

STUDY OF MOTOR CYCLE ENGINE
CHARACTERISTICS

BY

C. L. OTT

S. PIMSTEIN

ARMOUR INSTITUTE OF TECHNOLOGY

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Ott, C. L.

A study of motor cycle
engine characteristics

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**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

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H. M. Raymond

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CONCLUSION

The test results of the Electric
dynamometer, which may be run up to 5500
R.P.M., are very reliable and efficient for
testing high speed engines. It has been
found that it is the purpose of this
document to give the general results of
tests run with this dynamometer on two well
known makes of motorcycle engines.



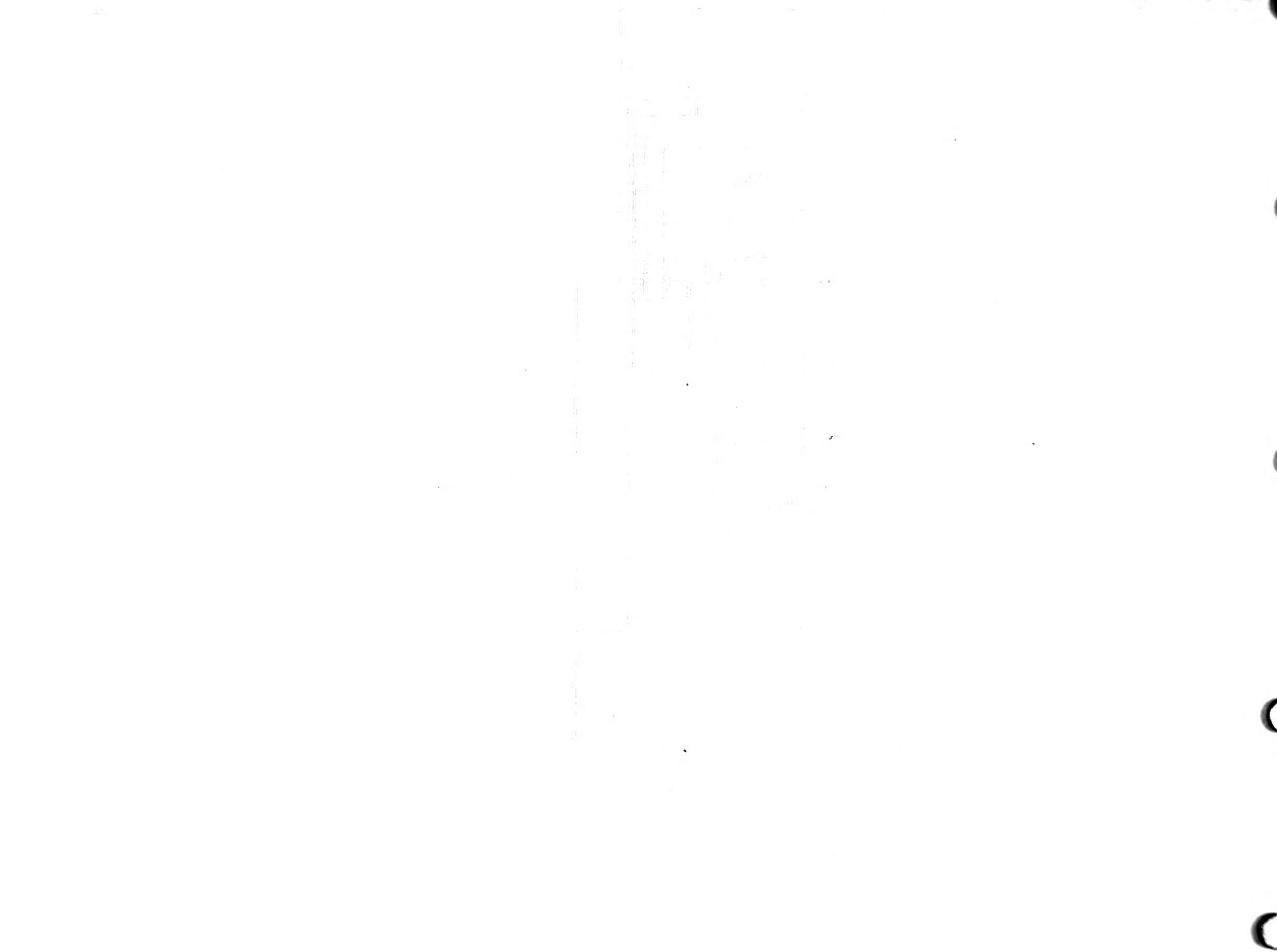
The circuit diagram is shown in Fig. 1. The motor is connected to the power supply through a switch and a voltmeter. The voltmeter is connected in parallel with the motor. The current is measured by an ammeter connected in series with the motor. The motor is connected to the power supply through a switch and a voltmeter. The voltmeter is connected in parallel with the motor. The current is measured by an ammeter connected in series with the motor.

$$\begin{aligned}
 I &= \frac{U - I R_{int}}{R_{ext} + R_{int}} \\
 I &= \frac{U}{R_{ext} + R_{int} + I R_{int}}
 \end{aligned}$$

The motor is connected to the power supply through a switch and a voltmeter. The voltmeter is connected in parallel with the motor. The current is measured by an ammeter connected in series with the motor. The motor is connected to the power supply through a switch and a voltmeter. The voltmeter is connected in parallel with the motor. The current is measured by an ammeter connected in series with the motor.

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The motor is connected in the power supply circuit and the voltmeter is connected to the supply.



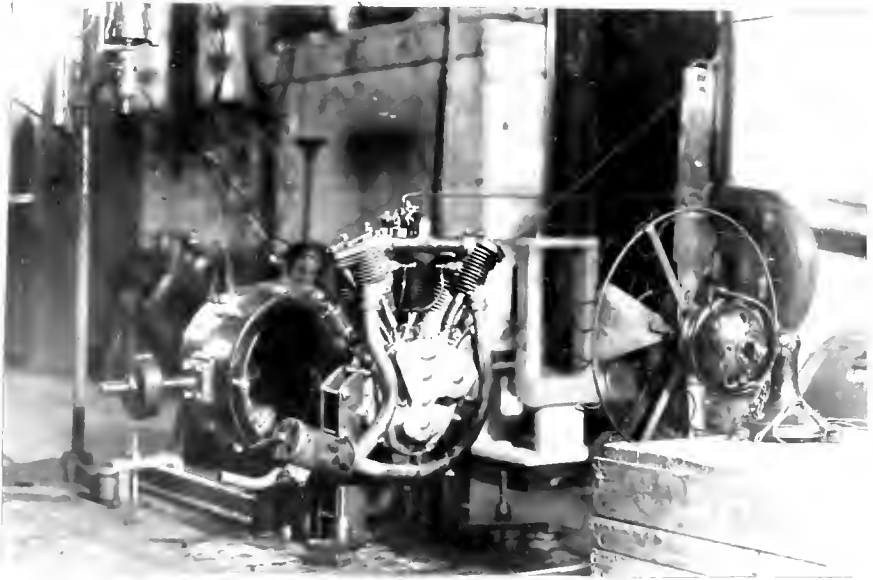


FIGURE 3.



FIGURE 4.

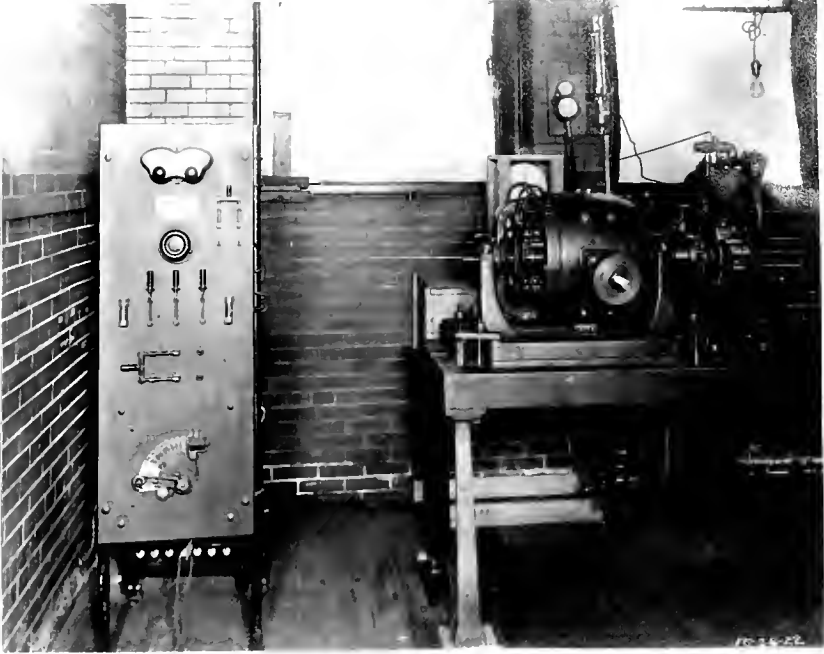
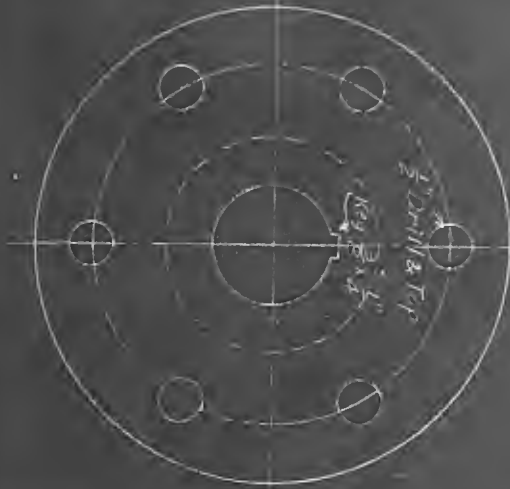
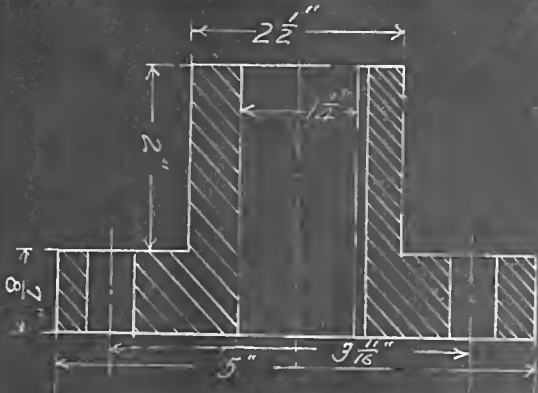


FIGURE 5.

$$\begin{array}{r}
 \frac{1}{2} \\
 \frac{1}{2} \\
 \hline
 1 \\
 \hline
 1 \\
 \hline
 1
 \end{array}$$

The following table shows the results of the experiment. The first column gives the number of trials, the second column gives the number of successes, and the third column gives the probability of success. The results show that the probability of success is approximately 0.5.

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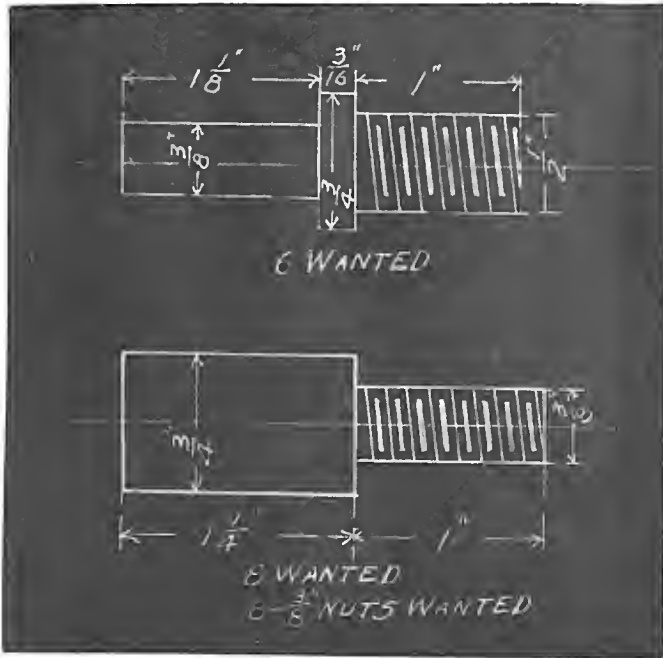
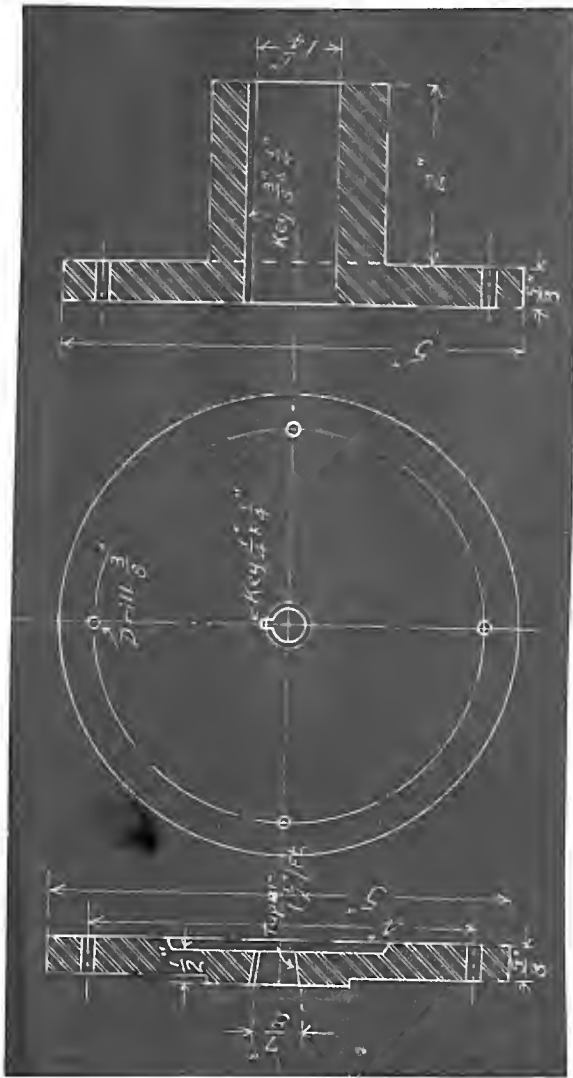
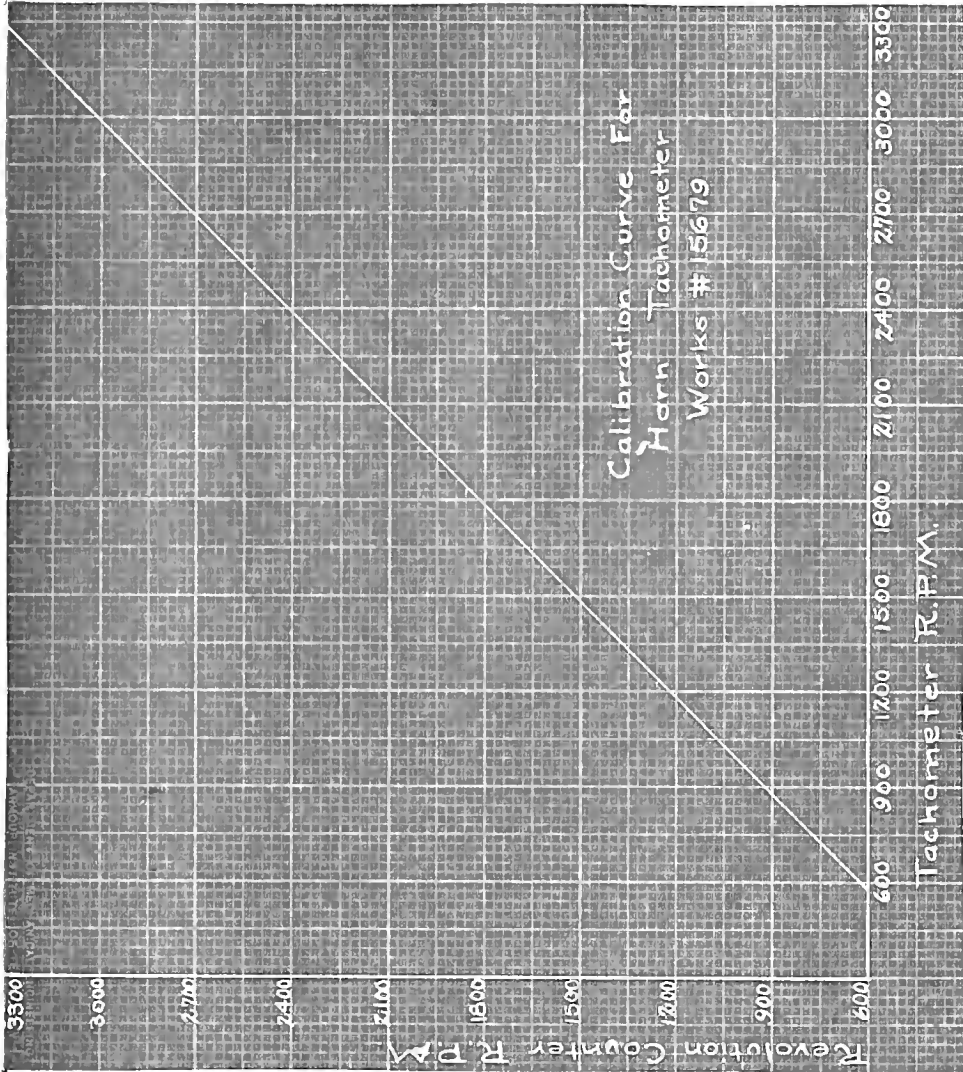
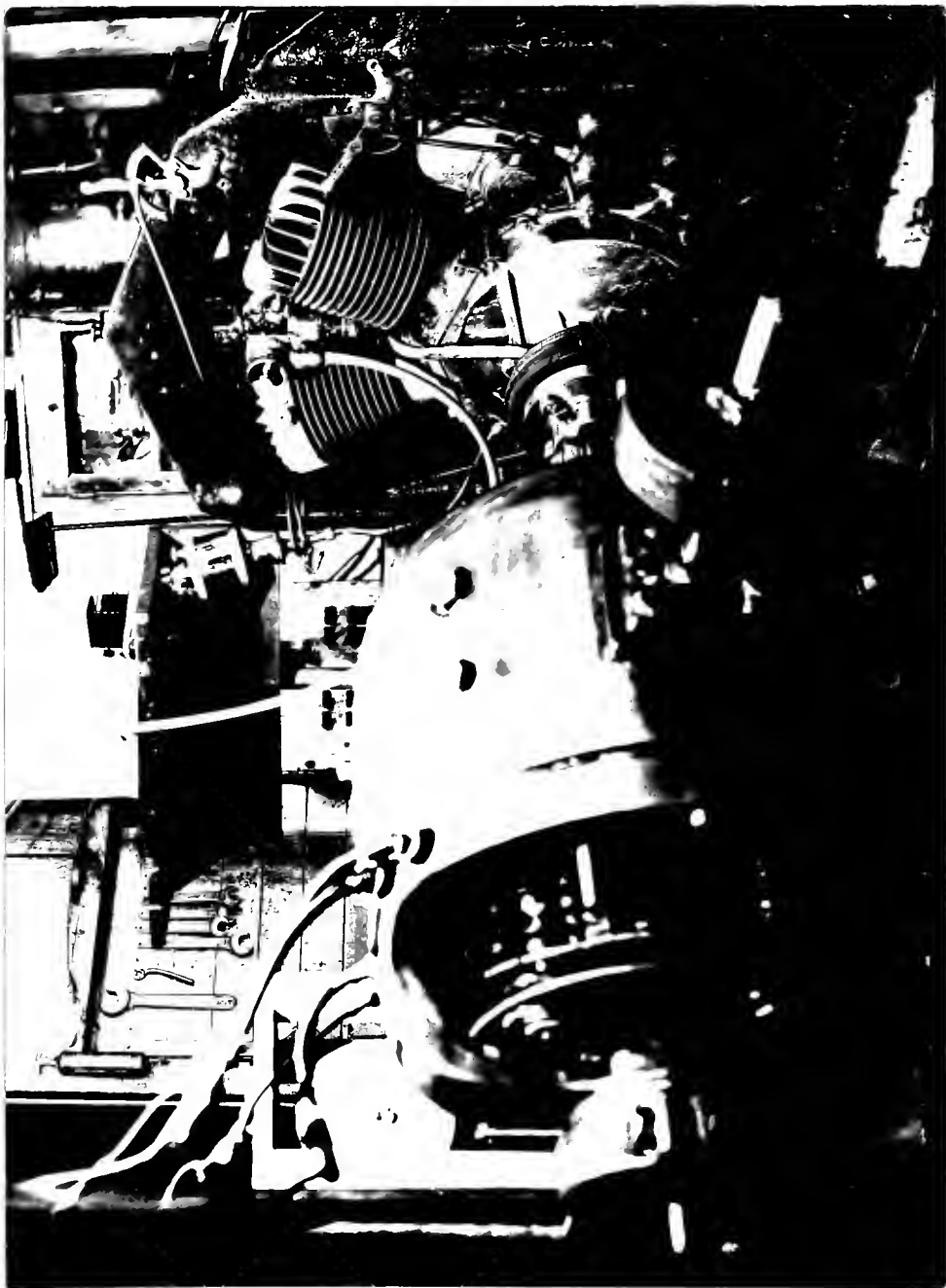


FIGURE 7.



10010.





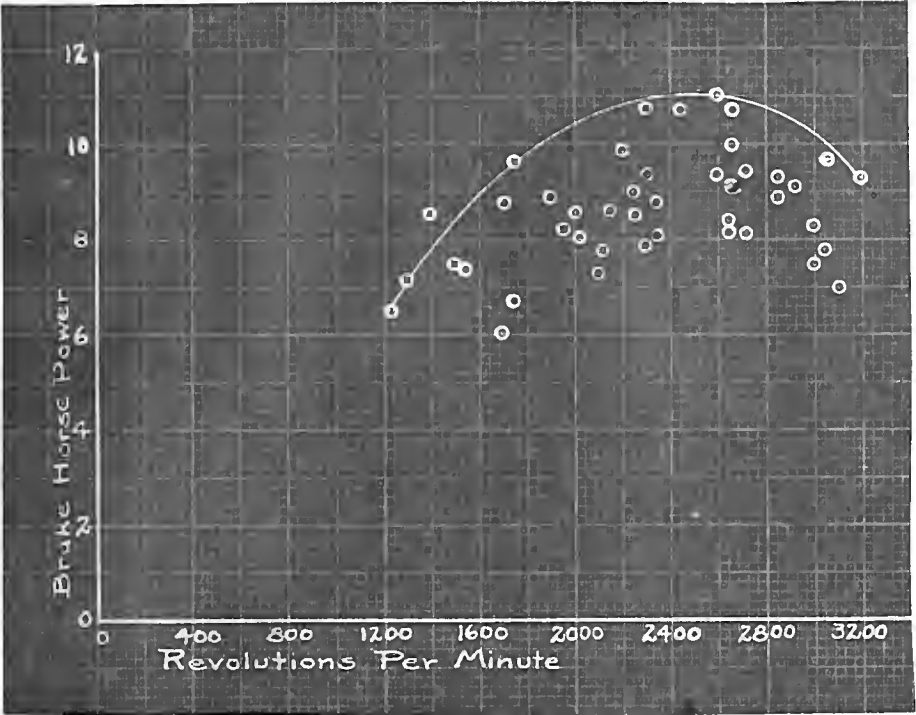
1410	11.5	6.50
1420	11.0	7.15
1410	12.1	5.54
1410	10.	7.50
1500	8.5	7.50
1604	10.0	8.75
1620	7.1	0.00
1700	11.1	0.71
1700	7.0	0.00
1800	0.4	5.00
1850	8.5	8.00
2010	8.5	5.50
2110	7.0	5.00
2110	7.0	7.55
2135	7.3	7.76
2150	9.0	5.60
2200	9.0	9.00
2250	7.0	8.55
2250	8.0	9.00
2250	8.4	10.81
2300	8.2	9.47
2333	6.6	7.05
2340	7.5	8.90
2350	6.9	6.10
2400	8.8	10.70
2610	7.0	8.55
2810	8.5	11.05

1940

1940

1940

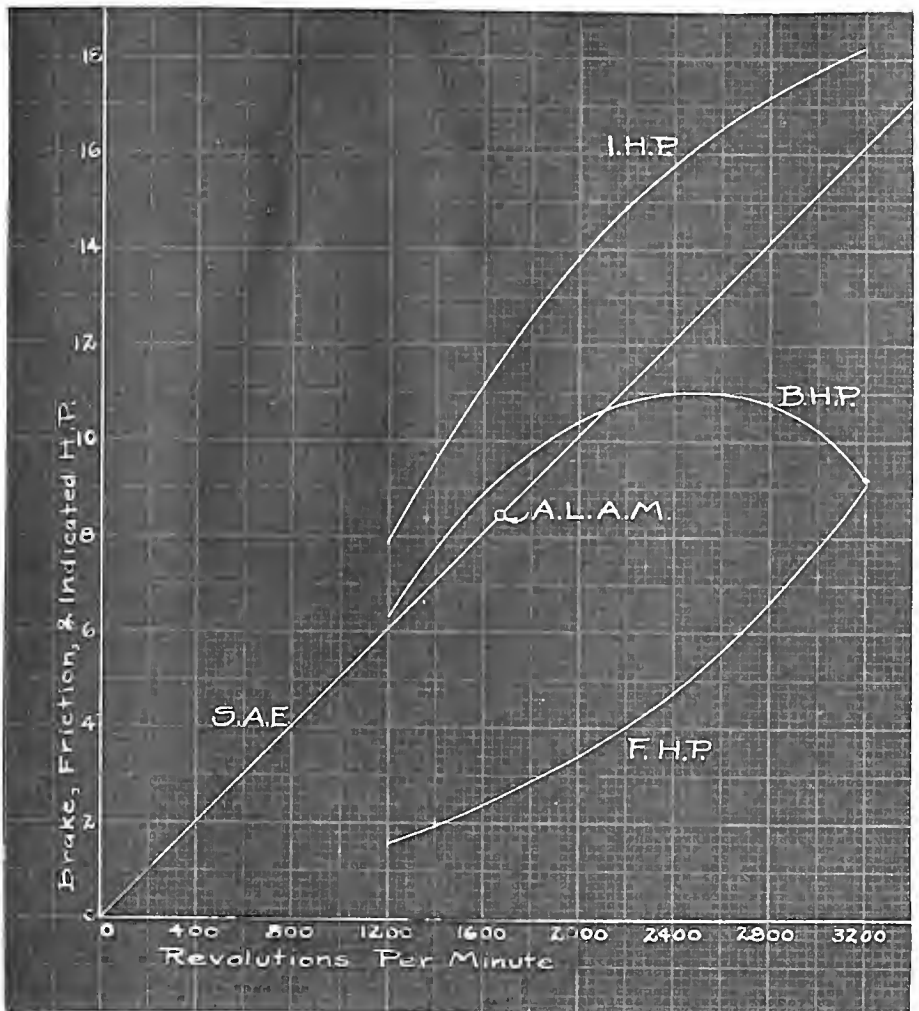
1940





1911 1912 1913 1914

Year	1911	1912	1913	1914
187	1.7	1.7	1.7	1.7
188	1.7	1.7	1.7	1.7
189	1.7	1.7	1.7	1.7
190	1.7	1.7	1.7	1.7
191	1.7	1.7	1.7	1.7
192	1.7	1.7	1.7	1.7
193	1.7	1.7	1.7	1.7
194	1.7	1.7	1.7	1.7
195	1.7	1.7	1.7	1.7
196	1.7	1.7	1.7	1.7
197	1.7	1.7	1.7	1.7
198	1.7	1.7	1.7	1.7
199	1.7	1.7	1.7	1.7
200	1.7	1.7	1.7	1.7
201	1.7	1.7	1.7	1.7
202	1.7	1.7	1.7	1.7
203	1.7	1.7	1.7	1.7
204	1.7	1.7	1.7	1.7
205	1.7	1.7	1.7	1.7
206	1.7	1.7	1.7	1.7
207	1.7	1.7	1.7	1.7
208	1.7	1.7	1.7	1.7
209	1.7	1.7	1.7	1.7
210	1.7	1.7	1.7	1.7
211	1.7	1.7	1.7	1.7
212	1.7	1.7	1.7	1.7
213	1.7	1.7	1.7	1.7
214	1.7	1.7	1.7	1.7
215	1.7	1.7	1.7	1.7
216	1.7	1.7	1.7	1.7
217	1.7	1.7	1.7	1.7
218	1.7	1.7	1.7	1.7
219	1.7	1.7	1.7	1.7
220	1.7	1.7	1.7	1.7
221	1.7	1.7	1.7	1.7
222	1.7	1.7	1.7	1.7
223	1.7	1.7	1.7	1.7
224	1.7	1.7	1.7	1.7
225	1.7	1.7	1.7	1.7
226	1.7	1.7	1.7	1.7
227	1.7	1.7	1.7	1.7
228	1.7	1.7	1.7	1.7
229	1.7	1.7	1.7	1.7
230	1.7	1.7	1.7	1.7
231	1.7	1.7	1.7	1.7
232	1.7	1.7	1.7	1.7
233	1.7	1.7	1.7	1.7
234	1.7	1.7	1.7	1.7
235	1.7	1.7	1.7	1.7
236	1.7	1.7	1.7	1.7
237	1.7	1.7	1.7	1.7
238	1.7	1.7	1.7	1.7
239	1.7	1.7	1.7	1.7
240	1.7	1.7	1.7	1.7
241	1.7	1.7	1.7	1.7
242	1.7	1.7	1.7	1.7
243	1.7	1.7	1.7	1.7
244	1.7	1.7	1.7	1.7
245	1.7	1.7	1.7	1.7
246	1.7	1.7	1.7	1.7
247	1.7	1.7	1.7	1.7
248	1.7	1.7	1.7	1.7
249	1.7	1.7	1.7	1.7
250	1.7	1.7	1.7	1.7
251	1.7	1.7	1.7	1.7
252	1.7	1.7	1.7	1.7
253	1.7	1.7	1.7	1.7
254	1.7	1.7	1.7	1.7
255	1.7	1.7	1.7	1.7
256	1.7	1.7	1.7	1.7
257	1.7	1.7	1.7	1.7
258	1.7	1.7	1.7	1.7
259	1.7	1.7	1.7	1.7
260	1.7	1.7	1.7	1.7
261	1.7	1.7	1.7	1.7
262	1.7	1.7	1.7	1.7
263	1.7	1.7	1.7	1.7
264	1.7	1.7	1.7	1.7
265	1.7	1.7	1.7	1.7
266	1.7	1.7	1.7	1.7
267	1.7	1.7	1.7	1.7
268	1.7	1.7	1.7	1.7
269	1.7	1.7	1.7	1.7
270	1.7	1.7	1.7	1.7
271	1.7	1.7	1.7	1.7
272	1.7	1.7	1.7	1.7
273	1.7	1.7	1.7	1.7
274	1.7	1.7	1.7	1.7
275	1.7	1.7	1.7	1.7
276	1.7	1.7	1.7	1.7
277	1.7	1.7	1.7	1.7
278	1.7	1.7	1.7	1.7
279	1.7	1.7	1.7	1.7
280	1.7	1.7	1.7	1.7
281	1.7	1.7	1.7	1.7
282	1.7	1.7	1.7	1.7
283	1.7	1.7	1.7	1.7
284	1.7	1.7	1.7	1.7
285	1.7	1.7	1.7	1.7
286	1.7	1.7	1.7	1.7
287	1.7	1.7	1.7	1.7
288	1.7	1.7	1.7	1.7
289	1.7	1.7	1.7	1.7
290	1.7	1.7	1.7	1.7
291	1.7	1.7	1.7	1.7
292	1.7	1.7	1.7	1.7
293	1.7	1.7	1.7	1.7
294	1.7	1.7	1.7	1.7
295	1.7	1.7	1.7	1.7
296	1.7	1.7	1.7	1.7
297	1.7	1.7	1.7	1.7
298	1.7	1.7	1.7	1.7
299	1.7	1.7	1.7	1.7
300	1.7	1.7	1.7	1.7



(See Table 3).

SAMPLE CALCULATION

... at 1000 ft. per min.
 piston speed is given by the formula

$$\text{piston speed} = \frac{d^2 n}{2.5}$$

where d = the bore in inches.
 n = the number of cylinders.

For this engine, 1000 ft. per min.
 piston speed = $\frac{12 \times 1000}{2 \times 5.6} = 1070$ r.p.m., and

$$\text{H.P.} = \frac{(0.35)^3 \times 1070}{2.5} = 3.44.$$

...
 at 1450 r.p.m. = 3.5 pounds per ...
 ...

$$\text{H.P.} = \frac{3.5 \times 0.50}{2.5} = 0.70.$$

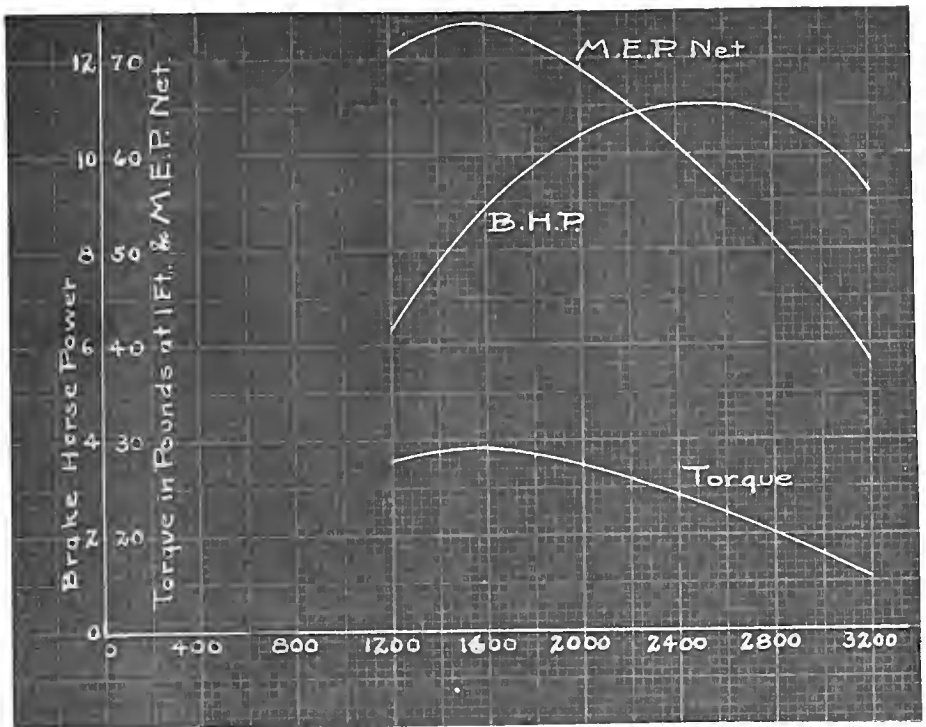


FIGURE 1.

$$= \frac{2.5 \times 10^{-4} \times 1.5 \times 10^{-4}}{2.5 \times 10^{-4} \times 1.5 \times 10^{-4}}$$

1.20

L = ch. of the r.p.r. net.

L = the stroke in dots.

n = the width of the picture in cm. in

n = the number of working strokes per

inch = the r.p.r. in this case.

Substituting the values for L and n in the formula for the r.p.r. net, we have

$$\begin{aligned} \text{r.p.r. net} &= \frac{31,100 \times 1}{2.5 \times 10^{-4} \times 1.5 \times 10^{-4} \times 1.5 \times 10^{-4}} \\ &= 15,780 \frac{\text{dots}}{\text{inch}} \end{aligned}$$

An expression for the time required to scan a foot may be derived from the relation

$$\text{D.H.P.} = \frac{0.03 \text{ F.P.I.}}{31,100}$$

Solving

$$\text{Time} = \text{F.P.I.} = 535 \frac{\text{D.H.P.}}{0.03}$$

Calculation of Valve Lift

The valve lift is calculated from the following equation:
$$L = \frac{1}{2} \left(\frac{d}{a} \right)^2 \left(\frac{h}{a} \right)$$

where:
L = the valve lift in inches.
d = the diameter of the valve in inches.
a = the radius of the opening in inches.
h = the valve lift in inches.

The following table shows the calculated valve lift for the following conditions:

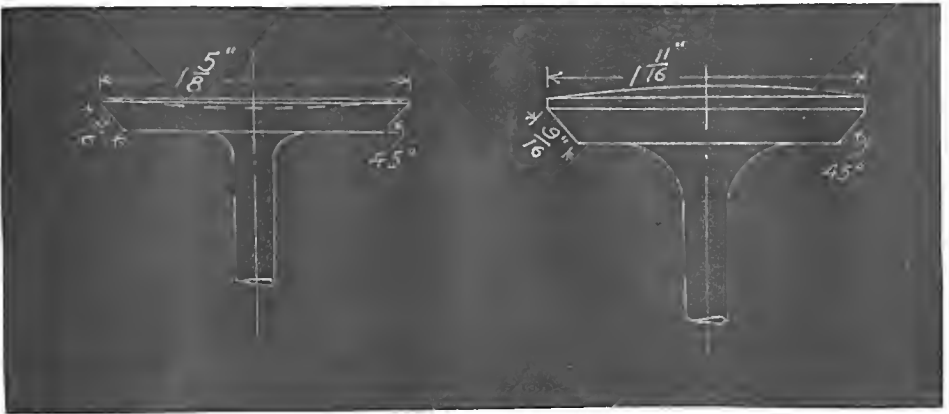
$$L = 0.1416 (0.717 d)^2 h$$

where

a = the radius of the opening in inches.

d = the diameter of the valve in inches.

h = the valve lift in inches.



1 1/16"

1 1/16"

FIGURE 13a.

FIGURE 13a.

1917-1918

1917-1918

1917-1918

1917-1918 . . . 1917-1918 . . . 1917-1918

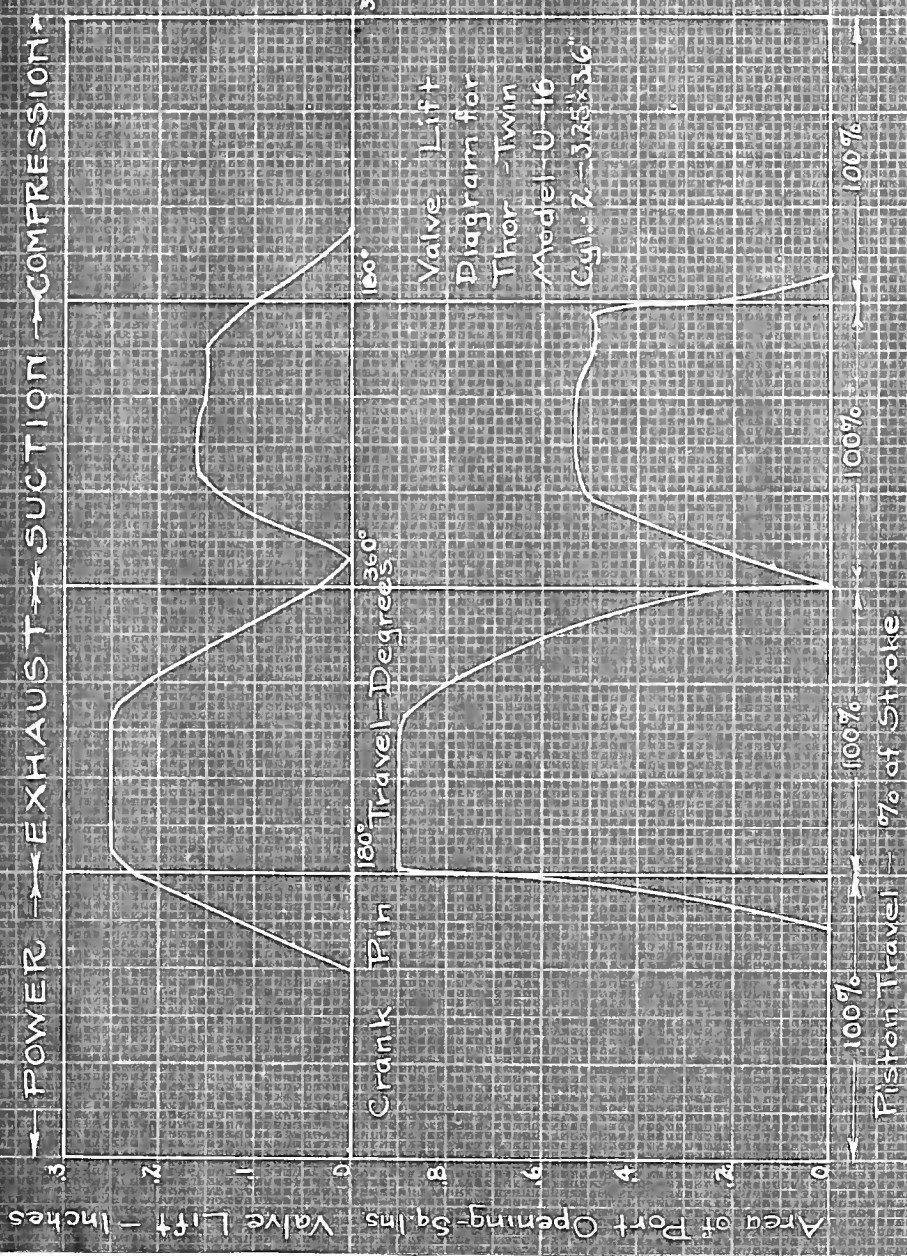
17		
30	.14	.317
45	.11	.317
30	.11	.45
35	.12	.515
0	.13	.515
105	.14	.515
151	.17	.57
105	.18	.497
150	.17	.57
105	.18	.41
1-1	.10	.317
105	.33	.1055
11	.33	.337
105	0	0

TABLE 1

PERCENTAGE OF ...

...

...
110		
185	.03	.237
185	.14	.415
185	.17	.598
191	.22	.780
185	.35	.900
211	"	"
215	"	"
211	"	"
205	"	"
270	"	"
285	.045	.395
330	.13	.780
315	.17	.598
331	.13	.450
148	.05	.370
331	.03	.151
10		



← POWER → EXHAUST → SUCTION → COMPRESSION →

360°

Valve Lift
Diagram for
Thor - Twin
Model U-16
Cyl. 2 - 3.75 x 3.6"

180°

180° Travel - Degrees

Crank Pin

180° Travel - Degrees

100%

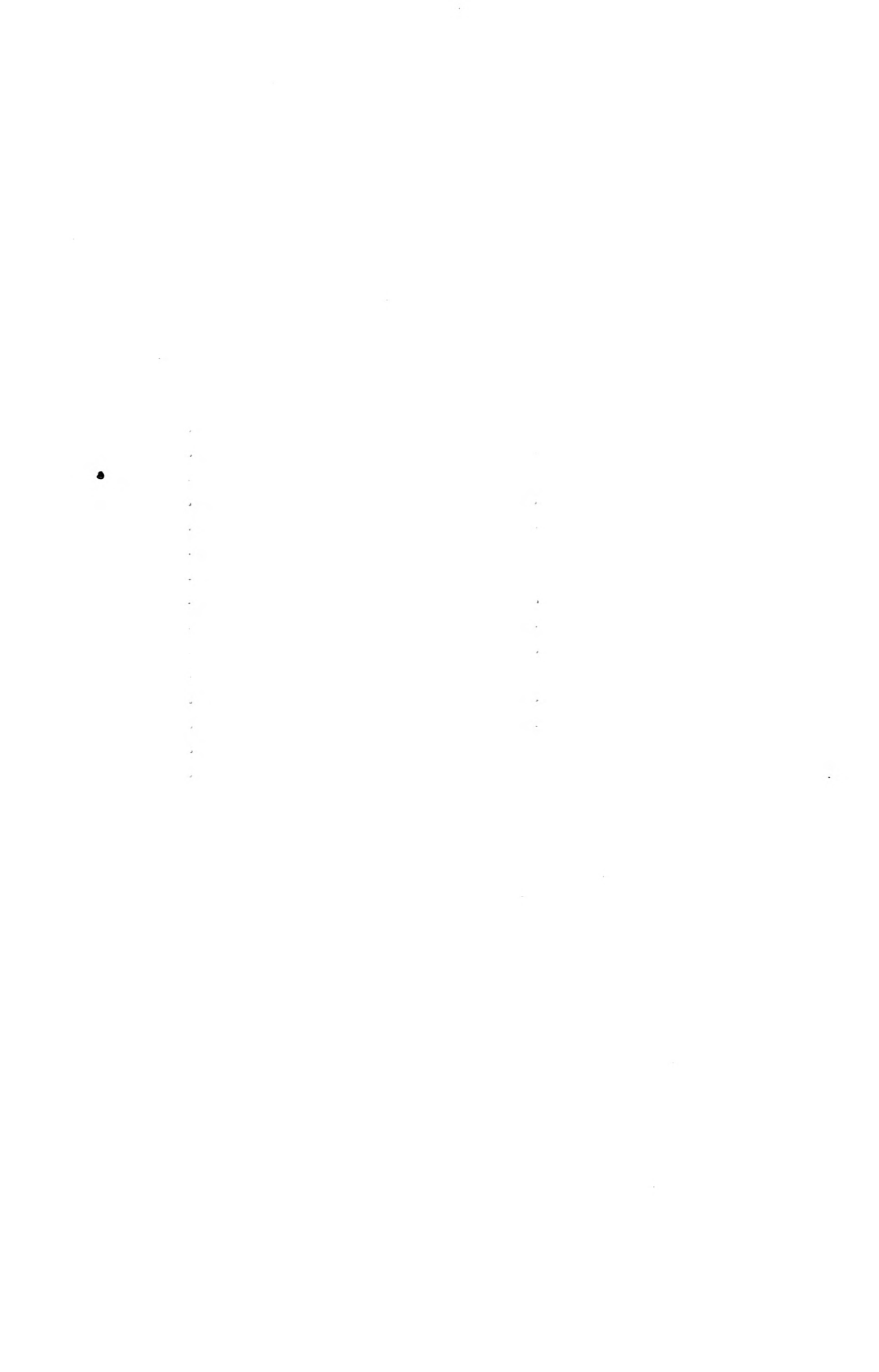
100%

100%

100%

Piston Travel - % of Stroke

Area of Port Opening - Sq. Inches
Valve Lift - Inches



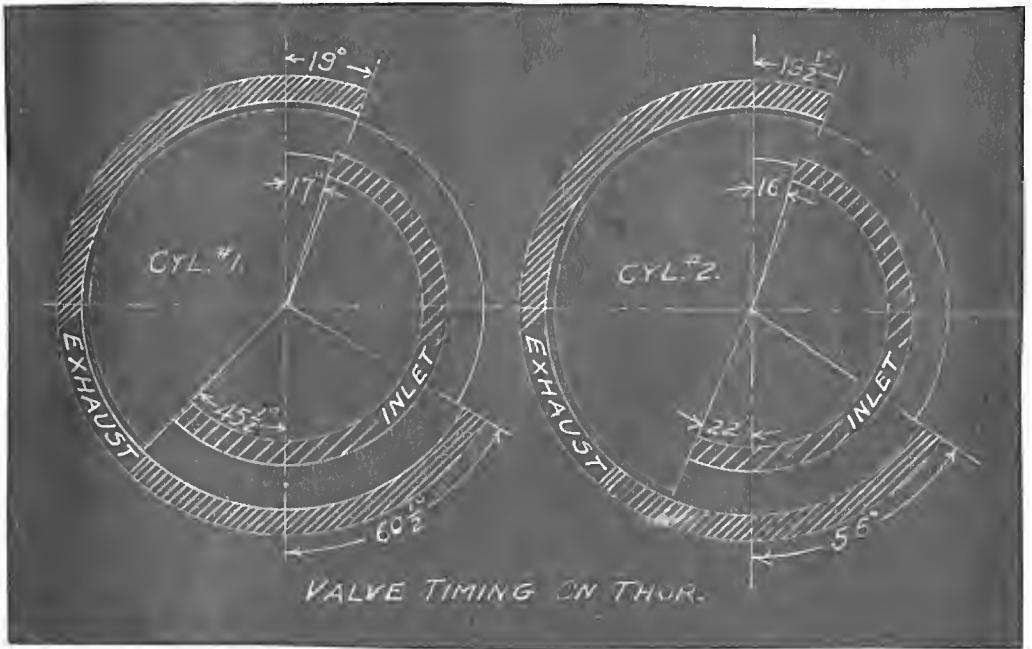


FIGURE 14 .

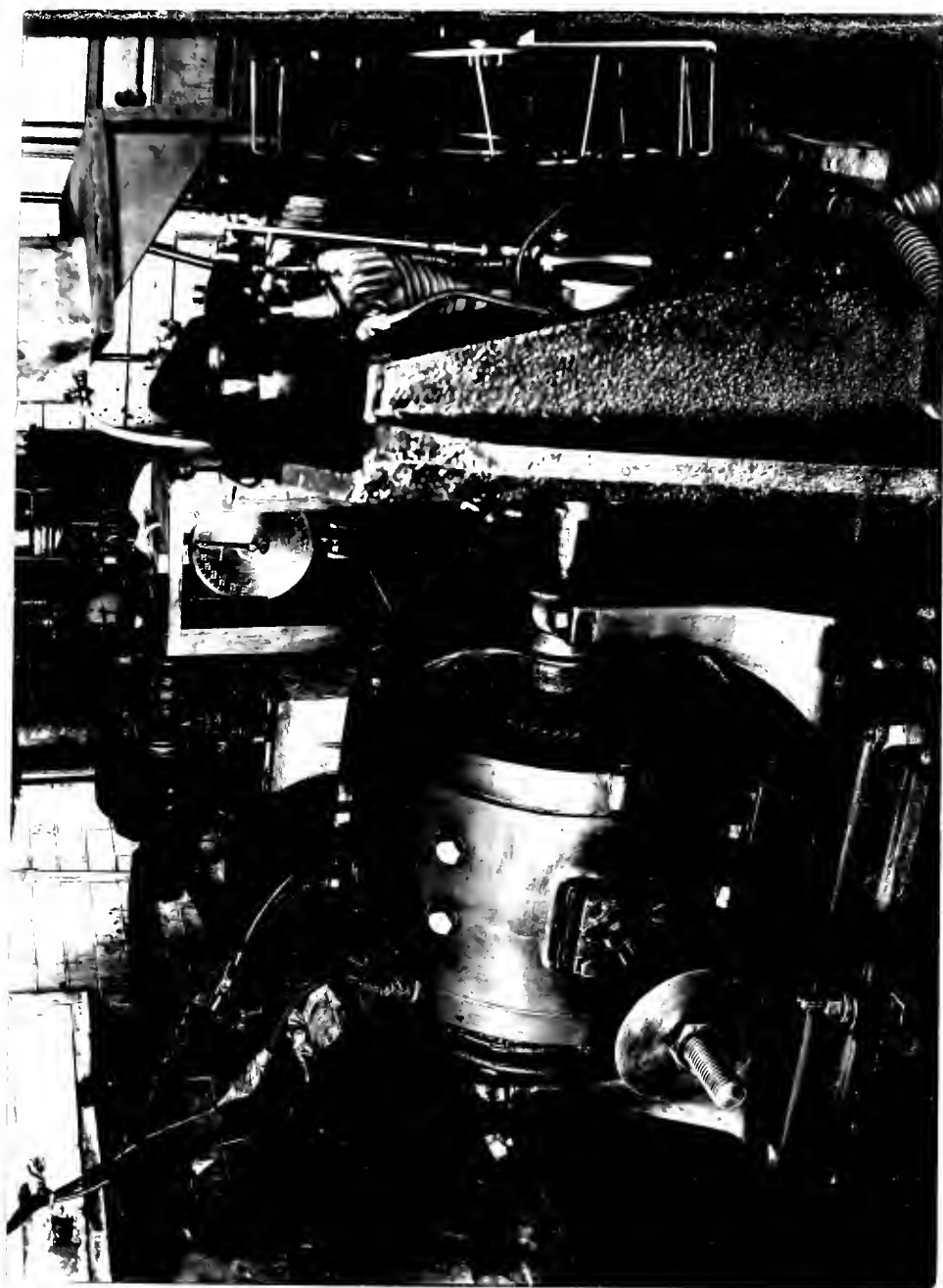
Table 1

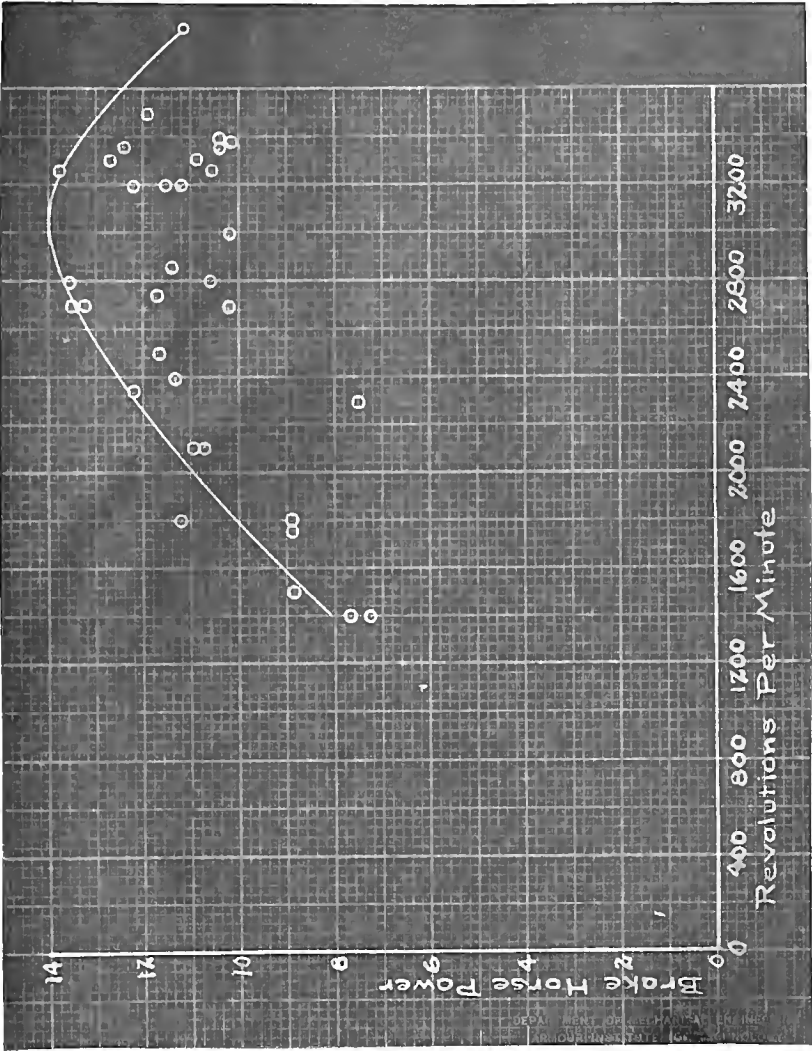
Table 1. Summary of the results of the analysis of variance for the effect of the different factors on the response variable. The values in the table are the mean squares and the corresponding F-values. The critical F-value for a 5% significance level is 1.94.

Source	Mean Square	F-value
Replication	1.2	0.1
Factor A	10.5	0.9
Factor B	15.8	1.4
Factor C	22.1	2.0
Factor D	18.7	1.7
Factor E	12.3	1.1
Factor F	9.8	0.9
Factor G	7.4	0.7
Factor H	5.9	0.5
Factor I	4.2	0.4
Factor J	3.1	0.3
Factor K	2.5	0.2
Factor L	1.8	0.2
Factor M	1.2	0.1
Factor N	0.8	0.1
Factor O	0.5	0.0
Factor P	0.3	0.0
Factor Q	0.2	0.0
Factor R	0.1	0.0
Factor S	0.1	0.0
Factor T	0.1	0.0
Factor U	0.1	0.0
Factor V	0.1	0.0
Factor W	0.1	0.0
Factor X	0.1	0.0
Factor Y	0.1	0.0
Factor Z	0.1	0.0

Table 2

Table 2. Summary of the results of the analysis of variance for the effect of the different factors on the response variable. The values in the table are the mean squares and the corresponding F-values. The critical F-value for a 5% significance level is 1.94.

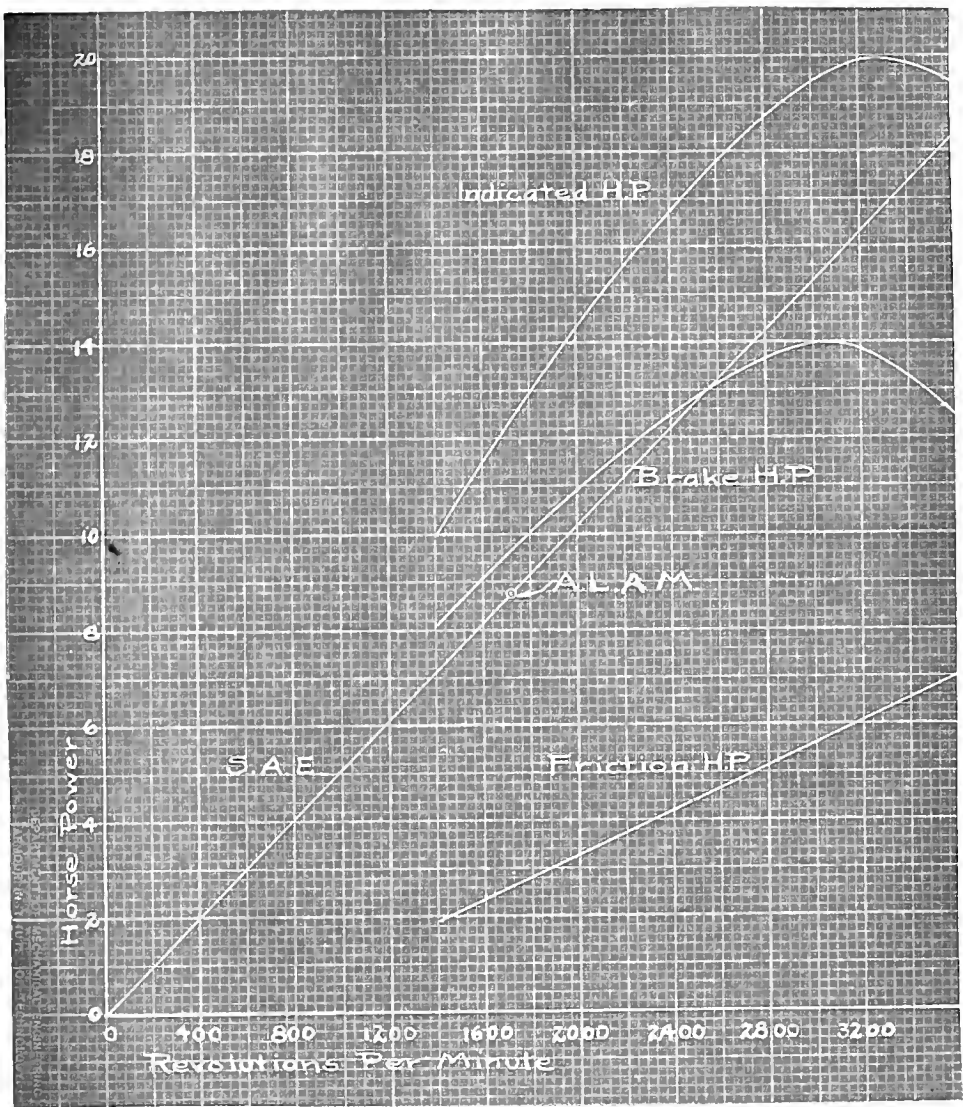




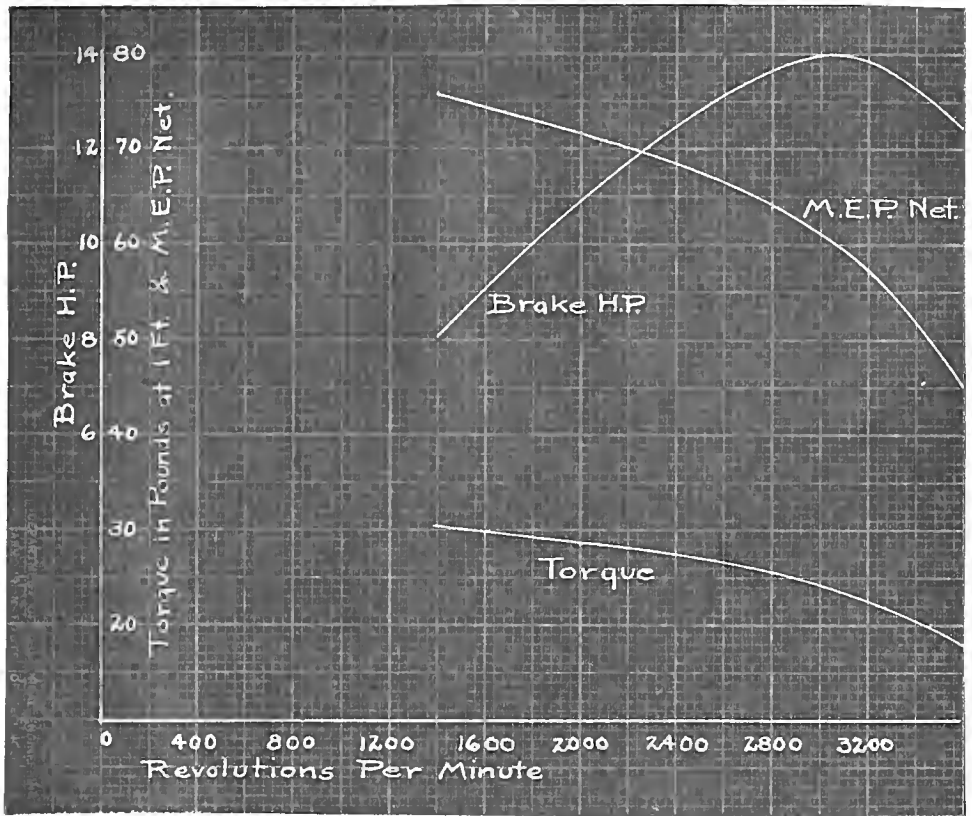
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920

1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931

1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942



Date	Description	Debit	Credit
1910			
12	Balance		100.00
13	...	50.00	
14	...	25.00	
15	...	15.00	
16	...	10.00	
17	...	5.00	
18	...	2.00	
19	...	1.00	
20	...	0.50	
21	...	0.25	
22	...	0.12	
23	...	0.06	
24	...	0.03	
25	...	0.01	
26	...	0.00	
27	...	0.00	
28	...	0.00	
29	...	0.00	
30	...	0.00	
31	...	0.00	
32	...	0.00	
33	...	0.00	
34	...	0.00	
35	...	0.00	
36	...	0.00	
37	...	0.00	
38	...	0.00	
39	...	0.00	
40	...	0.00	
41	...	0.00	
42	...	0.00	
43	...	0.00	
44	...	0.00	
45	...	0.00	
46	...	0.00	
47	...	0.00	
48	...	0.00	
49	...	0.00	
50	...	0.00	
51	...	0.00	
52	...	0.00	
53	...	0.00	
54	...	0.00	
55	...	0.00	
56	...	0.00	
57	...	0.00	
58	...	0.00	
59	...	0.00	
60	...	0.00	
61	...	0.00	
62	...	0.00	
63	...	0.00	
64	...	0.00	
65	...	0.00	
66	...	0.00	
67	...	0.00	
68	...	0.00	
69	...	0.00	
70	...	0.00	
71	...	0.00	
72	...	0.00	
73	...	0.00	
74	...	0.00	
75	...	0.00	
76	...	0.00	
77	...	0.00	
78	...	0.00	
79	...	0.00	
80	...	0.00	
81	...	0.00	
82	...	0.00	
83	...	0.00	
84	...	0.00	
85	...	0.00	
86	...	0.00	
87	...	0.00	
88	...	0.00	
89	...	0.00	
90	...	0.00	
91	...	0.00	
92	...	0.00	
93	...	0.00	
94	...	0.00	
95	...	0.00	
96	...	0.00	
97	...	0.00	
98	...	0.00	
99	...	0.00	
100	...	0.00	



11111-

The following table shows the results of the tests conducted on the various types of paper used in the tests. The results are given in terms of the percentage of the total weight of the paper which is lost in the tests. The results are given in the following table:

Type of Paper	Percentage of Weight Lost
Standard Paper	1.5%
High Quality Paper	2.0%
Low Quality Paper	3.0%

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CONCLUSIONS

The following table shows the results of the tests conducted on the various types of paper used in the tests. The results are given in terms of the percentage of the total weight of the paper which is lost in the tests. The results are given in the following table:

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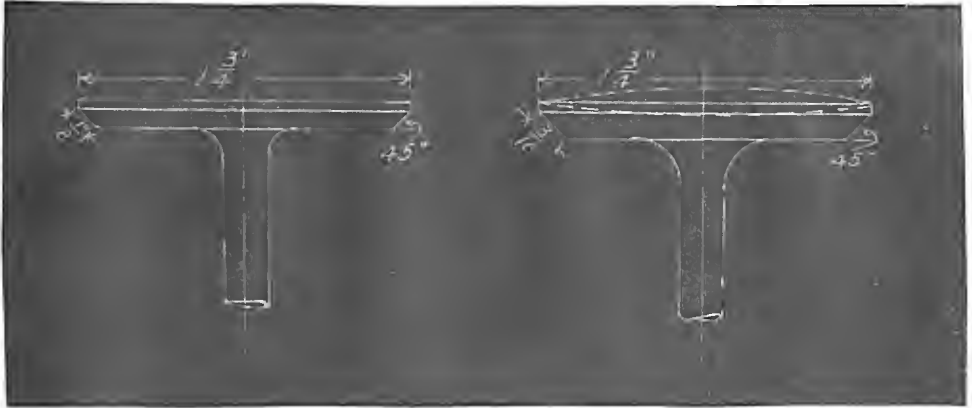
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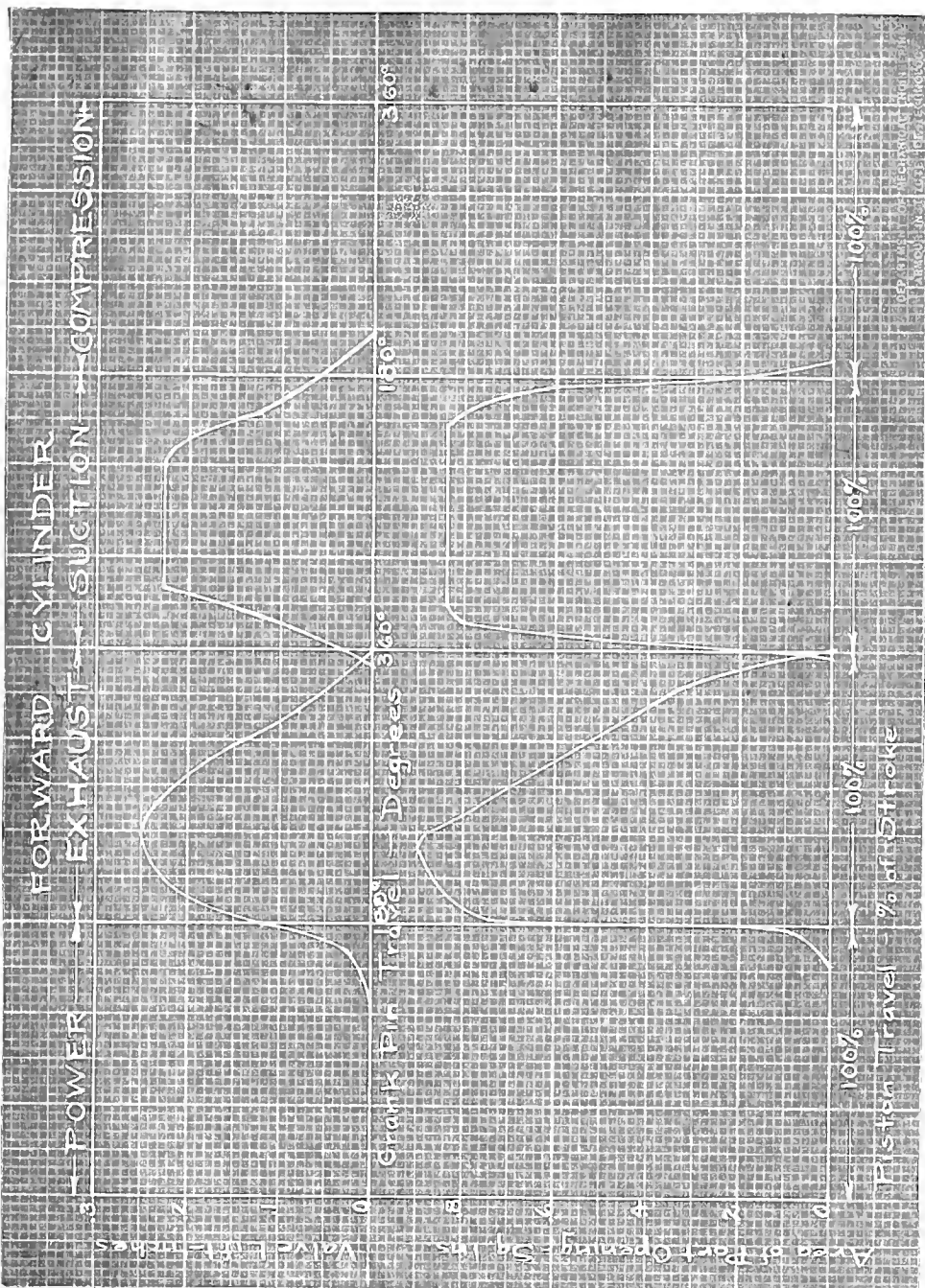


INLET

OUTLET

VALVES 1 IN LEAF-SHAPED PIPE

FIGURE 13a.



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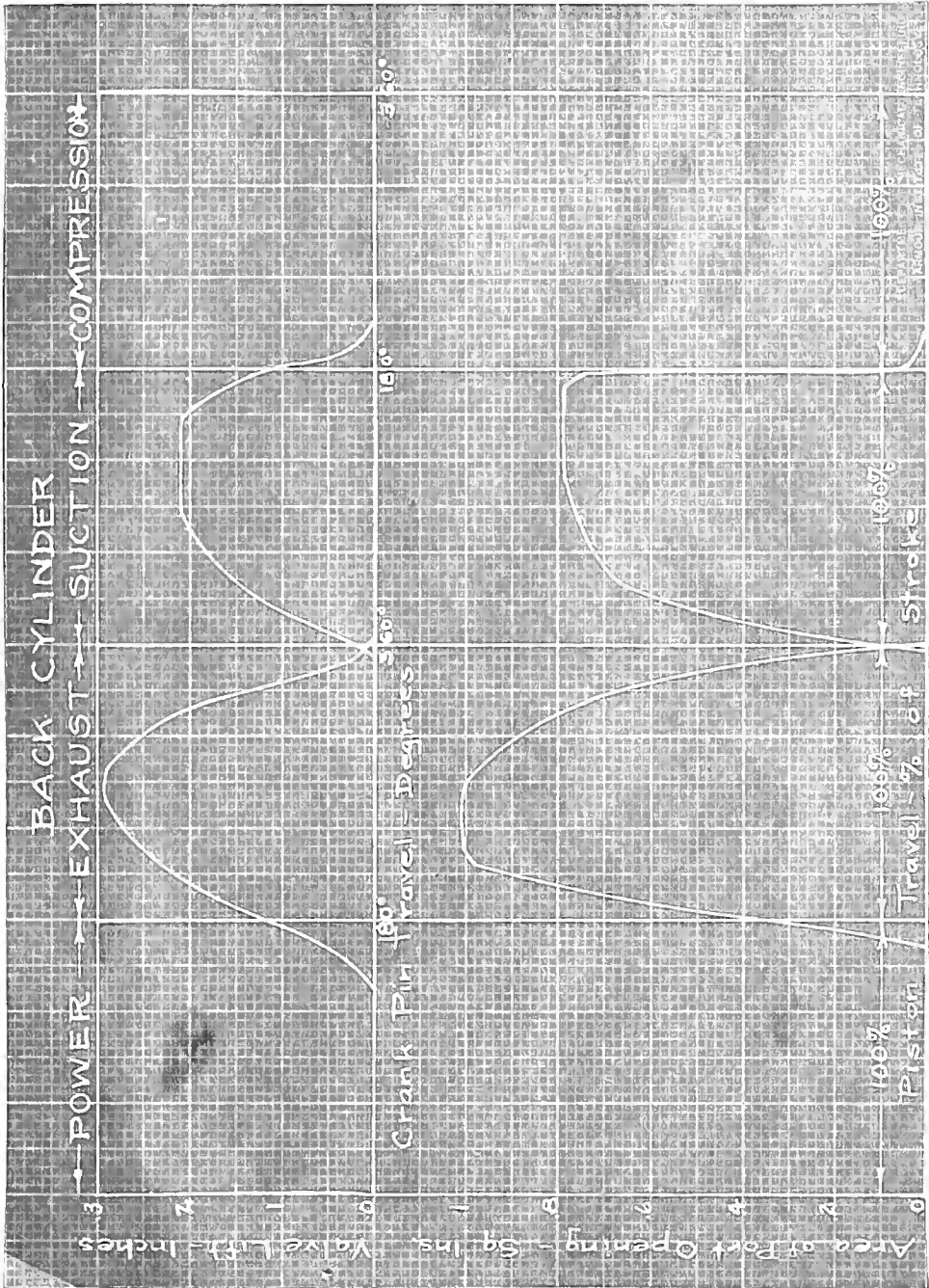
Table 1.17 - 1970 - 1971

Table 1.17.1 - 1970 - 1971

Year	1970	1971	1972
174			
175			
176			
177			
178			
179			
180			
181			
182			
183			
184			
185			
186			
187			
188			
189			
190			
191			
192			
193			
194			
195			
196			
197			
198			
199			
200			

Table 1.17.2 - 1970 - 1971

174			
175	.05	.116	0.5
176	.10	.379	0.5
177	.17	.502	0.5
178	.21	.794	1.0
179	.27	.974	1.7
180	.39	1.150	3.6
181	.50	1.352	4.0
182	.58	.910	3.5
183	.61	.747	3.2
184	.40	.808	2.4
185			1



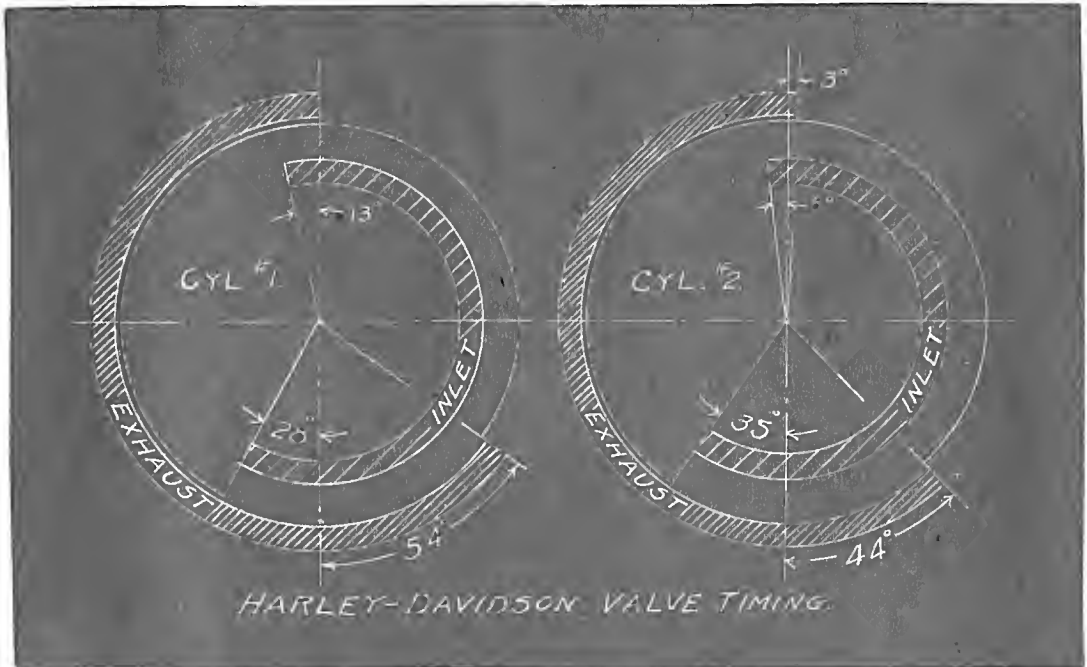


FIG 177 81.

THE SHOR IN TABLES.

Perhaps the first thing which struck the observers of these two tests was the necessity of having an engine stand of sufficient mass to damp out excessive vibration. In testing the Thor engine, this vibration was never so dead 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 clanging it to imbedded iron shots (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 surting thru the carburetor 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.M.P. rating un-









