STUDY OF MOTOR CYCLE ENGINE CHARACTERISTICS

BY

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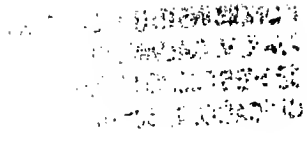
ARMOUR INSTITUTE OF TECHNOLOGY

1916



A STUDY OF MOTOR CYCLE ENGINE CHARACTERISTICS

A THESIS

PRESENTED BY

C. L. OTT
S. PIMSTEIN

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY IN

MECHANICAL ENGINEERING

MAY 25, 1916

[illegible]

LIST OF ILLUSTRATIONS.

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4. " " " " "
5. " " " " "
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7. Lining Used in Couplings.
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10. Photograph of Harley-Davidson Set Up.
11. Print Showing Complete Test of Thor Twin.
12. B.H.P., I.H.P., and F.H.P. Curves for Thor Twin.
13. Torque and B.H.P. Net Curves for Thor Twin.
13a. Valves in Thor Twin.
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TABLES.


1/2"
3/8" Drill
15 1/2"
14 1/2"
10"
3/4"
3 1/2"
3"

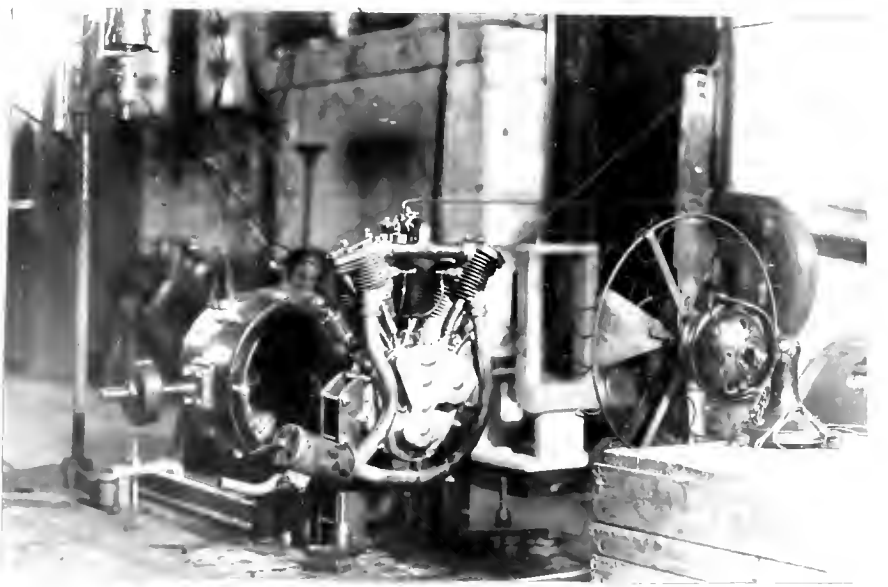


Fig. 3.

FIG. 4.

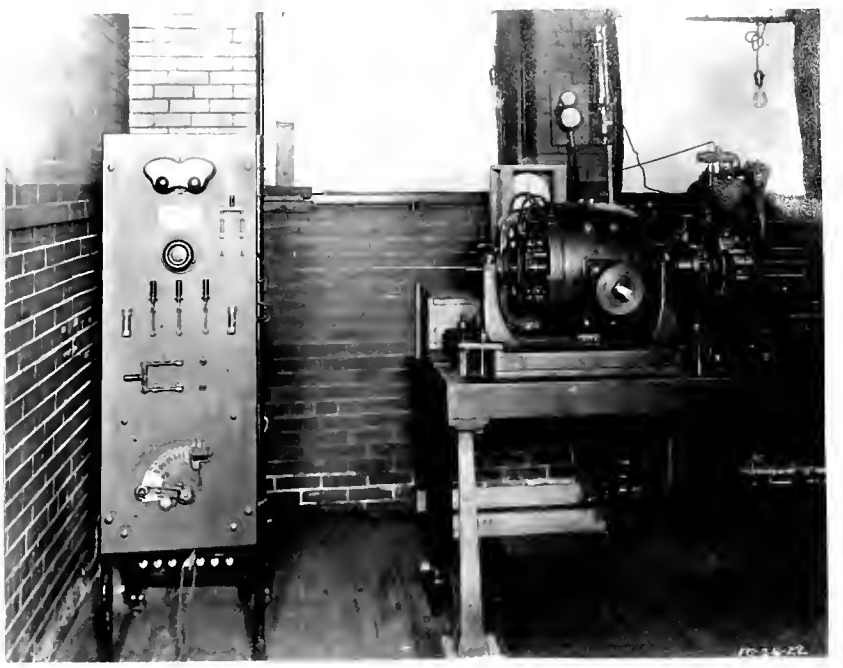
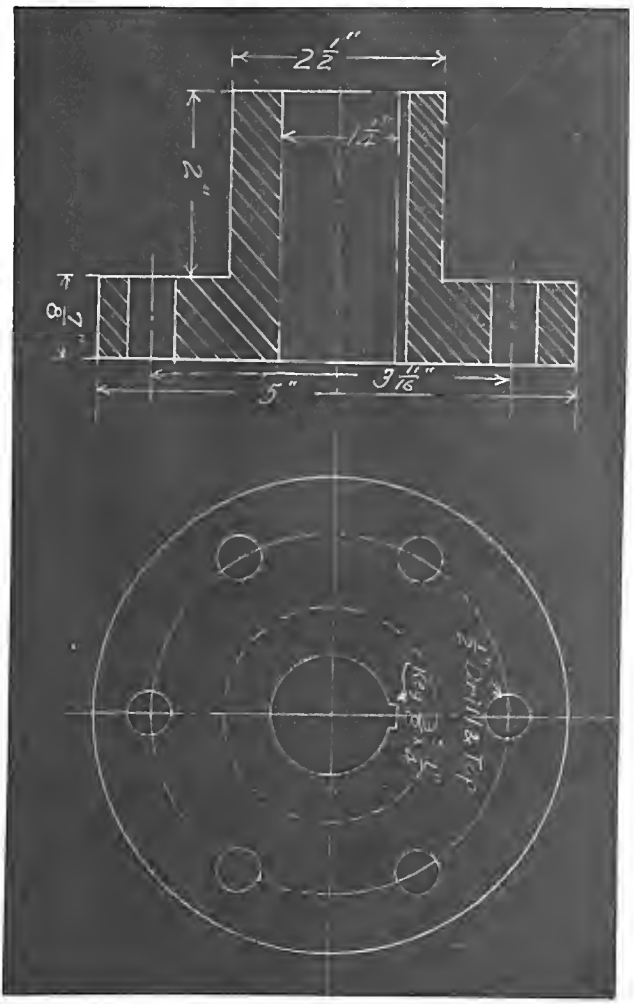


FIGURE 6.


2½"
1½"
2"
⅛"
5"
9 11/16"

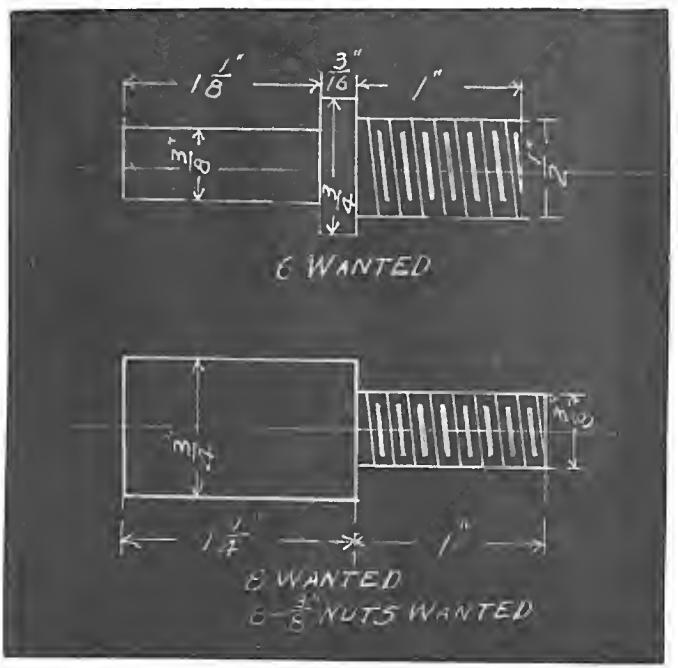
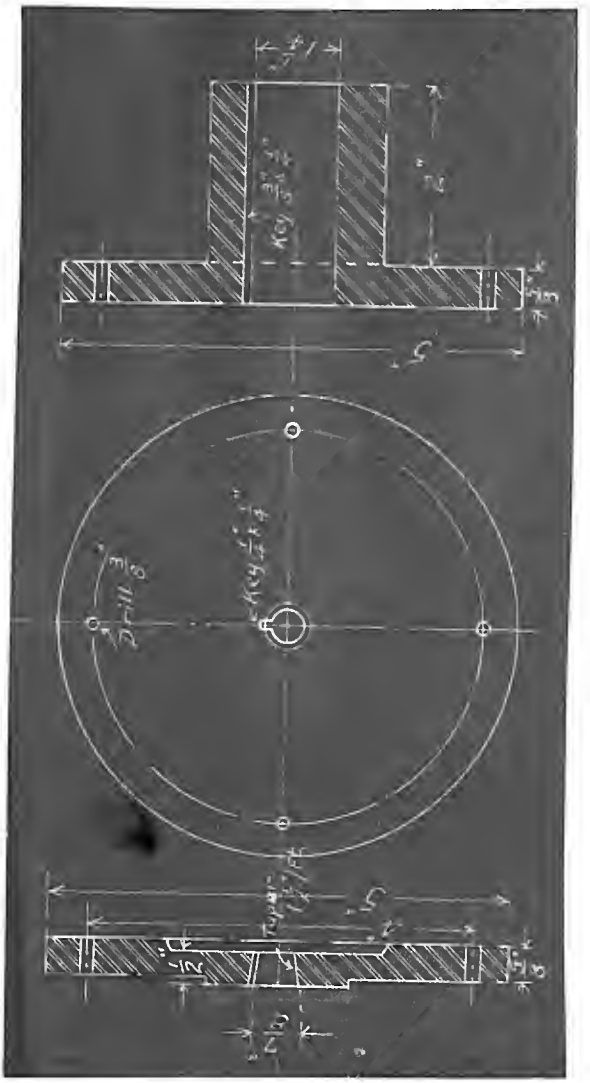
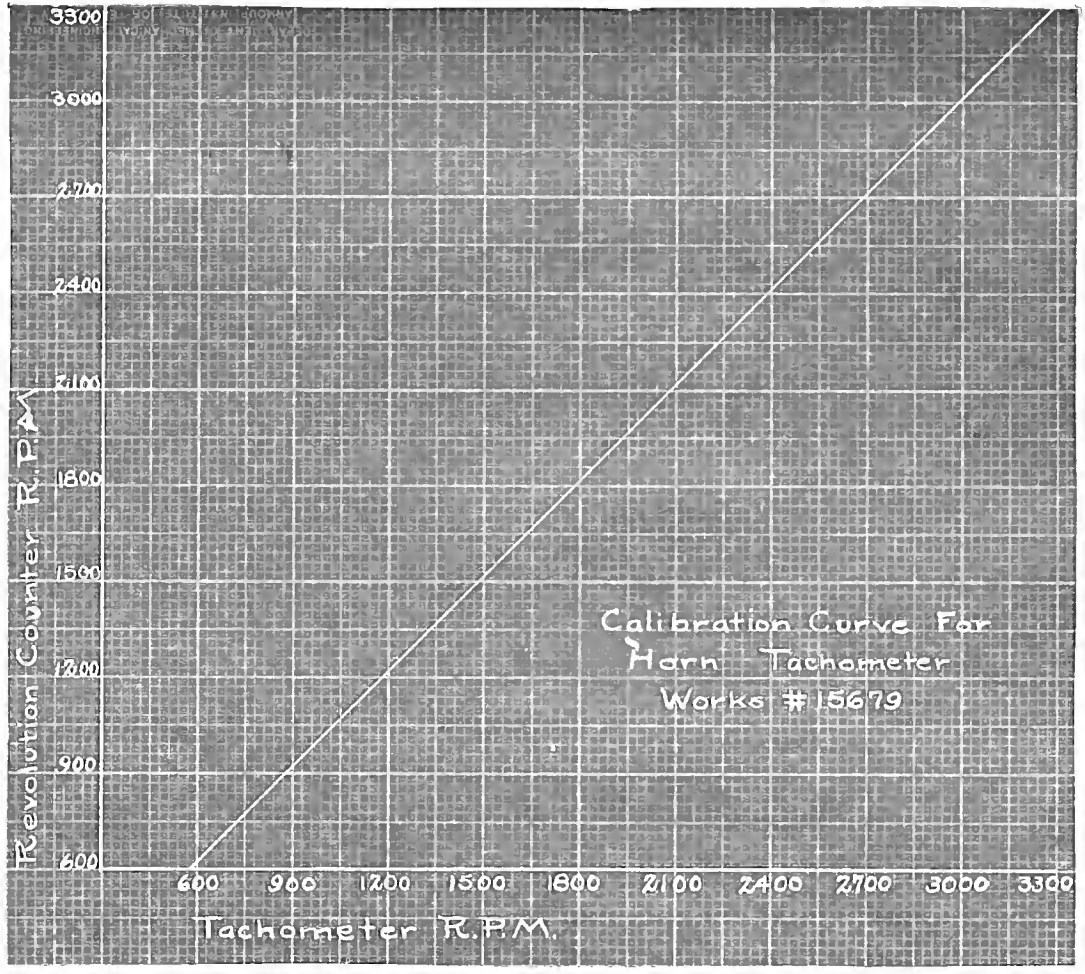


PLATE 7.




3300
3000
2700
2400
2100
1800
1500
1200
900
600
Revolution Counter R.P.M.
600
900
1200
1500
1800
2100
2400
2700
3000
3300
Tachometer R.P.M.
Calibration Curve For
Harn Tachometer
Works # 15679

1	11.5	8.50
1	11.0	7.15
1	13.5	8.54
1	10.	7.50
15	6.5	7.56
13	12.	8.75
1	7.1	8.10
17	11.1	8.71
17	7.8	8.38
1	6.4	8.01
10	8.5	8.38
2	6.5	8.50
1	7.0	8.60
21	7.0	7.55
2135	7.5	7.76
215	8.0	8.60
2	6.0	8.80
2150	7.0	8.55
2	8.0	8.00
27	6.4	10.81
23	8.2	8.47
2338	6.8	7.05
23	7.5	8.80
2352	6.8	8.10
1	8.8	10.70
2	7.0	8.55
2	8.5	11.05

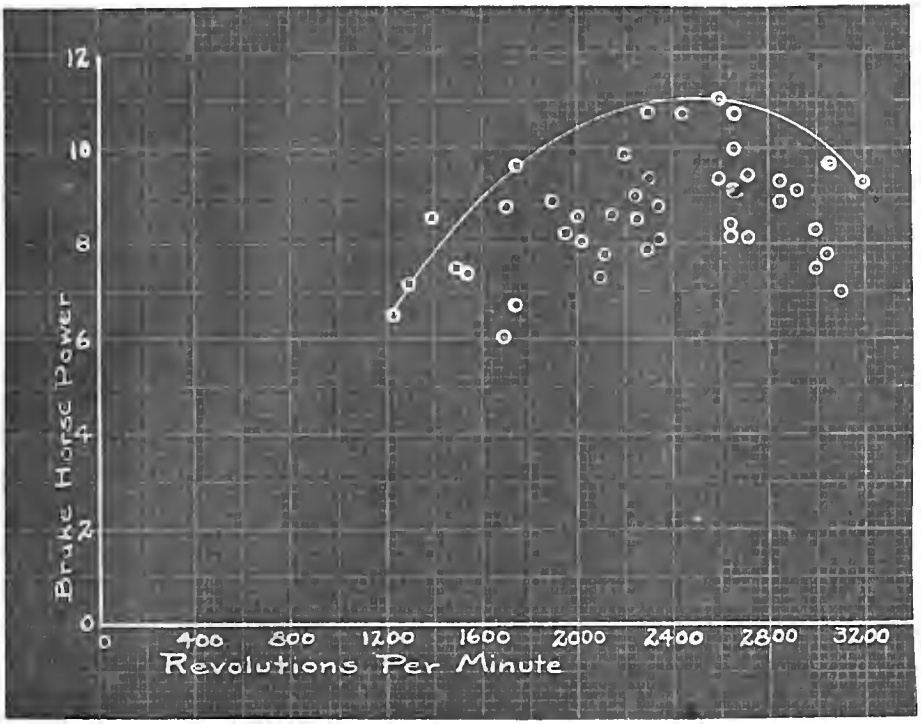
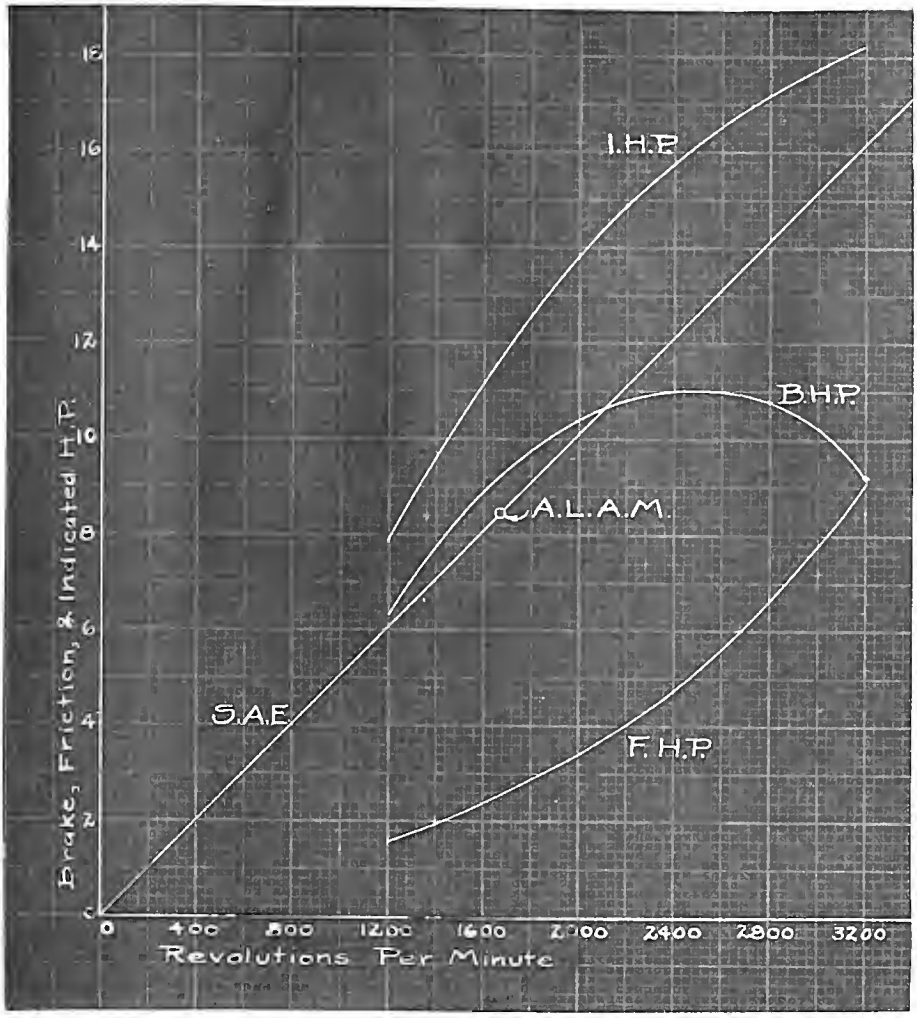

Brake Horse Power
0
2
4
6
8
10
12
0
400
800
1200
1600
2000
2400
2800
3200
Revolutions Per Minute

FIG. 11.


Brake, Friction, & Indicated H.P.
18
16
14
12
10
8
6
4
2
0
I.H.P.
B.H.P.
A.L.A.M.
S.A.E.
F.H.P.
0
400
800
1200
1600
2000
2400
2800
3200
Revolutions Per Minute

Dec Table 8).

SAMPLE CALC[illegible]:

[illegible] at [illegible] ft.

[illegible] is given by the formula

$$\text{[illegible]} = \frac{d^2 n}{2.5}$$

where d = the bore in inches.

n = the number of cylinders.

For this engine, 1000 ft. per min.

$$\text{[illegible]} = \frac{12 \times 1000}{2 \times 3.6} = 1670 \text{ r.p.m., and}$$

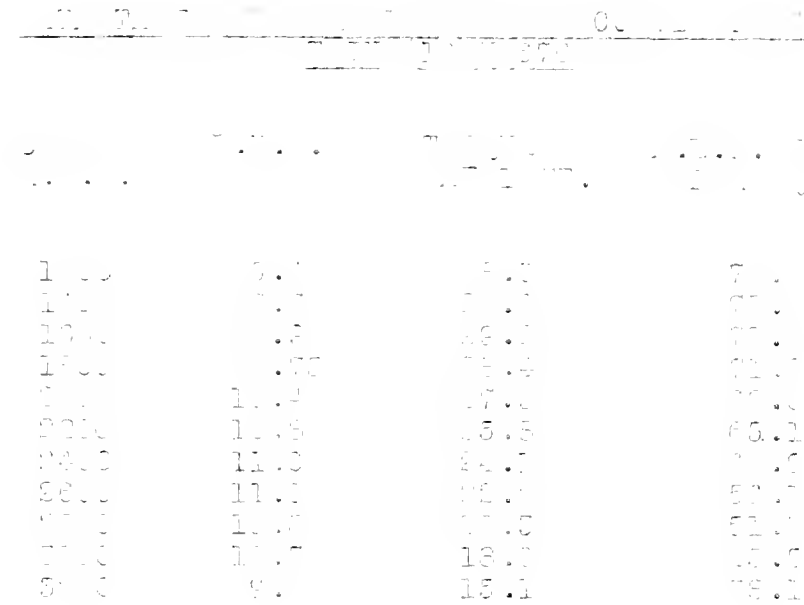
$$\text{H.P.} = \frac{(2.25)^2}{2.5} \times \frac{1}{2} = 2.02.$$

[illegible] = $\frac{\text{[illegible]}}{2,000}$.

[illegible] = 3.5 [illegible]

[illegible]

$$\text{[illegible]} = \frac{3.5 - 2.51}{2} = 1.49.$$



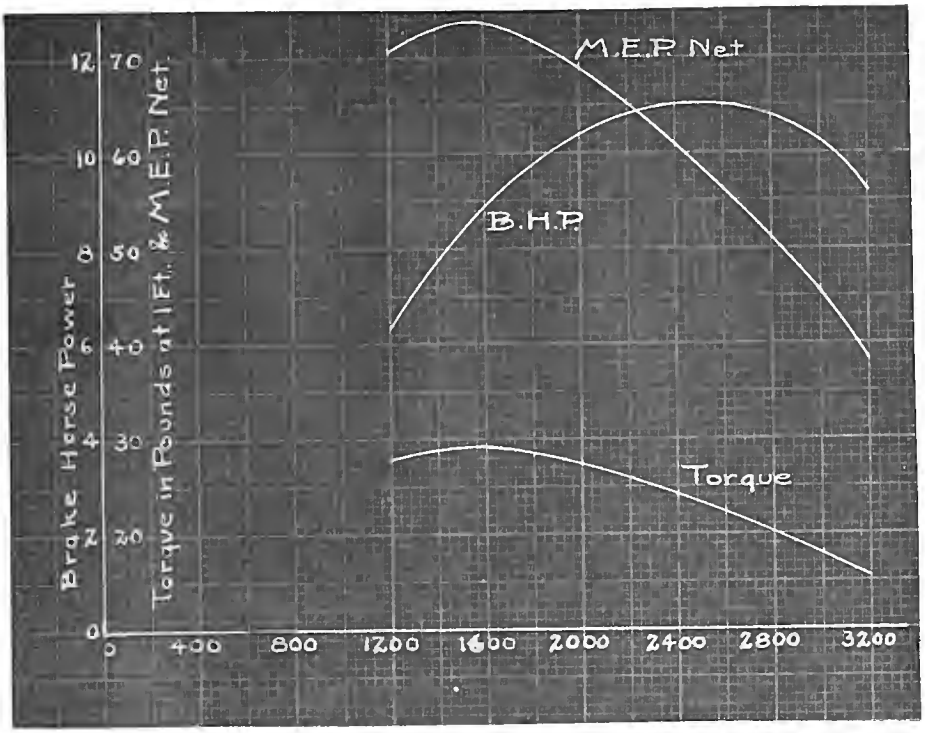

M.E.P. Net
B.H.P.
Torque
Brake Horse Power
Torque in Pounds at 1 Ft. & M.E.P. Net
0
2
4
6
8
10
12
20
30
40
50
60
70
0
400
800
1200
1600
2000
2400
2800
3200

FIG. 1.

[illegible]

[illegible] -, the [illegible] [illegible] the [illegible] [illegible] in 13 [illegible], [illegible] the [illegible] of the [illegible] lift [illegible] [illegible]. For the [illegible] [illegible] [illegible] 14.

The [illegible] [illegible] [illegible] the formula ([illegible]'s)

$$A = 3.1416(.7_7\ dh + .350\ h^2)$$

where

A = the [illegible] of the opening [illegible] sq. ins.

d = the [illegible] of the valve in [illegible].

h = the valve lift in inches.

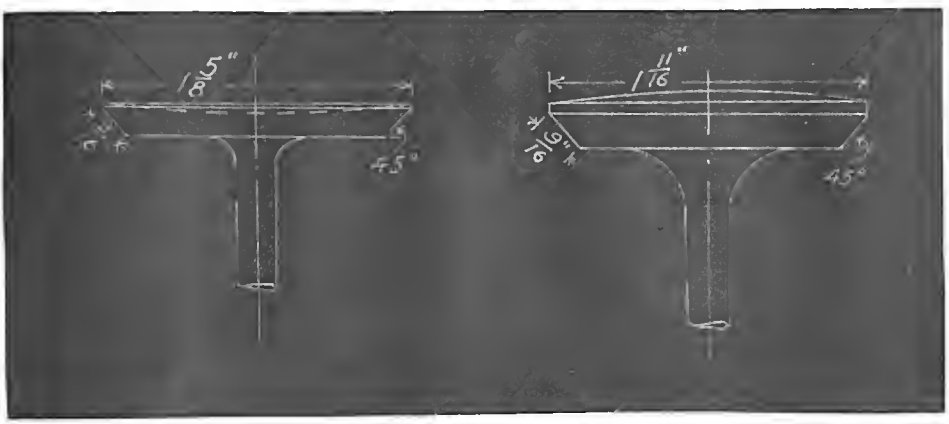
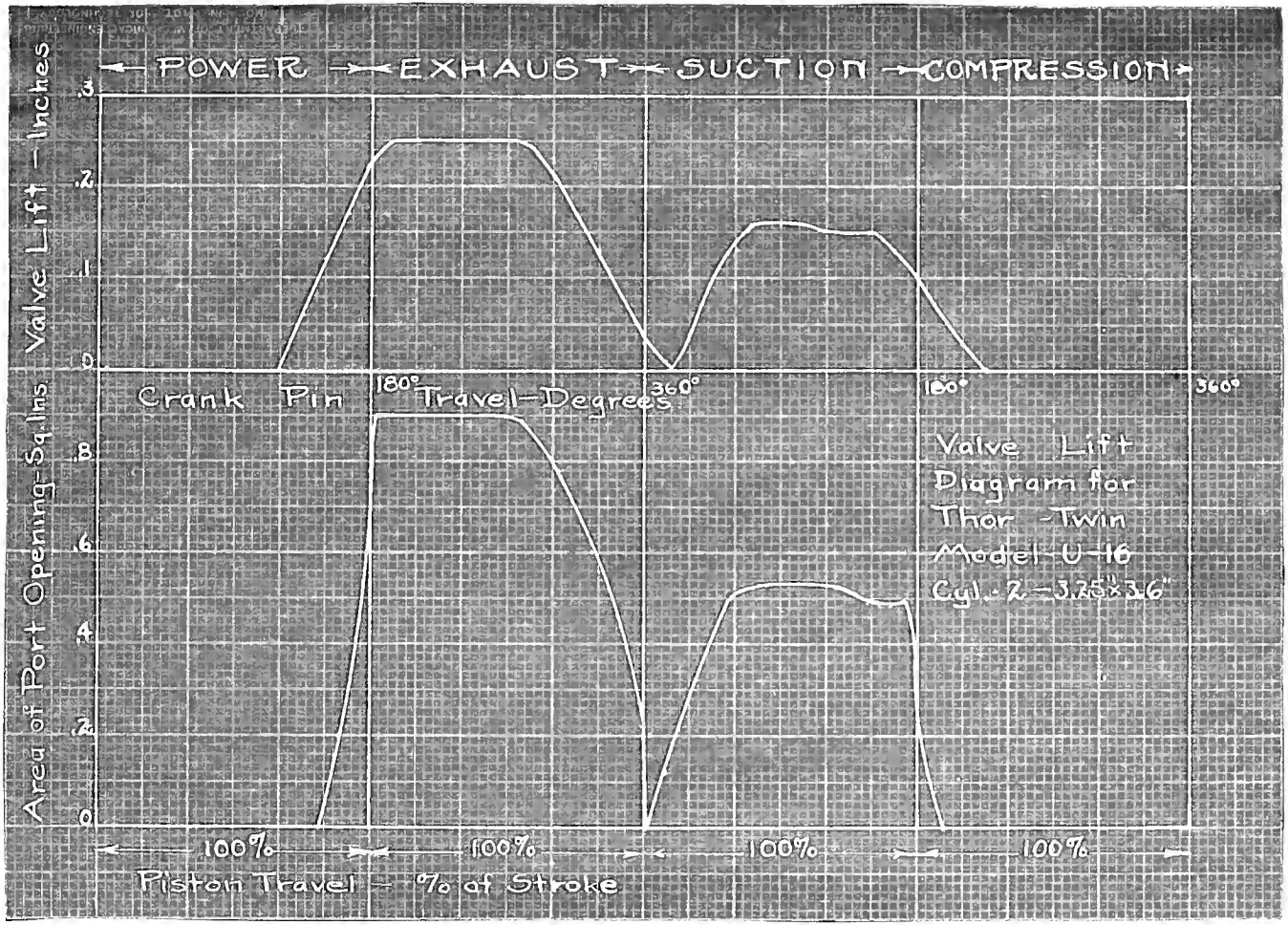


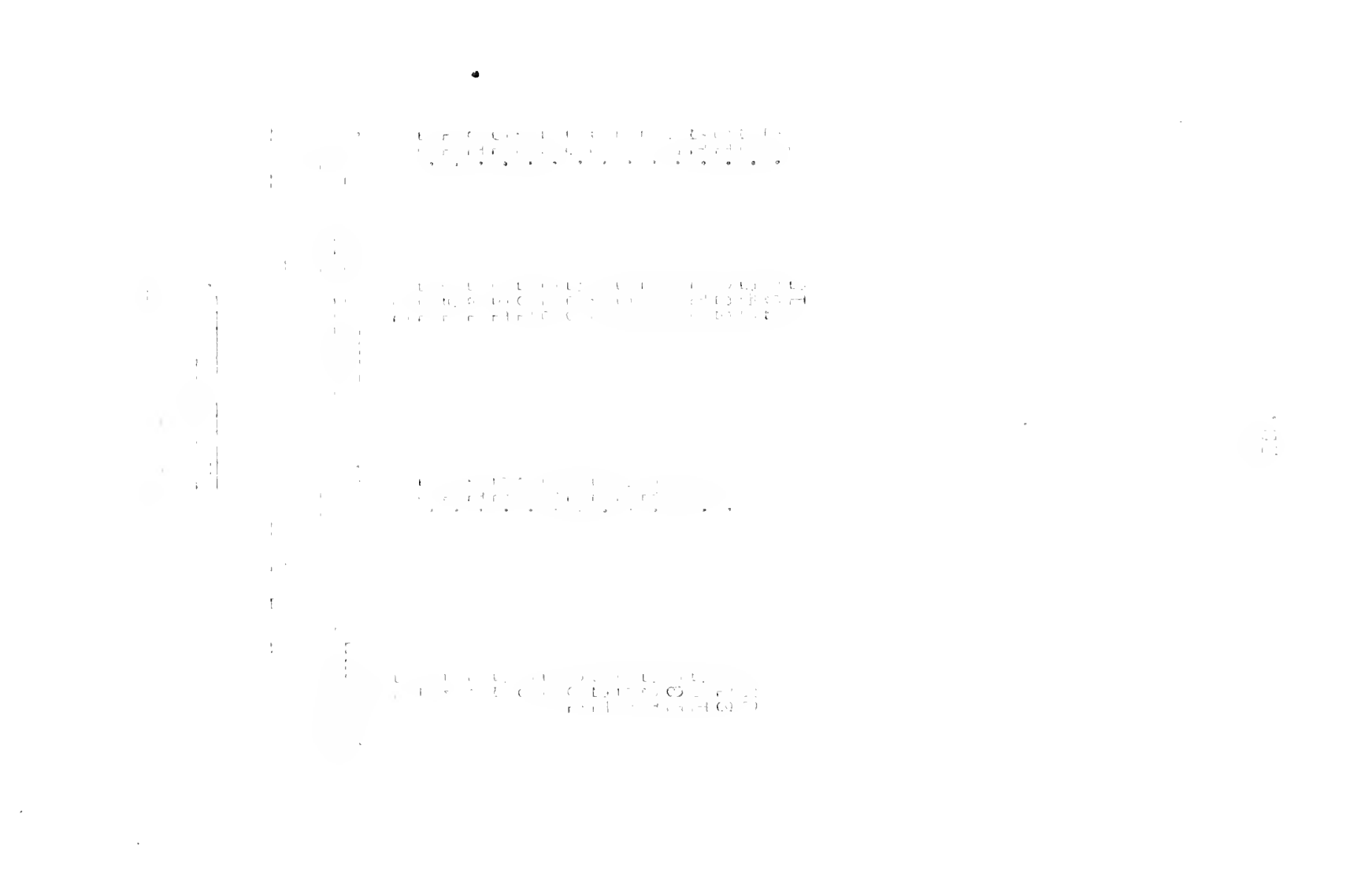
FIGURE 13a.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
110	"	"
105	.33	.611
100	.19	.415
95	.17	.508
90	.09	.792
85	.05	.000
80	"	"
75	"	"
70	"	"
65	"	"
60	"	"
55	.045	.385
50	.03	.780
45	.17	.588
40	.13	.454
35	.03	.778
30	.03	.131
10	"	"


POWER
EXHAUST
SUCTION
COMPRESSION
Area of Port Opening-Sq. Ins. Valve Lift - Inches
.3
.2
.1
0
.8
.6
.4
.2
0
Crank Pin
180°
Travel-Degrees
360°
180°
360°
Valve Lift Diagram for Thor - Twin
Model - U-16
Cyl. - 2 - 3.75" x 3.6"
100%
100%
100%
100%
Piston Travel - % of Stroke



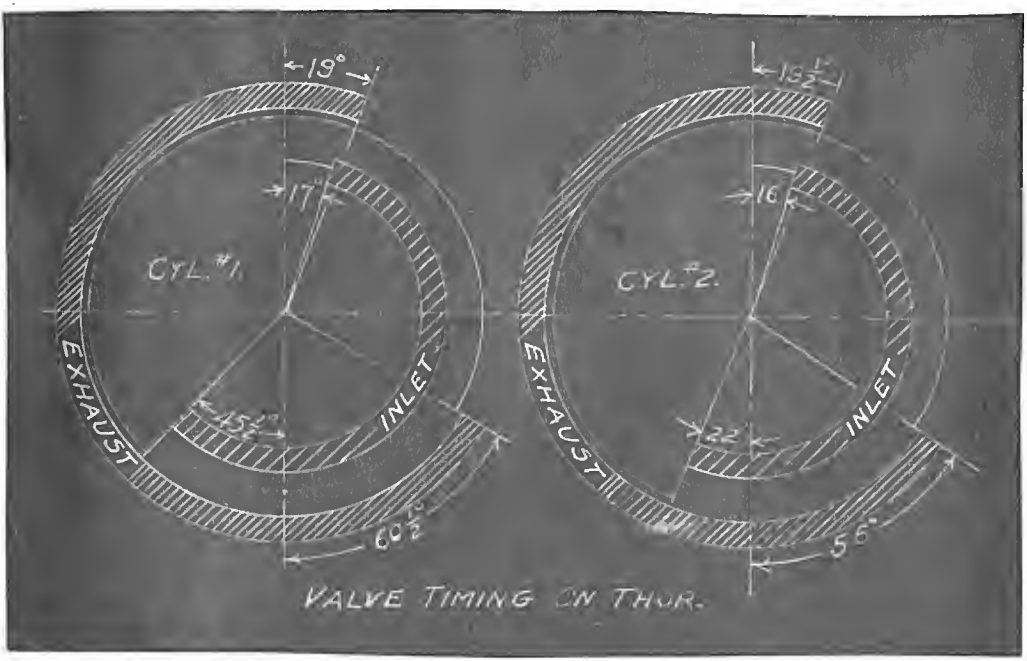
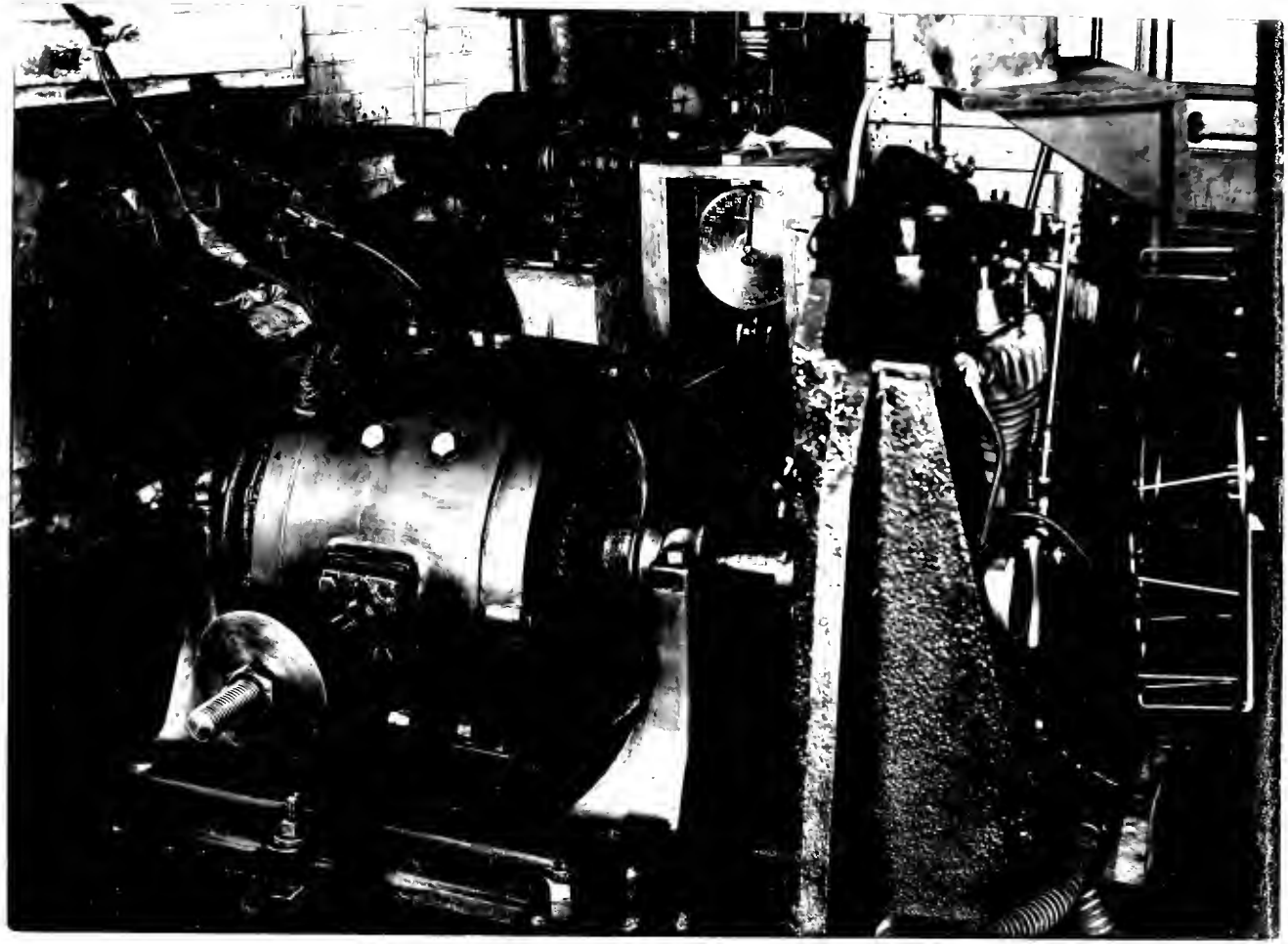
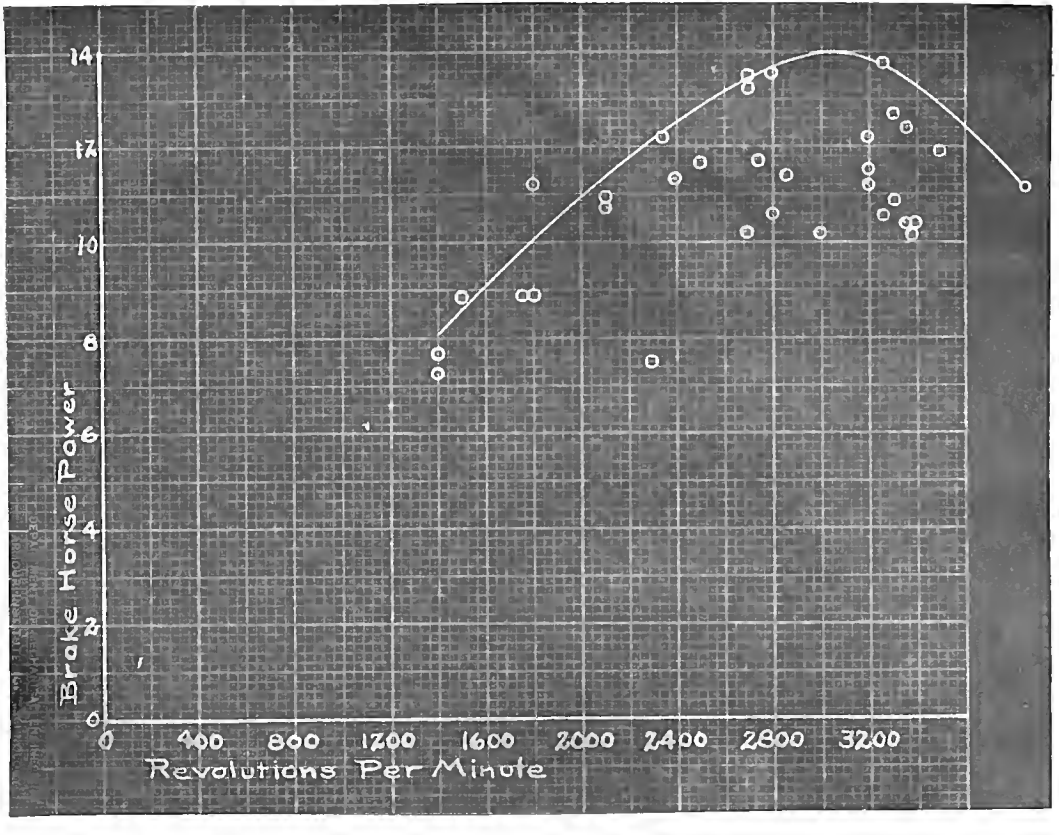
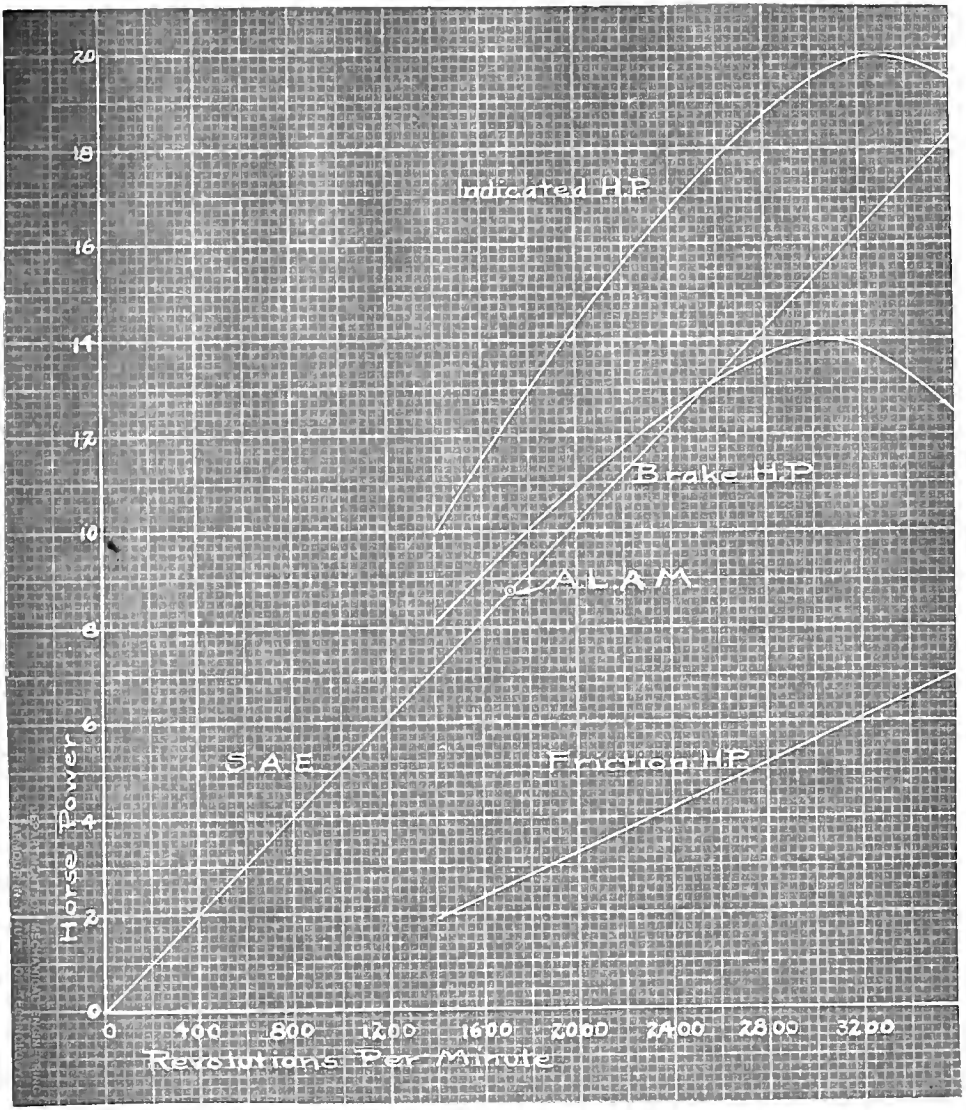

19°
17°
CYL. #1.
EXHAUST
INLET
45½°
60½°
13½°
16°
CYL. #2.
EXHAUST
INLET
22°
56°
VALVE TIMING ON THOR.

FIG. 14.




Brake Horse Power
14
12
10
8
6
4
2
0
0
400
800
1200
1600
2000
2400
2800
3200
Revolutions Per Minute


Indicated H.P
Brake H.P
S.A.E
A.L.A.M
Friction H.P
Horse Power
Revolutions Per Minute
0
2
4
6
8
10
12
14
16
18
20
400
800
1200
1600
2000
2400
2800
3200

[illegible]

[illegible] in [illegible] 7. [illegible] efficiency [illegible] curves (Fig. 18) were calculated [illegible] from the residual power curve (see Table 7).

[illegible]

For the complete formulas and derivation of formulas used in the following calculations see Chapters 1 and [illegible].

[illegible] rating at 1000 ft. per min. [illegible] speed (1715 r.p.m.)

$$[illegible] = \frac{d^2 n}{2.5}$$

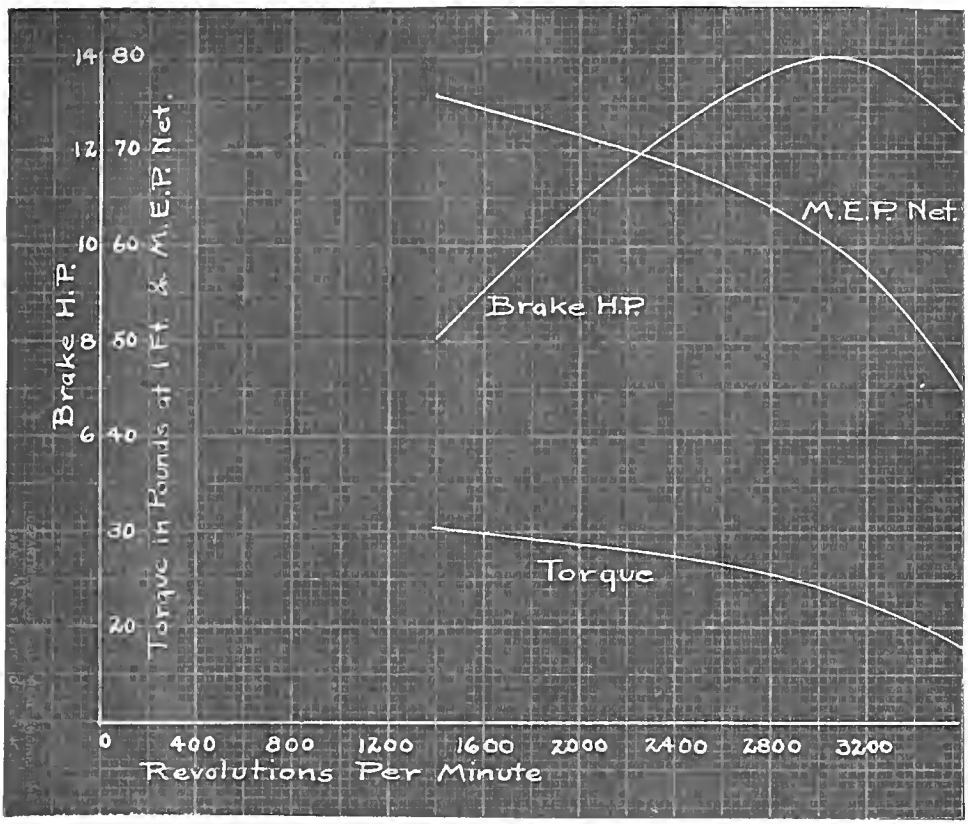
$$= \frac{([illegible])^2 \times 2}{2.5}$$

$$= [illegible]$$

Brake horse power = $\frac{[illegible]}{5,[illegible]}$.

At 1700 r.p.m. [illegible] = 11 [illegible] pounds.

[illegible] = $\frac{[illegible] \times 27[illegible]}{[illegible]}$ = 17.[illegible]


Brake H.P.
Torque in Pounds at 1 Ft. & M.E.P. Net.
14
12
10
8
6
80
70
60
50
40
30
20
M.E.P. Net.
Brake H.P.
Torque
0
400
800
1200
1600
2000
2400
2800
3200
Revolutions Per Minute

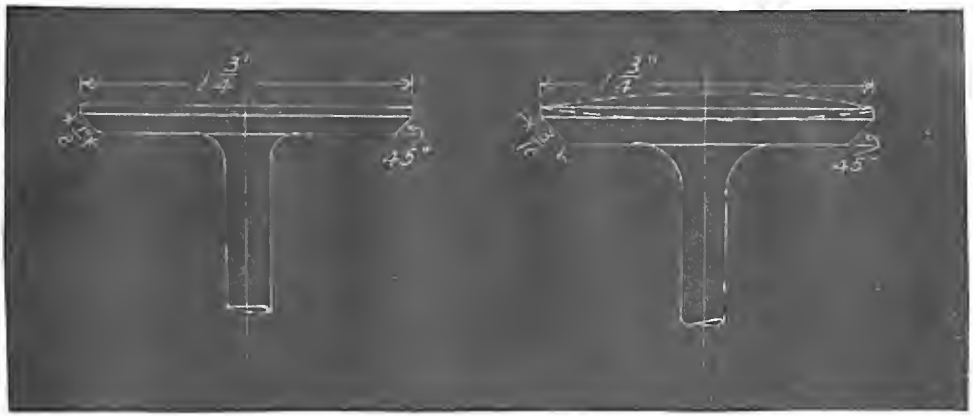
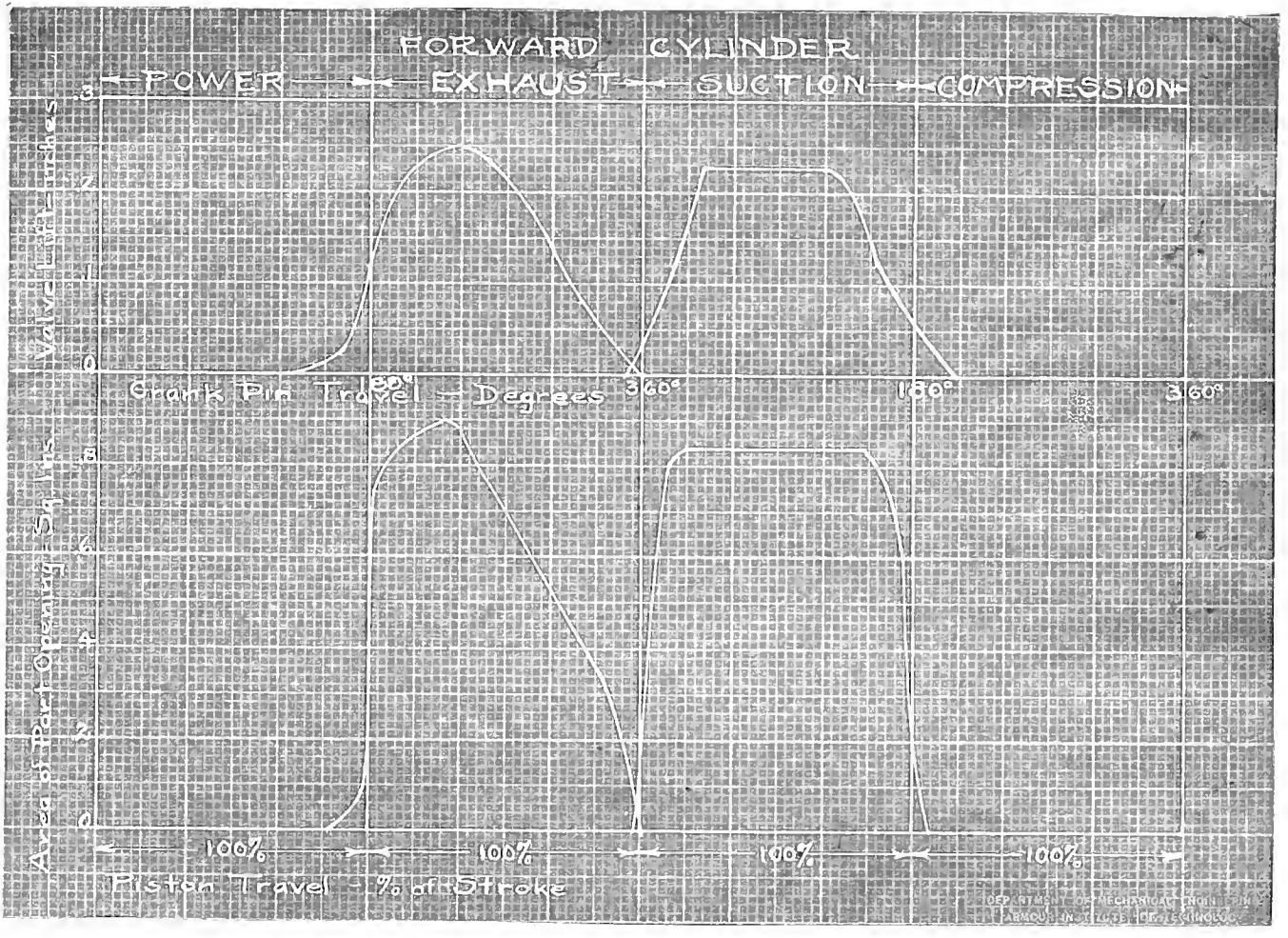
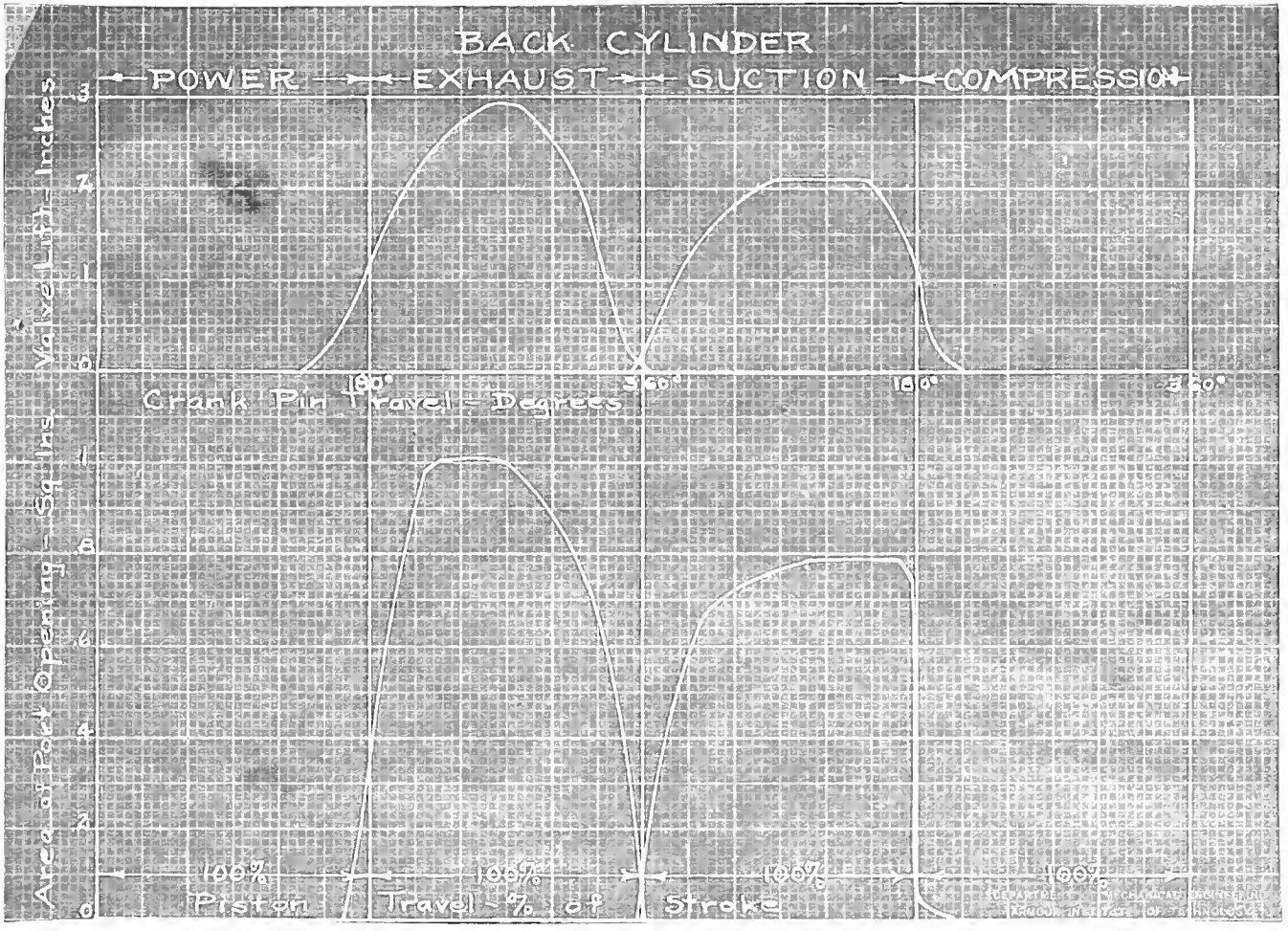
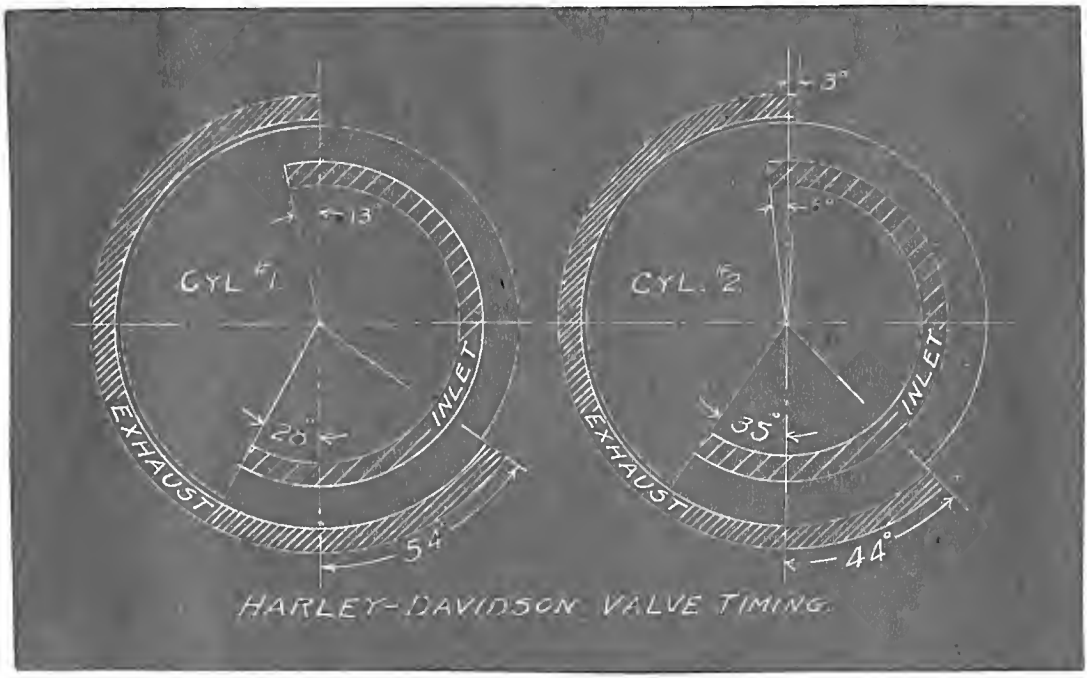


FIGURE 13a.


FORWARD CYLINDER
POWER
EXHAUST
SUCTION
COMPRESSION
Area of Port Opening Sq. Ins.
Valve Lift Ins.
Crank Pin Travel
180°
Degrees
360°
100%
100%
100%
100%
Piston Travel
% of Stroke


BACK CYLINDER
POWER
EXHAUST
SUCTION
COMPRESSION
Area of Port Opening - Sq. Ins. Valve Lift - Inches
3
2
1
0
Crank Pin Travel - Degrees
180°
360°
180°
360°
100% Piston
100% Travel - % of
100% Stroke
100%



HARLEY-DAVIDSON VALVE TIMING.

FIGURE 21.

[illegible].

[illegible] engine.

[illegible] perhaps the first thing which struck the observers of these two tests was the necessity of having a sufficiently rigid stand to carry out experiments. In testing the Thor engine, this vibration was never run down enough to give the engine a fair chance. At first the test was made on a heavy cast iron table (Fig. 5), but even after removing the engine to a cement floor and clamping it to imbedded iron slots (Fig. 6) the vibration was still annoying. At high speeds the gas seemed to hold back a little, and this was probably due to the gasoline spurting thru the rear ureter nozzle instead of flowing in a steady stream.

The performance of the Thor is shown clearly in Figures No. 12 and 13. The brake horse power drops above the S.A.E. rating un-