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NORMAN B. GRIDLEY

COMPARATIVE TEST OF GASOLINE ENGINES

Norman B. Gridley

1913

THESIS

WAGENVOORD & CO.
LITHOGRAPHERS
LAFAYETTE, IND.

This thesis was contributed by

Mr. N. B. Gridley

under the date indicated by the department stamp, to replace the original which was destroyed in the fire of March 5, 1917

A [illegible]

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BY

Norman B. Gridley.

A Thesis submitted for the Degree

of

Bachelor of Science

Michigan Agricultural College.

-1913-

THESIS

12-4-51
(9)

[illegible]

The principal object of this investigation was to determine the gasoline consumption per brake horse-power per hour at different loads.

To the average user of the small or medium size gasoline engine, the important point, aside from reliability, is not mechanical efficiency but cost of operation, and this immediately sifts down to the fuel consumption.

[illegible]

The engines used in the series of tests comprised the following;-

1---4 H.P. Bates and Edmonds.

1---6 H.P. Novo.

1---6 H.P. New-Way.

The last named engine was a late acquisition, it being installed to replace a 12 H.P. New-Way, for the reason which will be set forth later in this report.

The three engines are all of the stationary, single cylinder, four-cycle, hit-and-miss governing type, but they represent three different methods of cooling and three different systems of ignition.

The "Bates and Edmonds" is circulation-cooled, the Novo hopper-cooled, and the New-Way air-cooled.

The ignition on the Bates and Edmonds is by means of the make-and-break system with induction coil and dry-cells. In the Novo the jump-spark system with spark coil and dry-cells is used, while the New-Way is equipped for jump-spark ignition with Bosch high tension magneto.

The Bates and Edmonds and the Novo engines are vertical, the New- ay is horizontal.

[illegible]

The tests were run with the spark and the opening and closing of the exhaust valve occurring at such points as approximated,very closely, the best conditions for each individual engine. The inlet valves are automatic on all three engines.

[illegible]

The gasoline was contained in a pail resting on a scale which reads to [illegible].01 pound. From this pail it was fed to the carburetor of the engine either by gravity, by means of a pump, or by suction, these three methods being used with Bates and Edmonds, Novo, and New-Way respectively. In the first and last cases,a tube was connected to a valve near the bottom of the pail, and in the second case,the pipe thru which the gasoline was drawn up, extended down into the pail. In no case was a syphon used.

The power was absorbed by means of a rope brake applied, not to the fly-wheel, but to a brake-wheel keyed to the crank-shaft of the engine. This wheel was wide and thin of rim and had an internal flange for retaining cooling-water.

The revolutions were counted with a Starrett revolution counter.

[illegible]

These tests were performed in the engineering laboratory

at the Oklahoma Agricultural College.

The tests were run at approximately quarter, half, and full load, also three quarter, in terms of brake horse-power.

The duration of tests was one hour at quarter load, and forty-five minutes at each of the other loads.

The revolutions per minute were taken at frequent intervals during each test, the prevailing interval being five minutes.

The brake horse-power was computed as the product of the predetermined brake horse-power constant, net load in pounds, and average revolutions per minute during the test.

The weight of the fuel plus the pail and appurtenances was taken at the time of starting the test, with the engine running under load, and again on closing the test under the same conditions. During some of the tests, the weight was also taken at intermediate times.

[illegible]

Considerable trouble was encountered in starting the Dated and Diamonds, and after starting, it exhibited a marked tendency to miss and stop. This trouble was finally overcome by overhauling the spark block and cleaning it of the carbon deposit found thereon. It is probable that there had been a short circuit due to the carbon on the block.

After running the quarter and half load tests on the Hevo it was endeavored to bring the engine up to about 3.7 horse-power, the half load having been 3.01 horse-power. The engine refused to carry this load. It carried about three horse-power but knocked badly. The spark was thrown off but the engine continued until the gasoline was shut off.

These explosions were evidence of a very high cylinder temperature and possibly excessive carbon deposit.

The cylinder was removed but no great quantity of carbon was found, either on the head of the piston or in the head of the cylinder, but the cylinder and piston were both found to be badly scored. The carbon deposit was removed from the piston and cylinder head, and both both the cylinder and piston were dressed up somewhat with file and emery-cloth.

The cylinder was replaced, and the next day two tests were run on the engine, one at 3.68 horse-power, the other at 4.96 horse-power, a slight knocking being evident during the former test, and a rather severe knocking during the latter. During the latter test, a good deal of lubricating oil was supplied to the cylinder.

It should be here noted that this engine was not a stock engine from the Novo Engine Co. The castings were furnished by them but the machining, assembling, and erecting were done by students in the machine-shop of the Michigan Agricultural College, the engine being completed in March, 1913.

Prior to these tests, Messrs. C.L. Bauer and L.W. Dunn had run a series of tests on this engine with kerosene carburetors, and the carbon deposit found was probably due, in large measure,to the use of kerosene as fuel.

The 12 H.P.,Model L.C., New-Way engine, previously referred to, is a horizontal twin-cylinder engine, in other respects being similar to the horizontal single-cylinder, 6H.P.,Model H.C.,which replaced it.

The former engine gave a great deal of trouble in start-

ing. On two occasions, it was belted to an electric motor, and after being run for a short time in this manner, it started to fire. Later on, the difficulty was experienced in starting the engine on different occasions, and at no time did it develope anywhere near its rated horse-power for any length of time.

The engine was originally equipped with a two-inch exhaust pipe. This pipe had a rise of seven feet and led out through a window to exhaust into the outside air. The horizontal lengths of pipe were about ten feet for the H.H. cylinder and eighteen feet for the L.H. cylinder. Mufflers were attached to the outer ends of these pipes. There were also two elbows in each of the pipes.

A representative of the Gas-Engine Motor Co. expressed the opinion that the inability of the engine to pull its rated power was probably due, at least in large measure, to the effect of this exhaust piping. The automatic intake valves fluttered badly.

This two-inch pipe was accordingly replaced by four-inch but not much improvement was manifested in the performance of the engine.

This engine is equipped with an auxilliary exhaust manifold on each cylinder. The main exhausts on the two cylinders were then disconnected from the exhaust pipes leading to the outside air. This split the exhaust, allowing the main exhaust to come into the air of the laboratory. Under these conditions, two tests were run, for records of which, see blue-print log sheets Nos. 13 and 14.

Two days later, Mr. J.H. Bailey, engineer for the Gas-

ay Motor Co., visited the laboratory, and after observing the behavior of the engine both under the test conditions of exhaust, and also with the engine exhausting as originally designed to, that is, with with mufflers connected to a very short two-inch pipe, gave the opinion that there was faulty compression in the L.H. cylinder and that it was not developing anywhere near the power it should.

Mr. Bailey advised the substitution of another engine from the factory. In a conference of Prof. J.L. Nelson of the Department of Mechanical Engineering, Michigan Agricultural College, Mr. Tombleson of the Dow- ay Motor Co., and the writer, it was decided, as preferable, to use a 6 H.P., Ideal M.L. engine, rather than a 12 H.P. Ideal M.L. Such an engine was accordingly secured from the factory.

In running the tests on this latter engine, a peculiarity was noticed in the variation of the speed at different loads. The idle speed was observed as 436 R.P.M. and at half load 42[illegible] R.P.M. In the three- quarter load test however, the speed was determined as 433 R.P.M. The idle speed was taken and found to be 443 R.P.M., and in the full load test, the average speed observed was 433 R.P.M. After the completion of this last test, the idle speed was again taken and found to be 443 R.P.M. The same brake loads in pounds were then imposed as in tests Nos. 1 and 2 and the revolutions for two-minute periods observed to be 435 [illegible] and 87[illegible] respectively, giving 442 and 435 R.P.M. respectively.

This increase in speed was probably due to the governor weights acting more freely. This engine was fresh from the

shipping room of the factory and the governor weights had very likely been somewhat stuck up with paint.

These latter values were used in plotting the speed variations curve for this engine.

[illegible] of Engine

The Bates and Edmonds engine was probably handicapped to a certain extent by the fact that it exhausted through a 1-1/2" pipe about 22 feet long with two elbows in the pipe and a muffler on the end. The intake valve fluttered very noticeably under light loads.

The Novo engine exhausted through a straight 1-1/2" pipe about 7 feet long.

On the New-Way engine, a muffler was connected to a 2" nipple about 5" long, the muffler being about 6' from the main exhaust and about a foot from the auxiliary exhaust. This is the regular exhaust equipment for this engine.

[illegible] of Prony Brake and Friction

The same brake was used on all three engines. The same wheel was used on the Novo and the New-Way engines, while another was used on the Bates and Edmonds.

The diameter of the rope is 7/8".

The circumference of the wheel used on the Bates and Edmonds is 43-1/4", while the circumference of the one used on the Novo and the New-Way is 47-1/2".

$7/8\ \pi = 2.75$

$43.25 + 2.75 = 46.$

$47.5 + 2.75 = 50.25$

The B.H.P. constant for the Bates and Edmonds engine is:-

$$\frac{46.[illegible]}{12 \times 33,000} = \frac{46.[illegible]}{396,000} = .[illegible]116$$

The B.H.P. constant for the Novo and the New-Way engines is:-

$$\frac{56.25}{12 \times 33,000} = \frac{56.25}{396,000} = .[illegible]136$$

[illegible]

The compression space was determined, in the case of the Bates and Edmonds and the New-Way, by means of filling with water.

Two receptacles, "A" and "B" were used. The temperature of the water was observed, and the receptacles each weighed with water in them. With the engine on outer, or firing, dead center, water was poured into the cylinder until the space was filled, the time occupied in filling being recorded. Water was then poured in from "B" so that at the end of one minute the level of the water was the same as at the end of the filling.

The receptacles were again weighed with the water that remained in them. One half the weight of the water poured from "B" multiplied by the time, in minutes, occupied in filling the space was subtracted from the weight of the water poured from "A" as a correction for leakage.

Data and results:-

Engine		Bates and Edmonds	Now-Way
Temp. of Water-°F		61°	67°
Wt. "[illegible]"-Lbs.	Before	5.04	5.[illegible]
	After	3.82	[illegible].62
Diff.- Lbs.		1.22	4.4[illegible]
Wt. "[illegible]'"-Lbs.	Before	1.32	1.[illegible]4
	After	1.00	1.[illegible]
Diff.-Lbs		0.32	[illegible].[illegible]6
Time of filling		1 min.-2[illegible] sec.	4 min.-1[illegible] sec.
Correction-Lbs.		0.01	0.12
Corrected Wt.-Lbs		1.21	4.0[illegible]
Clearance Volume-cu. in.		33.[illegible]	11[illegible].[illegible]1

The clearance volume in the Novo cylinder was determined by Messrs. Bauer and Dunn, who arrived at a value of 53.91 cu. in.

The following table shows the compression ratios of the three engines.

Engine	Clearance Volume-cu.in.	Piston Displ.cu.in.	Compression Ratio
Bates and Edmonds	33.[illegible]	130.67	4.9[illegible]
Novo	53.91	155.8[illegible]	3.89
Now-Way	119.21	226.19	2.[illegible]

[illegible]

A composite sample of the gasoline used in the tests was collected, and three determinations of the specific gravity

were made by means of Mohr's hydrostatic balance.

The following values were obtained:-

(a) 0.730[illegible] at 32° C.

(b) 0.73[illegible] at 31-1/2° C.

(c) 0.730[illegible] at 33° C.

Probably it is a fairly close approximation to assume the highest and the lower heating values of this fuel as 21,[illegible] and 19,[illegible] B.T.U. per pound, respectively.

This higher value is the one used later in the calculation of thermal efficiency.

[illegible] of Trials

For the purpose of plotting speed variation curves, the following determinations of speed were made, besides those recorded on the log. sheets.

Mile speed in R.P.M.

Dates and Seconds	Nov.	Nov-Dec
416		
418		
420	430	
420	430	443
422	439	448
Average or Accepted Value 422	439	448

Net Brake Load-lbs.	Quarter-and Half-load speeds of Test- ev * Revs. in 2 minutes	A.H.P.	B.H.P.
27	885	462	1.58
57	87[illegible]	435	3.12

(* See page 6)

The following reports are patterned, as far as possible, after the A.S.M.E. gas and oil engine code of 1912, short form.

I.

(1) Test of Gates and Edmonds engine, located at Michigan Agricultural College, to determine fuel consumption, conducted by H.D. Gridley.

(2) Type and class of engine and number of cycles--stationary-gasoline--4 cycle.

(3) Dimensions:-

(a) Single or double acting----------single acting.

(b) Diameter of cylinder----------5-1/2"

(c) Stroke of piston----------.458 feet.

(d) Compression space or clearance-----33.7 per cent.

(4) Rated capacity----------4 H.P.

(5) Date----------6-7 and 8-9,1913.

	(a)	(b)	(c)	(d)	
(6) Duration-----	1.[illegible]	[illegible].75	[illegible].75	[illegible].75	hours.

(7) Kind of oil----------Gasoline

(8) Physical properties of oil---------- specific gravity .7

	(a)	(b)	(c)	(d)	
(9) Barometric pressure----	[illegible]	29.37	[illegible]	[illegible]	inches Hg.
(10) Gasoline consumed------	[illegible]	[illegible]	2.56	2.76	pounds.

(11) Calorific value of fuel per lb. (higher value) assumed [illegible] B.T.U.

	(a)	(b)	(c)	(d)	
(12) Gasoline consumed per hour---	[illegible]	3.13	[illegible]	[illegible]	lbs.
(13) Revolutions per minute--------	[illegible]	[illegible]	[illegible]	301	
(14) Brake horse-power------------	1.14	[illegible]	3.36	[illegible]	
(15) Pounds of gasoline consumed per brake horse-power per hour-----	[illegible]	1.07	[illegible]	[illegible]	lbs.
(16) Heat units consumed per per brake horse-power per hour-----	[illegible]	27,9[illegible]	[illegible]	17,2[illegible]	B.t.u.
(17) Thermal efficiency, based on brake horse-power and higher calorific value of fuel----------	4.2	9.2	12.7	[illegible]	per cent

II

(1) Test of Novo engine, located at Michigan Agricultural College, to determine fuel consumption-- conducted by H.B. Gridley.

(2) Type and class of engine and number of cycles--- stationary, gasoline, 4 cycle.

(3) Dimensions:-

(a) Single or double acting----------single acting.

(b) Diameter of cylinder----------5-1/4"

(c) Stroke of piston----------6.5 inches

(d) Compression space or clearance----------34.6 per cent

(4) Rated capacity----------6 H.P.

(5) Rate----------6-10 and 6-11, 1.13

(6) Duration---------- 1.[illegible] (a) (b) 0.75 (c) 0.75 (d) 0.75 hour

(7) Kind of oil----------Gasoline

(8) Physical properties of oil----------Sp. Gr. 0.730

(9) Barometric pressures--[illegible] (a) (b) 29.57 (c) [illegible] (d) 29.57 inches Hg.

(10) Gasoline consumed-----1.63 (a) 3.12 (b) 3.97 (c) 5.93 (d) lbs.

(11) Calorific value of fuel per lb.(higher value)assumed 21,5[illegible] B.t.u.

(12) Gasoline consumed per hour---1.63 (a) 3.09 (b) 3.96 (c) 5.87 (d)

(13) Revolutions per minute-------481 (a) 468 (b) 436 (c) 490 (d)

(14) Brake horse-power----------1.93 (a) 3.51 (b) 3.68 (c) 4.96 (d) H.P.

(15) Pounds of gasoline consumed per brake horse-power per hour----1.37 (a) 1.67 (b) 1.[illegible] (c) 1.[illegible]6 (d) lbs.

(16) Heat units consumed per brake horse-power per hour---------20,4[illegible] (a) 21,7 (b) 21,9 (c) 21,[illegible] (d) B.t.u.

(17) Thermal efficiency, based on brake horse-power and higher calorific value of fuel----------9.6 (a) 11.7 (b) 11.6 (c) 11.8 (d) per ct.

III

(1) Test of New- ay engine, located at Michigan Agricultural College, to determine fuel consumption---- conducted by H.T. Gridley.

(2) Type and class of motor and number of cycles----- stationary, gasoline, 4 cycle

(3) Dimensions:-

(a) Single or double acting----------single acting

(b) Diameter of cylinder----------6"

(c) Stroke of piston----------0.667 feet

(d) Compression space or clearance------33.7 per cent

(4) Rated capacity----------6 H.P.

(5) Date----------6-19, 1913

	(a)	(b)	(c)	(d)	
(6) Duration----------	1.	1.75	1.75	1.75	hour

(7) Kind of oil----------Gasoline

(8) Physical properties of oil----------Sp.G. .739

	(a)	(b)	(c)	(d)	
(9) Barometric pressure--	30.[illegible]	30.03	29.92	29.83	inches Hg.
(10) Gasoline consumed----	3.14	6.31	8.73	11.45	lbs.

(11) Calorific value of fuel per lb.(High value)assumed 21,3[illegible] B.T.U.

	(a)	(b)	(c)	(d)	
(12) Gasoline consumed per hour--	3. 4	3.73	4.97	5.9[illegible]	lbs.
(13) Revolutions per minute------	4[illegible]	48[illegible]	483	482	

	(a)	(b)	(c)	(d)	
(14) Brake horse-power---	1.97	3.[illegible]	4.[illegible]	6.[illegible]	H.p.
(15) Pounds of gasoline consumed per brake horse-power per hour----------	2.[illegible]7	1.34	1.[illegible]6	[illegible].95	lbs.
(16) Heat units consumed per brake horse-power per hour----------	42,[illegible]	26,[illegible]	21,[illegible]	19,[illegible]	B.t.u.
(17) Thermal efficiency based on brake horse-power and higher calorific value of fuel----	8.1	1[illegible].1	11.8	13.2	per cent

NOTE:-

The original records of these tests will be found on blue print log. sheets, Nos. 1 to 12 inclusive.

CURVES

Following the blue print log. sheets are three sets of curves, showing fuel consumption, thermal efficiency, and speed variation, all plotted against brake horse-power, for each engine. The fuel consumption and thermal efficiency curves are on sheets Nos. 1 to 3, inclusive, the speed variation curves on sheets Nos. 4 to 6, inclusive.

[illegible]

From a study of results and curves, it is seen that the greatest economy occurred at full load with all three engines. The curves show no tendency to rise as is the case with economy curves of steam engines. The gas, oil, or gasoline engine will not carry an actual overload, although if each an engine is conservatively rated it may carry an apparent overload. It should be borne in mind that a reciprocating steam engine is usually rated at its most economical performance and that it is at greater loads that the economy curve rises.

The Bates and Edmonds engine gave the greatest economy, at full load and also the least economy at quarter-load, of any of the three engines. It is probable however that the fuel consumption of this engine at quarter-and half-loads would have been materially less if the conditions of exhaust had been as favorable as in the cases of the other two engines.

The results on the Nove engine are peculiar in that the fuel consumption per brake horse-power per hour was practically the same at half, three-quarter, and full loads.

The average fuel consumption per brake horse-power per hour for the range of loads covered in these tests was least in the in the case of the Nove engine and greatest in the case of the Bates and Edmonds, with the New-ley about midway between.

It is a striking point, however, that the curves show practically the same identical fuel consumption per brake horse-power per hour for all three engines at three-quarters of their respective rated capacities.

Probably the most extensive series of fuel consumption tests

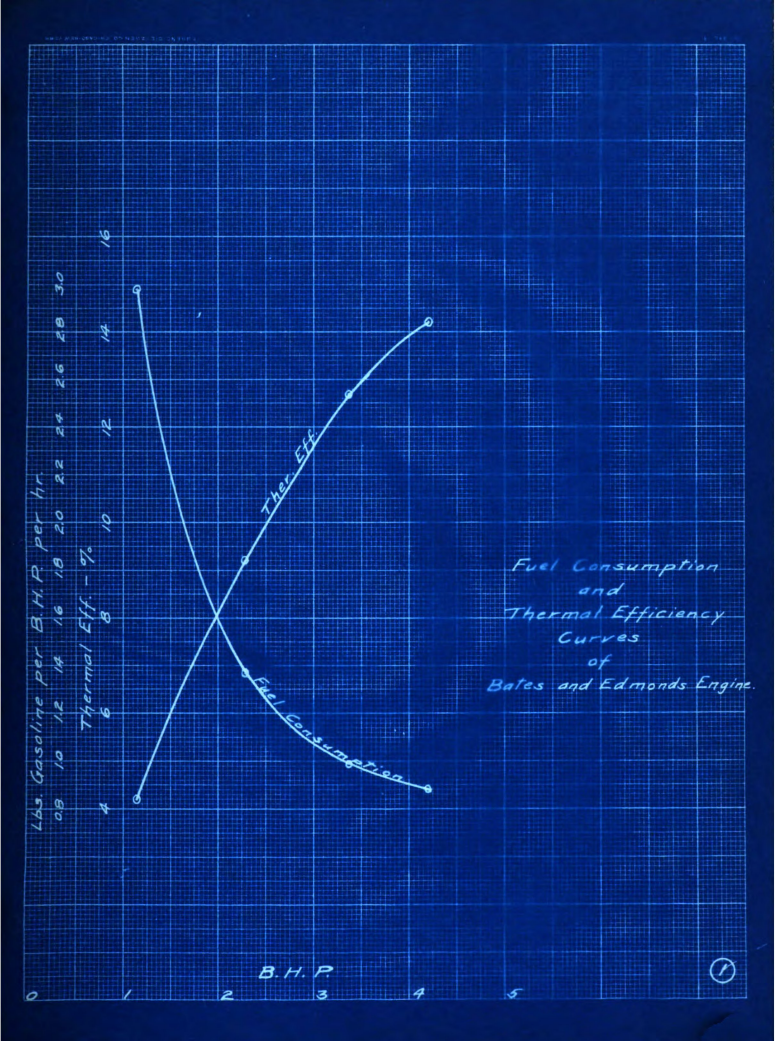
performed in recent years was conducted by the United States Geological Survey. The report of these tests is set forth in Bulletin 43 of the Bureau of Mines, entitled "Comparative Fuel Values of Gasoline and Denatured Alcohol in Internal combustion Engines".

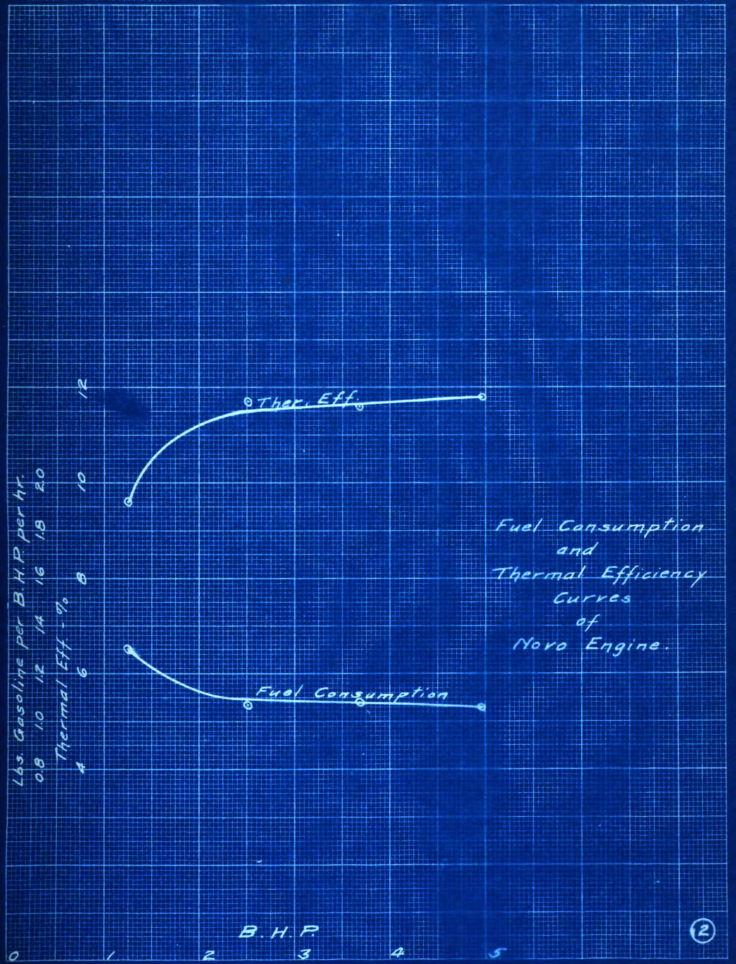
In these tests, fuel consumption as low as, and a trifle under, .6 pounds of gasoline per brake horse-power hour were obtained. It is worthy of note that in a series of tests of brake fuel economy versus load, on a 15 H.P. Otto engine, the greatest economy was found at a load between three-quarters and full rated capacity.

[illegible]

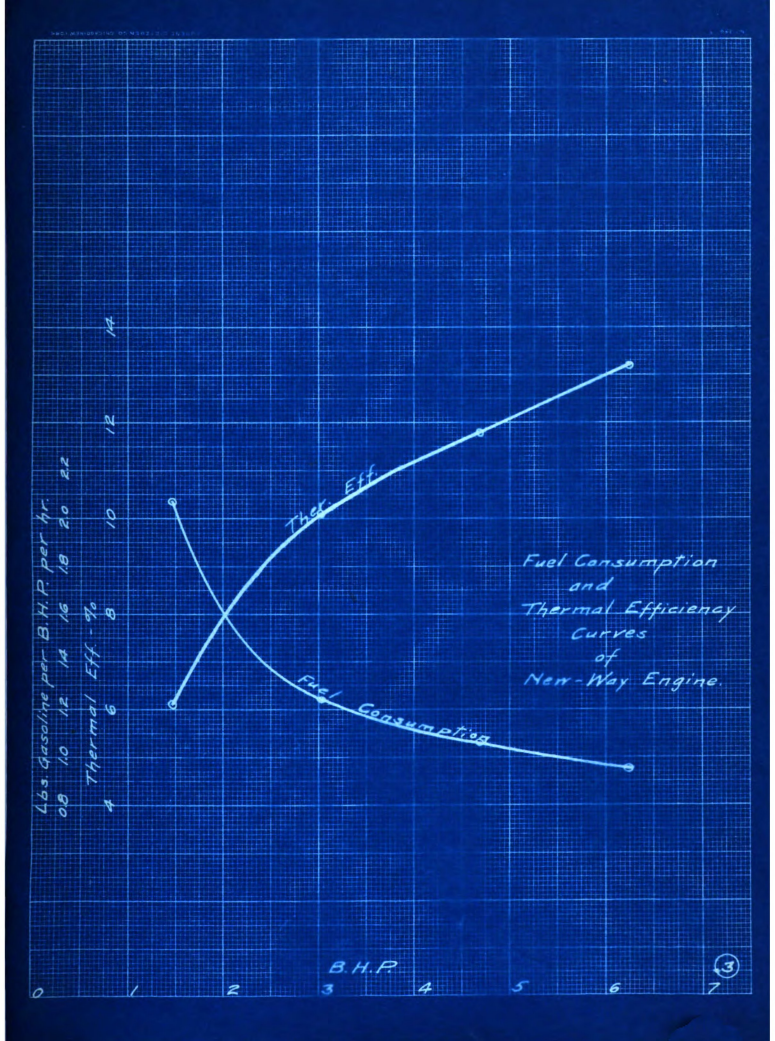
The speed variation curves are seen to be straight lines, except in the case of the Bates and Edwards engine. This latter curve shows a marked deviation from a straight line.

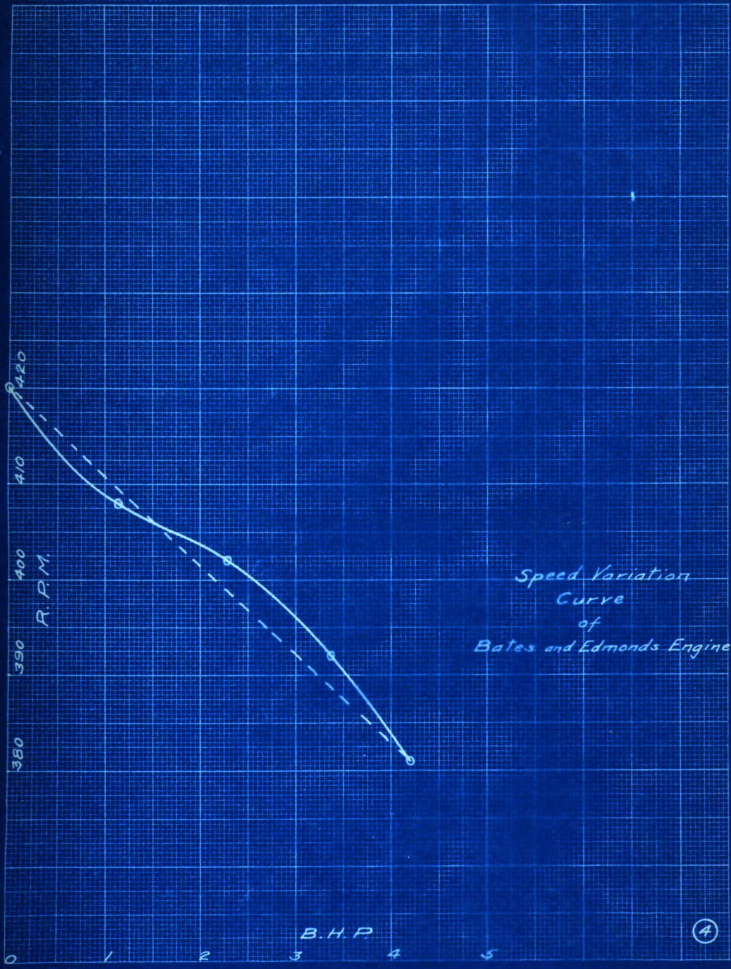
The drop in speed from no load to full load was about 6, 7, and 9 per cent, in terms of the no-load speed, with the New-Way, Novo, and Bates and Edwards engines respectively.


Lbs. Gasoline per B.H.P. per hr.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Thermal Eff. - %
4 6 8 10 12 14 16
Ther. Eff.
Fuel Consumption
B.H.P.
0 1 2 3 4 5
Fuel Consumption and Thermal Efficiency Curves of Bates and Edmonds Engine.
1

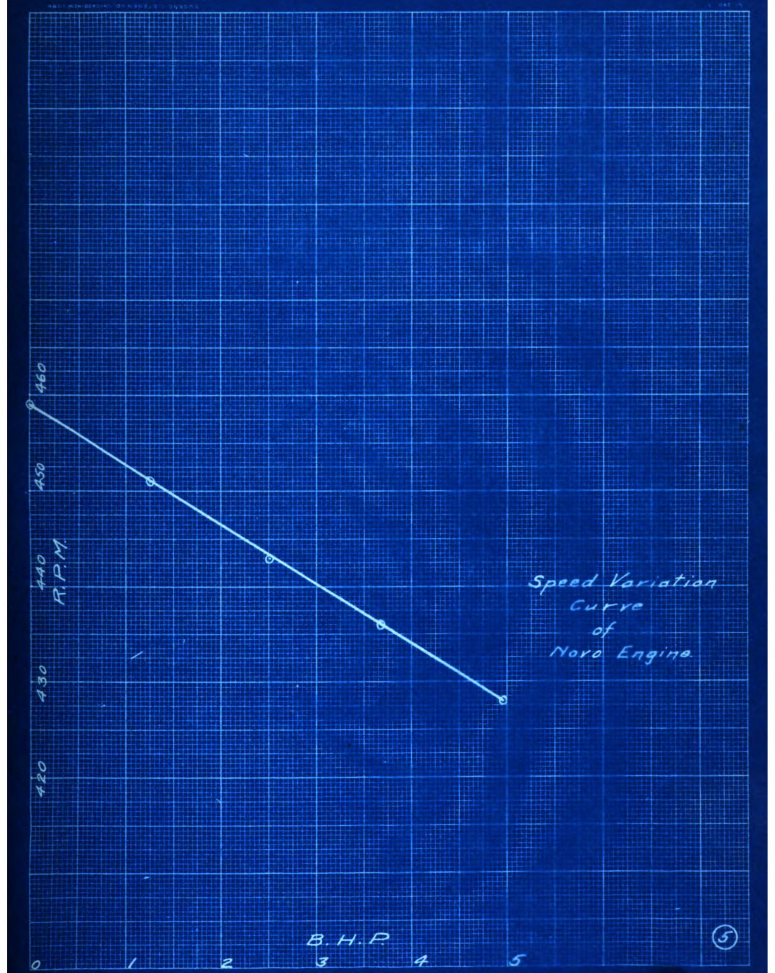


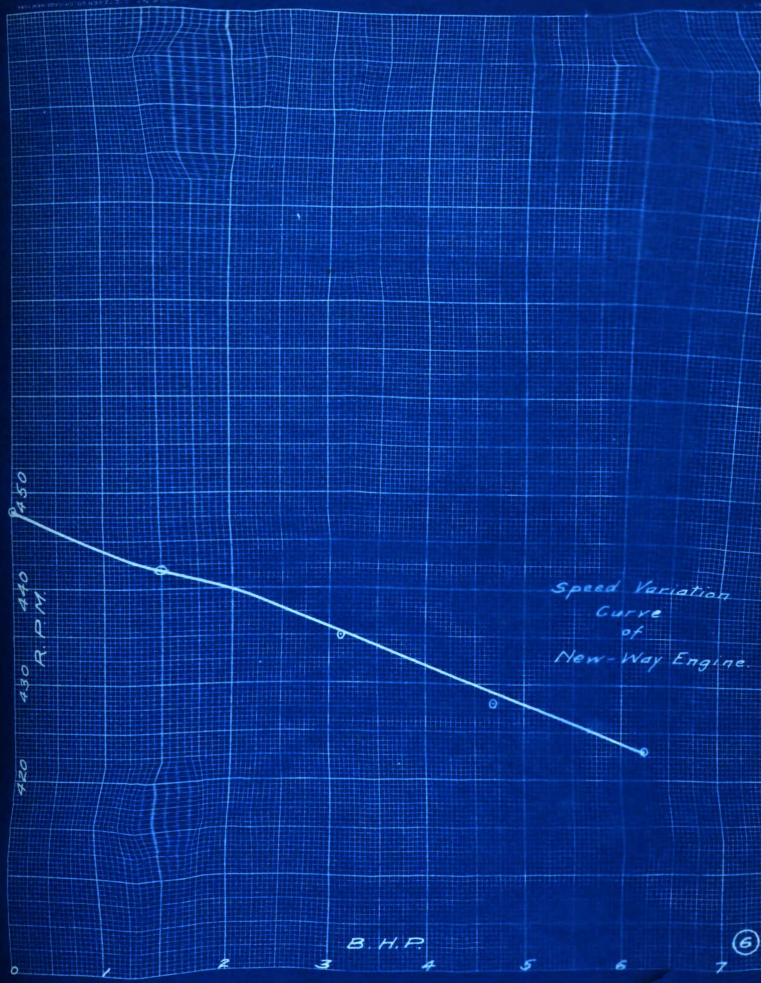
Fuel Consumption
and
Thermal Efficiency
Curves
of
Novo Engine.


Fuel Consumption and Thermal Efficiency Curves of New-Way Engine.
Ther. Eff.
Fuel Consumption
B.H.P
0
1
2
3
4
5
6
7
Thermal Eff. - %
8
10
12
14
Lbs. Gasoline per B.H.P. per hr.
.08
.10
.12
.14
.16
.18
.20
.22



Speed Variation
Curve
of
Bates and Edmonds Engine


460
450
440
430
420
R.P.M.
Speed Variation
Curve
of
Novo Engine
B.H.P.
0
1
2
3
4
5


Speed Variation
Curve
of
New-Way Engine.
420
430
440
450
R.P.M.
0
1
2
3
4
5
6
7
B.H.P.

Form M. E 07-1—0750

SHEET NO. 1

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF BATES AND EDMONDS

TEST #1

OBSERVERS — IN CHARGE: N.B. Gridley; ASSISTANTS: Tornbloom

DATE 6-7 191

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. Fill Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per hr. Lbs.	Wt. Gaso. per B.H.P. per hr. Lbs.
9:25	1	85	61	24		.000116	14.05				
9:26	2				409						
9:31	3				404						
9:36	4				408						
9:41	5				408						
9:46	6				410						
9:51	7				405						
9:56	8				409						
10:01	9				410						
10:06	10				406						
10:11	11				407						
10:16	12				409						
10:21	13				409						
10:25	14						10.65				
	15								3.40		
	16				Ave.					340	
	17				408		1.14				2.98
	18										
	19										
	20										

Barometer 29.26

Remarks:

Spark 15° +

Exhaust Valve { Opens 19° + / Closes 4° −

Form M. E 07-1—6/20

SHEET NO. 2

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF BATES AND EDMONDS TEST #2.

OBSERVERS — IN CHARGE: N.B. Gridley — ASSISTANTS: Tornbloom

DATE 6-7 19[illegible]

Time	No.	Scale Load Lbs. Wt. Brake	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
10:45	1	110 61	49		.000116		13.95			
10:47	2			402						
10:52	3			402						
10:57	4			403						
11:02	5			402						
11:07	6			401						
11:12	7			402						
11:17	8			402						
11:22	9			401						
11:27	10			400						
11:30	11						11.60			
	12							2.35		
	13			Ave.					3.13	
	14			402		2.28				1.37
	15									
	16									
	17									
	18									
	19									
	20									

Barometer 29.27

Remarks:

Spark 15°+

Exhaust Valve { Opens 19°+ / Closes 4°−

Form M. E 07-1—07899

SHEET NO. 3

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF BATES AND EDMONDS

TEST #3.

OBSERVERS — IN CHARGE: N.B. Gridley — ASSISTANTS: Colby

DATE 6 - 7 19 1

Time	No.	Scale Load Lbs. Wt. Brake	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. Pail + Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
8:52	1	135 61	74		.000116		10.00			
8:53	2			392						
8:58	3			388						
9:03	4			390						
9:08	5			392						
9:13	6			395						
9:18	7			392						
9:23	8			395						
9:28	9			393						
9:33	10			395						
9:37	11						7.50			
	12							2.50		
	13			Ave.					3.33	
	14			392		336				0.99
	15									
	16									
	17									
	18									
	19									
	20									

Barometer 29.36

Remarks:

Spark 15°+

Exhaust Valve { Opens 19°+ / Closes 4°-

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF BATES AND EDMONDS

TEST #4.

OBSERVERS — IN CHARGE: A. B. Gridley — ASSISTANTS: Tornbloom

DATE 6-9 19/

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. Pail Lbs.	Wt. Gaso. Used - Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P per Hr. Lbs.
2:50	1	156	61	95		.000116		11.37			
2:51	2				380						
2:56	3				375						
3:01	4				382						
3:06	5				382						
3:11	6				382						
3:16	7				382						
3:21	8				381						
3:26	9				382						
3:31	10				382						
3:35	11							8.61			
	12								2.76		
	13				Ave.					3.68	
	14				381		4.20				0.88
	15										
	16										
	17										
	18										
	19										
	20										

Remarks: Barometer 29.56

Engine cuts out about every 20 or 30 explosions

Spark 15°

Exhaust Valve { Opens 19°
Closes 4°

Form M. E 974—97881

SHEET NO. 5

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF Novo

TEST #1

	IN CHARGE	ASSISTANTS
OBSERVERS	N. B. Gridley	Tornbloom

DATE 6-10 19

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B. H. P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per hr. Lbs.	Wt. Gaso. per B.H.P. per hr. Lbs.
1:15	1	80	58	22		.000126		15.50			
1:16	2				450						
1:21	3				454						
1:26	4				451						
1:31	5				449						
1:36	6				452						
1:41	7				451						
1:45	8							14.70			
1:46	9				451						
1:51	10				451						
1:56	11				451						
2:01	12				451						
2:06	13				450						
2:11	14				452						
2:15	15							13.87			
	16								1.63		
	17				Ave.					1.63	
	18				451		1.25				1.30
	19										
	20										

Barometer 29.58

Fired 67 times per min.

Remarks:

Spark 15°+

Exhaust Valve { Opens 37°+ / Closes 7°−

$\frac{67}{\frac{451}{2}} = 0.30$

Form M. E. 7-1-

SHEET NO. 6

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE.

RUNNING LOG OF Novo

TEST #2.

IN CHARGE ASSISTANTS

OBSERVERS M. B. Gridley / Tornbloom

DATE 6-10 19

Time	No.	Scale Load Lbs.	Wt. Brake Lbs	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
2:30	1	103	58	45		.000126		13.46			
2:31	2				444						
2:36	3				444						
2:41	4				443						
2:46	5				441						
2:50	6							12.56			
2:51	7				444						
2:56	8				443						
3:01	9				445						
3:06	10				445						
3:11	11				442						
3:15	12							11.44			
	13								2.02		
	14									2.69	
	15				Ave. 443		2.51				1.07
	16										
	17										
	18										
	19										
	20										

Remarks:

Barometer 29.57

Spark 15°+

Exhaust Valve { Opens 37°+ / Closes 7°-

Fired 113 times per min.

$\frac{113}{\frac{443}{2}} = 0.51$

Slight knocking

Form M. E.07-1-97859

SHEET NO. 7

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF Noro

TEST #3

OBSERVERS — IN CHARGE: N. B. Gridley — ASSISTANTS: Tornbloom

DATE 6-1-19

Time	No.	Scale Load Lbs. Wt. Brake	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per hr. Lbs.	Wt. Gaso. per B.H.P per Hr. Lbs.
2:05	1	125	58	67	.000126		11.97			
2:06	2			436						
2:11	3			437						
2:16	4			430						
2:21	5			435						
2:25	6						10.59			
2:26	7			438						
2:31	8			435						
2:36	9			440						
2:41	10			438						
2:46	11			438						
2:50	12						9.00			
	13							2.97		
	14			Ave.					3.96	
	15			436		3.68				1.08
	16									
	17									
	18									
	19									
	20									

Barometer 29.38

150 Explosions per m

$\frac{150}{218} = 0.69$

Remarks:

Spark 43° +

Exhaust Valve practically the same as in tests #2 and #1

Slight knocking

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF Nov 6

TEST #4

IN CHARGE: N. B. Gridley

ASSISTANTS: Tornbloom

OBSERVERS:

DATE 6-11 19

Time	No.	Scale Load Lbs. Wt. Brake	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
2:55	1	150 58	92	.000126			8.55			
2:56	2			428						
3:01	3			428						
3:06	4			426			←			← 1.57
3:11	5			427						Gaso. 20
3:15	6						8.31			
3:16	7			426						
3:21	8			430						
3:26	9			430						
3:31	10			428						
3:36	11			432						
3:40	12						6.17			
	13							3.95		
	14			Arc.					5.27	
	15			428		4.96				1.06
	16									
	17									
	18									
	19									
	20									

Barometer 29.37

180 Explosions per min.

$\frac{180}{214} = 0.84$

Remarks:

Spark 15°

Exhaust Valve practically same as in tests #2 and #1

Rather severe knocking

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF NEW-WAY MODEL HC - ENGINE #1122

TEST #1

OBSERVERS — IN CHARGE: N.B. Gridley — ASSISTANTS: Tornbloom

DATE 6-12 1913

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. in Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
9:30	1	85	58	27		.000126		15.86			
9:31	2				432						
9:36	3				435						
9:41	4				434						
9:46	5				433						
9:51	6				432						
9:56	7				430						
10:00	8							14.30			
10:01	9				430						
10:06	10				431						
10:01	11				430						
10:16	12				431						
10:21	13				427						
10:26	14				435						
10:30	15							12.82			
	16								3.04		
	17				Ave.					3.04	
	18				432.		1.47				2.07
	19										
	20										

Barometer 29.30

92 Explosions per min.

$\frac{92}{216} = 0.43$

Remarks:

Spark 23° +

Exhaust Valve { Opens 25° + / Closes 6° −

436 R.P.M. - running idle.

Form M. E 07-1—9789

SHEET NO. 10

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF New-Way Model HC - Engine #1122
Test #2

IN CHARGE: N B Gridley
ASSISTANTS: Tornabloom

OBSERVERS:

DATE 6-12-1913

No.	Time	Scale Load Lbs. Wt. Brake	Lbs. Net Load	Lbs. R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. in Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
1	10:43	115	58	57	.000126		15.25			
2	10:46			420						
3	10:51			418						
4	10:56			420						
5	11:01			420						
6	11:05						14.05			
7	11:06			418						
8	11:11			418						
9	11:15						13.42			
10	11:16			422						
11	11:21			422						
12	11:26			420						
13	11:30						12.45			
14								2.80		
15				Ave.					3.73	
16				420		3.02				1.24
17										
18										
19										
20										

Barometer 29.28

RemarKs:

122 Explosions per min.

$\frac{122}{210} = 0.58$

Spark and Exhaust Valve
same as in Test #1

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF NEW-WAY - MODEL HC - ENGINE # 1122

TEST #3

OBSERVERS — IN CHARGE: N. B. Gridley — ASSISTANTS: Tornbloom

DATE 6-12 1913

Time	No.	Scale Load Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P per Hr. Lbs.
1:40	1	145 58	87		.000126		15.90			
1:41	2			429						
1:46	3			430						
1:51	4			425						
1:56	5			428						
2:00	6						14.25			
2:01	7			427						
2:06	8			427						
2:10	9						13.35			
2:11	10			429						
2:16	11			426						
2:21	12			428						
2:25	13						12.17			
	14							3.73		
	15								4.97	
	16			Ave.						
	17			428		4.69				1.06
	18									
	19									
	20									

Barometer 29.22

Remarks:

165 Explosions per min.

$\frac{165}{214} = 0.77$

Spark and Exhaust Valve same as in Tests #1 and #2

448 R.P.M. running idle

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF NEW-WAY - MODEL HC - ENGINE #1122

TEST #4.

OBSERVERS — IN CHARGE: N. B. Gridley — ASSISTANTS: Tornbloom

DATE 6-12 1913

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. per Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
3:15	1	175	58	117		.000126		15.50			
3:16	2				425						
3:21	3				425						
3:26	4				420						
3:33	5				425						
3:35	6							13.45			
3:40	7				420						
3:46	8				422						
3:51	9				426						
3:56	10				419						
4:00	11							11.05			
	12								4.45		
	13				Ave.					5.93	
	14				423		6.24				0.95
	15										
	16										
	17										
	18										
	19										
	20										

Barometer 29.20 202 Explosions per min.

$\frac{202}{211} = 0.96$

Remarks:

Spark and Exhaust Valve same as in Tests #1, #2 and #3.

MECHANICAL ENGINEERING LABORATORY
MICHIGAN AGRICULTURAL COLLEGE

RUNNING LOG OF New-Way ENGINE #656. MODEL LC.

TEST #1

OBSERVERS IN CHARGE N.B. Gridley ASSISTANTS Tornbloom

DATE 6-7 1913

Time	No.	Scale Load Lbs.	Wt. Brake Lbs.	Net Load Lbs.	R.P.M.	B.H.P. Constant	B.H.P.	Wt. Gaso. + Pail Lbs.	Wt. Gaso. Used Lbs.	Wt. Gaso. per Hr. Lbs.	Wt. Gaso. per B.H.P. per Hr. Lbs.
3:14	1	55	22	33		.000193		14.40			
3:15	2				455						
3:20	3				459						
3:25	4				455						
3:30	5				453						
3:35	6				454						
3:40	7				457						
3:45	8				455						
3:50	9				457						
3:55	10				456						
4:00	11				455						
4:05	12				456						
4:10	13				456						
4:14	14							9.35			
	15								5.05		
	16									5.05	
	17				Ave. 456		2.90				1.74
	18										
	19										
	20										

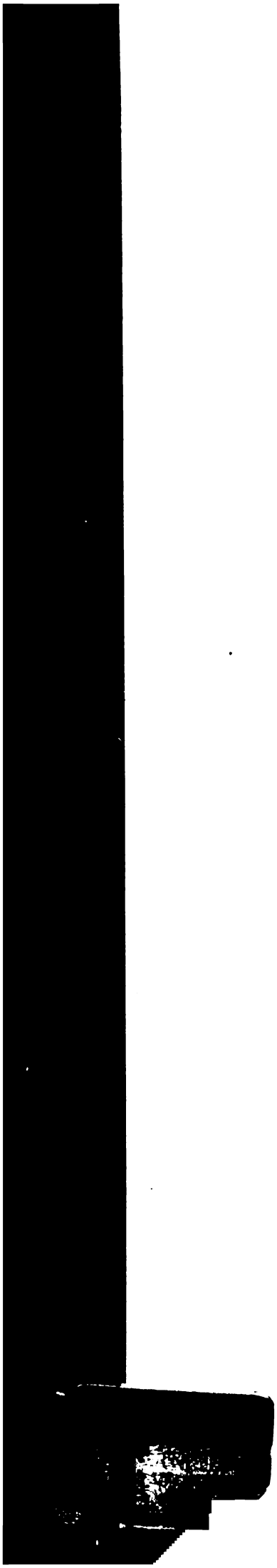
Barometer 29.29

Remarks:

Spark 30° +

Exhaust Valve { R.H. Cylinder { Opens 22° + / Closes 3° − ; L.H. Cylinder { Opens 26° + / Closes 1° + } } 26° + 1° +

ROOM USE ONLY
ROOM USE ONLY



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