TEST OF A
DELAVERGNE OIL ENGINE

BY
WILLIAM SIECK

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Sieck, William
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ENGINE.

A THESIS

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APPROVED

G. F. Gebhardt
,,,...
Professor of Mechanical Engineering.

....
Dean of Engineering Studies.

7 L. C. Monin
Dean of Cultural Studies

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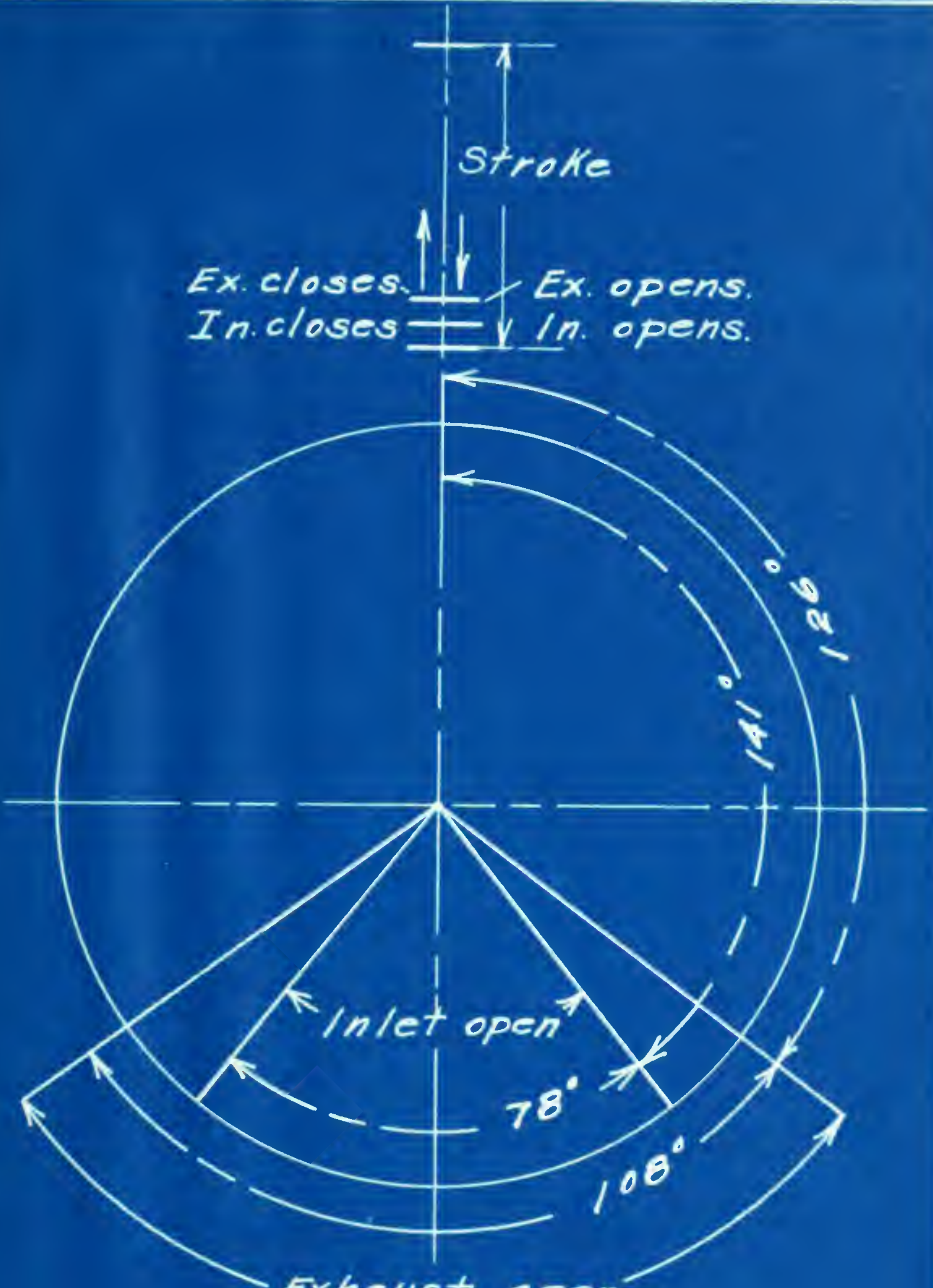
Test Of DeLaVergne

Oil Engine.

The following pages contain the results of a series of tests made on a 7 H.PM oil engine in order to determine its adaptability to the different grades of low priced petroleum products. The engine is manufactured by the DeLaVergne Machine Company of New York and is known as their type S engine.

The DeLaVergne type S oil engine is of the two port, two cycle type with bore and stroke of 7 and 7 1/2 inches respectively. The engine draws in a charge of pure air thru a check valve in the crank case on the upward stroke of the piston, and compresses it on the downward stroke to a pressure of about 6 pounds per sq. in. When the piston nears the bottom center it uncovers a port in the side of the cylinder which allows the products of combustion of the preceeding explosion to escape. The charge of air is transferred from the crank case to the cylinder by means of another port in the side of the cylinder which is uncoverd by the piston slightly after the exhaust port. This charge of air is then compressed by the upward stroke of the piston into the clearance space and the ignition bulb, which is kept at a low red heat by the successive explosions. The power stroke of the engine is effected by injecting a quantity of oil in a finely divided condition



Port Diagram.

into the ignition bulb. The heat of compression combined with the heat of the bulb ignites the oil and the resulting expansion of the gases give the power stroke.

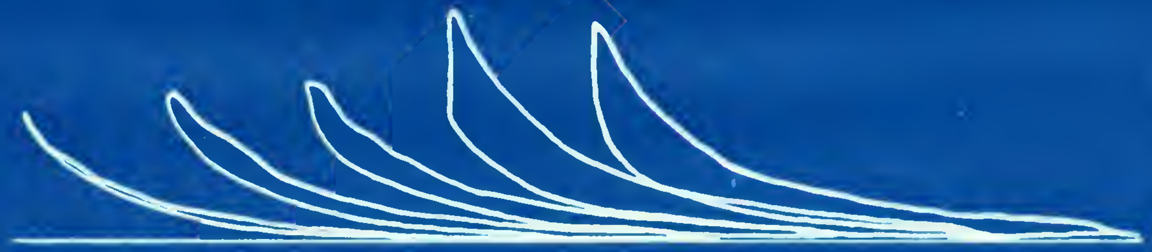
The engne is governed by varying the amount of oil injected during the power stroke. This is effected as follows:-

The flywheel carries a cam which operates the oil pump thru a roller on the plünger of the pump. The cam is hinged to the flywheel at a point opposite the highest point on the cam and is free to swing in a plane perpendicular the axis of the wheel. The cam is held in engagement with the plunger roller of the oil pump by means of a wedge between the back of the cam and the flywheel and behind the highest point on the cam. This wedge is pivoted at one end and carries a weight at the other whose outward movement is controlled by means of a spring.

When the speed of the engine excedds the normal the weight tends to move outward, drawing out the wedge from behind the cam, thus causing the high point on the cam, which gives the pump its stroke, to move inwards to the flywheel resulting in a shortening of the pump stroke. The resulting decrease in the quantity of oil injected brings the speed of the engine down to normal. The stroke of the pump may also be regulated fro large variations in load by means of a vertical rod on the side of the engine which is connected to the bell crank the other end of which presses against the plunger of the pump. By means of lock nuts on this rod the stroke of the pump may be adjusted to suit the load.

The method of procedure in starting the engine is as follows:-

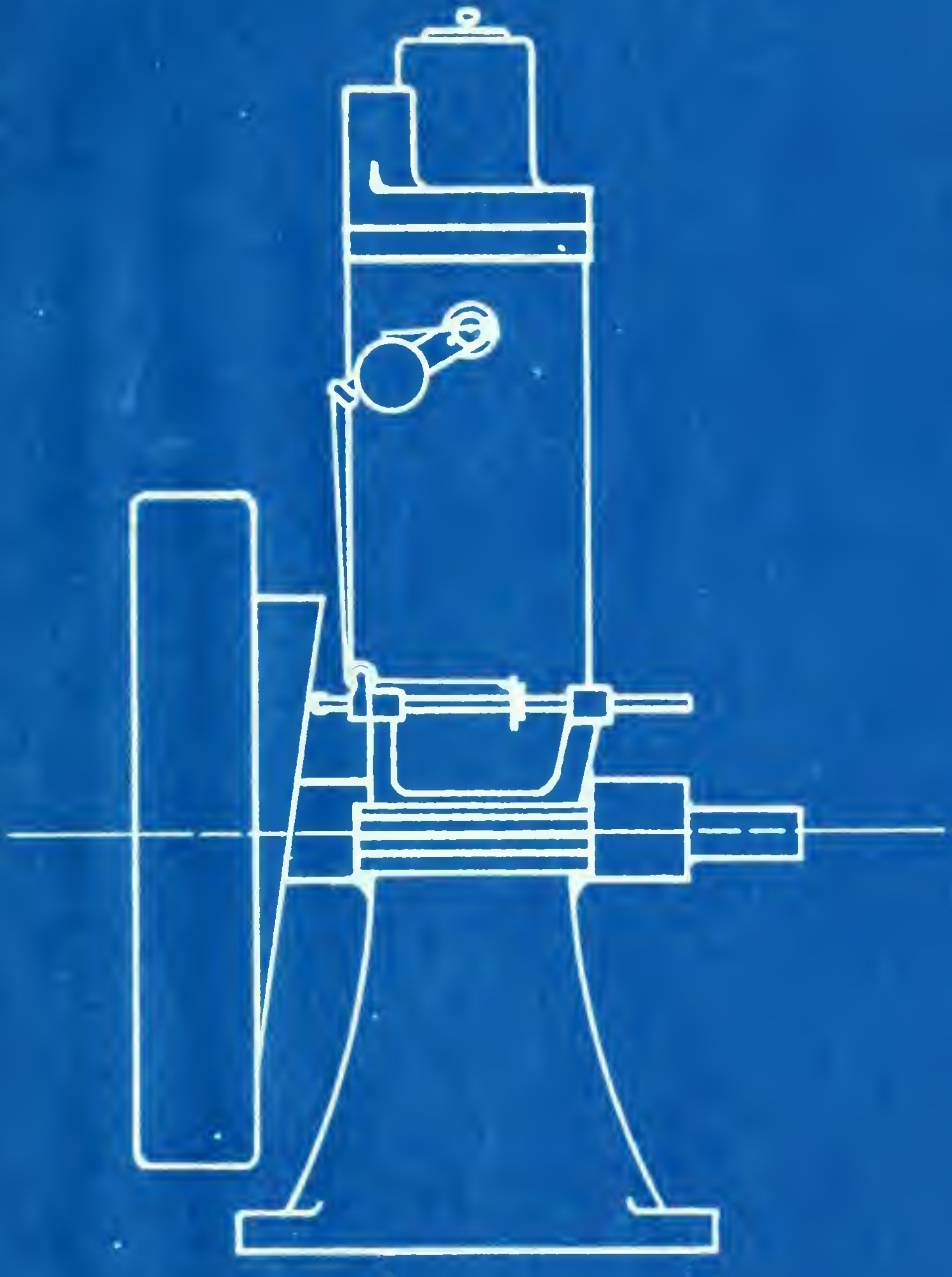
Fill the torch with a mixture of half kerosene and half gasoline to within about



Series of cards taken with a gradually increasing load illustrating method of governing.

one inch of the filler openning. Heat the head of the torch bybmeans of gasoline poured into the cup below the torch head. When the gasoline in the cup is nearly all burned out close the small relief valve in the filler plug and pump air into the tank. Ignite the gas as it comes out of the vaporizer. Allow the flame to play on the ignition head for about 20 minutes. Turn the flywheel so that the handle is on top, open the cylinder cock and depress the pump rod quickly several times. If dense white smoke issues from the cock the engine is ready to start. Turn wheel so that handle is at the bottom, close cylinder cock, press down on pump rod several times, turn flywheel up against compression in a counter clockwise direction and let go. The oil pump may be then adjusted for the load by screwing the nuts on the pump rod up for less oil and down for more oil. Turn on the cooling water slowly and shut off torch. To stop the engine press the pump rod down as far as it will go and turn to the right.

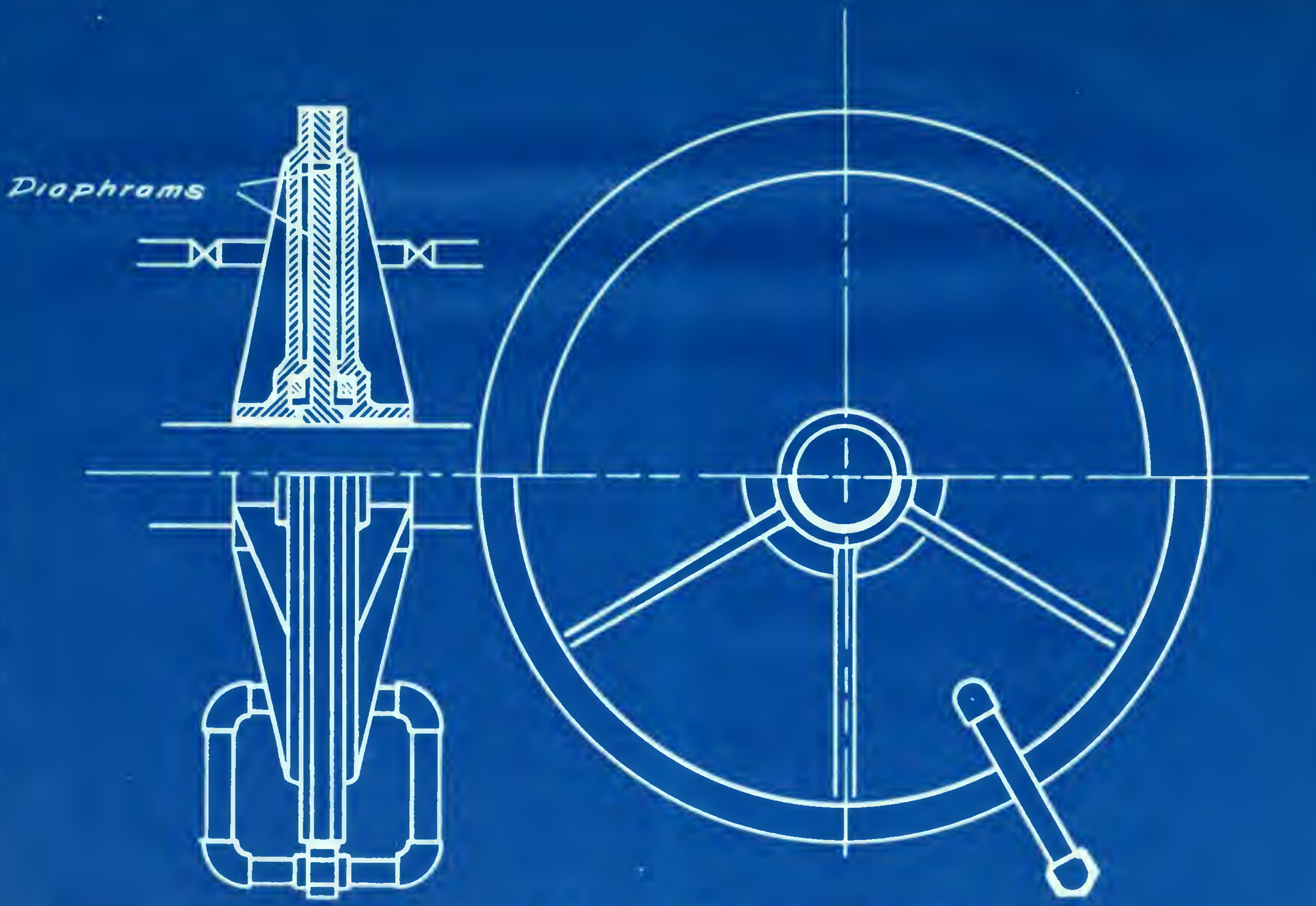
If the engine fails to start it is a sign that either the ignition bulb is not hot enough, the spray nozzle is clogged up, or that the check valves in the oil pump are not working properly. The spray nozzle should give a fine spray when it is taken out and a quantity of oil forced thru it by forcing down the pump rod. The pressure of the oil should be such that it will be impossible to keep the end of the oil pipe closed by holding the finger over it. If the pressure is not great enough the trouble is with the check valves in the pump, the plunger packing, or an empty supply tank.



Indicator Motion.

As the moving parts of the engine are entirely enclosed it was necessary to design a form of reducing motion for the indicators which could be attached to the outside of the engine. The reducing motion designed and constructed by the author consists of a cam bolted to the inside of the flywheel. A follower sliding in a bracket on the base of the engine is held in engagement with the profile of the cam by means of a spring and the tension of the indicator cords which pass thru pulleys on the flywhhel end of the bracket. The profile of the cam was obtained by laying out the different positions of the piston in a slider crank mechanism of 3 inch stroke and with the same relation of connecting rod length to crank lenght as exists in the actual engine. The several piston displacements were transferred to a piece of sheet metal which was cut out and used as a guide in the filing of the profile of the cam. The indicators used were of the Crosby gas engine type on the cylinder and a Tabor steam engine indicator on the crank case.

The power of the engine was absorbed and measured by means of an absorption dynamometer of the Alden type. The dynamometer consists of a casing made in halves and free to revolve on the shaft of the engine. The engine shaft has a cast iron disk keyed tb and running between two copper diaphrams secured to the inside of the casing. A separating ring is placed between the two halves of the casing and is of such thickness that the clearance between the disk and the diaphrams is about 1/64 inch. Water under city pressure is circulated thru the casing, the entrance and discharge pipes being fitted with valves for regulating the pressure inside of the casing. The pressure on the diaphrams forces them against the disk, the resulting friction tending to rotate the casing. A lever arm secured to the casing and



Alden Dynamometer.

resting on a platform scale recorded the torque. The diameter of the disk is 12 inches and with water pressure at 20 lbs. the dynamometer is able to absorb 7 H.P. at a speed of 350 R.P.M. The space between the disk and the diaphrams was kept well filled with oil to prevent the disks from cutting.

Fuel Used In The Tests.

The oils used in these tests were those which are obtained in the various stages of the refining of crude petroleum.

The crude petroleum is distilled with the aid of injected steam and the following products obtained:-

Benzine Distillate or Crude Naptha.
Burning Oil Distillate.
Residue.

The residue is then transferred to another still and redistilled giving the following products:-

Solar Oil.
Spindle Oil.
Machine Oil.
Tar.

The crude distillate used in the tests was the " burning oil distillate ". This contains besides the kerosene a small amount of the heavier oils. It is a redish liquid about the consistency of water. Its specific gravity was 0.851 corresponding to about 36° Baumé. The heat value as determined in the Mhler bomb calorimeter was found to be 18900 B.T.U. per pound.

The kerosene is obtained by the redistillation of the burning oil distillate. In this distillation the products are kerosene and the heavier Solar oil. The specific gravity of the kerosene was 0.806 and the heat value 19000 B.T.U. per pound. The kerosene was water white and had the characteristic bluish sheen when viewed by reflected light.

The Solar oil is the first product obtained in the distillation of the benzine-kerosene residue and is the impurity found with the kerosene in the burning oil distillate. It

is a rather viscous oil of a redish color. It contains a large amount of sulphur as is shown by its strong sulphurous odor. The specific gravity at 22° C. is 0.908 and the heat value 18180 B.T.U. per pound.

The tests consisted of 2 hour runs with the loads varying from the smallest load the engine would run at steadily to the heaviest load it could carry. The govenor of the engine was set for 350-400 R.P.M. as it would be impossible to get a card at the rated speed of 500 R.P.M. Temperature readings, R.P.M. and indicator cards were taken every 10 minutes, the oil and water being weighed up every hour. The temperature of the water was kept as high as possible it being necessary to run it cooler with the distillate and the solar oil than with the kerosene in order to keep the ignition bulb from overheating.

160# spring

160# spring

160# spring

10# spring. Crank case.

Run No. 1-A.

160# spring

160# Spring

160# spring

10# Spring. Crank case.

Run No. 2-A.

240# spring

240# spring.

10# spring. Crank case.

Run No. 3-A.

160# spring.

160# spring.

10# spring. Crank case.

Run No. 1-B.

160# spring

160# spring

10# spring, Crank case.

Run No. 2-B.

160# spring

160# spring.

10# spring. Crank case.

Run No. 3-B

160# spring

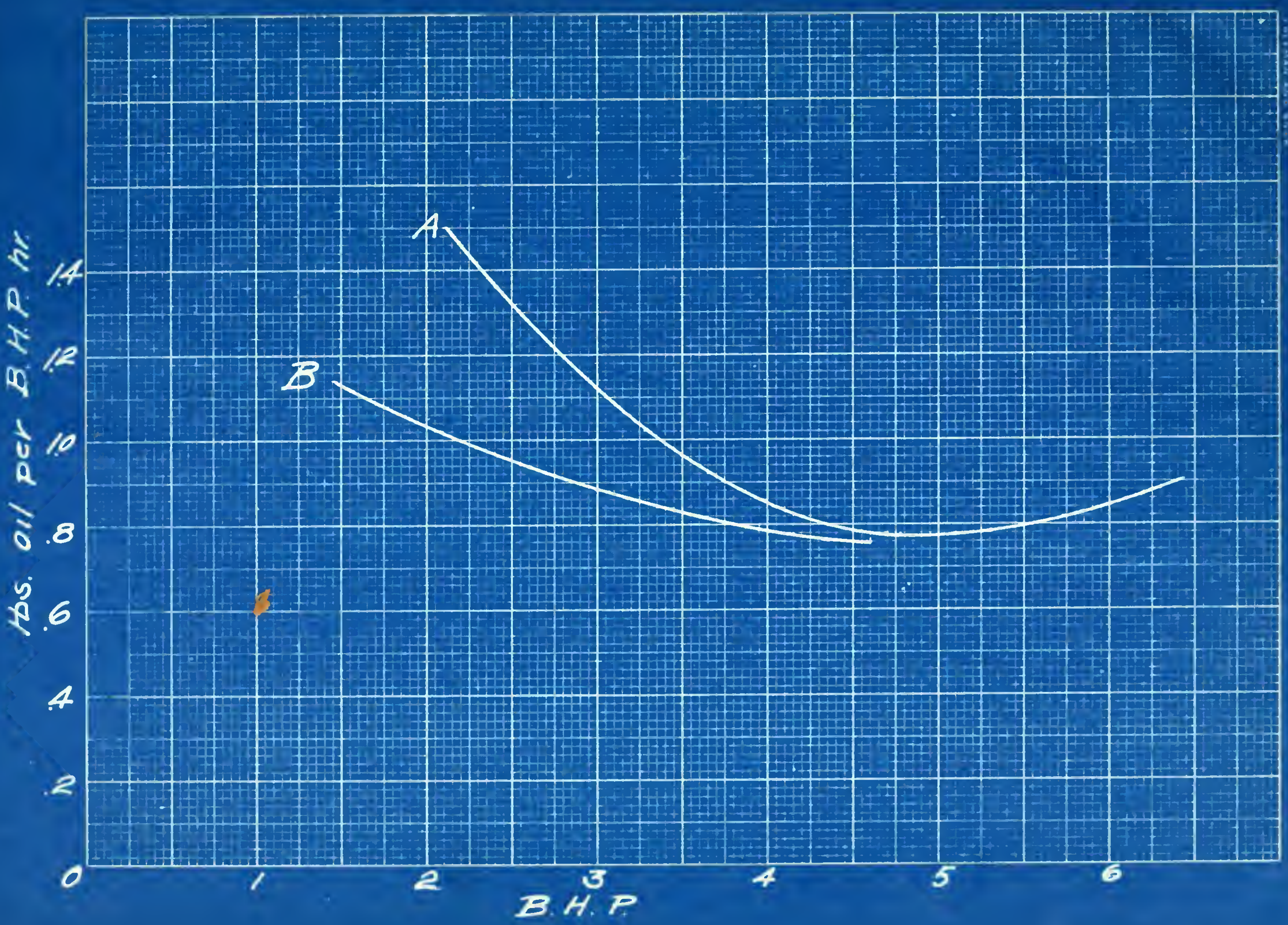
160# Spring

10# spring. Crank case

Run No. 1-C

Run No.	1-A	2-A	3-A
Fuel	Kerosene	✓	✓
B.T.U. per lb.	19000	✓	✓
Net. wgt. on brake lbs.	16	30	41
R.P.M.	370.7	384.1	396.4
Temp. inlet water	53.2	51.8	52.5
Temp. outlet water	149.	175.4	161.1
B.H.P.	2.26	4.39	6.2
I.H.P.		8.66	12.74
I.H.P., crank case	.725	.561	7.62
Wgt. oil per hr. lbs.	2.98	3.39	5.31
Wgt. oil per B.H.P. hr.	1.32	.773	.866
I.H.P. eff. %		32.5	29.83
B.H.P. eff. %	10.1	17.6	15.5
Mech. eff. %		54.2	51.8
Water loss. %	31.6	30.6	40.8

Run No.		1-B	2-B	3-B	1-C
Fuel		Distilite	〃	〃	Sol. oil
B.T.U. per lb.		18900	〃	〃	18,180
Net wgt. on brake	lbs.	15	30	35	15
R.P.M.		375	346	346	328.1
Temp. inlet water		55.8	53.6	54.3	58.8
Temp. outlet water		156	145	113.2	164.1
B.H.P.		2.14	3.95	4.6.1	1.88
I.H.P.		5.27	7.32	7.46	5.06
I.H.P., crank case		.611	.627	.654	.596
Wgt. oil per hr.	lbs.	2.39	3.16	3.55	2.5
Wgt. oil per B.H.P. hr.		1.12	.798	.77	1.33
I.H.P. eff.	%	26.33	27.95	25.9	25.2
B.H.P. eff.	%	12.1	16.45	17.5	10.6
Mech. eff.	%	45.9	58.8	67.6	42.1
Water loss.	%	35.8	44.	38.1	40.



lbs. oil per B.H.P. hr.
1.4
1.2
1.0
.8
.6
.4
.2
0
1
2
3
4
5
6
B.H.P.
A
B

The results of these tests show a good brake efficiency at all but the lighter loads. This is probably due to the high friction load at low powers caused by an accumulation of a gummy carbonaceous residue in the cylinder. This deposit is undoubtedly the cause of the low mechanical efficiency. The gumming up of the cylinder was more apparent with the distillate and solar oil than with the kerosene. After the engine had been standing for some time after running on distillate it could not be turned over until the deposit had been softened by pouring kerosene or gasoline into the cylinder.

The action of the check valve in the base is well shown on the card taken from the crank case in Run No. 2-A. The suction line shows a decided drop after it crossed the atmospheric line probably due to wire drawing in the valve as the piston gets to the center of its stroke where its velocity is greatest and the velocity of the air thru the check valve is greatest. This wire drawing results in a vacuum the result of which is that the pressure does not rise to atmospheric again until the piston has traveled about one-sixth of the return stroke. The compression line does not rise immediately because the check valve does not clase tightly instantly but lags behind somewhat. The sudden drop in pressure just before the end of the stroke is where the transfer port in the cylinder is uncovered by the piston.

The tests showed that the engine was readily adaptable to the use of kerosene and distillate oils but hardly for such heavy oils as Solar oil. The kerosene oil gave the least trouble from carbon deposits in the cylinder but the engine did not run

as steadily as with distillate. With kerosene the engine was able to carry the largest load. With distillate or Solar oil the engine could not carry a load much greater than 4 1/2 H.P. without bringing the temperature of the ignition bulb up to a yellow heat. When solar oil was used the same trouble was experienced. The engine could however, pull momentary heavy loads as easily with distillate as with kerosene. The power of the engine was limited to about 5 H.P. with Solar oil. This is probably due to the higher specific gravity which made it impossible to get a finely divided spray from the nozzle and not to the lower heat content of the oil.