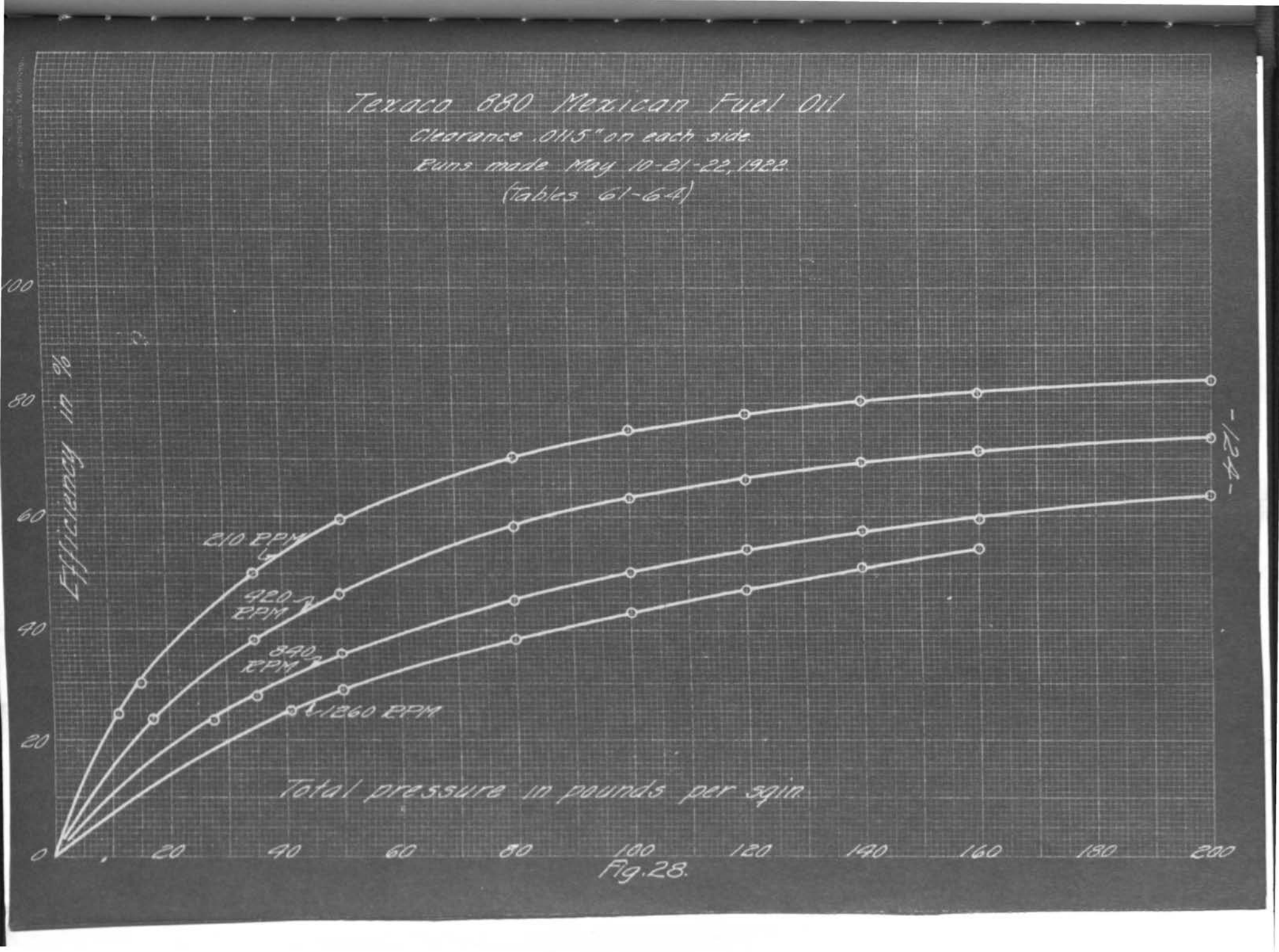

Texaco 880 Mexican Fuel Oil
Clearance .0115" on each side.
Runs made May 10-21-22, 1922.
(Tables 61-64)
Efficiency in %
100
80
60
40
20
0
210 RPM
420 RPM
840 RPM
1260 RPM
20
40
60
80
100
120
140
160
180
200
Total pressure in pounds per sq in.

Fig. 28.

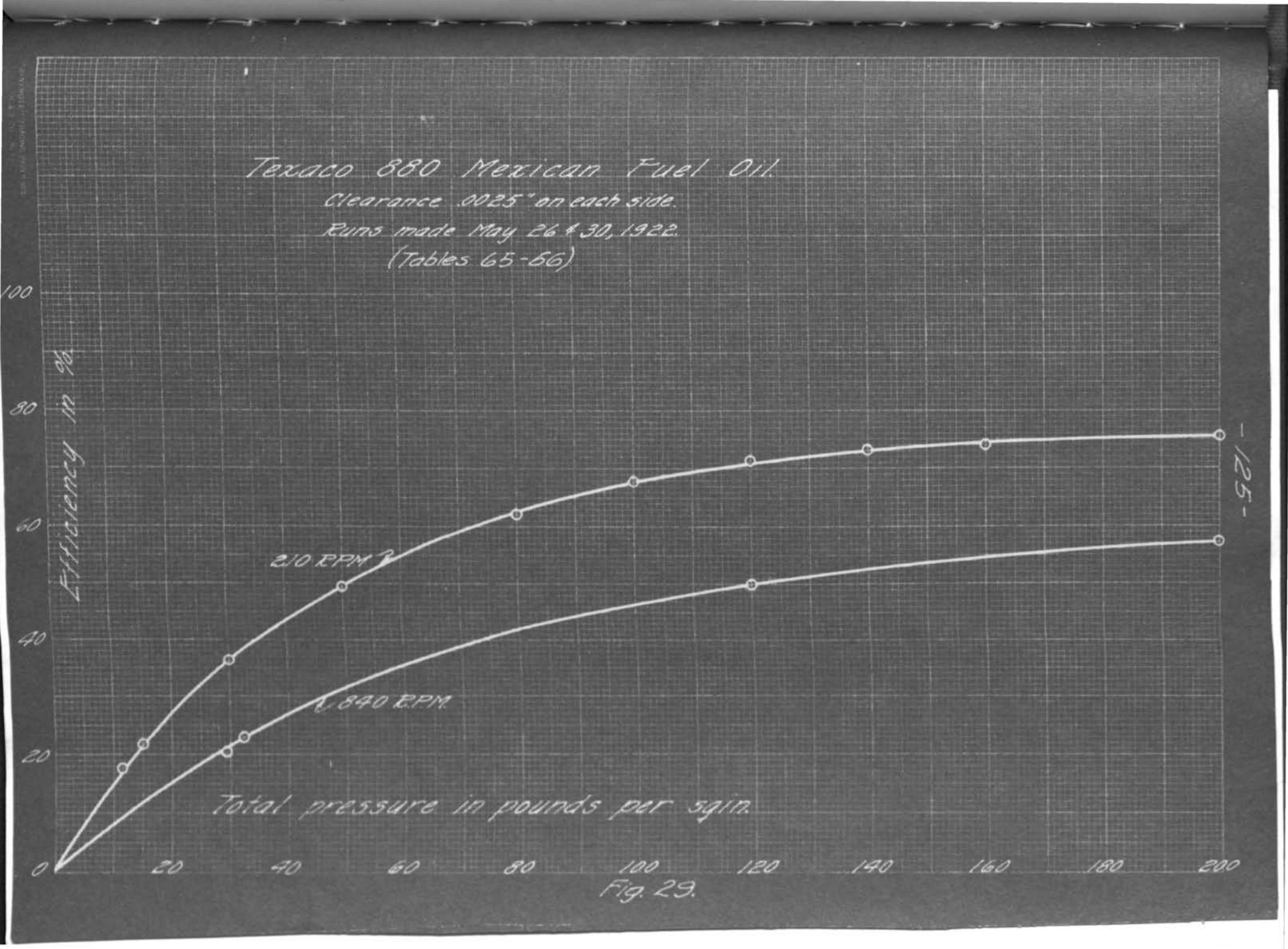
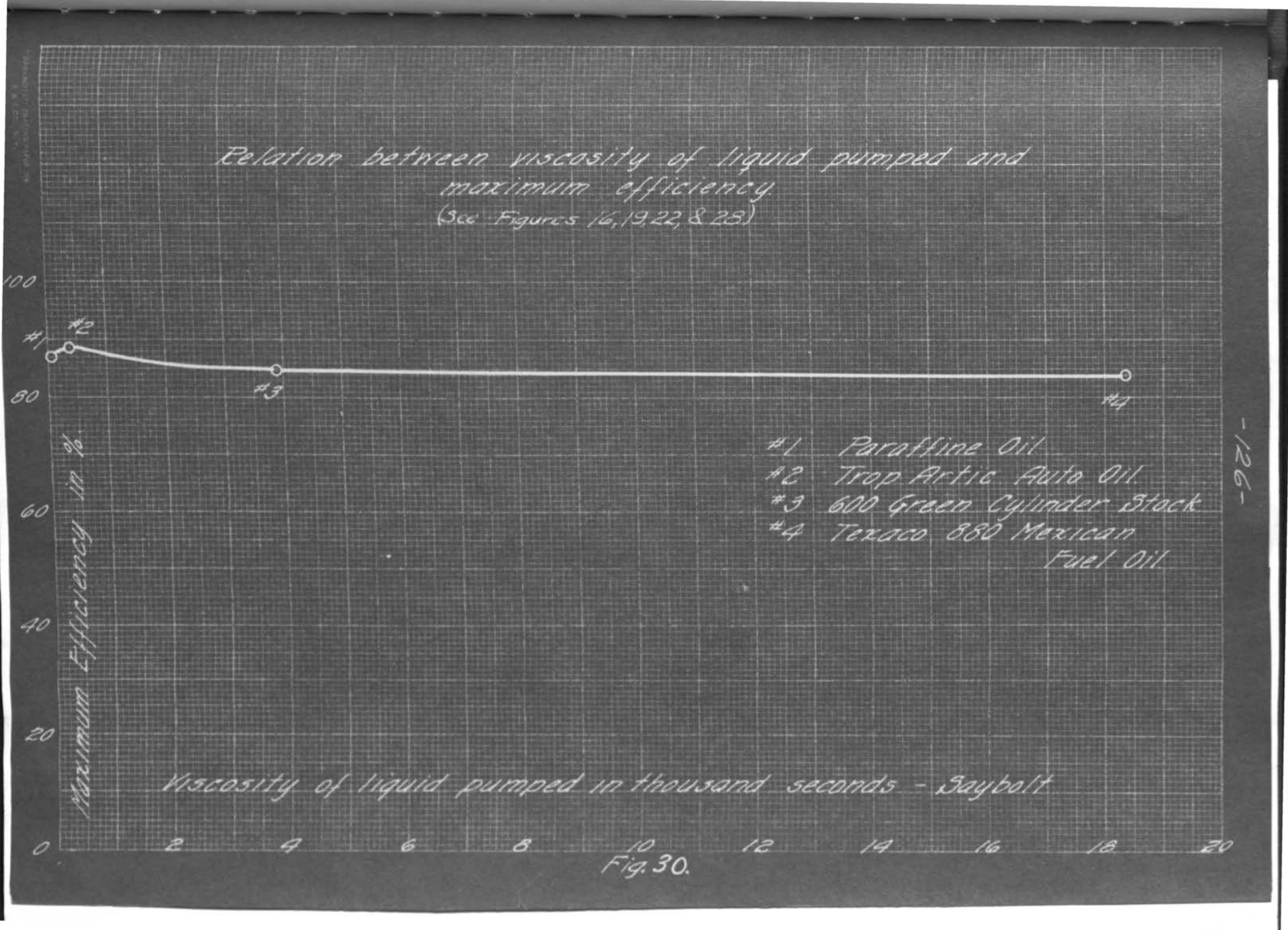

Texaco 880 Mexican Fuel Oil.
Clearance .0025" on each side.
Runs made May 26 & 30, 1922.
(Tables 65-66)
Efficiency in %
100
80
60
40
20
0
210 R.P.M.
1,840 R.P.M.
20
40
60
80
100
120
140
160
180
200
Total pressure in pounds per sq.in.

Fig. 29.


Relation between viscosity of liquid pumped and maximum efficiency.
(See Figures 16, 19, 22, & 28)
Maximum Efficiency in %
100
80
60
40
20
0
#1
#2
#3
#4
#1 Paraffine Oil
#2 Trop Artic Auto Oil
#3 600 Green Cylinder Stock
#4 Texaco 880 Mexican Fuel Oil
Viscosity of liquid pumped in thousand seconds - Saybolt
2
4
6
8
10
12
14
16
18
20
Fig. 30.

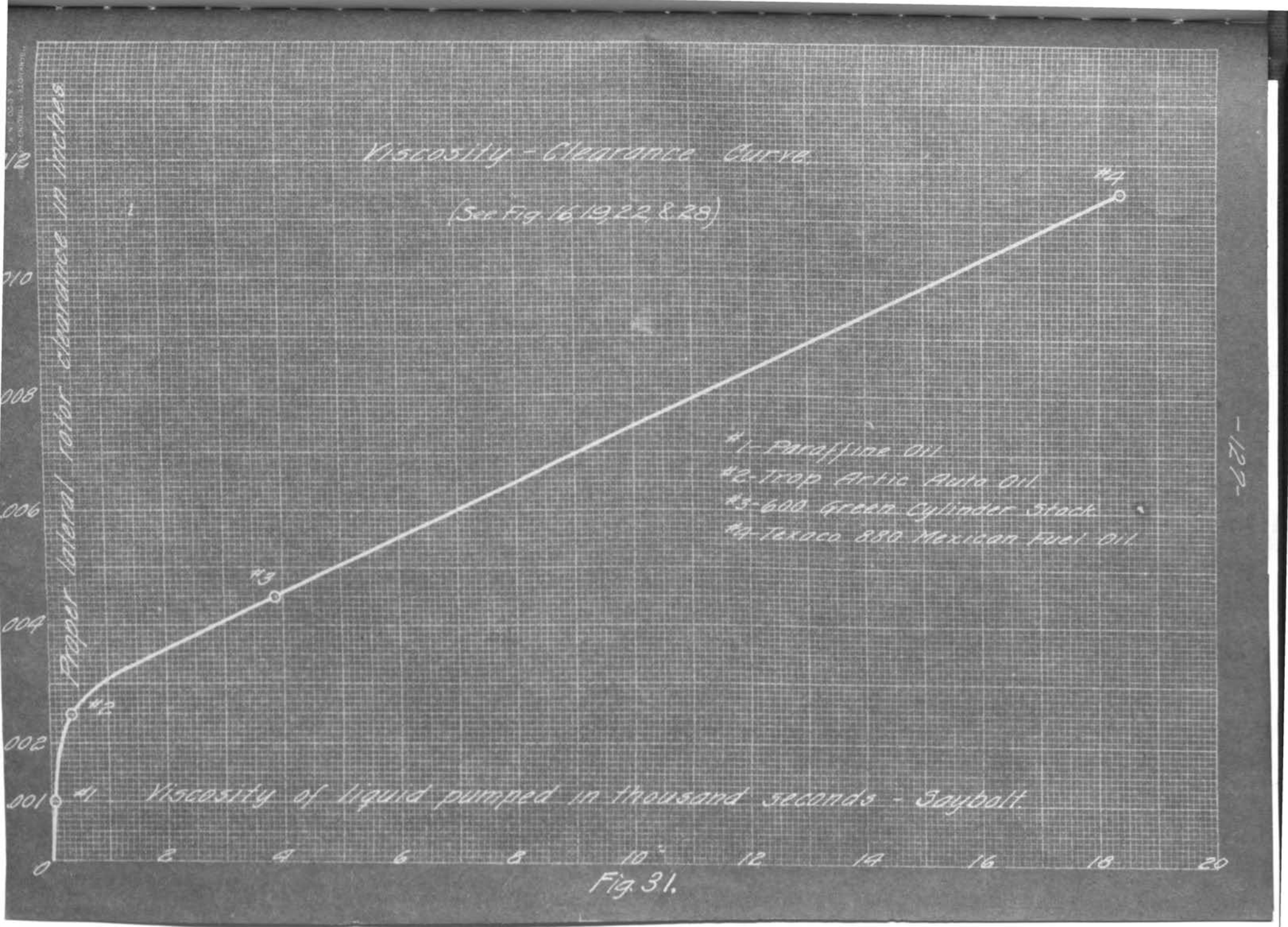

Viscosity - Clearance Curve.
(See Fig. 16, 19, 22, & 28)
#1 - Paraffine Oil
#2 - Trop Artic Auto Oil
#3 - 600 Green Cylinder Stock
#4 - Texaco 880 Mexican Fuel Oil
#1
#2
#3
#4
Total Diametral Clearance in Inches
.012
.010
.008
.006
.004
.002
.001
0
2
4
6
8
10
12
14
16
18
20
Viscosity of liquid pumped in thousand seconds - Saybolt

Fig. 31.

V.

DISCUSSION.

The efficiency curves for water (figure 14) when compared with those for kerosene show little difference in the behavior of the two liquids. The water on the whole has a higher efficiency, especially at 210 R. P. M. and 200 pounds per sq. in pressure.

The curves on paraffine oil (figures 16, 17, and 18) show that a lateral rotor clearance of .001 inches is the best clearance to use. With a clearance of .0045 (figure 18) the efficiency of the pump at 210 R. P. M. and 200 pounds pressure is only 35% whereas with a clearance of .001 inches the efficiency is 75% or over double that of the former. At the higher speeds there is no such marked difference, but nevertheless lateral rotor clearance becomes an important factor in the consideration of characteristics of a rotary pump.

Both the curves for paraffine oil and for "Trop Artic Auto Oil" (figure 19) reveal that the lubricating value of the oil pumped is an important factor in the efficiency of the pump. The maximum efficiency with water which is relatively a poor lubricant is about 78%

whereas that for paraffine oil and "Trop Artic Auto Oil" are respectively 87% and 89% approximately.

Comparing paraffine oil and "Trop Artic Auto Oil" at the higher speeds, the efficiency is appreciably greater for paraffine oil which has a much lower viscosity than that of "Trop Artic Auto Oil". This would seem to indicate that for liquids of high viscosity it is advisable to use low speeds in order that high efficiencies may be maintained.

Lateral rotor clearance was alos found to be important with "Trop Artic Auto Oil" though a small change in clearance did not produce nearly as great a difference in efficiency as did that with paraffine oil. The proper lateral clearance for "Trop Artic Auto Oil" was found from the curves (figures 19, 20, and 21) to be .0025 inches on a side.

The curves for "600 Green Cylinder Stock" (figures 22 - 26) show the proper lateral rotor clearance to be .0045 inches on each side. When the clearance is increased form .0045 inches to .027 inches, the efficiency is greatly lowered at the slower speeds (figures 22& 26).

At 210 R. P. M. and 140 pounds pressure, the efficiency is lowered from 84% to 37%, or to less than one-third of the first value.

For "Texaco 880 Mexican Fuel Oil" (figures 37 - 39) .0115 inches was found to be the proper lateral rotor clearance. The efficiencies at both .0025 inches clearance and .027 inches clearance are considerably lower than that for .0115 inches. Only three points were obtained for the 840 R. P. M. curve at .0025 clearance. Due to the friction created by the relatively high speed and close clearance, gas bubbles formed in the oil, thereby rapidly decreasing the density and making it impossible to accurately obtain more data. Runs at 1260 R. P. M. and .0025 inches clearance could not be obtained because the available power was insufficient to overcome the friction caused by the small clearance.

It should be noted that the clearance giving the best average efficiency is not the clearance which gives the highest efficiencies at the low pressures, but is some smaller clearance. Pumping at high pressures re-

quires a closer fitting pump and smaller clearances to maintain capacity than is necessary at the lower pressures. This smaller clearance means more mechanical friction which materially reduces the efficiency at low pressures.

From the data sheets it may be seen that a small increase in clearance reduces the capacity considerably, especially at low speeds and at high pressures. When the proper lateral rotor clearance is used, viscosity of the liquid pumped has little influence on capacity. The main effect is that the capacity of the pump at slow speeds and high pressures is slightly better maintained with the more viscous oils.

So far there has been no discussion on radial clearance, which is one-half of the difference between the inside diameter of the cylinder and the outside diameter of the rotor. It is not necessary to change this clearance since springs force the packing strips (figure 2) to always press against the cylinder walls. Through these springs the packing strips readily adjust themselves to the liquid pumped. Though, for the very heavy oils it is possible that the radial clearance may be too

small for the packing strips to function properly.

Proper lateral rotor clearance for oils of any viscosity up to 18,000 may be found from the curve in figure 31.

A careful study of all the efficiency curves brings out the extreme importance that speed has on efficiency. The maximum efficiency for each oil pumped with the exception of kerosene was at the lowest speed. At the higher speeds the liquid passes through the pump at a velocity much greater than the velocity of the liquid in the suction and discharge pipes. When the liquid enters the pump it is first suddenly speeded up to the speed of the rotor and then suddenly reduced in speed to that of the liquid in the discharge pipe. Under these conditions the velocity head, which is considerable at high speeds, is not changed to pressure head, and the kinetic energy of the rapidly moving particles of oil is largely expended in heat. At high speeds this loss and consequent decrease in efficiency is much greater than at low speeds since the velocity head of the liquid varies as the square of the speed.

With the very viscous liquids there is also the additional loss caused by fluid friction which lowers the efficiency of the pump very rapidly as the speed of the pump increases. Figure 28 for "Texaco 880 Mexican Fuel Oil" shows that at 160 pounds pressure the efficiency of the pump is lowered from 82% to 54% when the speed is increased from 210 R. P. M. to 1260 R. P. M. As the viscosities of the oils decrease this difference in efficiency between low and high speeds gradually diminishes.

The lubricating value of the liquid appears to have a marked effect on efficiency. The maximum efficiency for water is only a trifle better than 78 per cent (figure 14), and that for kerosene is almost one per cent less (figure 15). All of the other liquids have a maximum efficiency of about 85 per cent, this marked increase being accounted for by the fact that these liquids are much better lubricants than water or kerosene.

Figure 30 gives the relation of viscosity to maximum efficiency. For liquids possessed with lubrication qualities, increasing the viscosity does not mater-

ially effect the efficiency of the pump, providing the speed of the pump is low. It may be well to repeat that the maximum efficiency for each oil was obtained at the slowest speed. At this speed the pump also operated the smoothest and with the least noise, an indication that the smallest wear was taking place under this condition.

The high efficiencies which were obtained over a wide range of pressures for oils of very different viscosities, mark the pump as being particularly well adapted for the handling of oils.

VI.

CONCLUSIONS.

1. Proper lateral rotor clearance is essential to maximum pump efficiency.

2. Viscous liquids should be pumped at slow speeds to obtain best results.

3. Changing the viscosity of an oil does not materially effect pump efficiency at low speeds.

4. The type of rotary pump tested is particularly well adapted for the pumping of oils.

B I B L I O G R A P H Y

"American Lubricants"
by L. B. Lockhart.

"The Practice of Lubrication"
by T. C. Thomsen.

"Pumping Machinery"
by William M. Barr.

"Pumping Machinery"
by Arthur M. Greene.