A STUDY OF THE INFLUENCE OF DIFFERENTIAL PRESSURES IN INTAKE-MANIFOLD BRANCHES UPON DEVELOPED ENGINE HORSEPOWER

By

William Earl Bishop

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan
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THESIS

WILLIAM E. BISHOP ABSTRACT

It is difficult to find any major engine component or assembly which can be as indeterminate in design as the induction system. Although practices in induction system design have changed very little, much new information is still necessary.

The main object in this experiment is a study of the relation between intake-manifold branch pressure differential and developed engine horsepower. Differential pressures are measured for each cylinder between the base of the carburetor and the intake port. Indicated horsepower is recorded for the same operating conditions. Four different manifold systems were tested with the throttles at fixed positions and increments in r.p.m. were varied by a change in load. The performance characteristics of the engine for each intake manifold system may help to distinguish the most effective system with particular emphasis on output.

There is not a specific variation or a definite relationship between pressure differential and developed engine horsepower. There are other variables present that affect the state of distribution. Load, r.p.m., and flow rate are the most important of these.

The developed horsepower will be more uniform when the load and r.p.m. are high. At low r.p.m. and high load, the developed horsepower will be higher per cylinder, if the pressure differential is high with the low pressure end of the differential located at the intake port. This does not imply that the developed horsepower will only be a maximum under those conditions. The same high horsepower can be obtained with a low pressure differential with the valve having the higher pressure. This is most likely due to the liquid end of the fuel particles that enter the cylinder at that time.

The liquid fuel particles do not have a definite flow pattern. Under assumed low volumetric efficiency conditions, the minimum velocity in the largest intake manifold branch is slightly less than 10 feet per second. The minimum carrying velocity for a liquid fuel of the specific gravity of gasoline is 2 feet per second.

At high flow rates, the pressure differential has little effect on the developed horsepower, and the ramming effect is almost always present. When the ramming effect is not present, the absolute pressure is high enough to obtain an adequate flow to the cylinder.

The load factor shifts the point where ram initiates. As the load is increased the r.p.m. where ram starts is reduced.

WILLIAM E. BISHOP ABSTRACT

The performance curves for each induction system vary little for engine speeds below 3800 r.p.m. Further increases in r.p.m. exhibit a little more variation.

In brief summary, when ramming effect is present, the developed horsepower will be high per cylinder. When ramming effect is absent, the horsepower is usually lower. Under an absolute pressure analysis, if the absolute pressure is high at the intake port, the developed horsepower will be high.

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INTRODUCTION

It is difficult to find any major engine component or assembly which can be as indeterminate in design as the induction system. Although practices in induction system design have changed very little, much new information is still necessary. The design engineer cannot say, "These are the requirements we must meet, and the induction system will be designed in this way." One cannot predetermine with any exactness the configuration or size of an induction system. This unit is usually built by trial and error.

In design it is known that a carburetor directly connected to an intake port in a single cylinder engine will give higher horsepower per cubic inch than a multicylinder engine fitted in a like manner. This might be attributed to the elimination of an intake manifold, where an increase in charge resistance is encountered. This may not be the situation, but little material is presented on induction systems in the literature. The few articles that are presented are old with reference to updraft carburetion, where riser velocities have a minimum for good fuel entrainment. Charge rebound and accompanying precipitation of fuel within the manifold are important factors in charge resistance. Practically all modern engines use downdraft induction systems and it is the opinion of this author that the requirements for updraft carburetion do not become requirements for downdraft carburetion.

HISTORY

The function of a carburetor is to proportion the fuel to the air stream and break up the fuel into small droplets so it can be carried by that air stream. The resulting combustible mixture should be homogeneous and suitable for positive and economical operation of the engine.

As the air velocity past the jets increases, the fuel particles discharged from the jets become smaller and the proportion of large particles decreases, giving better mixture conditions at the carburetor. The condition of the mixture at the cylinder depends upon the shape of the manifold, the velocity of flow, and the heat energy imparted to the mixture. The intake manifold should distribute the carburetor mixture to all cylinders in equal proportions or maintain the same mass flow to all cylinders. There is not a manifold designed which can accomplish this throughout the range of operating conditions.

The following are some of the conditions or restrictions placed on the design of an induction system.

Relative engine load is one of the most important factors affecting the performance of the intake manifold. Dilution of the fresh charge by residual exhaust gas varies inversely with engine load. For example, at constant speed when operating at high load, there is more fuel-air mixture inducted per cycle into each cylinder than at low load. The degree of dilution in each cylinder varies from cycle to cycle as the exhaust pressure in each cylinder causing the dilution varies from cycle to cycle. Therefore, it is almost impossible to induct equal quantities of fuel and air into each cylinder.

The particular purpose for which the engine is designed has an effect. High-output engines require large flow areas and a fine dispersion of the fuel in the mixture or the so-called dry-mix. Engines designed for good economy can use small flow areas with their resulting higher velocities which will support a wet-mix. The requirement of a wet mix is that the quantity of fuel admitted to the air stream must be such that at the end of compression, all fuel is vaporized.

The firing order has a large effect on the process of induction. Too many cylinders drawing mixture from the same branch successively promote unequal distribution, particularly at part throttle and light load. Reversals of flow in branches cause drop-out of fuel droplets from the mixture. By trial and error, it has

been established that not more than three cylinders may fire in any one branch without materially affecting the distribution of charge. Manifolds are designed for a minimum of reversals.

The clearance gases flash back into the intake manifold upon opening of the intake valve, and cause a reversal of flow. At the same time, if the exhaust manifold pressure is high, it will impede the flow of mixture. Valve overlap has an important relation in this respect. The higher the valve overlap, the more there is a chance for blow-back into the manifold. This flash-back or blow-back dilutes the incoming charge, or if it does not return to the same cylinder, it will cause a rich mixture there, and a lean mixture elsewhere. Once the cylinder pressure is reduced below that of the manifold the flow of mixture will start. Available time for charging of any cylinder is lessened by any factor which creates a resistance to the mixture flow. Therefore, less charge can enter that cylinder.

A circular sectional area will have the least flow resistance, but minimum surface area is not always a desirable feature. If the mixture is wet, heating of the mixture might be desirable so that the precipitated liquid fuel can be returned to the mix. Entrainment of the fuel is never complete, so some provision should be made to aid the return of the precipitated particles to the mixture.

The separation of the mixture in the manifold begins at the manifold tee. Because of the inertia of heavy particles, a puddle of fuel will form at the base of the tee, and this section should be level and perpendicular to the flow axis, so that the liquid fuel will not flow more into one branch than into the other, by gravity or inertia action. If this occurs, one branch will be rich and the other will be lean, indicating poor distribution. This perpendicular section is usually heated by the exhaust gas so that a limitation is imposed upon the amount of fuel than can collect. This also aids in making the mixture more homogeneous. The section below the tee may be a depression in the manifold so that the forward motion of the vehicle will not cause the liquid fuel to flow to the rear branch by inertia. This rear branch can be elevated slightly to limit the liquid flow. This applies to long straight branches of a manifold that are found in large in-line engines.

The throttle valve prohibits a uniform mixture in the riser section, especially at part-throttle operation. The fuel particles will be deflected from the throttle valve to one side of the riser and will tend to flow into the branch connected at that point.

This enrichens the cylinders fed by this branch. When this occurs, the best condition of mixture distribution for economy is to have one rich cylinder and the rest receive a uniform mixture. The poorest condition for economy would be the inverse, where one cylinder is lean and the rest receive the same mixture. With one lean cylinder the mixture ratio must be enriched in order to fire the lean cylinder and the balance of the cylinders will receive excessive amounts of fuel.

Maximum power mixture ratios with gasoline as fuel are in the vicinity of 12.5:1, where maximum economy mixture ratios vary from 13:1 to 20:1. The combustible range in mixture ratio is about 7:1 to 20:1, dependent upon the particular engine characteristics. Some engines will run satisfactorily on a 16:1 or higher mixture ratio, while another of the same design will not fire the same mixture continuously without missing.

BRIEF STATEMENT OF THE PROBLEM

The main object in this experiment is a study of the relation between intake-manifold branch pressure differential and indicated horsepower. Differential pressures are measured for each cylinder between the base of the carburetor and the intake port. Indicated horsepower is recorded for the same operating conditions. In testing, the throttle was fixed and increments in r.p.m. were varied by a change in load. Four manifolds were tested so that the conclusions will not be judged by the operation of any one intake manifold. All data recorded in the Appendix are not the average data, but the values which were the most consistent. Performance characteristics of the engine for each intake manifold installation may help to distinguish the most effective induction system with particular emphasis on output.

CONCLUSIONS

There is not a specific variation or a definite relationship between pressure differential and developed engine horsepower. There are other variables present that affect the state of distribution. Load, r.p.m., and flow rate are the most important of these.

The developed horsepower will be more uniform when the load and r.p.m. are high. At low r.p.m. and high load, the developed horsepower will be higher per cylinder, if the pressure differential is high with the low-pressure end of the differential located at the intake port. This does not imply that the developed horsepower will only be a maximum under these conditions. The same high horsepower can be obtained with a low-pressure differential with the valve having the higher pressure. This is most likely due to the liquid end of the fuel that enters that cylinder at that time. In other words, when ramming effect is present, the developed horsepower will be high. When ramming effect is absent, the horsepower is usually lower.

At high flow rates, the pressure differential has little effect on the developed horsepower. Under conditions of high flow rates, the ramming effect is almost always present. When it is not,

the absolute pressure is high enough to obtain an adequate flow to the cylinder.

The load factor shifts the point where ram initiates. As the load is increased, the point where ram starts is reduced. For an example, operating at 1/4 throttle opening and 2000 r.p.m., the point where ram starts might be 2500 r.p.m. Upon opening the throttle for higher load and holding the r.p.m. at 2000, the point where ram starts will be lower than 2500 r.p.m.

The liquid-fuel particles do not have a definite flow pattern. Under assumed low volumetric efficiency conditions, the minimum velocity in the largest intake manifold branch is slightly less than 10 ft./sec. The minimum carrying velocity for a liquid fuel of the specific gravity of gasoline is 2 ft./sec. From this, drop-out of the liquid end will not occur except by an instantaneous zero velocity from reversals of flow or intermittent flow. The control of liquid fuel is of major importance in obtaining high brake mean effective pressure and volumetric efficiency curves.

Performance curves were drawn for all conditions of operation. The only curves that can be compared are the full throttle curves, as the load varied from one manifold to another at the same part-throttle opening. These curves can be adjusted for comparative performance, but the pressure differential cannot be adjusted. The data for pressure differential must be taken under operating conditions.

The full-throttle brake horsepower curves for all induction systems fall within a 1 percent variation for engine speeds below 3800 r.p.m. Further increases in r.p.m. exhibit a little more variation. The brake specific fuel consumption varied between manifolds. The miles per gallon would not be a measuring device as each manifold has its own advantages, dependent upon the range of r.p.m. desired.

In comparing the friction horsepower curves of all manifolds at full throttle, the dual-carburetor manifold was expected to be the least. This is not true; the larger cross-sectional area manifold, the quad, was the lowest in frictional horsepower. One could assume from this that cross-sectional area and internal surface are more important to frictional resistance than the length of flow path, at least in the testing range of this experiment. This might not be true at higher r.p.m.

Performance is higher in the quad. manifold when operating at 3/4 throttle, than when operating at full throttle. Throttling of mixture must occur at the intake valve or the displacement is not high enough to cause higher flow rates.

The quad. carburetor adapted to the standard manifold had no apparent effect on the performance of the engine. The fuel consumption was a little higher, but the output compared to the rest of the manifolds. The frictional horsepower was the same as the standard manifold and carburetor.

In brief summary, under an absolute pressure analysis, if the absolute pressure is high near the valve, the developed horsepower will be high.

DISCUSSION OF PROBLEM

The particular problem in this experiment is the relationship between the differential pressure and the developed horsepower of each cylinder. The differential pressure is that change in pressure that occurs between the base of the carburetor and the intake port. This is completely within the limits of the induction system.

This is not a discussion of the mixture ratio produced by the carburetor, except to assume the carburetor will meter the fuel uniformly, regardless of the actual mixture ratio. This is a discussion of the distribution of the mixture to each cylinder and the determination of the influence of pressure change on developed horsepower. The mixture ratio in each cylinder is not measured, but if the developed horsepower of each cylinder is equal to that of the other cylinders, one might assume their mixture ratios are similar. The pressure differential could reflect this condition.

The optimum condition in the operation of an induction system will be when the maximum possible weight of mixture passes the intake valve. The mixture should be as close to atmospheric pressure and temperature as possible. When any fluid flows through a closed channel, there is always some pressure loss caused by friction against the wall surface and a pressure loss by shear of adjacent layers of fluid which move at different velocities.

The Reynolds number is always sufficiently high so that streamline flow is almost an impossible situation. Operation is almost entirely in the turbulent range of the Reynolds number, but at very low r.p.m., the intermediate condition is sometimes obtained. When operation is within this region, the flow is pulsating so that all the variables present are not constant. Any unbalance will tend toward the turbulent condition which is the usual state. Therefore, a pressure loss from turbulence within the fluid caused by irregular, nonstreamline flow is a factor which will limit the weight of charge that can enter any cylinder.

These pressure losses appear as heat in the mixture. The magnitude of the energy losses are dependent upon the type of fluid, the relative roughness of the flow path, the configuration and length of the flow path, the cross-sectional area of the path, and the rate of flow. There are too many variables present to be able to design a manifold for certain operational conditions. The effect of wall roughness and configuration cannot be predetermined; but for minimum pressure losses, keep all bends as streamlined as possible and the channel walls smooth. Pressure losses due to rate of flow, length of flow path, and the cross-sectional area can be calculated as the pressure losses increase with the square of the rate of flow.

Small cross-sectional area manifolds will have high velocity of flow throughout the range of r.p.m. Drop-out of entrained fuel will be less when pressures change by throttle control. Engine output at high r.p.m. is limited by the throttling effect of the small cross-sectional manifold.

In order for some of the past variables to enter into this problem, a dual carburetor manifold was chosen because of its different flow conditions, such as length of flow path and the rate of flow in that path. The cross-sectional areas are the same as in the standard production manifold, but the pressure losses should be one-fourth of those in the standard manifold. This is approximately correct because the rate of flow is reduced by the addition of another carburetor. If one can assume the rates of flow through each carburetor are equal, the pressure losses will be one-fourth of their original value with one carburetor. This in turn reduces

the mixture velocity and drop-out of liquid fuel will be higher at corresponding speeds. At very low speed, an over-carbureted condition may develop upon sudden opening of the throttle valves due to a large drop-out of liquid fuel by the sudden change in pressure in the intake manifold. At high r.p.m., there should be no loss of power by the throttling effect of the small manifold as the flow rates are about one-half of that in the standard manifold.

A manifold larger in cross-sectional area and a carburetor from a large displacement engine called a quad. carburetor and manifold was tested. This carburetor is designed so that one throttle, designated as the primary throttle, controls the rate of flow through the manifold until a particular opening of that throttle is reached. At this time, another throttle called the secondary throttle starts to open into the same branches fed by the primary. Both throttles reach the full open position simultaneously. This manifold being larger in cross-sectional area should exhibit properties between the dual-carburetor manifold and the standard manifold. It should be superior to the dual-carburetor manifold at low speed due to the higher velocity of flow. It should compare with the dual-carburetor manifold at high speeds if throttling in the manifold does not occur.

In order to determine the relative position or the more critical component in the induction system, an adapter was made to fit the large quad. carburetor to a standard manifold of smaller cross-sectional area than the carburetor. Even though the primary purpose of this investigation is to determine the effect of pressure differential on developed engine horsepower, the performance of the above manifold and carburetor should give valuable information, especially if the maximum horsepower compares with the rest of the intake manifolds.

CHOICE OF OPERATING CONDITIONS

The effect of differential pressures on the output of each cylinder is the prime objective. Therefore, the operating conditions should be such as to indicate a wide range in pressure differential. The brake mean effective pressure and the volumetric efficiency are affected at low speeds by low flow rates, and these can be aggravated by more blow-back in the intake manifold. A longer intake-valve opening duration, where the intake valves close later and open sooner, should exhibit more blow-back. At the same time, a longer overlap between intake and exhaust valves should give poor low-speed performance. These conditions should increase the limits of pressure differential.

The compression ratio was increased to insure complete vaporization of the mixture upon compression by the corresponding increase in compression temperature and pressure.

Variable speed testing appeared to be more suitable with this type of installation than constant speed. The throttle opening was held to a predetermined value and the r.p.m. was controlled by a change in load.

An eddy-current dynamometer was used for absorbtion of torque and the indicated horsepower was determined by the short circuiting of one cylinder and then summed for the total. The indicated horsepower of one cylinder was determined by the difference in brake horsepower at the same speed when all cylinders were firing and when one cylinder was shorted. The result was the indicated horsepower of the shorted cylinder. The friction horsepower, determined by the difference between indicated and brake horsepowers, will be close to the actual value as engine operation more nearly approaches the firing conditions of all cylinders.

Four manifolds were tested with the following throttle opening:

Standard Manifold: 1/8, 1/4, 1/2, 3/4, and full throttle;

Dual-Carburetor Manifold: 1/16, 1/8, 1/4, 1/2, and full throttle;

Quad. Manifold with the secondary throttle opening at 1/2 Primary Throttle: 1/8, 1/4, 1/2, 3/4, and full throttle;

Quad. Carburetor adapted to a standard manifold with the secondary throttle opening at 1/4 Primary Throttle: 1/8, 1/4, 1/2, and full throttle.

For additional information on the quad. manifold and carburetor, the secondary throttle was adjusted to open at 1/4 primary

and data taken for the following throttle openings: 1/8, 1/4, 1/2, and full throttle.

The throttles of the dual carburetors were synchronized so both would open simultaneously. The throttle positions started at 1/16 throttle opening in the hope of coming close to the same load as that obtained when the throttles of the other carburetors were open at 1/8 throttle.

Another test with the dual carburetors would be to operate the throttle of the first carburetor while the second is in idle position and then let the throttle of the second carburetor open to the same position as the first when speed of maximum torque is reached. This procedure should reduce the overcarbureted condition that occurs when both carburetor throttles are synchronized.

When the large quad. carburetor was installed on a small displacement engine, the velocity of flow through the carburetor would be lower and a lean mixture could result, especially at low r.p.m. Due to larger metering jets, the mixture may have been on the rich side.

Perhaps some of the above conditions or hypotheses could be proven from the pressure analysis and the performance characteristics.

PROCEDURE

In order to limit the number of variables that might enter into this project from the operation of the engine itself, the engine was completely rebuilt and the following components replaced or reconditioned:

Rebore to 0.080 inch oversize.

New pistons and chrome rings (4 ring piston).

New crankshaft and bearing inserts.

New wrist pins and pin bushings.

New timing gears and reground camshaft.

New valve springs and valve guides.

Valves reconditioned.

Valve seats reconditioned.

Connecting rods checked and aligned.

The clearance volume of each cylinder was checked so that the developed horsepower of each cylinder would be compared. By calculation, if 0.003 inch was removed from one cylinder head, the clearance volumes would be very close. For an increase in compression ratio, 0.045 inch was machined from one head and 0.042 inch from the other. The resulting clearance volumes were the

same for six cylinders and varied one ml. above and two ml. below for the other two cylinders. This little variation should not alter the compression ratio in each cylinder appreciably.

The error would be less than 0.5 percent if the measurements were close.

Before assembly of the engine, the intake ports were polished, then bored and tapped for tubing connections. These are the static pressure taps and were located as near to the intake valve as possible, but in such a position on the outside of a long radius bend that they were not near a stagnation point or an eddy-current center. These pressure taps were drilled for an 0.051-inch orifice to limit the flow and fluctuation of the liquid in the U tube manometers.

The engine was connected to the dynamometer and the dynamometer was corrected and adjusted for balance. The scale reading was twice the actual applied force.

The standard intake manifold was tapped for static pressure measurements in each branch of the riser section and as close to the base of the carburetor as possible. The change in the direction of the airstream by the throttle valve could cause a velocity pressure at the orifice of the pressure tap. Thus, the static pressure taps were located at the side of the throttle valve to eliminate direct impingement of the airstream on the pressure tap. These pressure taps also were drilled for a 0.051-inch orifice, but later changed to a larger size to reduce the loss of measuring liquid in the manometers by sudden changes in static pressure from acceleration of the engine. All manifolds were equipped in the same manner, although orifice size varied in some.

In order to obtain data quickly and efficiently, the performance tests were run first where atmospheric conditions have a great influence on final results. All correction factors were according to S.A.E. specifications. The following data were recorded for the performance tests:

Throttle Opening

r.p.m.

Beam Load--lbs.

Pressure Differential--"H_2O (C and V refer to the point of lower pressure.)

Cylinder Number - 1
4
6
7
2
3
5
8

Oil Pressure--#/"

Jacket Temp.--°F

Intake Vac.--''Hg

S.P. Adv.--°BTDC

Exhaust Press., L.B.--''Hg
R.B.--''Hg

Weight of Fuel--oz.

Revolutions--

Time of Rev.--Min.

Fuel Temp.--°F

Dry Bulb Temp.--°F

Wet Bulb Temp.--°F

Bar. Press.--''Hg

Some of the data were not used in this experiment, but might prove useful for someone who might have another approach to this problem or a similar project.

In this problem, atmospheric conditions do not have an effect on the determination of indicated horsepower per cylinder as a comparison or trend between the pressure differential and indicated horsepower per cylinder as a comparison or trend between the pressure differential and indicated horsepower is the object. It is not necessary to use a correction factor on the indicated horsepower per cylinder.

Further data were taken for the evaluation of friction horsepower and indicated horsepower per cylinder, and the classification follows:

Throttle Opening--same as performance tests.

r.p.m.--same as performance tests.

Beam Load--all cylinders firing---#

Beam Load--#1 cylinder grounded---#

Beam Load--#2 cylinder grounded---#

Beam Load--#3 cylinder grounded---#

Beam Load--#4 cylinder grounded---#

Beam Load--#5 cylinder grounded---#

Beam Load--#6 cylinder grounded---#

Beam Load--#7 cylinder grounded---#

Beam Load--#8 cylinder grounded---#

Beam Load--all cylinders firing---#.

DESCRIPTION OF APPARATUS

The absorption unit was a Midwest Dynamatic Dynamometer of the eddy-current type. It had a water-cooled field with a heat exchanger and circulating pump. The horsepower rating was 175, and the operating constants were as follows:

$$HP = \frac{(\text{Beam Load})(\text{r.p.m.})}{8000}$$

Torque = (0.6565)(Beam Load) in ft. #

The torque arm is 15.756 inches. The electrical input to the dynamometer is supplied from either a D.C. line or the control panel where close regulation is possible.

The r.p.m. indicator, the revolution counter, and the clock are a synchronized assembly, operating from the dynamometer and an electrical source.

The jacket temperature of the engine was controlled by a heat exchanger where the flow of cooling water is manually operated. An automobile radiator was submerged in a tank and the cooling water flowed around the core of the radiator.

The exhaust system had an external water jacket, but this was only a safety feature to guard against burning to anyone who might touch it.

DESCRIPTION OF TEST RESULTS

Discussion of Figures 1-22

This section is not intended to credit or discredit the performance of any particular induction system, but only to describe and perhaps clarify any inconsistencies that might appear in each system. Due to the radical change in valve timing, some of the results good or bad might be assessed to the induction system, when they are actually an internal effect. Each curve will not be discussed. Only those curves that have peculiar shapes will be discussed with a possible explanation to each. Some of the curves do not apply directly to this investigation, but are presented so that anyone who is interested in another phase of investigation may have the data to work from. A complete listing of the curves appears in the List of Figures. These figures are arranged in numerical order and appear at the end of this section. The range of r.p.m. was not sufficiently high to cause an intersection of some curves or a definite drop in performance.

In Figure 1, the no-load speed is approximately 1850 r.p.m., where an intersection of the friction horsepower and indicated horsepower curves will occur and the torque and brake horsepower curves simultaneously go to zero. This is not shown in Figure 1, as the maximum r.p.m. reading is 1600.

In Figure 2, the indicated horsepower curve has a definite dip at 2000 r.p.m. This is due to a rotational inertia unbalance. At the time of testing, a pronounced roughness at 1050 r.p.m. was exhibited and the same condition was noticeable at 2100 r.p.m., but the amplitude of vibration was not as high.

The indicated horsepower and torque curves have a dip in Figure 3, and this is reflected on the brake-horsepower curve as a flat spot, all in the range of 3000 to 3500 r.p.m. A roughness of operation was not apparent, but might have been dampened due to the large flywheel effect caused by the heavy stator in the dynamometer.

The torque curve of Figure 5 has a very definite dip at 1000 r.p.m. In Figures 3 and 4, this is not apparent as the initial reading was taken at 1000 r.p.m. where the dip should occur. If the initial reading was 500 r.p.m. as in Figure 5, more definite conclusions could be drawn at the 1000 r.p.m. reading. Inertia unbalance is the probable cause for the loss of horsepower and torque.

The torque and indicated horsepower curves exhibit a slight loss of performance in the range of r.p.m. from 1500 to 2000, Figure 6. This loss is reflected in Figure 7, but the r.p.m. range is a little higher.

All of the curves in Figures 8, 9, and 10 are smooth except the indicated horsepower curves in Figures 9 and 10 around 3600 r.p.m. This was probably due to the high frictional horsepower at this speed. A small percentage of error in the calculations involving the indicated horsepower for each cylinder will account for a larger percentage of error in the corrected indicated horsepower totals. Larger values are obtained at higher r.p.m., as the indicated horsepower varies directly with the r.p.m., at least within 10 percent of maximum r.p.m. If these indicated horsepower dips were caused by harmonic vibrations, these vibrations were small in magnitude and the lower harmonics do not appear in the results where the amplitudes were necessarily much higher. The exhaust back pressure suddenly increased at this point (no longer a linear variation with r.p.m.), but for that increase the output was not reduced to any great extent. This particular condition must have been a combination of factors, at least more evidence is necessary for a more definite explanation.

The performance curves for the quad. manifold covering Figures 11 to 15 have few ranges that are not smooth. In Figure 12, the torque and indicated horsepower curves have slght dips at 2000 r.p.m. Figures 14 and 15, the dips occur on torque, indicated horsepower and brake horsepower curves at 3000 r.p.m. The reason again was inertia unbalance where the higher harmonics gave rise to the loss of horsepower and torque.

Figures 16 to 19 refer to the special manifold where the quad. carburetor was adapted to a standard manifold. In Figure 17 at 2000 r.p.m., the indicated horsepower and torque curves show a decrease in performance and the same is true in Figure 18, but occurs at 3100 r.p.m. with the addition of the brake horsepower curve and its flat section. This was due to inertia unbalance.

Figures 20, 21, and 22 indicate the same conditions of operation as the previous figures except for the brake horsepower curve in Figure 22, where a flat spot covers a wider range in r.p.m., from 2300 to 4200.

At the time of testing there were several possible explanations for the configurations of the curves just discussed. Some merited further investigation, but most had some disadvantages. Some of these theories follow.

Torsional vibration of the crankshaft could be the cause where the second harmonic is approximately 900 r.p.m., the fourth harmonic at 1800 r.p.m., and the sixth harmonic at 2700 r.p.m. If this were true, the vibration would occur at these r.p.m. readings regardless of throttle position and load. The resonant condition seemed to vary with load. When the load and r.p.m. readings were high with wider throttle openings, the lower r.p.m. ranges with the high load did not exhibit the same magnitude of vibration as the light load condition. If the vibration was present there must have been an unknown damping factor which limited the magnitude of vibration. At very light loads the point of resonance was at low r.p.m. and was not present at high r.p.m. The intermediate condition of load and throttle position may exhibit resonance at mid r.p.m. range and again in the high r.p.m. range. The low r.p.m. range seldom showed a resonant condition.

Another possible solution was column vibrations from periodic rebounds in the long exhaust system. This should give a sudden increase in exhaust back pressure by reinforcement of the sound waves. The data on exhaust pressure does not support this theory at all resonant conditions.

The intake manifold might have had column vibrations but they would have been very short in wave length. The time element for the rebounds of the sound waves would be very short to travel from the intake valve to the carburetor and back again when the intake valve is in the exact opposite position in the succeeding cycle. Atmospheric conditions and variable charging pressures should vary the results from day to day. This is not apparent from the data. For the above condition any change of any variable would upset the timing of the sequence and the column vibrations would not annihilate each other. A reinforcement of these waves would cause a gain in horsepower from a psdueo-supercharger.

Due to blow-back in the manifold at low r.p.m., the mixture ratio might have been the variable giving low performance from improper mixture. The higher r.p.m. ranges might have been a transient condition in mixture ratio or poor carburetor characteristics. This cannot be true, as the various manifolds had flat spots or dips at the same r.p.m. changes. The products of combustion were analyzed by an engine analyzer and the mixture ratio was always within the combustible range.

After testing was completed, all rotating masses were balanced and this removed the roughness at all engine speeds except the 1000 r.p.m. condition. At this point, the magnitude is very small in comparison to the roughness at the time of testing. Number seven piston was heavy. Holes were drilled in the skirt so that all pistons were of the same weight.

Discussion of Figures 23-56

A description or discussion of the curves in this section is impractical as one curve in itself will not support any conclusions that might be drawn from the trend of pressure differential. Instead, these curves have value as reflections of other curves that are not drawn.

The brake mean effective pressure curve indicates the general shape of the volumetric efficiency curve. These curves are almost an exact duplication of one another at low and medium speed. The breathing efficiency of an engine is a direct measure of the brake mean effective pressure if friction is not considered. The trend of mixture ratio is indicated by the brake mean effective pressure. If the mixture ratio is toward the lean, low output results or low brake mean effective pressure and high brake specific fuel consumption is obtained.

The weight of the charge is reduced as the engine speed increases because higher velocities are necessary to move more charge to the cylinder. The higher velocities are caused by a

greater pressure drop in the induction system, resulting in lower cylinder pressures and therefore less weight of charge. The brake mean effective pressure curves should relate these conditions.

The pumping losses are part of the total friction horsepower and the trend of the mechanical efficiency curves should indicate the comparisons in these losses.

Data for demand horsepower curves were not recorded but miles per gallon curves were drawn for constant throttle openings. Vehicles operate at variable throttle, so one must not draw conclusions concerning vehicle performance directly from the miles per gallon curves. Comparisons between manifolds at the same throttle opening must be tempered by the load factor, as the load varied between manifolds at the same throttle opening and r.p.m.

The curves in Figures 42 to 56 are intended for general information. The comparison of these curves shows the trends of each characteristic upon opening and closing of the throttle.

Discussion of Figures 57-100

Figures 57 to 100 are arranged face to face with all operating conditions the same so that comparisons or trends can be drawn. Each line graph is drawn according to individual

induction systems, and only refer to those cylinders fed by one riser. All intake manifolds have at least two separate branch systems. The dual-carburetor manifold has four risers, but two small connecting passages join the risers in pairs.

These graphs have reference to the change in pressure within the extremes of the branch systems. With higher velocities of flow, a greater differential in pressure must exist between the atmosphere and the cylinder to accomplish adequate mixture flow in the short time available for charging. This is not measured by the internal pressure differential in which this problem is concerned.

Standard Manifold

Figures 57 and 58, 1/8 throttle opening. Cylinder number six has a higher than average indicated horsepower value and the pressure differential is less than average. Cylinder number five has a low developed horsepower value and an average value of pressure differential. The points of higher pressure occur at the valve.

Figures 59 and 60, 1/4 throttle opening. Cylinder number six has a high indicated horsepower and a low pressure differential. Cylinder number four has a high indicated horsepower and a high pressure differential. Higher pressures are located at the valve but are lower than previous figures.

Figures 61 and 62, 1/2 throttle opening. There is not much fluctuation in the developed horsepower except cylinder numbers six and seven are slightly higher than the rest. The pressure differential does not exhibit a very wide range, but cylinders six and seven are a little lower than average. The point of higher pressure fluctuates from one end of the induction system to the other. The ramming effect is just starting.

Figures 63 and 64, 3/4 throttle opening. The graphs of developed horsepower exhibit little variance. Cylinder number seven is high at 4000 r.p.m. The pressure differential is high for cylinder seven with the valve pressure the lower. Cylinder four has an almost constant pressure, but is higher than average throughout the range of r.p.m. Almost all pressure measurements show ram in good progress.

Figures 65 and 66, full throttle opening. The graphs are comparable to Figures 63 and 64, except the change in pressure is more gradual between r.p.m. increments. The developed

horsepower is higher and the pressure differential is higher. Ram is present at all conditions of operations.

Dual-Carburetor Manifold

Cylinder numbers 1, 6, 2, and 5 are fed by one carburetor, and 3, 8, 4, and 7 by the other carburetor. There are four risers and each feed two cylinders as follows: 1 and 6, 2 and 5, 3 and 8, 4, and 7. A small passage between risers connects the following cylinders in the branch systems: One system is 2 and 5, 3 and 8; the other system is 1 and 6, 4 and 7.

Figures 67 and 68, 1/16 throttle opening. A trend is not apparent in these figures. There is too much variation in pressure and developed horsepower.

Figures 69 and 70, 1/8 throttle opening. Cylinder number six has a comparatively low pressure differential and a low developed horsepower. Cylinder number seven has a low horsepower and the lowest pressure differential and shows ram at low r.p.m. The point of higher pressure is the valve end of the induction system.

Figures 71 and 72, 1/4 throttle opening. There is little variation between these figures and the previous figures. The developed horsepower is higher and the valve pressure a little lower.

Figures 73 and 74, 1/2 throttle opening. The developed horsepower is practically a constant for all cylinders. One riser section of one carburetor shows high valve pressures and the other riser, low valve pressures. The other carburetor has the same conditions. This must be due to flow resistance.

Figures 75 and 76, full throttle opening. The operating conditions are the same as the 1/2 throttle position. Developed horsepower is slightly higher, but the variations are also higher. The increased flow rate shows greater losses in cylinders 1 and 6, 3 and 8, but the output of all cylinders is not different.

Quad. Manifold

In this manifold the secondary throttles feed the same cylinders as the primary throttles.

Figures 77 and 78, 1/8 throttle opening. Cylinder seven has a lower than average developed horsepower and the pressure differential is low. Cylinder number eight has high output and the pressure differential gradually decreases with increase in r.p.m. This cylinder has high differential at low r.p.m. with the valve end of the induction system being the greatest. The increase in r.p.m. is accompanied with a lower pressure differential until the pressure is the same at both ends of the induction system. There is some fluctuation in the point of maximum pressure, but generally, the valve end is the higher.

Figures 79 and 80, 1/4 throttle opening. Cylinder number one has a low pressure differential and an average indicated horsepower. Cylinder number four has an average output and a high pressure differential. Cylinder number five has a low pressure differential and a high output. There is not definite point of maximum pressure, but varies between a range of 2'' H_2O differential around the 0'' H_2O differential point.

Figures 81 and 82, 1/2 throttle opening. (This is the position where the secondary throttles start to open.) One induction system has a high pressure differential with the valve end the higher for all values and the other system a low pressure differential with all values the lower at the valve end of the induction system. The later condition exhibits a more uniform distribution of developed horsepower and the pressure variation is very small around the 0'' H_2O value of pressure differential.

Figures 83 and 84, 3/4 throttle opening. Most of the values of pressure differential are fairly uniform for all cylinders and the valve end of the induction system is the lower. The developed horsepower is almost constant for all cylinders.

Figures 85 and 86, full throttle opening. The pressure differential changed slightly from the 3/4 throttle opening. The developed horsepowers are lower at low r.p.m. and have identical valves at higher r.p.m. There is evidence of throttling in the induction system.

Quad. Carburetor Adapted to a Standard Manifold
(the secondary throttle open at
1/4 primary throttle)

Figures 87 and 88, 1/8 throttle opening. Distribution of pressure differential is uniform and limited over a small range. In all cases the valve end of the induction system is the higher pressure. Cylinders one and four have low values of pressure differential and the developed horsepower is higher than average.

Figures 89 and 90, 1/4 throttle opening. There is a distinct variation in developed horsepower but there is no apparent direction or trend in the pressure differential as there is extreme fluctuation. The average pressure differential is high with the valve end of the induction system the higher.

Figures 91 and 92, 1/2 throttle opening. There is a uniform pressure variation with all values of pressure differential lower at the valves. The developed horsepower is regular with very good distribution, although cylinders seven and two have the lowest pressures. Ramming effect is present.

Figures 93 and 94, full throttle opening. The only differences between these figures and the past two figures are the extremes of variation. The output is higher and the range of pressure differential variation is greater, although the average numerical value is lower. Ramming effect is present.

Quad. Manifold
(secondary throttles open at 1/4 primary throttles)

Figures 95 and 96, 1/4 throttle opening. The pressure differential is evenly distributed for all cylinders. The developed horsepower is higher than average, but cylinder number seven is low with no pressure differential. Cylinder number four has a higher differential and an average output. Ram is present in some cylinders.

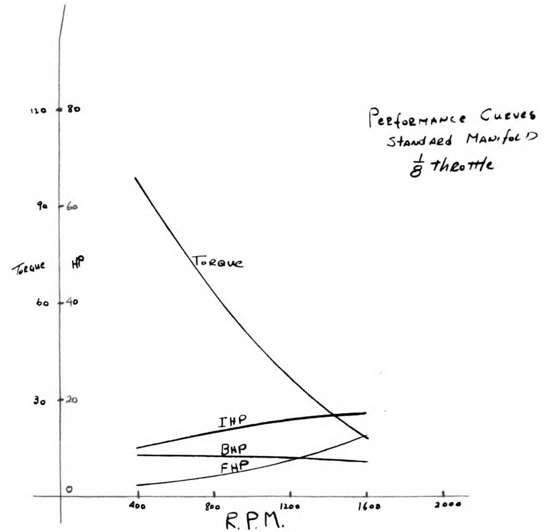
Figures 97 and 98, 1/2 throttle opening. One induction system feeding cylinders 2, 3, 5, and 8 has lower valves of pressure differential than the other induction system that feeds cylinders 1, 4, 6, and 7. The output of the former is higher than the output of the latter.

Figures 99 and 100, full throttle opening. The pressure differential is similar to that of the previous figures. The indicated horsepower is higher but regular from cylinder to cylinder.

PERFORMANCE CURVES

Figures 1-22

Indicated Horsepower
Brake Horsepower
Friction Horsepower
Torque



PERFORMANCE CURVES
STANDARD MANIFOLD
1/8 throttle
120
90
60
30
80
60
40
20
0
TORQUE
HP
TORQUE
IHP
BHP
FHP
400
800
1200
1600
2000
R.P.M.

FIG. 1

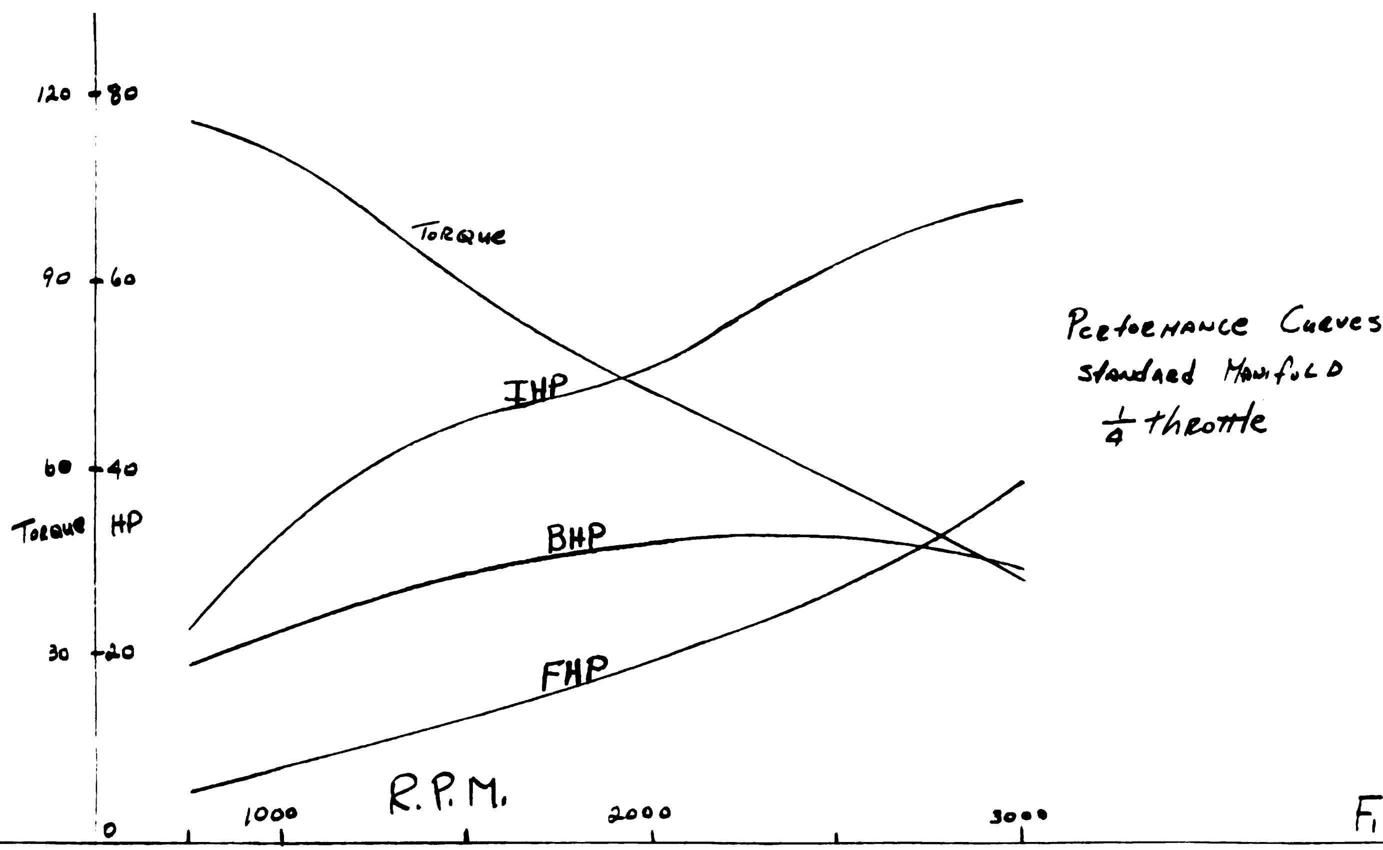

120 80
90 60
60 40
Torque HP
30 20
0
1000
2000
3000
R.P.M.
Torque
IHP
BHP
FHP
Performance Curves
standard Manifold
$\frac{1}{4}$ throttle

FiG. 2

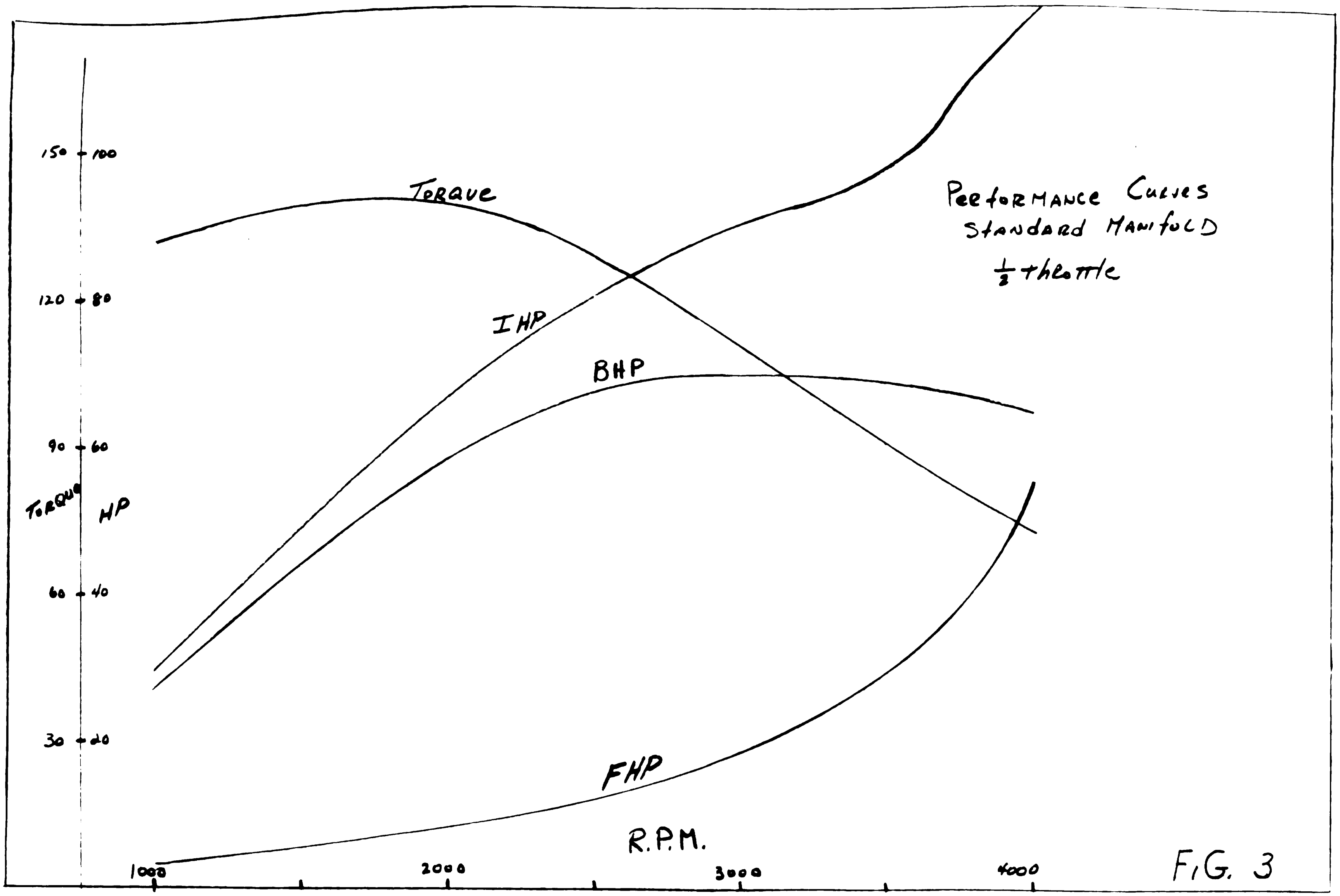

Performance Curves
Standard Manifold
½ throttle
Torque
IHP
BHP
FHP
Torque
HP
150
120
90
60
30
100
80
60
40
20
R.P.M.
1000
2000
3000
4000

FIG. 3

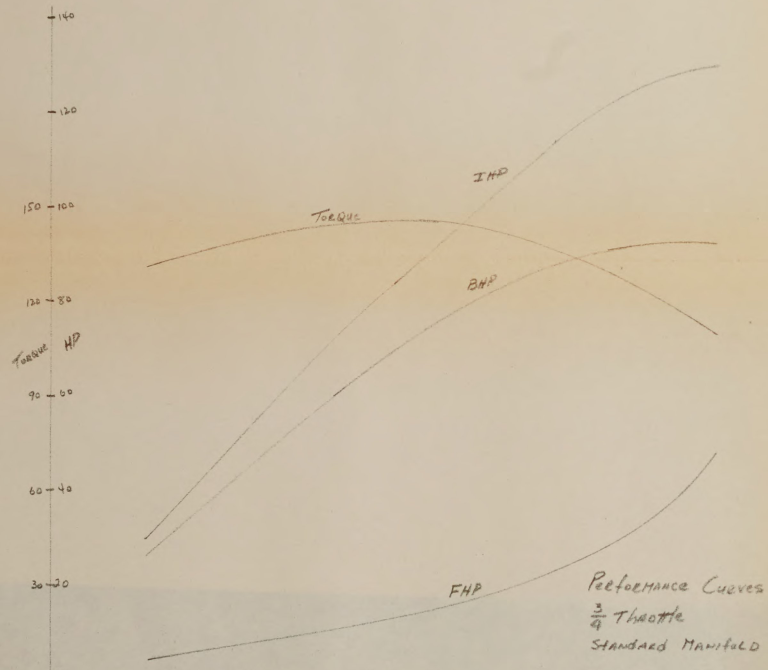

140
120
150 100
Torque
IHP
120 80
BHP
Torque HP
90 60
60 40
30 20
FHP
0
1000
1500
2000
2500
3000
3500
4000
R.P.M.
Performance Curves
$\frac{3}{4}$ Throttle
Standard Manifold

Fig. 4.

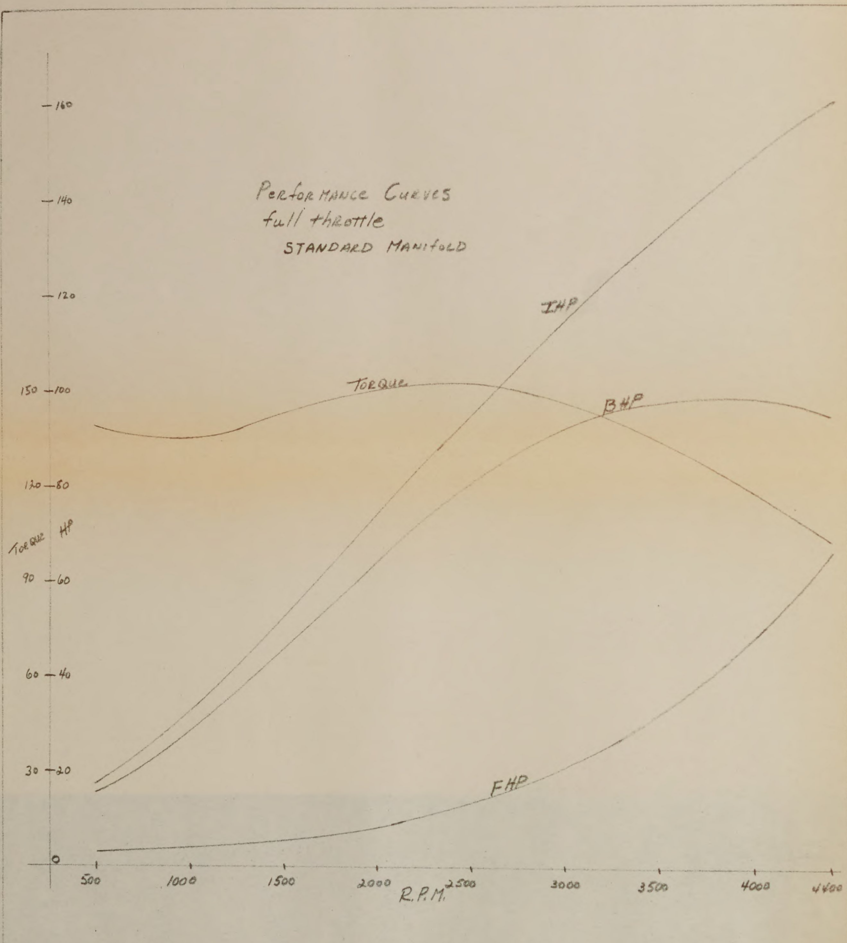

PERFORMANCE CURVES
full throttle
STANDARD MANIFOLD
IHP
TORQUE
BHP
FHP
TORQUE HP
160
140
120
150 100
120 80
90 60
60 40
30 20
0
500
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.

FIG. 5.

Performance Curves
Dual Carburetor Manifold
$\frac{1}{16}$ throttle
Throttles Synchronized

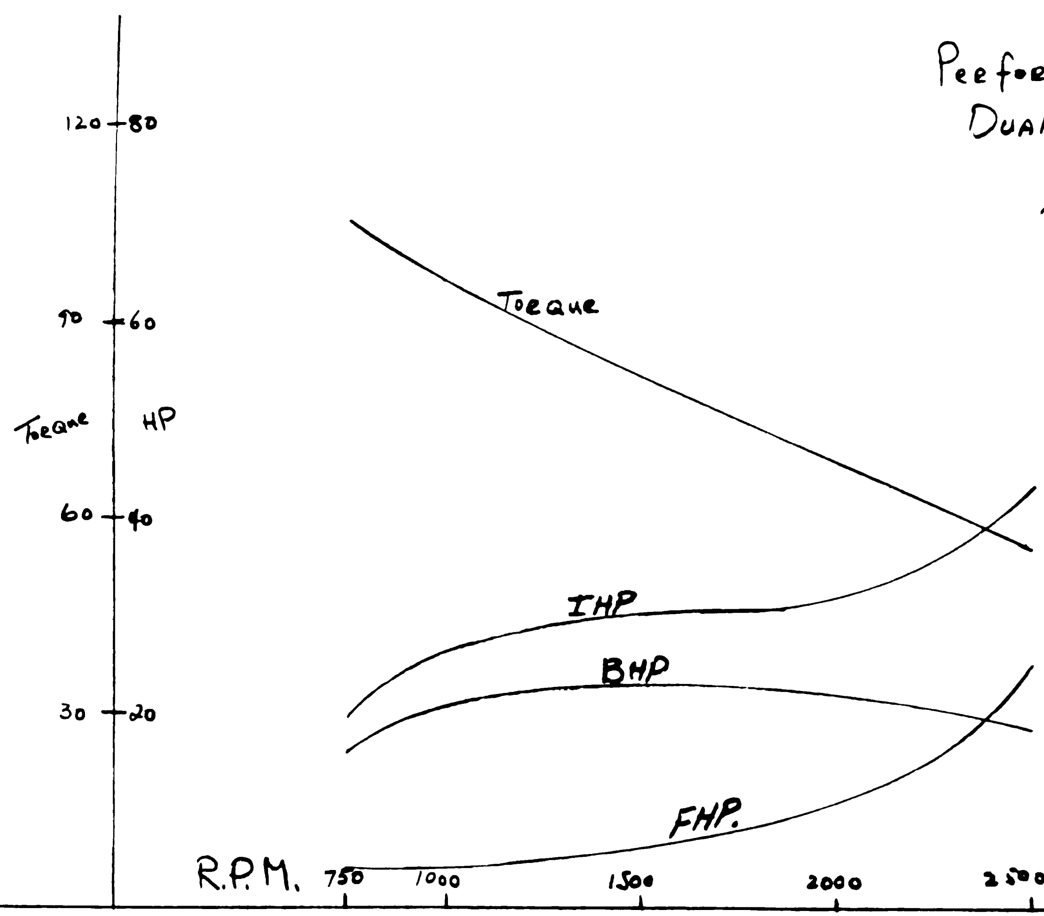
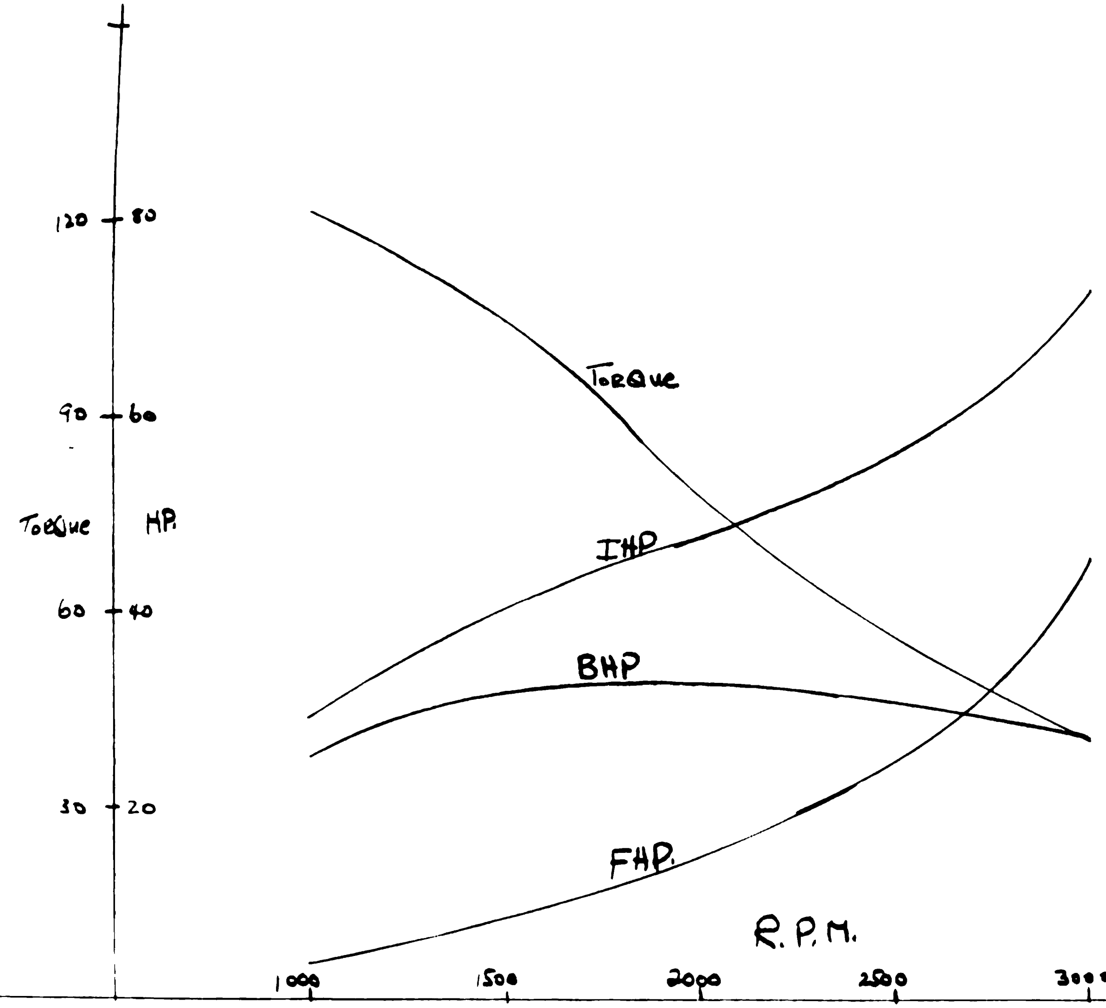


FIG. 6



Performance Curves
Dual Carburetor Manifold
$\frac{1}{8}$ throttle
throttles Synchronized

FIG. 7

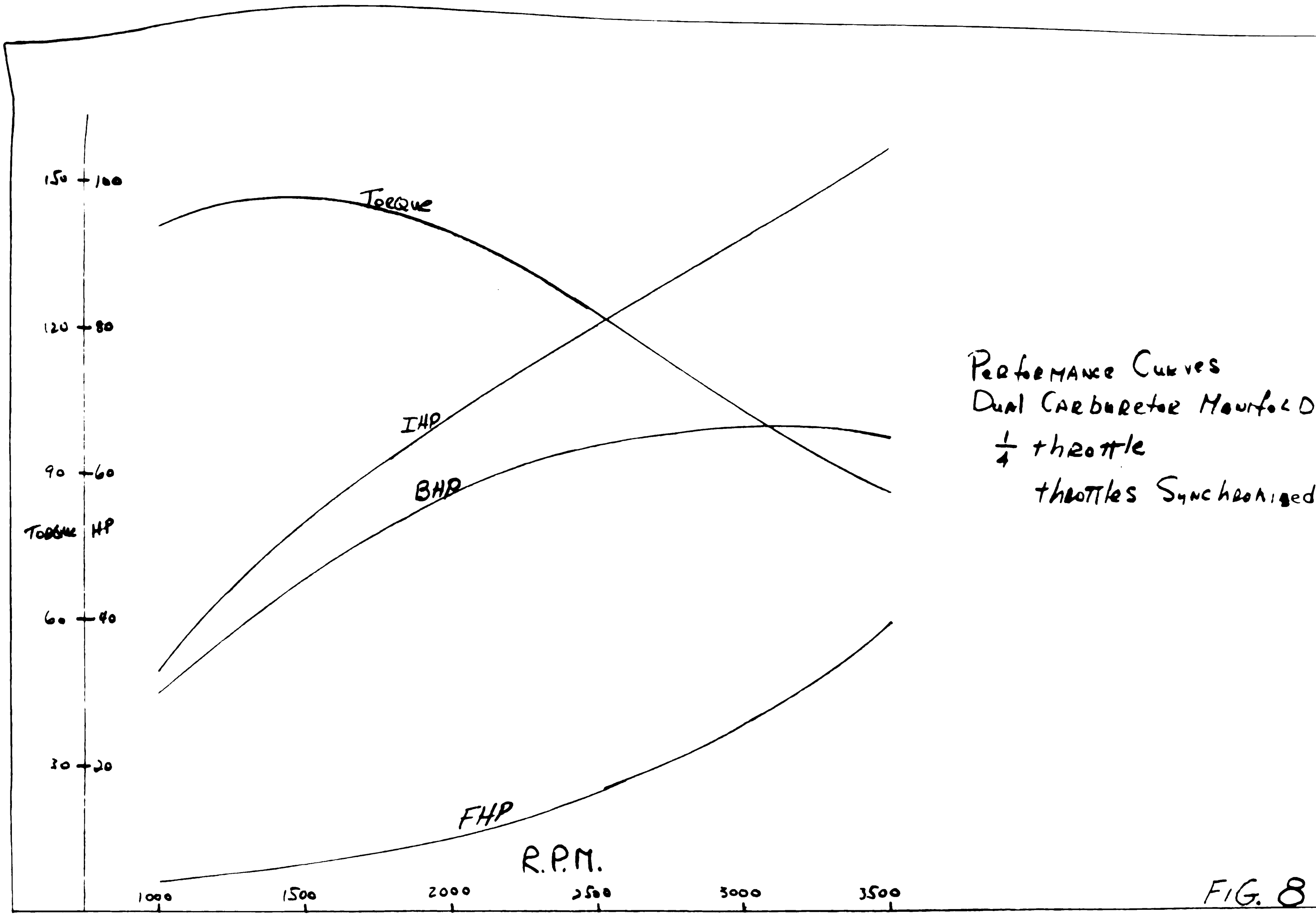

Performance Curves
Dual Carburetor Manifold
$\frac{1}{4}$ throttle
throttles Synchronized.
Torque
IHP
BHP
FHP
R.P.M.
Torque HP
150 100
120 80
90 60
60 40
30 20
1000
1500
2000
2500
3000
3500

FIG. 8

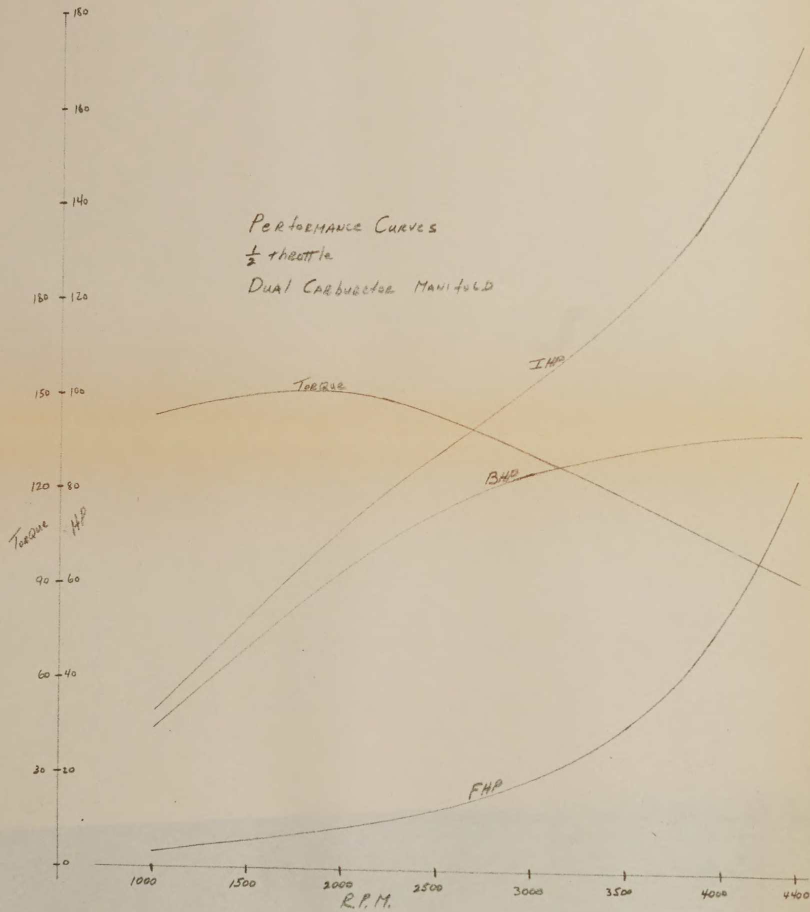
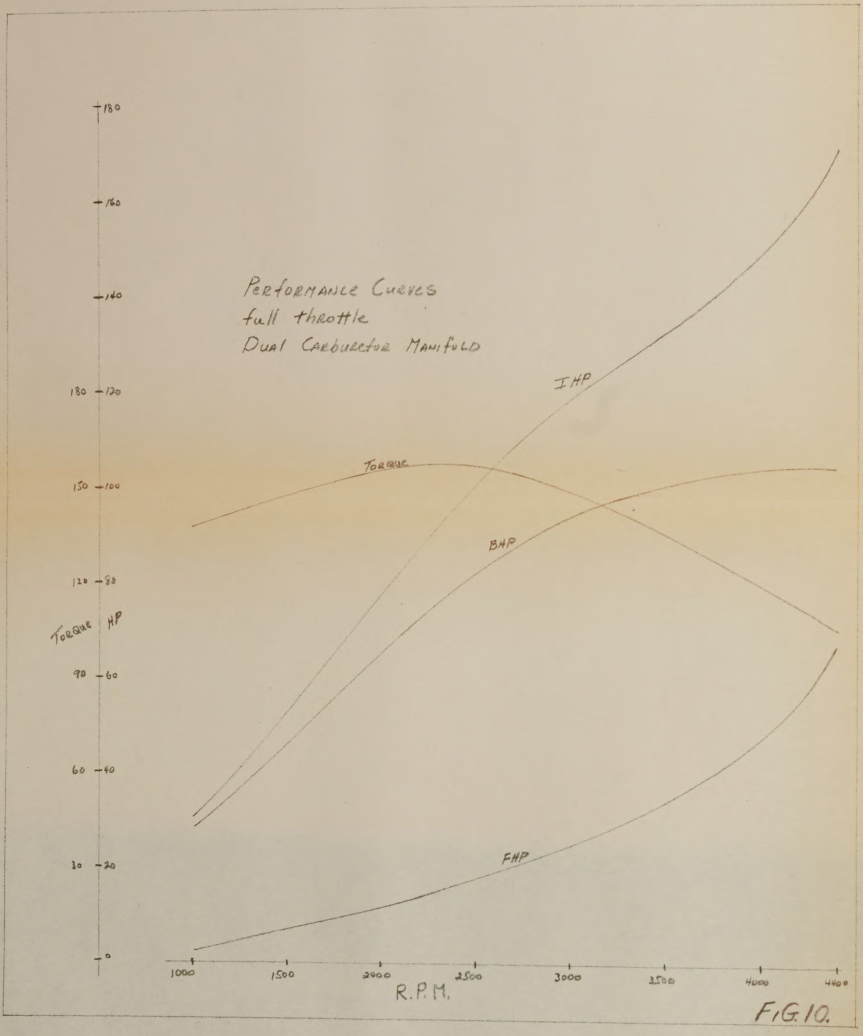

Performance Curves
½ throttle
Dual Carburetor Manifold
180
160
140
120
100
80
60
40
20
0
180
150
120
90
60
30
Torque
HP
Torque
IHP
BHP
FHP
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.

FIG. 9.



Performance Curves
full throttle
Dual Carburetor Manifold
IHP
Torque
BHP
FHP
Torque HP
180
160
140
180 120
150 100
120 80
90 60
60 40
30 20
0
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.

FIG. 10.

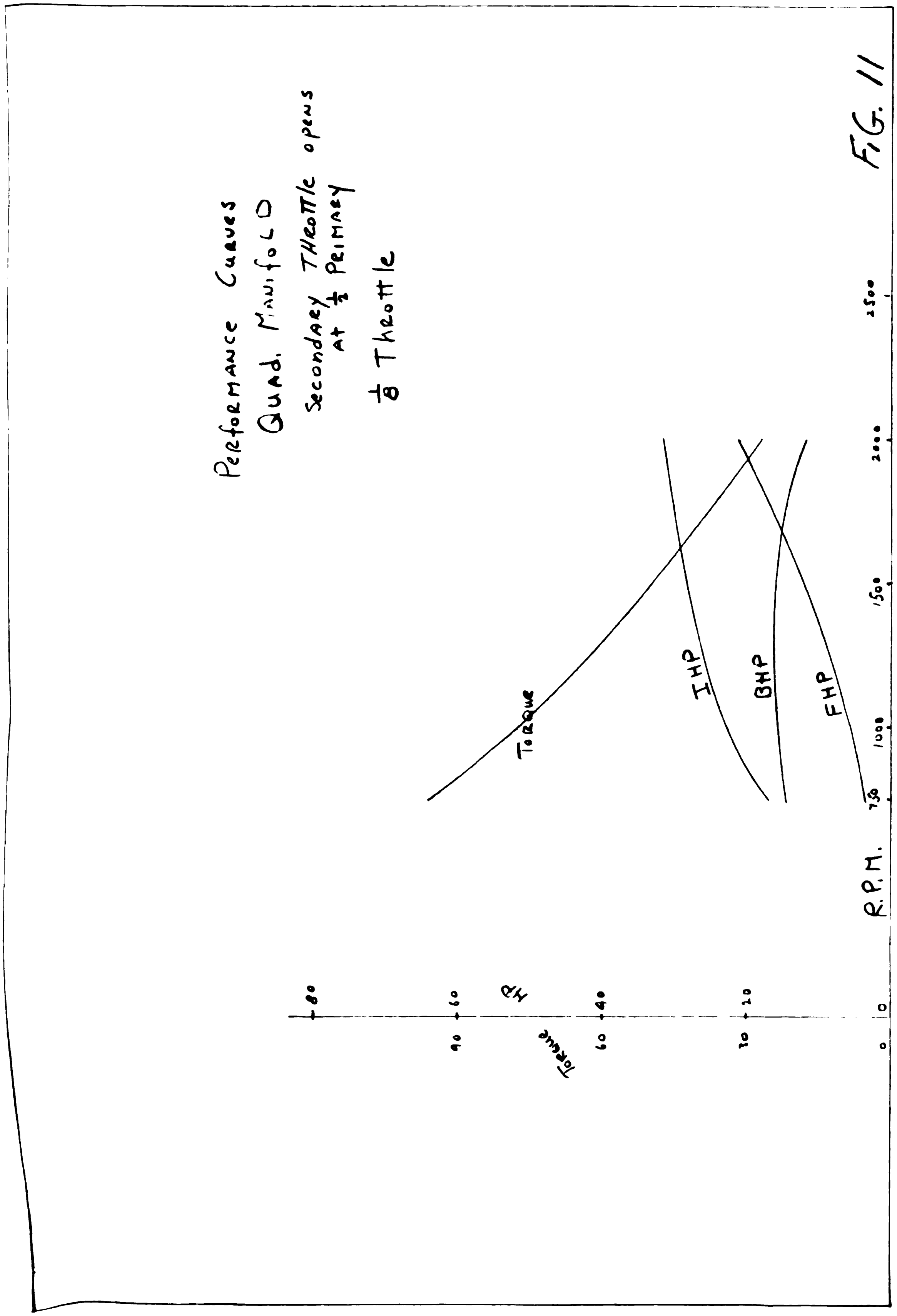
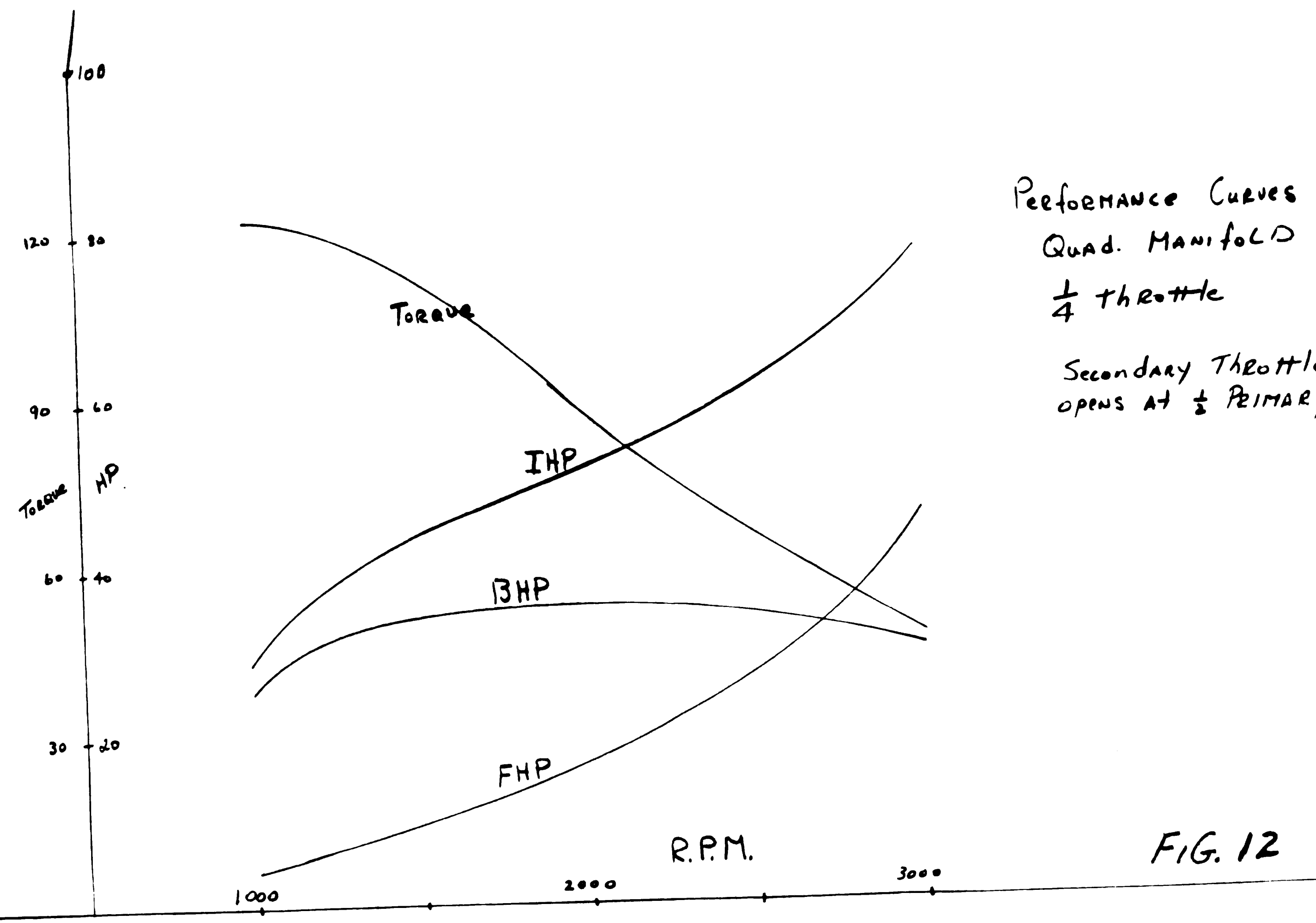

Performance Curves
Quad. Manifold
Secondary Throttle opens at 1/2 Primary
1/8 Throttle
Torque
IHP
BHP
FHP
R.P.M.
750
1000
1500
2000
2500
HP
80
60
40
20
0
Torque
90
60
30
0

FIG. 11



Performance Curves
Quad. Manifold
$\frac{1}{4}$ throttle
Secondary Throttle
opens at $\frac{1}{2}$ Primary
Torque
IHP
BHP
FHP
Torque
HP
100
120
80
90
60
60
40
30
20
1000
2000
3000
R.P.M.

FIG. 12

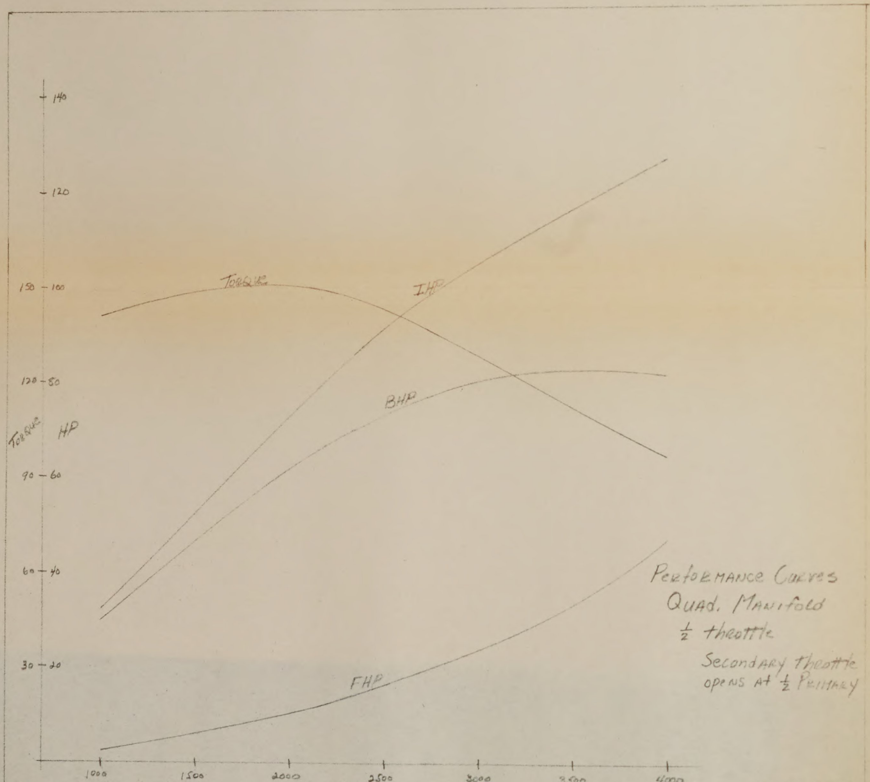
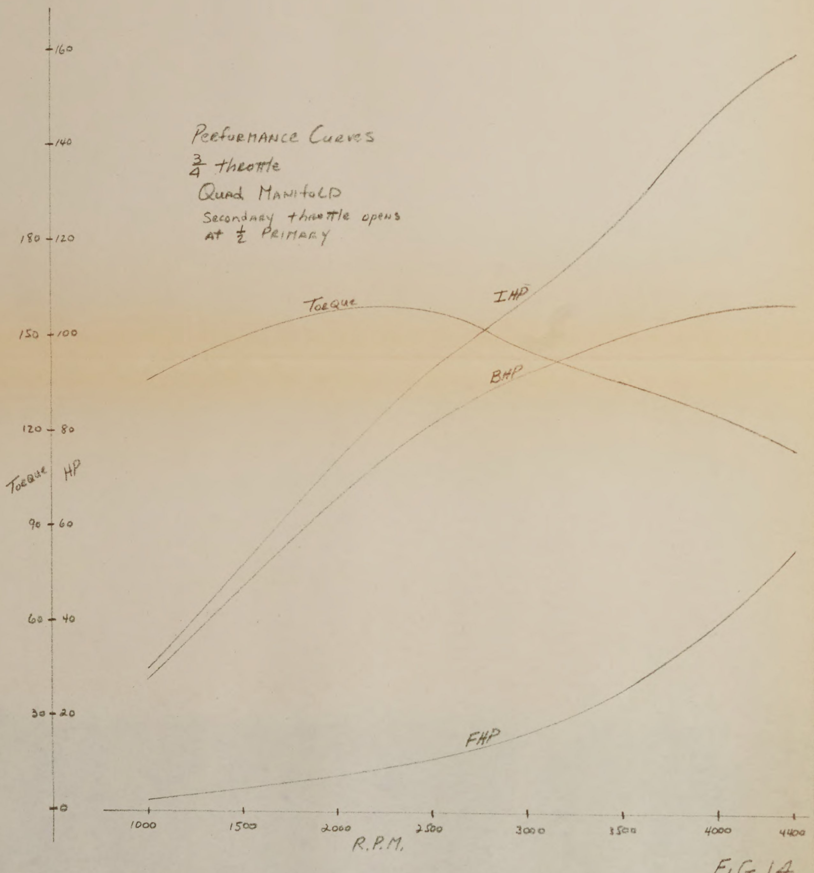

140
120
150 – 100
120 – 80
90 – 60
60 – 40
30 – 20
Torque
HP
Torque
IHP
BHP
FHP
1000
1500
2000
2500
3000
3500
4000
R.P.M.
Performance Curves
Quad. Manifold
1/2 throttle
Secondary throttle
opens at 1/2 Primary

FIG. 13.



Performance Curves
$\frac{3}{4}$ throttle
Quad Manifold
Secondary throttle opens
at $\frac{1}{2}$ Primary
Torque
IHP
BHP
FHP
160
140
180 120
150 100
120 80
Torque HP
90 60
60 40
30 20
0
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.

FIG. 14.

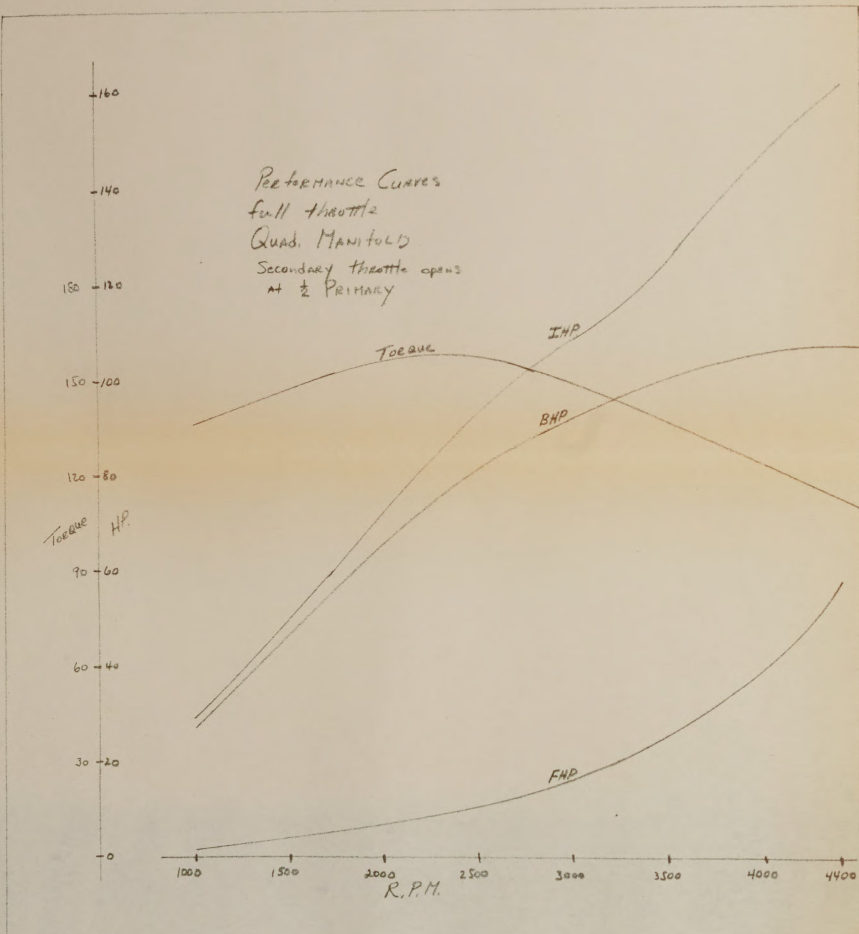
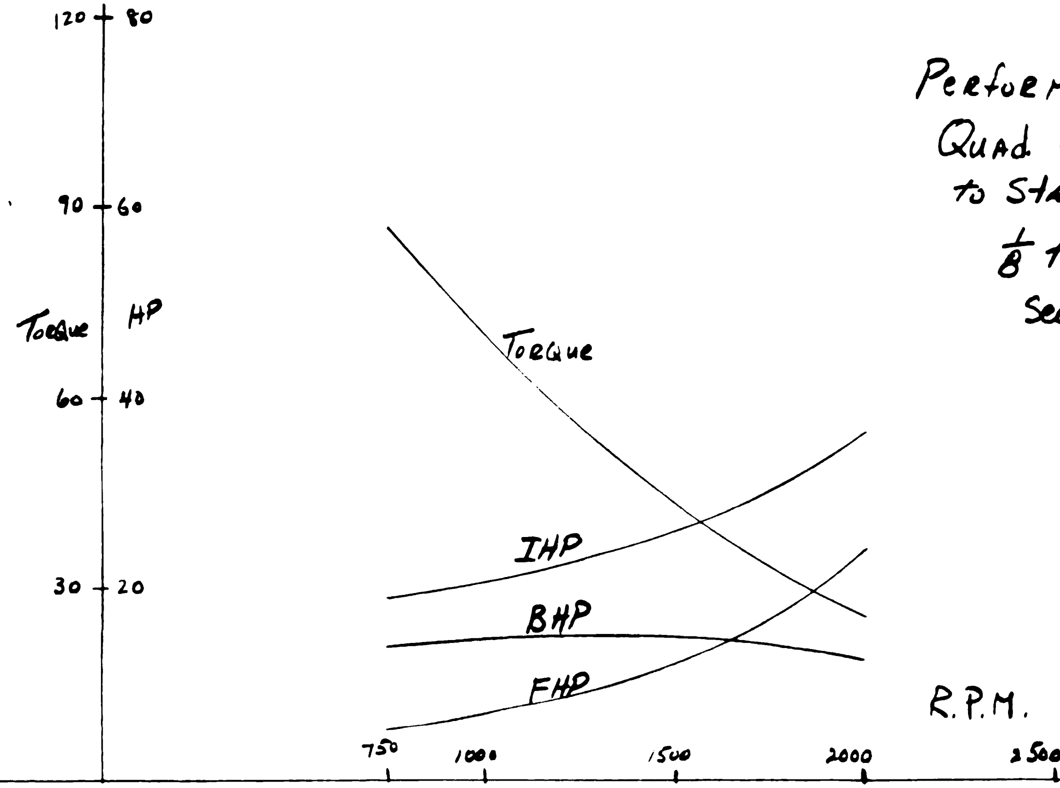
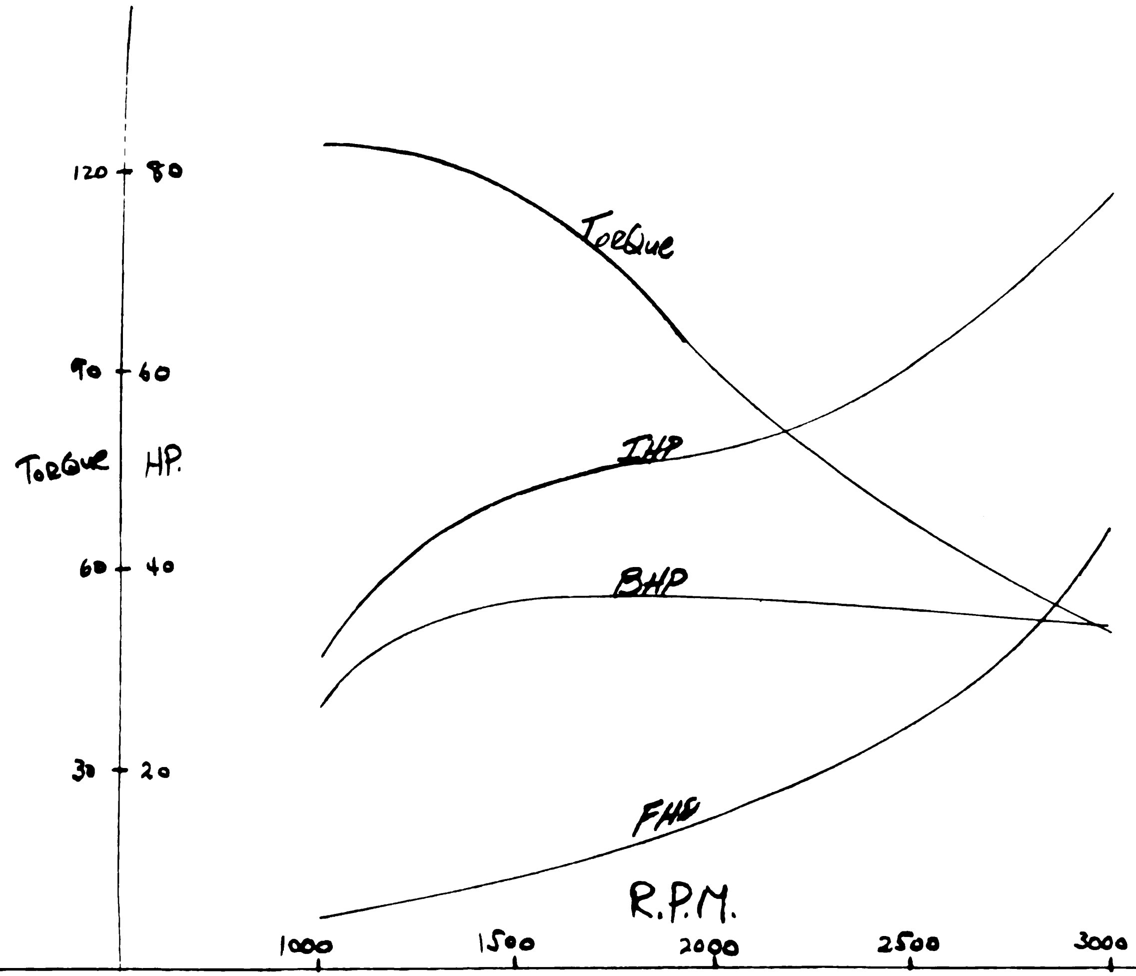

Performance Curves
full throttle
Quad. Manifold
Secondary throttle opens
at ½ Primary
IHP
Torque
BHP
FHP
Torque
HP.
160
140
180 120
150 100
120 80
90 60
60 40
30 20
0
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.

FIG. 15.



Performance Curves
Quad Carburetor Adapted
to Standard Manifold
$\frac{1}{8}$ Throttle
Secondary throttle opens
at 1/4 Primary

FIG. 16



Performance Curves
Quad. Carburetor adapted
to Standard Manifold
$\frac{1}{4}$ throttle
Secondary throttle opens
at $\frac{1}{4}$ Primary

FIG. 17

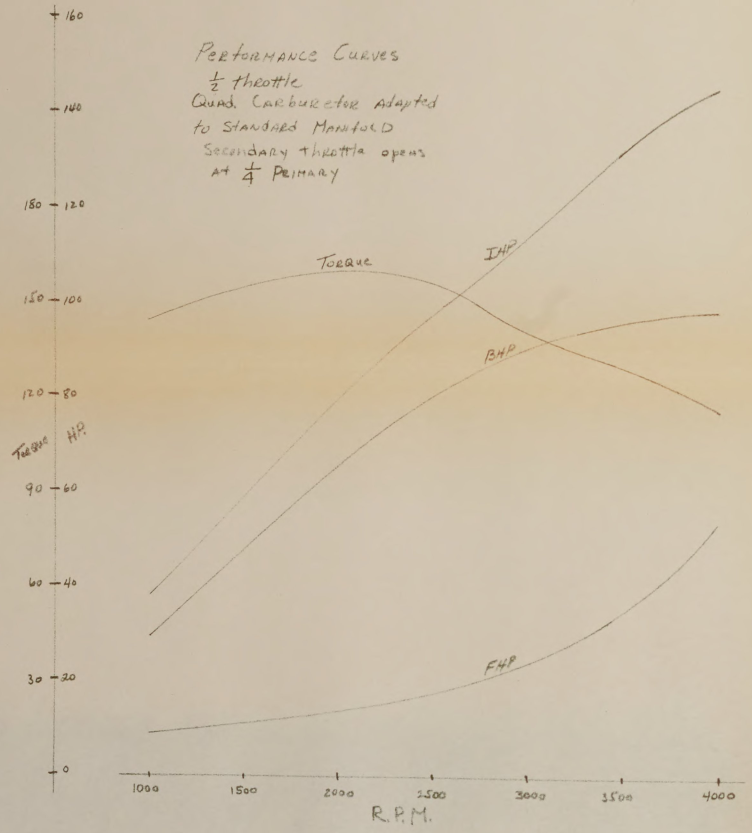

Performance Curves
½ throttle
Quad. Carburetor Adapted
to Standard Manifold
Secondary throttle opens
at ¼ Primary
Torque
IHP
BHP
FHP
Torque
HP.
160
140
180 120
150 100
120 80
90 60
60 40
30 20
0
1000
1500
2000
2500
3000
3500
4000
R.P.M.

FIG. 18.

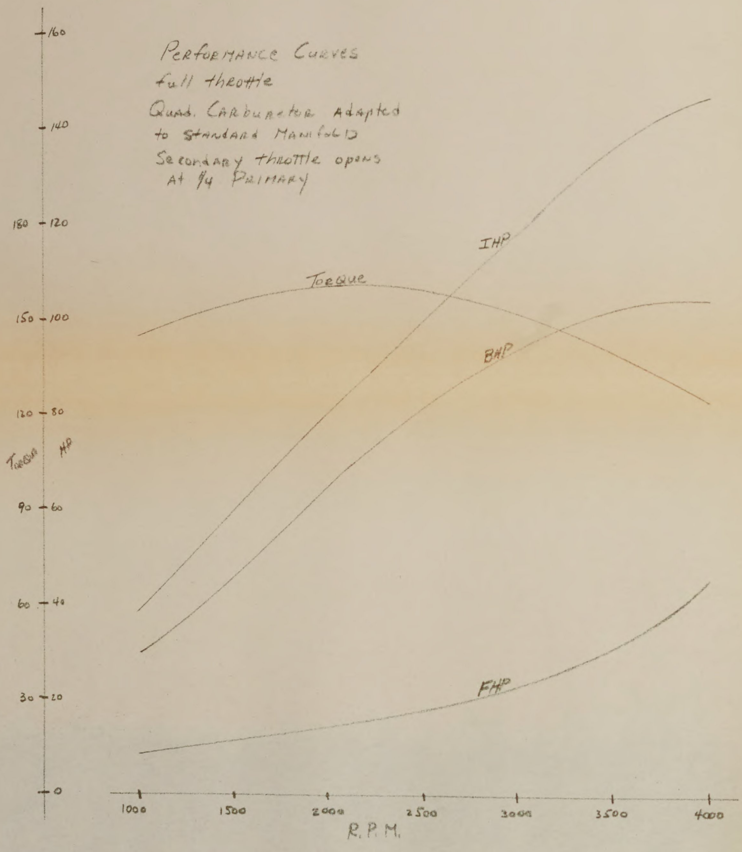
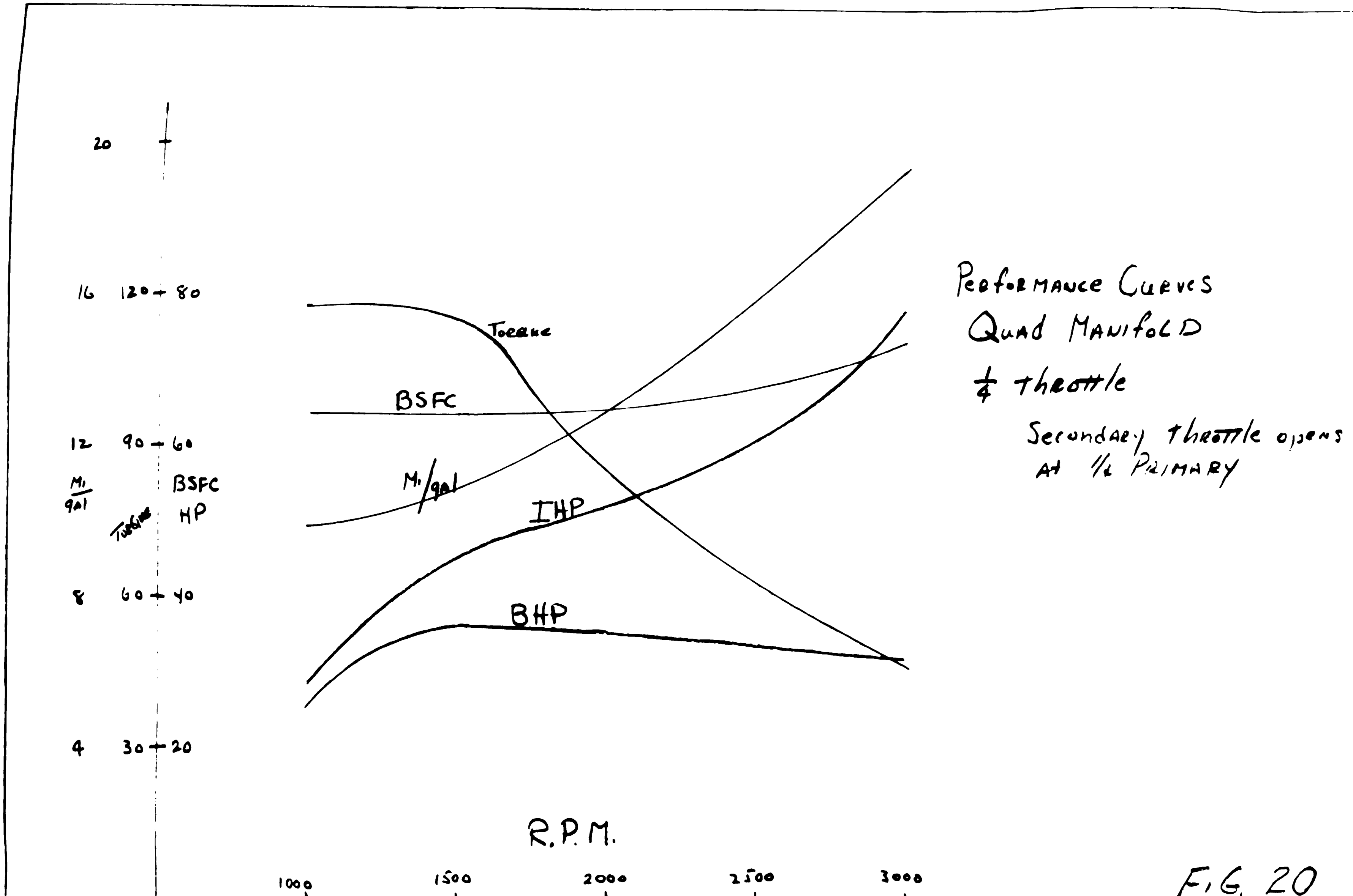

PERFORMANCE CURVES
full throttle
QUAD. CARBURETOR ADAPTED
to STANDARD MANIFOLD
Secondary throttle opens
At 1/4 PRIMARY
IHP
TORQUE
BHP
FHP
Torque
HP
160
140
180
120
150
100
120
80
90
60
60
40
30
20
0
1000
1500
2000
2500
3000
3500
4000
R.P.M.

FIG. 19.



Performance Curves
Quad Manifold
1/4 throttle
Secondary throttle opens
At 1/4 Primary
20
16 120 80
12 90 60
Mi/gal
BSFC
HP
Torque
8 60 40
4 30 20
Torque
BSFC
Mi/gal
IHP
BHP
R.P.M.
1000
1500
2000
2500
3000

FIG. 20

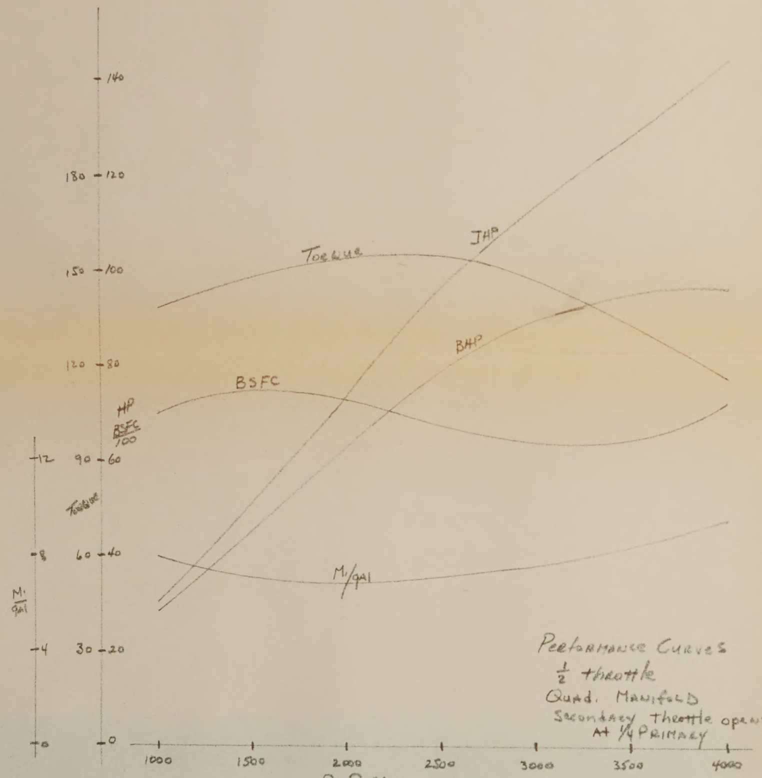
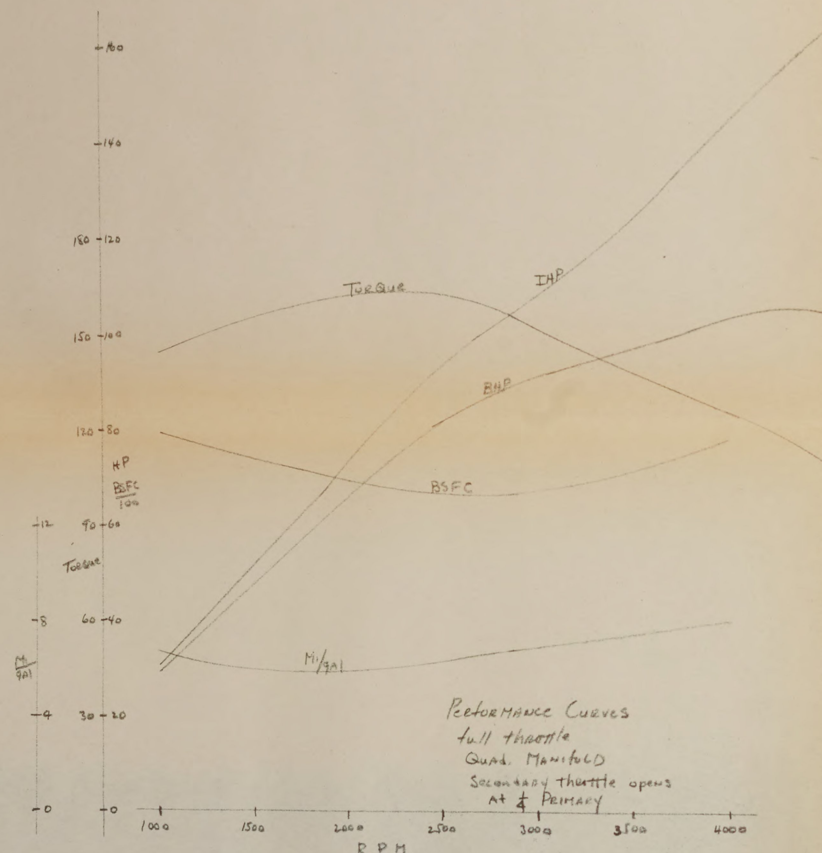

Performance Curves
½ throttle
Quad. Manifold
Secondary throttle opens
At ¼ Primary
Torque
IHP
BHP
BSFC
M/gal
HP
BSFC/100
Torque
M/gal
R.P.M.
1000
1500
2000
2500
3000
3500
4000
140
180 120
150 100
120 80
90 60
60 40
30 20
0
12
8
4
0

FIG. 21.



160
140
180 120
150 100
120 80
90 60
60 40
30 20
0
12
8
4
0
HP
BSFC/100
Torque
Mi/gal
Torque
IHP
BHP
BSFC
Mi/gal
1000
1500
2000
2500
3000
3500
4000
R.P.M.
Performance Curves
full throttle
Quad. Manifold
Secondary throttle opens
At 1/4 Primary

FIG. 22.

PERFORMANCE CURVES

Figures 23-41

Brake Mean Effective Pressure
Brake Specific Fuel Consumption
Mechanical Efficiency
Miles per Gallon

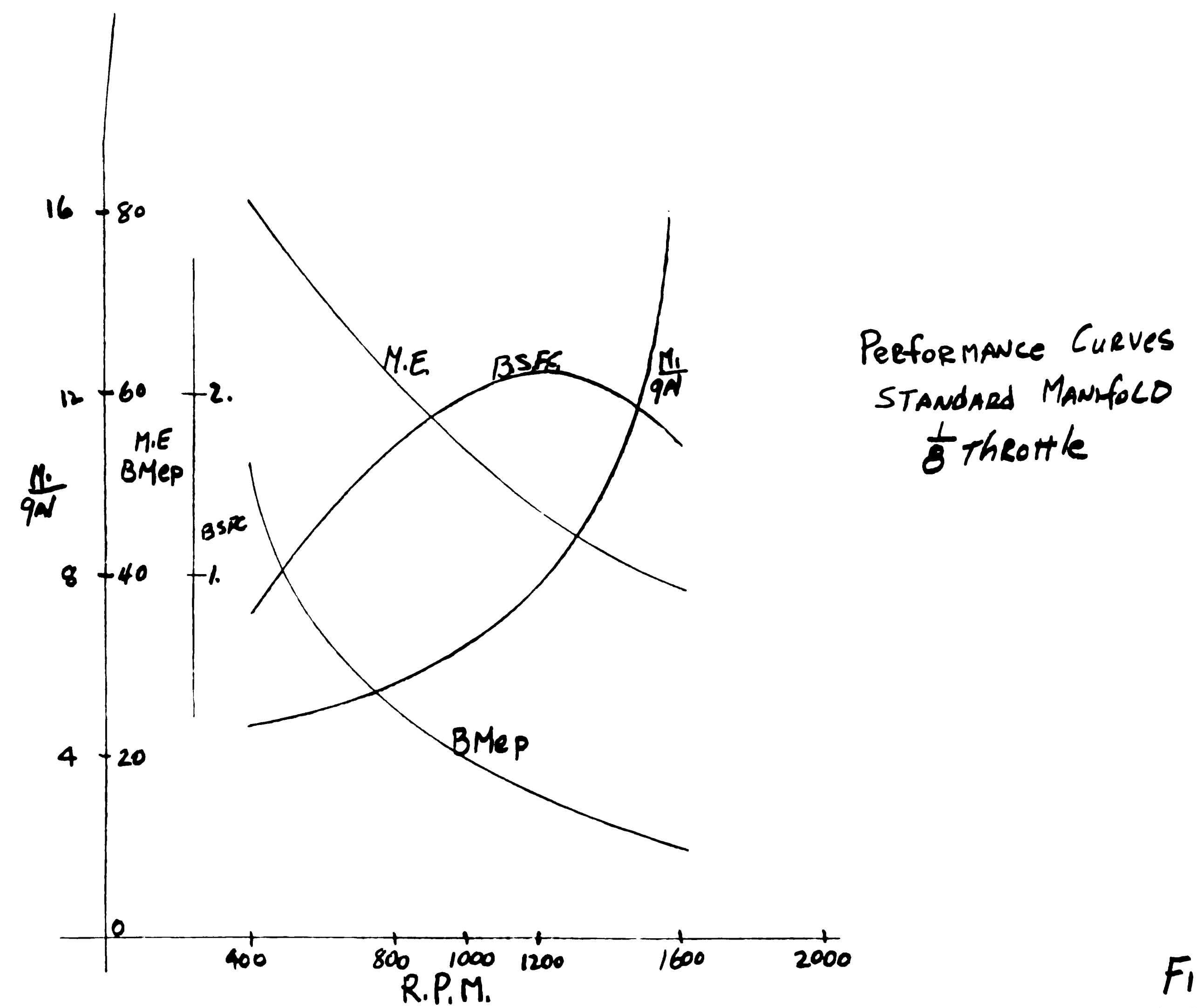
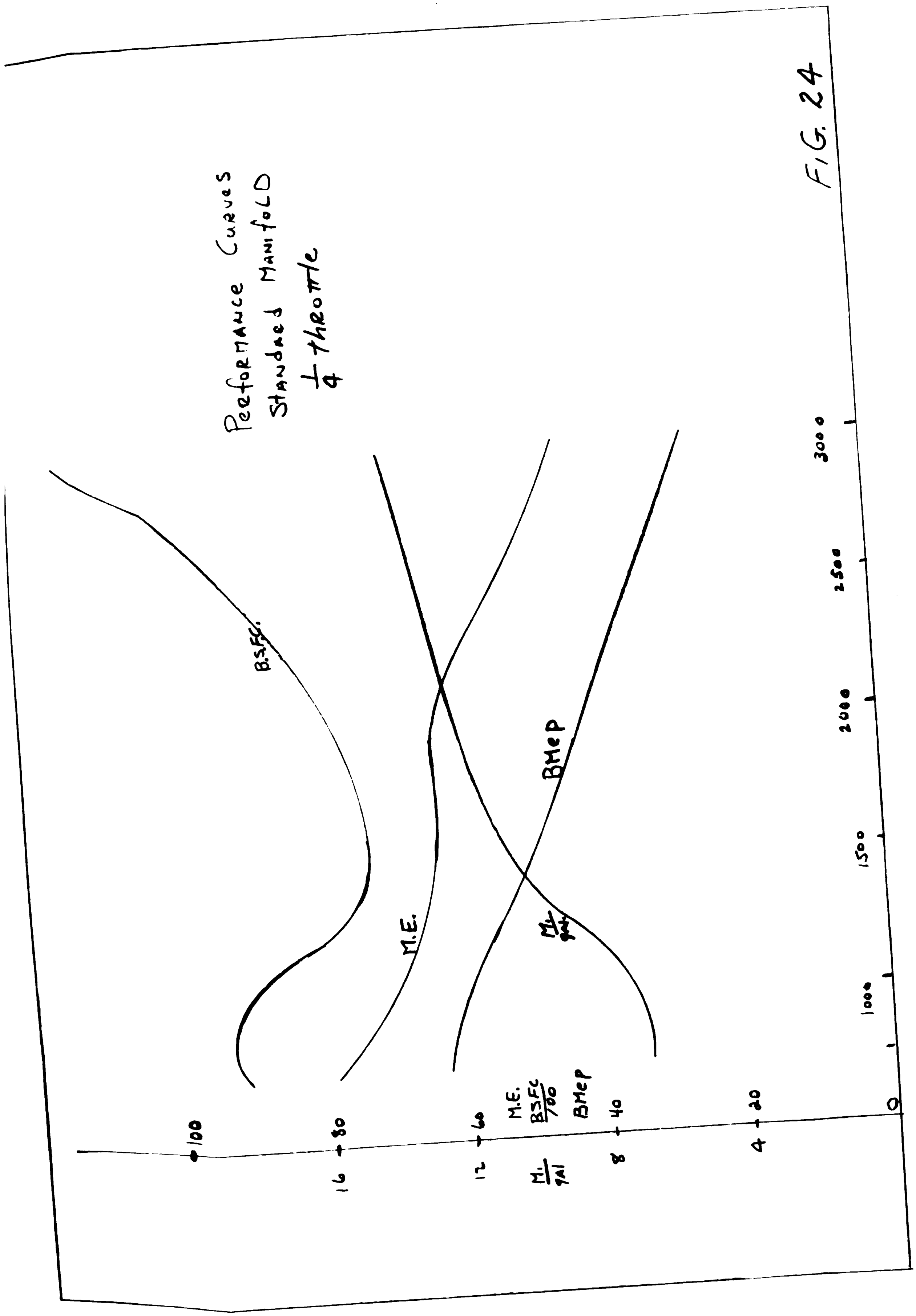
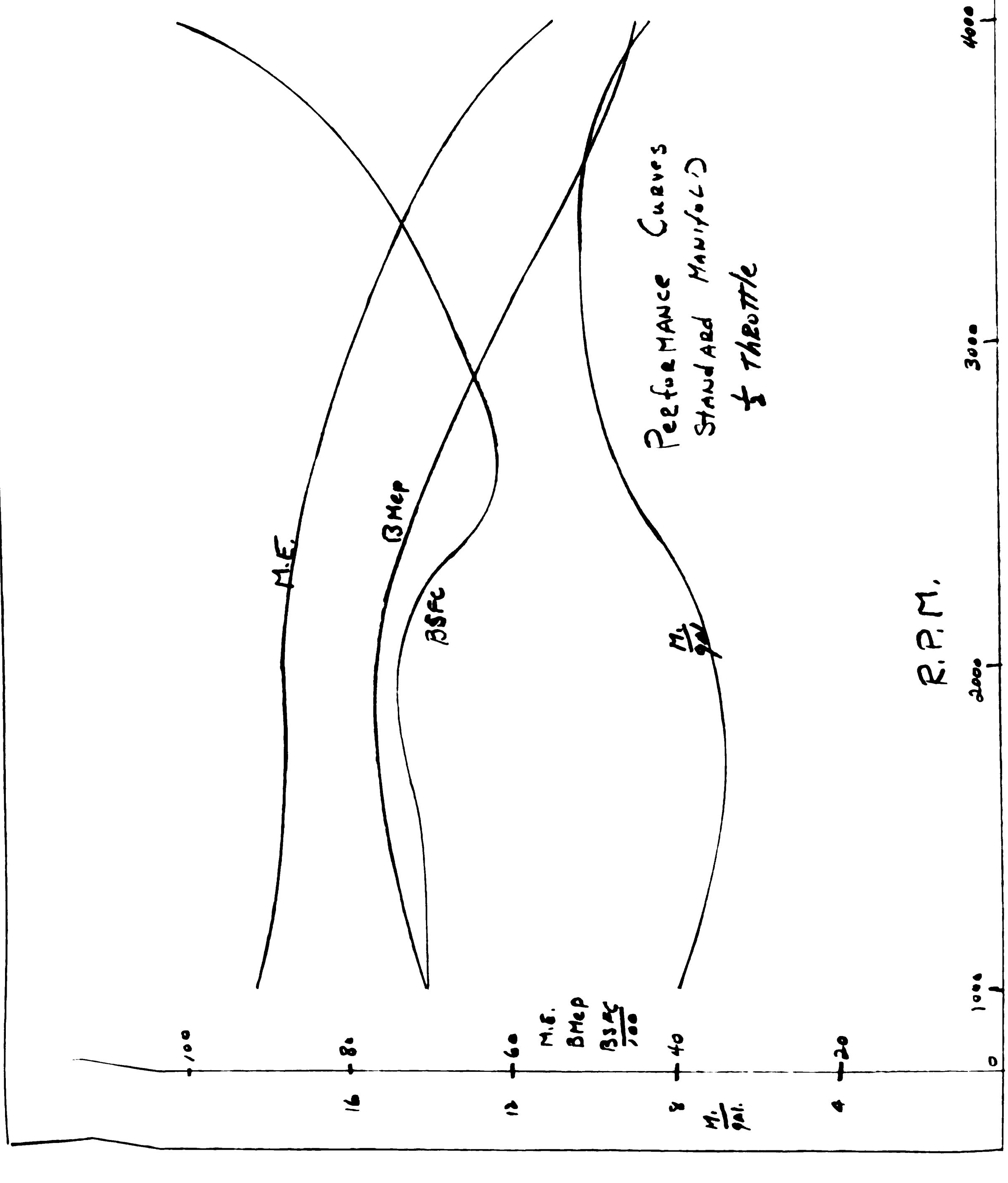

Performance Curves
Standard Manifold
$\frac{1}{8}$ Throttle
16
12
8
4
80
60
40
20
0
$\frac{M_i}{gN}$
M.E
BMep
BSFC
2.
1.
M.E.
BSFC
$\frac{M_i}{gN}$
BMep
400
800
1000
1200
1600
2000
R.P.M.

FIG. 23



Performance Curves
Standard Manifold
1/4 throttle
B.S.F.C.
M.E.
BMEP
M./F.A.
0
1000
1500
2000
2500
3000
100
16 80
12 60
M.E.
BSFC/700
BMEP
M./FA
8 40
4 20

FIG. 24



Performance Curves
Standard Manifold
½ Throttle
M.E.
BMep
BSFC
Mi/gal
R.P.M.
M.E.
BMep
BSFC/100
Mi/gal
100
80
60
40
20
0
16
12
8
4
1000
2000
3000
4000

FIG. 25

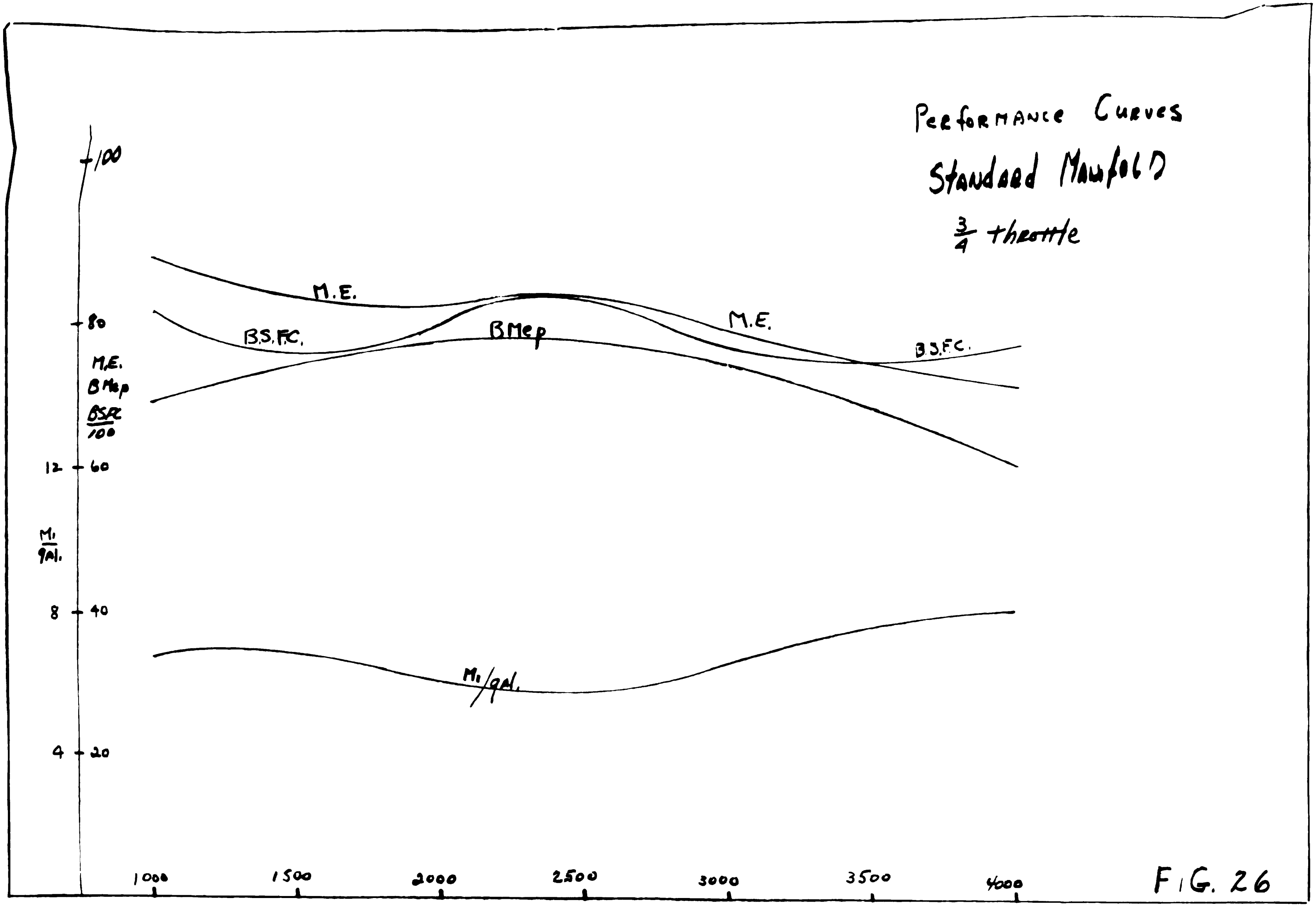

Performance Curves
Standard Manifold
$\frac{3}{4}$ throttle
100
80
60
40
20
12
8
4
M.E.
BMep
BSFC/100
Mi/gal.
M.E.
B.S.F.C.
BMep
M.E.
B.S.F.C.
Mi/gal.
1000
1500
2000
2500
3000
3500
4000

FIG. 26

Performance Curves
Standard Manifold

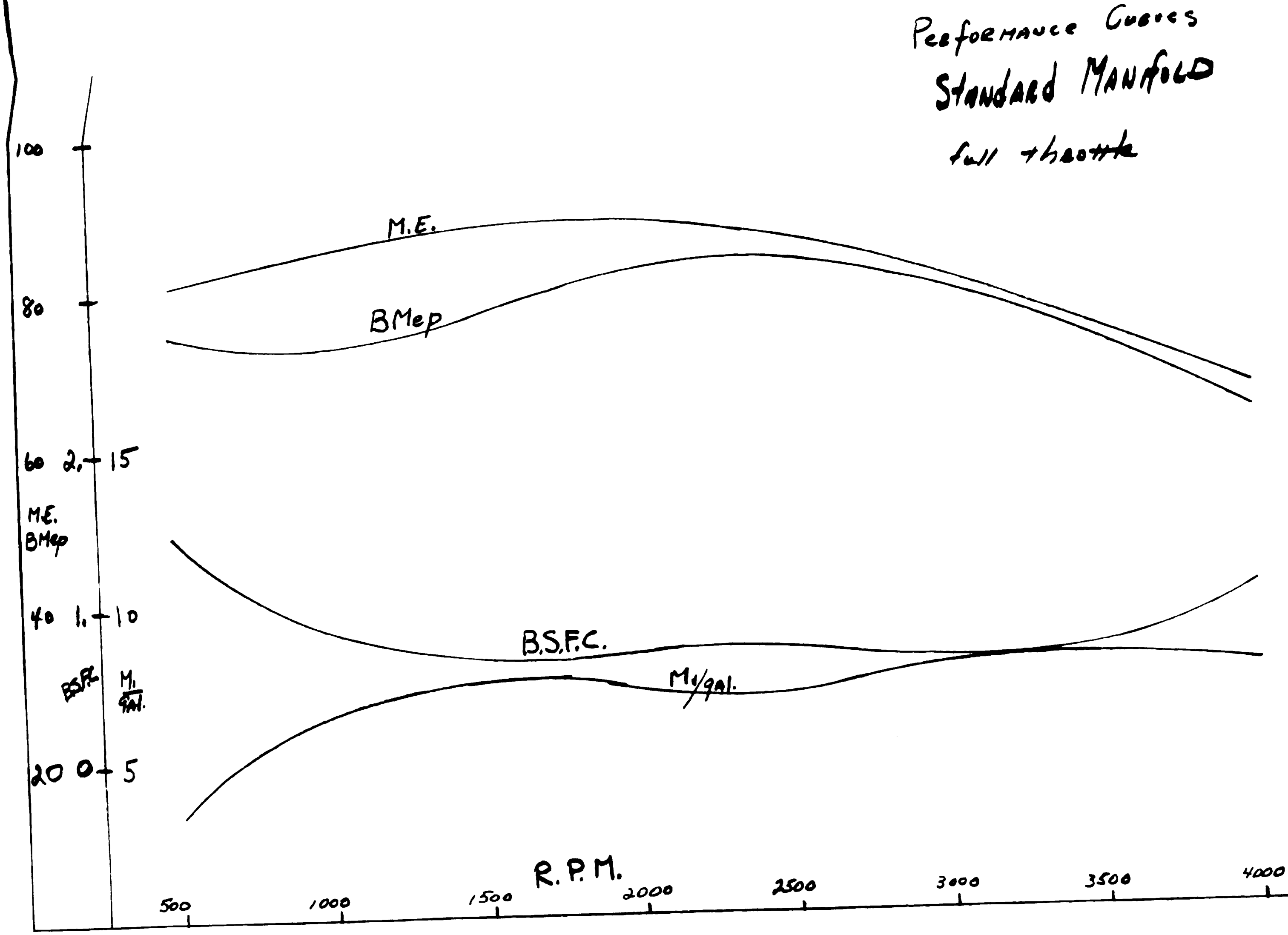

Performance Curves
Standard Manifold
full throttle
M.E.
BMep
B.S.F.C.
Mi/gal.
100
80
60 2. 15
M.E.
BMep
40 1. 10
BSFC
Mi/gal.
20 0 5
R.P.M.
500
1000
1500
2000
2500
3000
3500
4000

FIG. 27

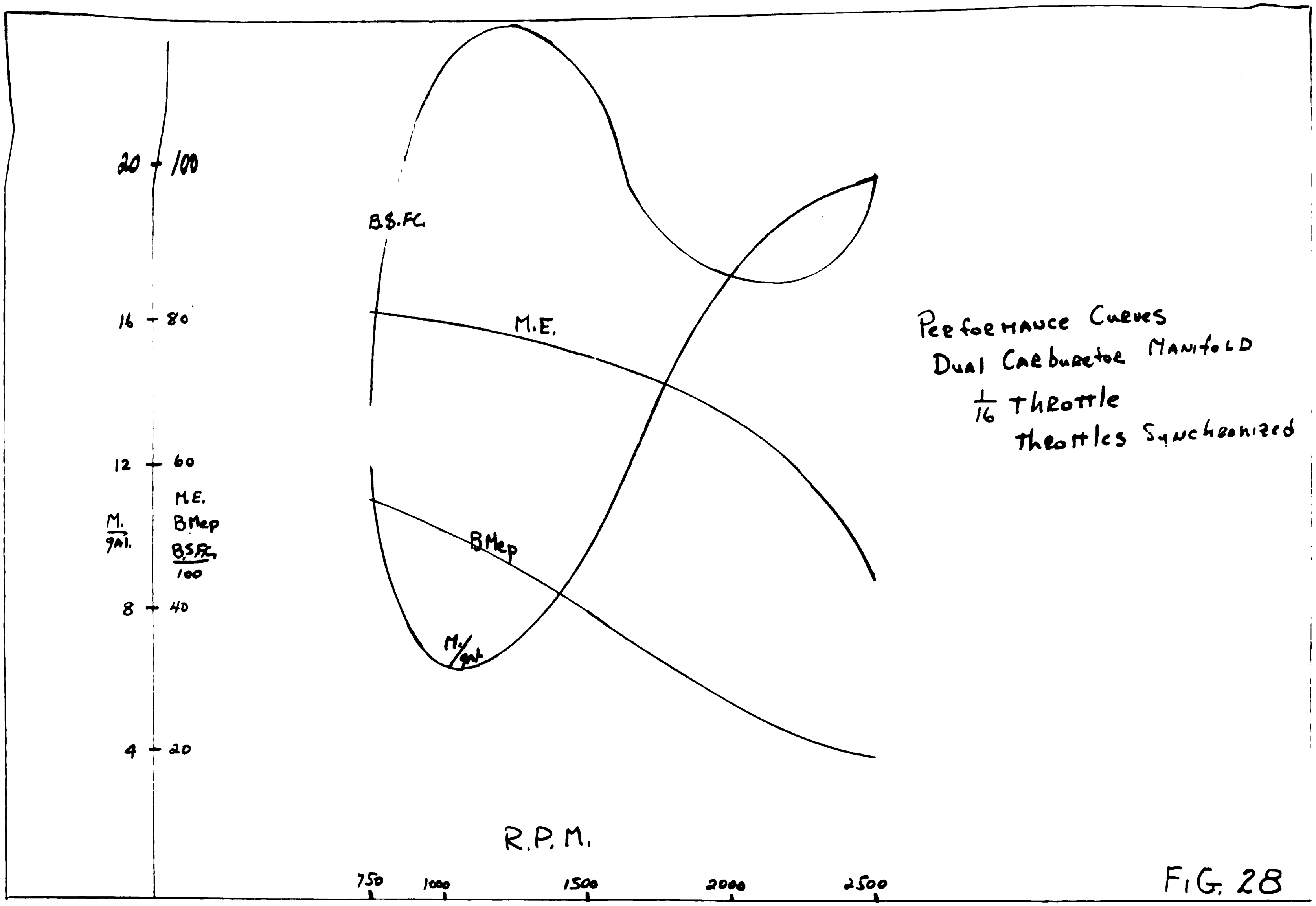
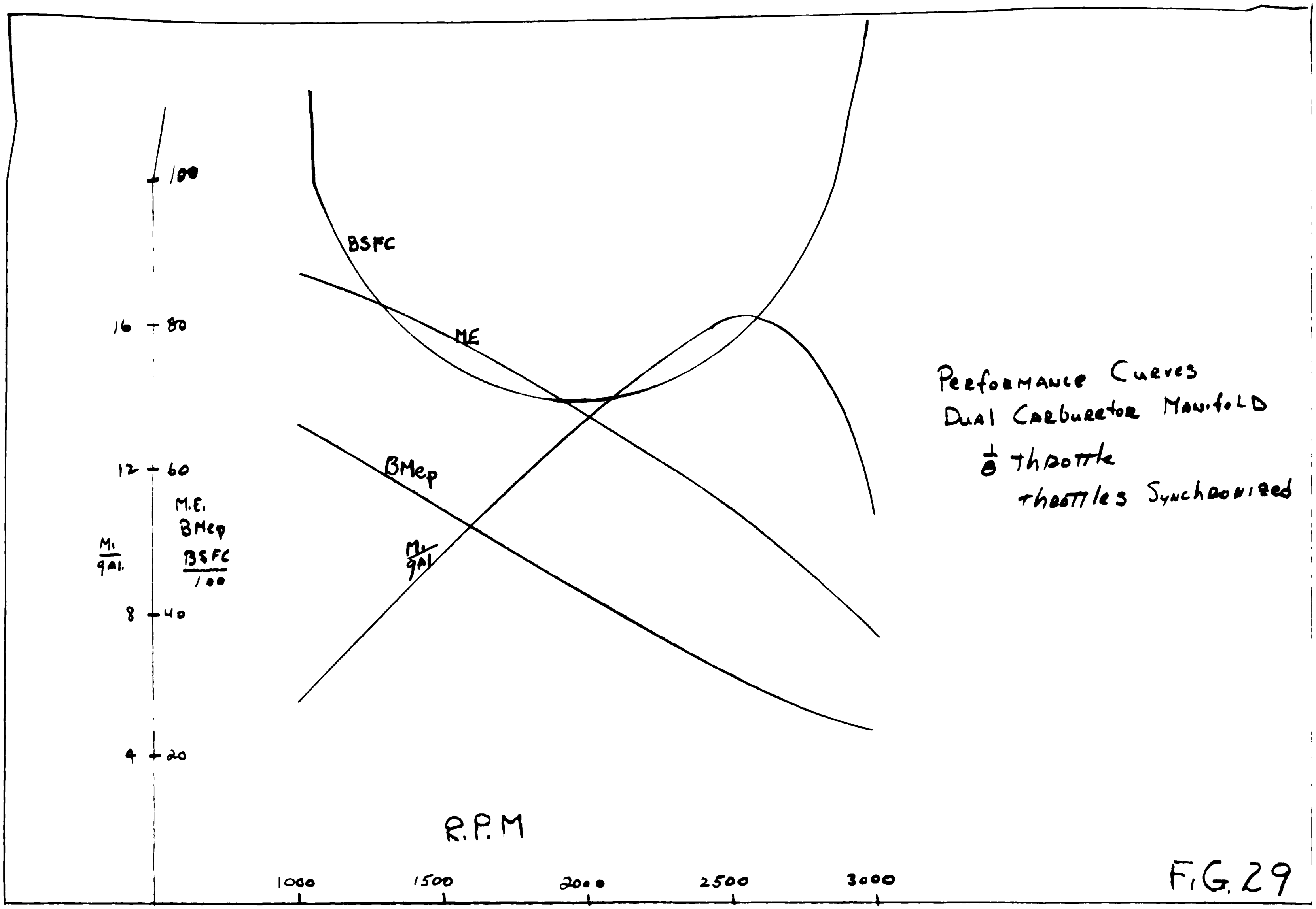
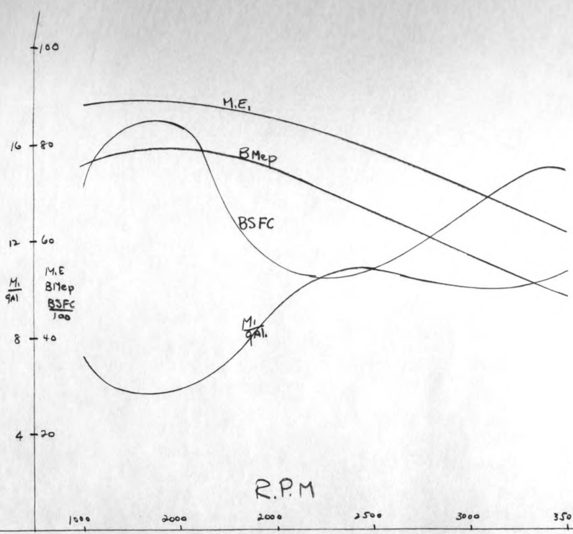

Performance Curves
Dual Carburetor Manifold
$\frac{1}{16}$ Throttle
Throttles Synchronized
B.S.F.C.
M.E.
BMep
M./gal.
20
16
12
8
4
M./gal.
100
80
60
40
20
M.E.
BMep
BSFC/100
R.P.M.
750
1000
1500
2000
2500

FIG. 28



100
16
80
12
60
8
40
4
20
M.E.
BMep
BSFC/100
Mi/gal.
BSFC
ME
BMep
Mi/gal
R.P.M
1000
1500
2000
2500
3000
Performance Curves
Dual Carburetor Manifold
1/8 throttle
throttles Synchronized

FIG. 29



Performance Curves
Dual Carburetor Manifold
$\frac{1}{4}$ throttle
Throttles Synchronized

FIG. 30

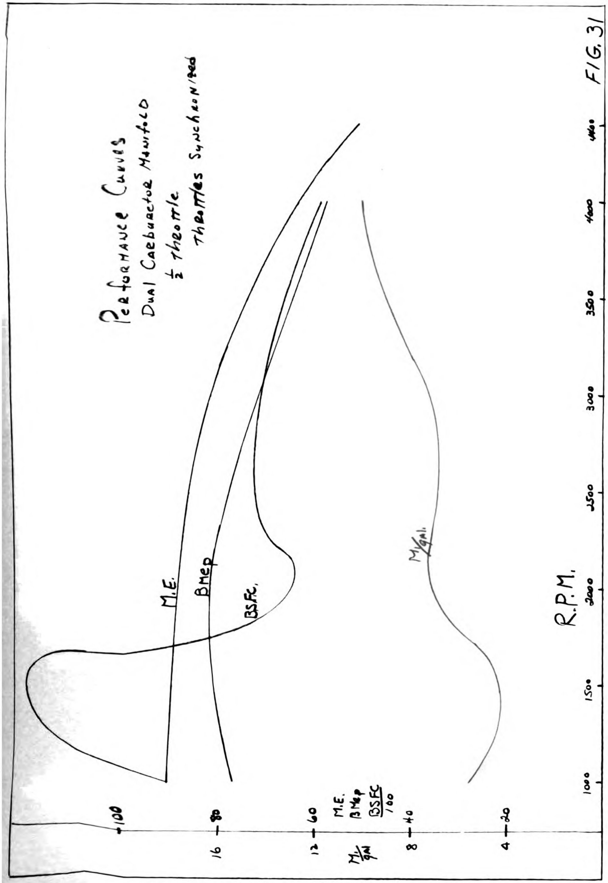

Performance Curves
Dual Carburetor Manifold
1/2 throttle
Throttles Synchronized
M.E.
BMep
BSFC.
M/gal.
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4500
100
80
60
40
20
16
12
8
4
M.E.
BMep
BSFC/100
M/gal

FIG. 31

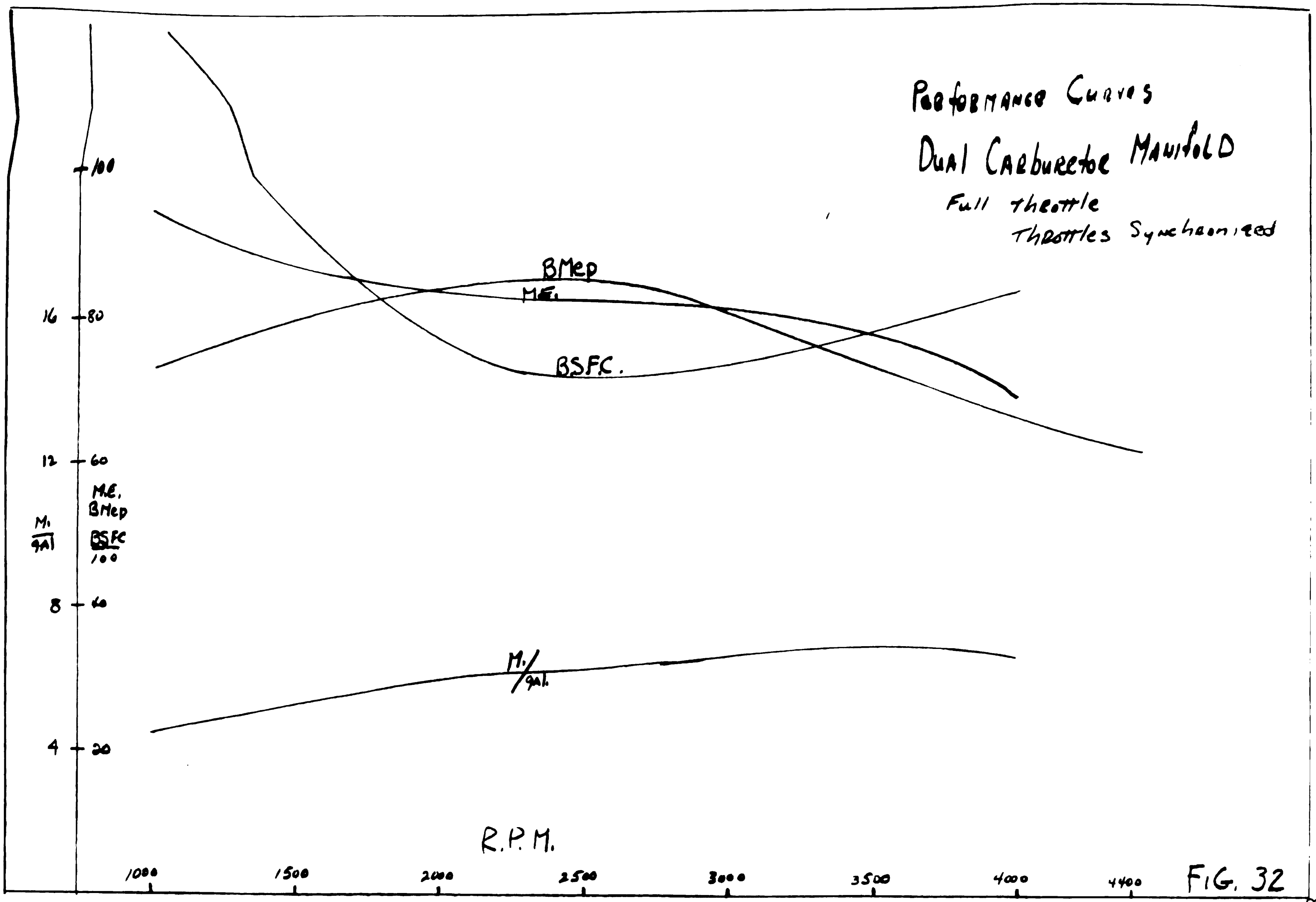

Performance Curves
Dual Carburetor Manifold
Full throttle
Throttles Synchronized
BMep
M.E.
BSFC.
M./gal.
16
12
8
4
100
80
60
40
20
M.E.
BMep
BSFC/100
M./gal
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400

FIG. 32

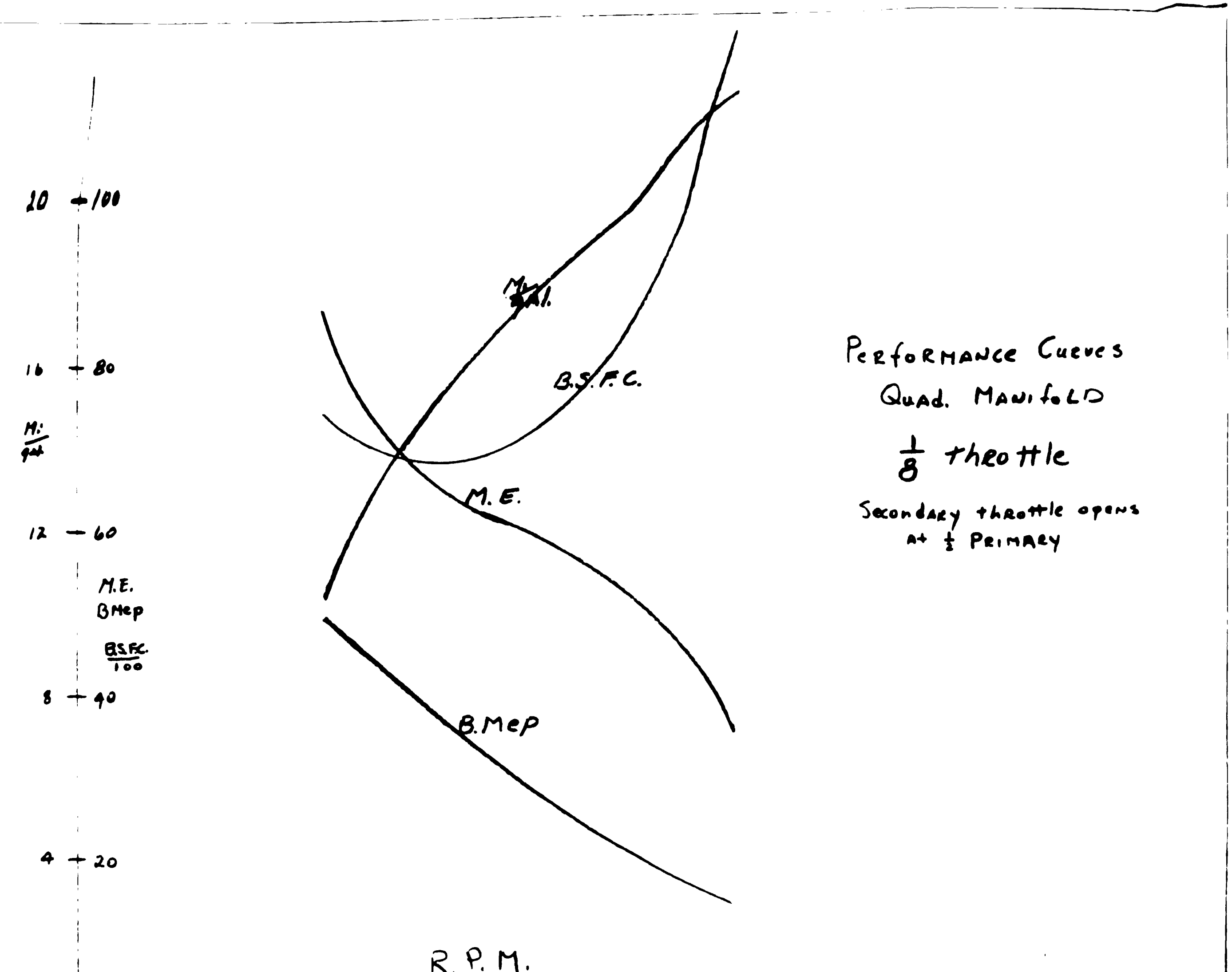
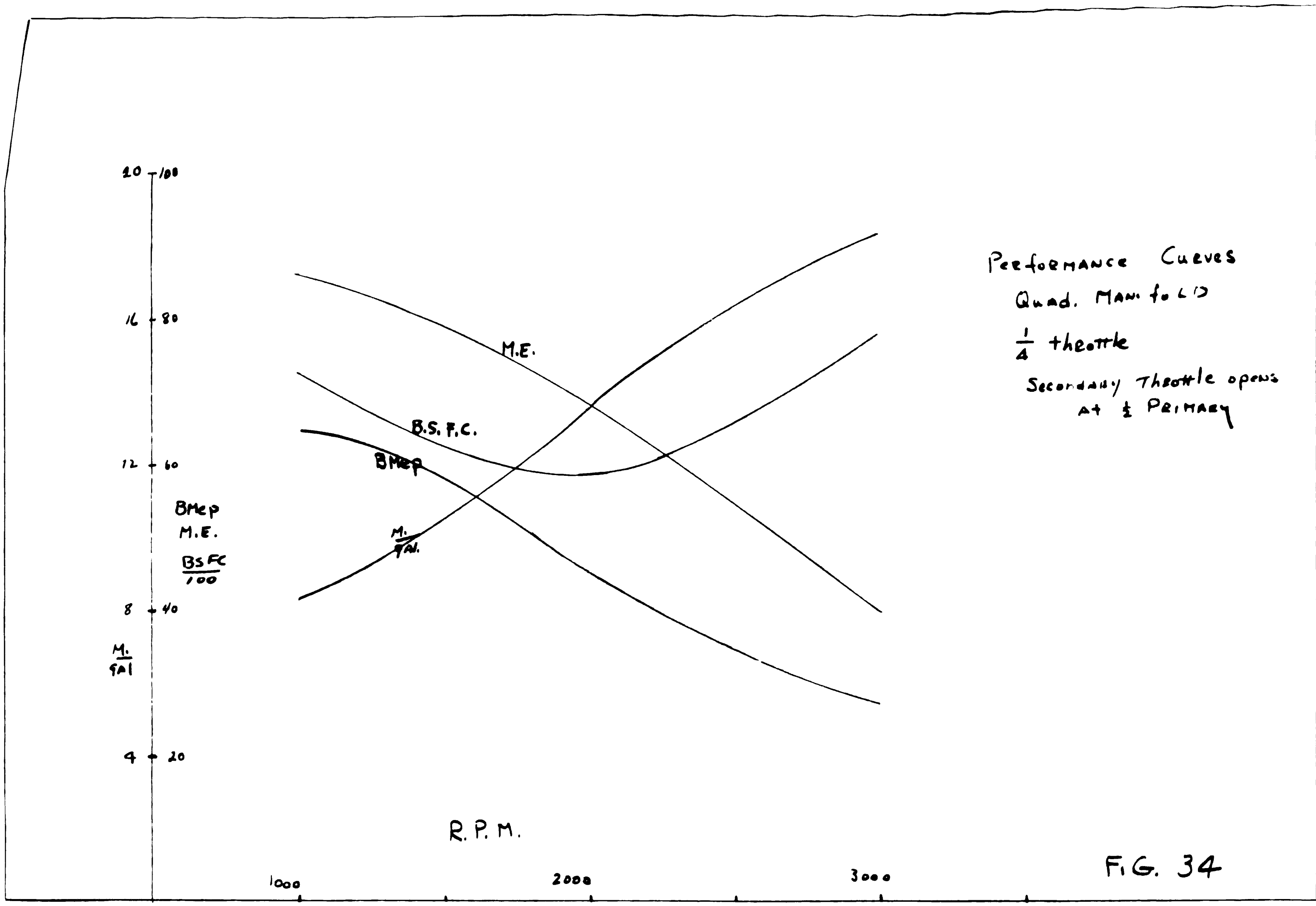

Performance Curves
Quad. Manifold
$\frac{1}{8}$ throttle
Secondary throttle opens
at $\frac{1}{2}$ Primary
M.I.
B.S.F.C.
M.E.
B.Mep
20
16
12
8
4
100
80
60
40
20
0
Mi/gal
M.E.
BMep
B.S.F.C./100
R.P.M.
750
1000
1500
2000
2500

FIG. 33



Performance Curves
Quad. Manifold
1/4 throttle
Secondary Throttle opens
at 1/2 Primary
20
16
12
8
4
100
80
60
40
20
BMEP
M.E.
BSFC/100
M./gal
M.E.
B.S.F.C.
BMEP
M./gal.
R.P.M.
1000
2000
3000

FIG. 34

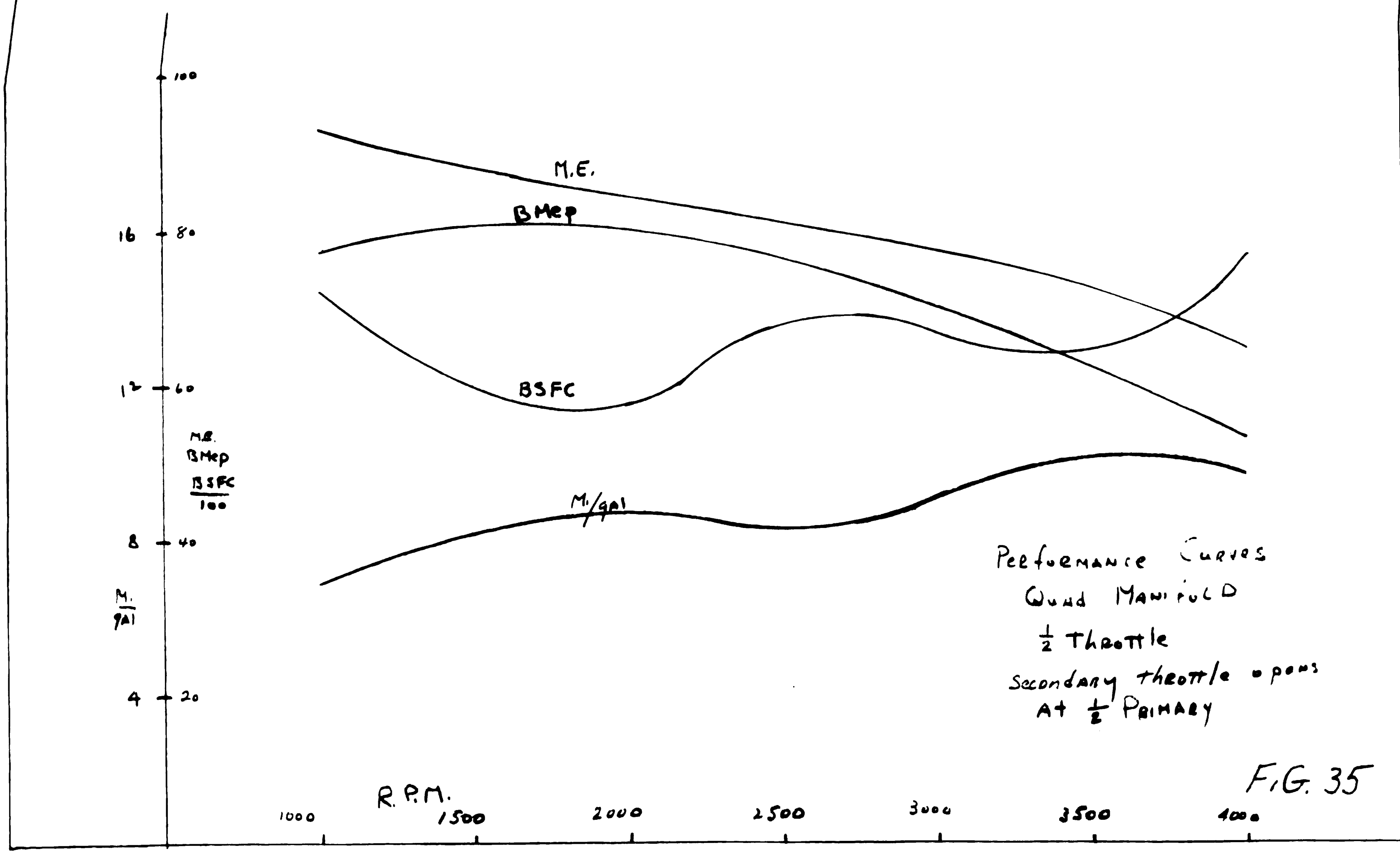
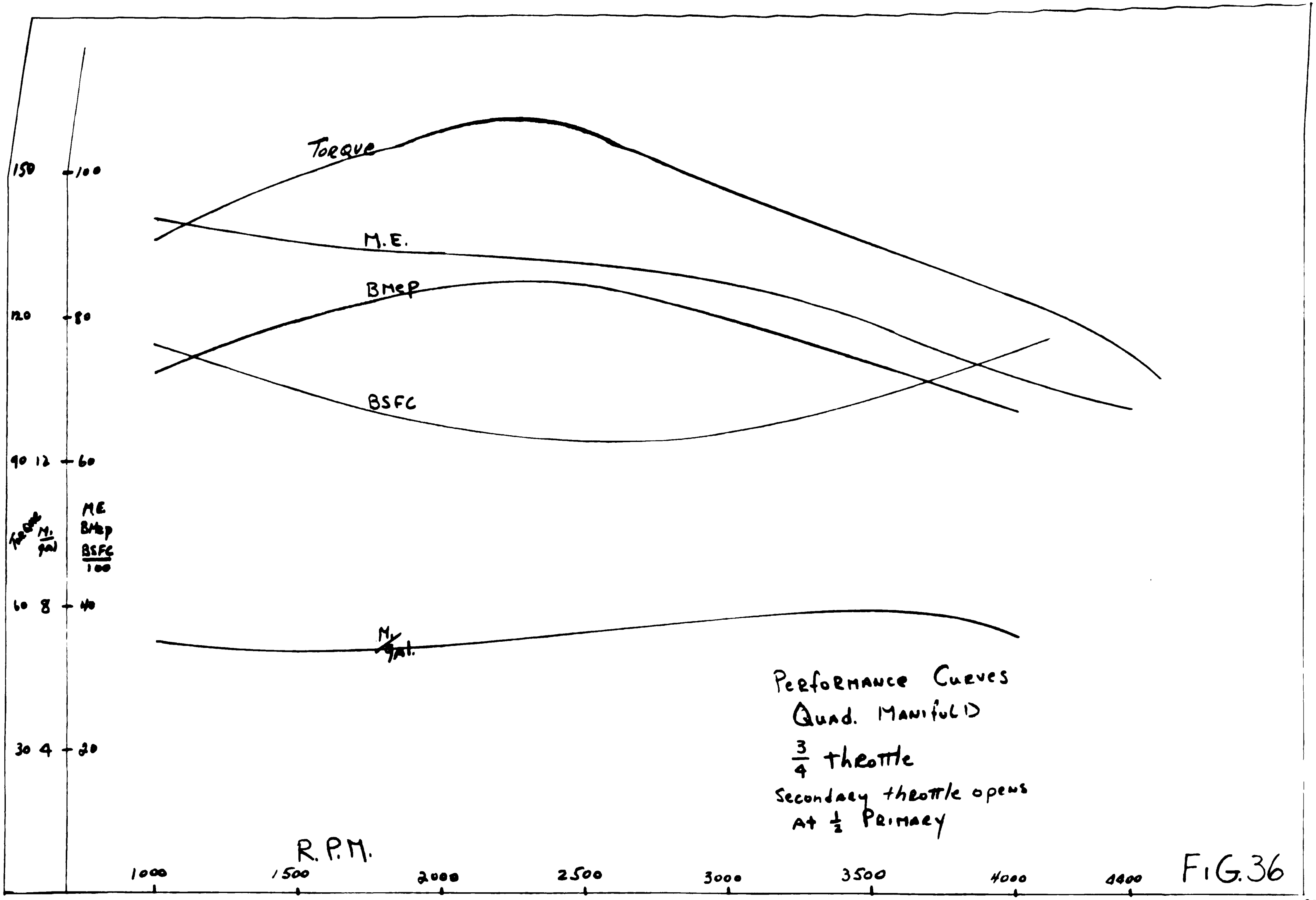

100
16 80
12 60
8 40
4 20
M.E.
BMep
BSFC/100
M./gal
M.E.
BMep
BSFC
M./gal
R.P.M.
1000
1500
2000
2500
3000
3500
4000
Performance Curves
Quad Manifold
½ Throttle
Secondary throttle opens
At ½ Primary

FIG. 35



Performance Curves
Quad. Manifold
$\frac{3}{4}$ throttle
Secondary throttle opens
At $\frac{1}{2}$ Primary
Torque
M.E.
BMeP
BSFC
M/gal.
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400
150
120
90
60
30
12
8
4
100
80
60
40
20
ME
BMep
BSFC/100
M./gal

FIG. 36

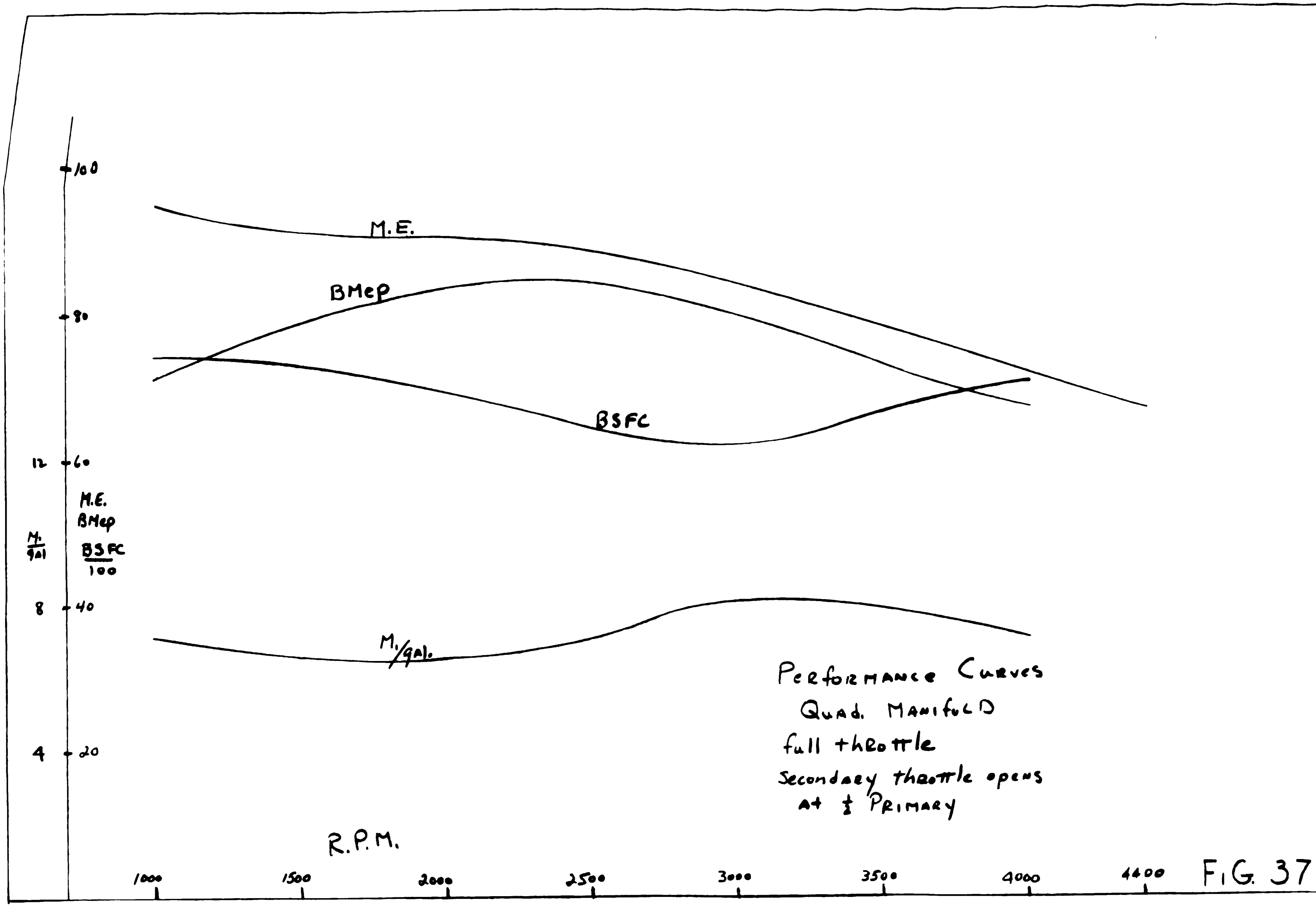

M.E.
BMep
BSFC
M/gal.
Performance Curves
Quad. Manifold
full throttle
Secondary throttle opens
at ½ Primary
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400
100
80
60
40
20
12
8
4
M.E.
BMep
BSFC/100
M/gal

FIG. 37

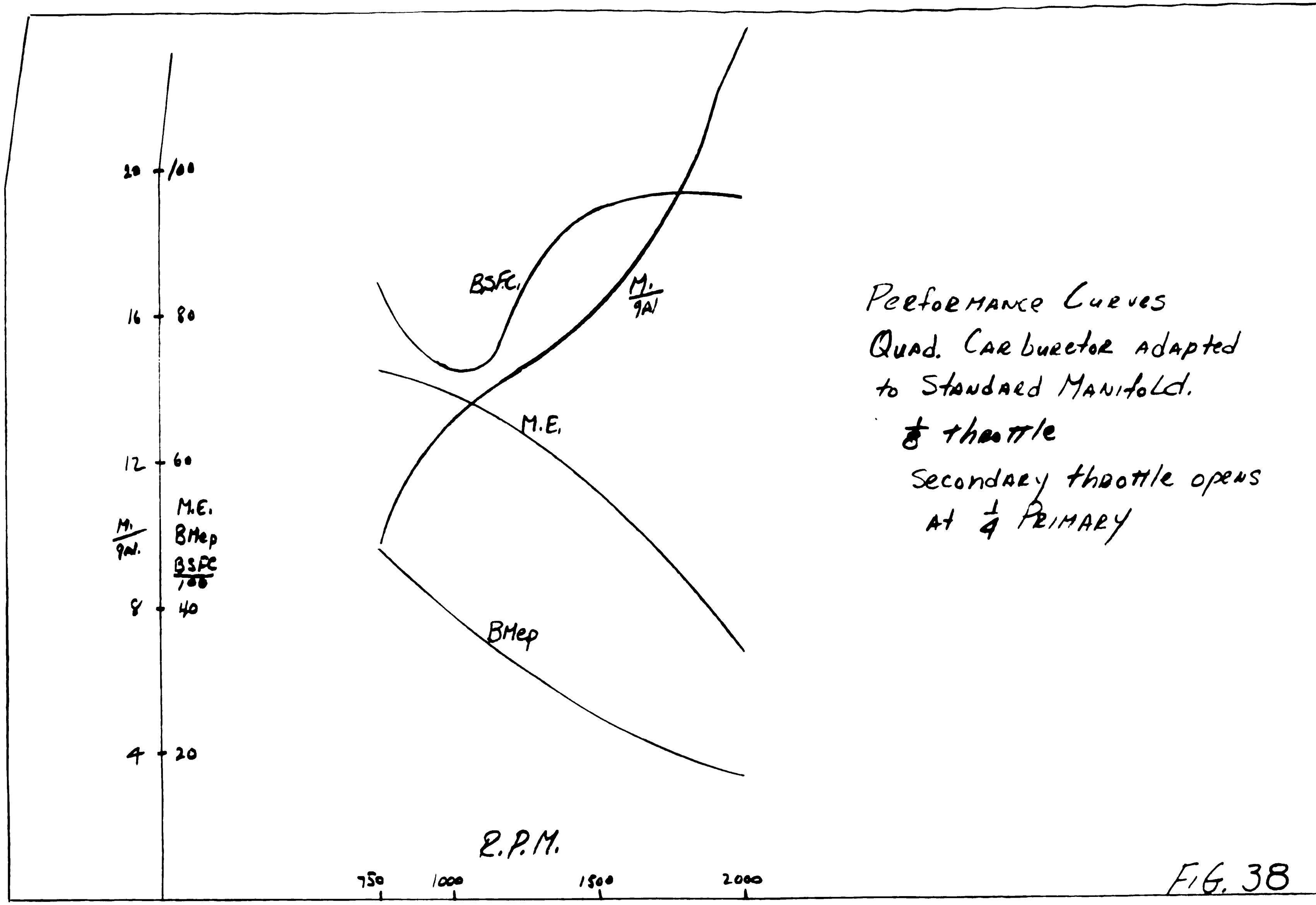
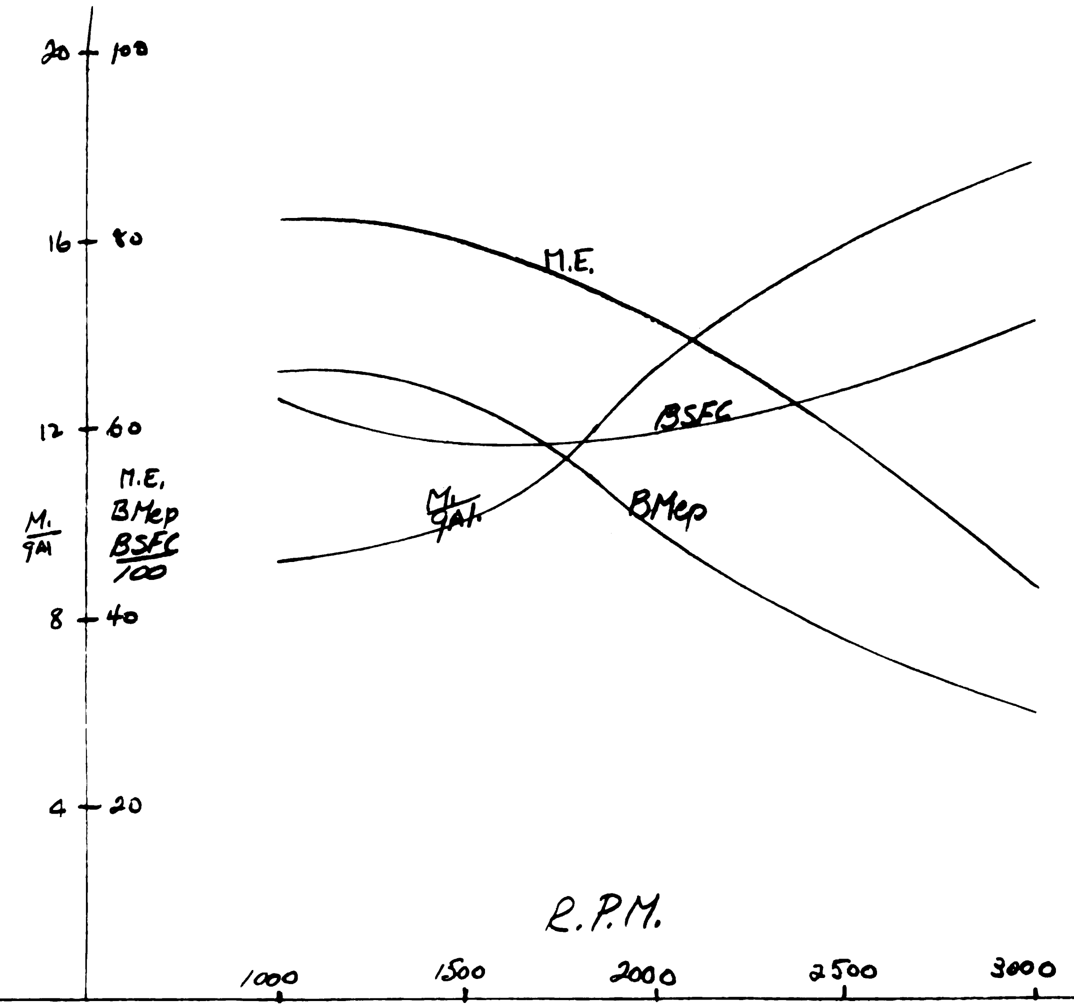

Performance Curves
Quad. Carburetor adapted
to Standard Manifold.
$\frac{1}{8}$ throttle
Secondary throttle opens
at $\frac{1}{4}$ Primary
BSFC.
M./gal.
M.E.
BMep
R.P.M.
750
1000
1500
2000
20
16
12
8
4
100
80
60
40
20
M./gal.
M.E.
BMep
BSFC/100

FIG. 38



Performance Curves
Quad. Carburetor adapted to Standard Manifold
1/4 throttle
Secondary Throttle opens At 1/4 Primary

FIG. 39

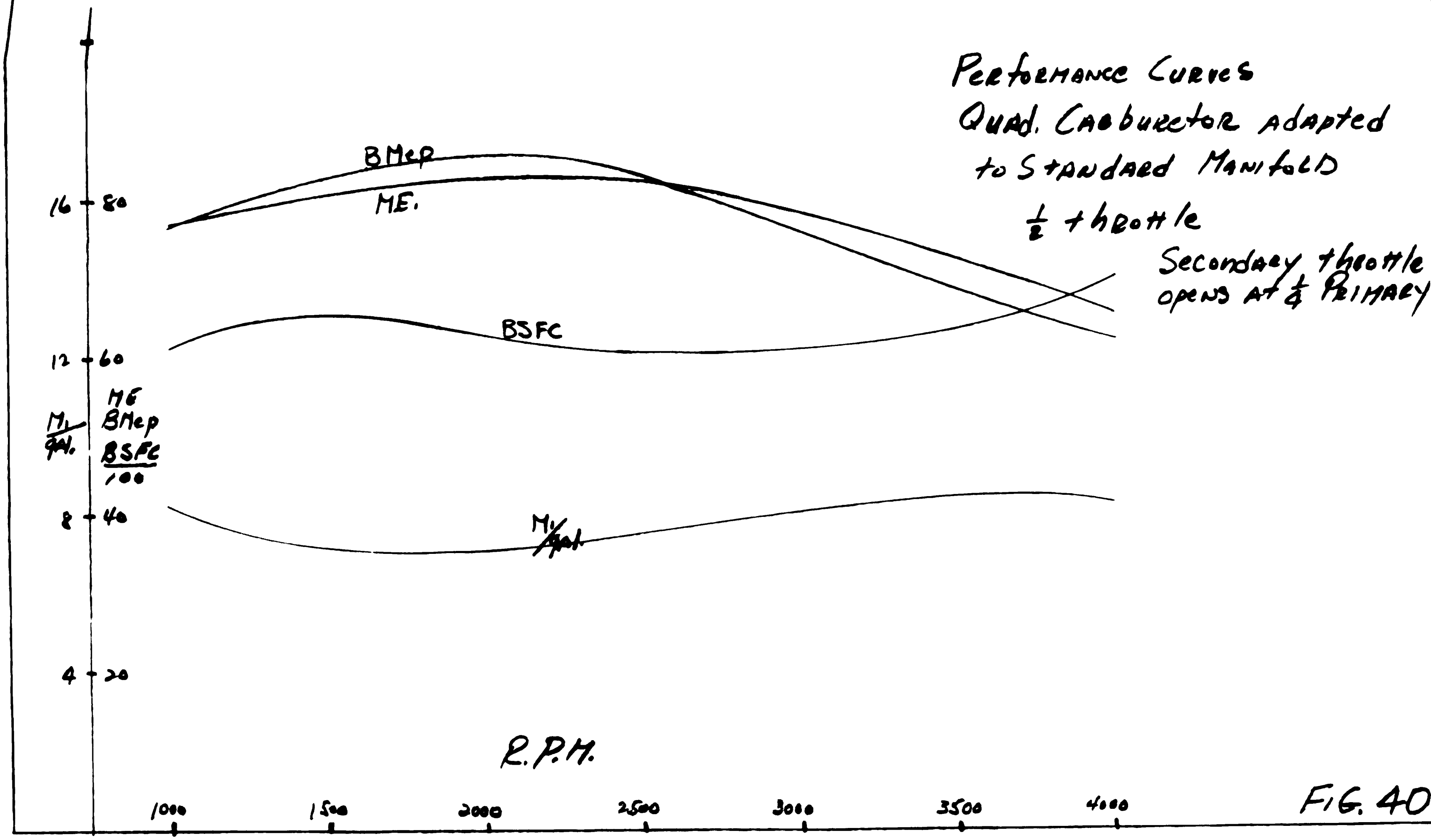

Performance Curves
Quad. Carburetor adapted
to Standard Manifold
$\frac{1}{2}$ throttle
Secondary throttle
opens at $\frac{1}{4}$ Primary
BMep
ME.
BSFC
Mi/gal.
16
12
8
4
80
60
40
20
Mi/gal.
ME
BMep
BSFC/100
1000
1500
2000
2500
3000
3500
4000
R.P.M.

FIG. 40

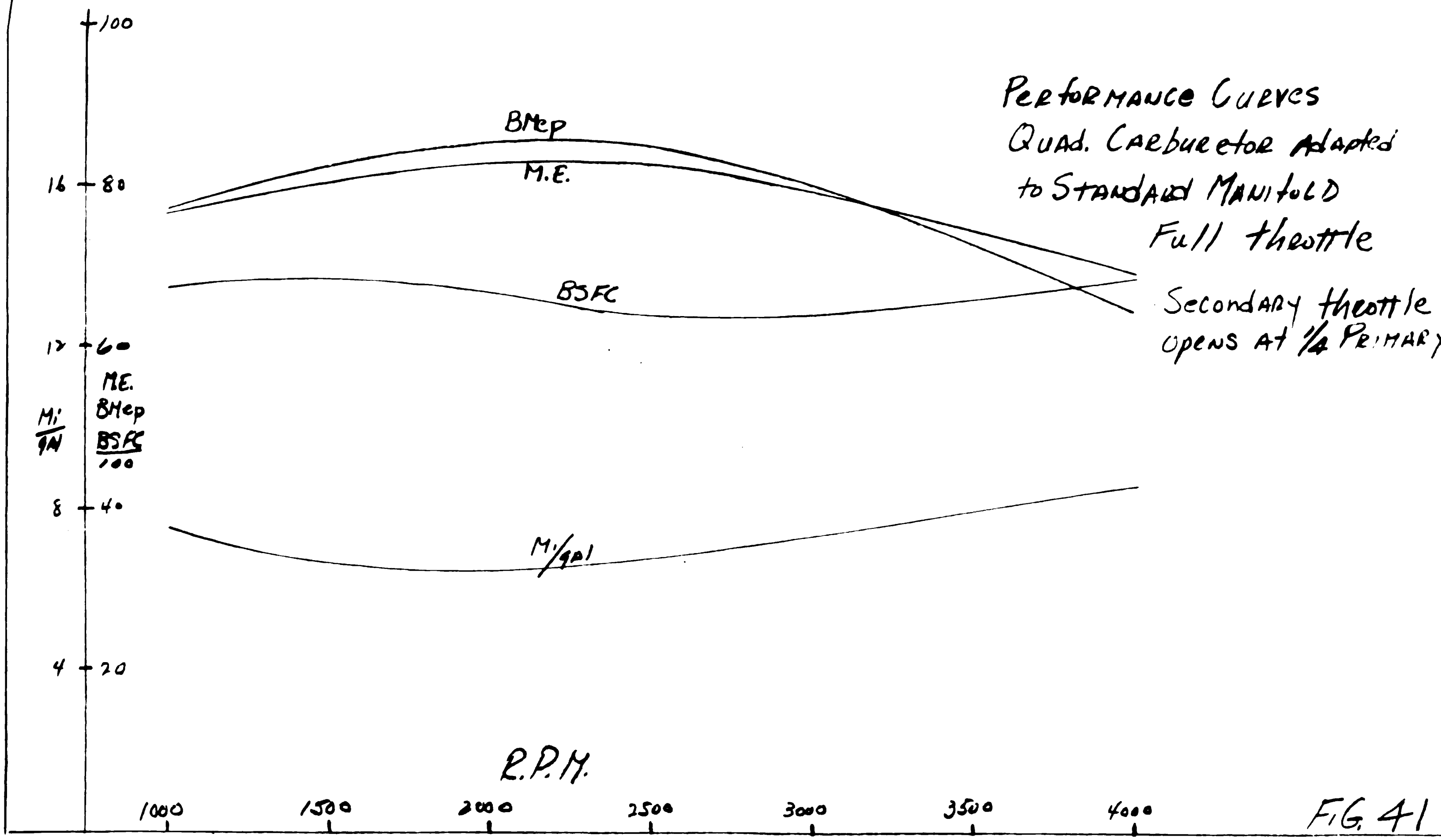

Performance Curves
Quad. Carburetor Adapted
to Standard Manifold
Full throttle
Secondary throttle
opens at 1/4 Primary
BMep
M.E.
BSFC
Mi/gal
Mi/gal
M.E.
BMep
BSFC/100
100
16 80
12 60
8 40
4 20
R.P.M.
1000
1500
2000
2500
3000
3500
4000

FIG. 41

COMPARISON OF CURVES

Figures 42-56

Indicated Horsepower
Brake Horsepower
Torque

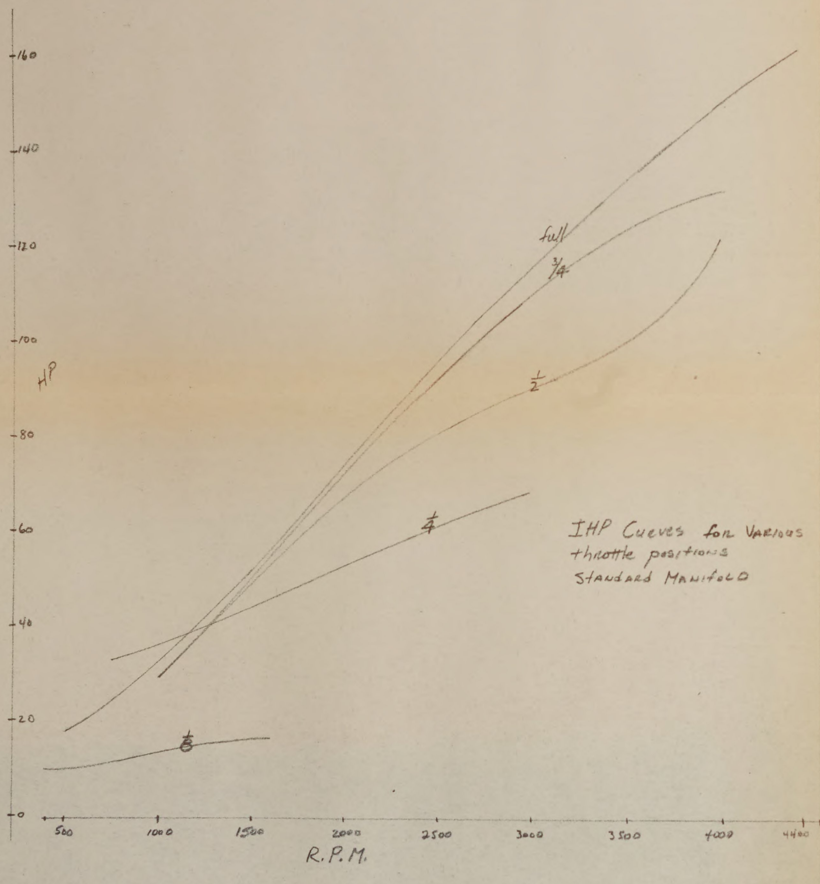

IHP Curves for Various
throttle positions
Standard Manifold
HP
160
140
120
100
80
60
40
20
0
R.P.M.
500
1000
1500
2000
2500
3000
3500
4000
4400
full
3/4
1/2
1/4
1/8

FIG. 42.

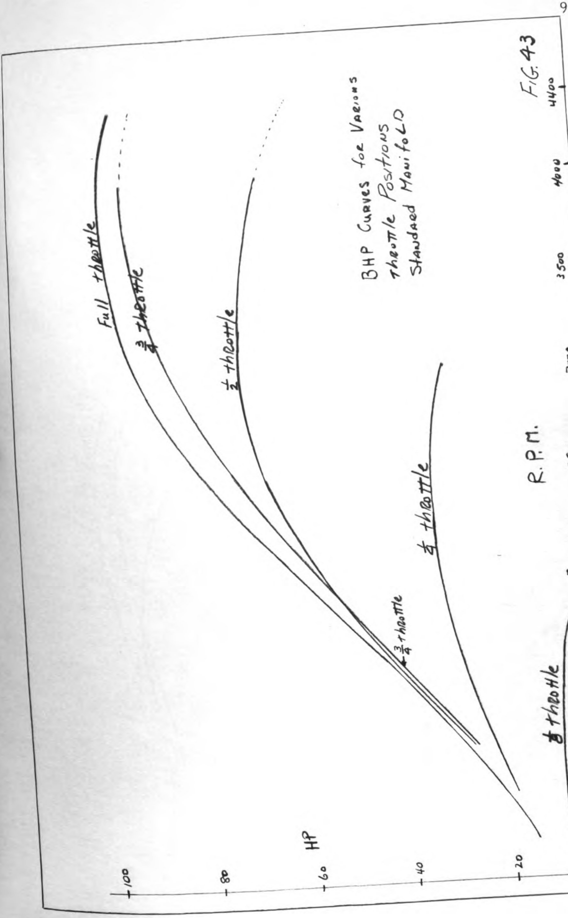

BHP Curves for Various
throttle Positions
Standard Manifold
Full throttle
3/4 throttle
1/2 throttle
1/4 throttle
1/8 throttle
3/4 throttle
HP
R. P. M.
20
40
60
80
100
500
1000
1500
1850
2000
2500
3000
3500
4000
4400

FIG. 43

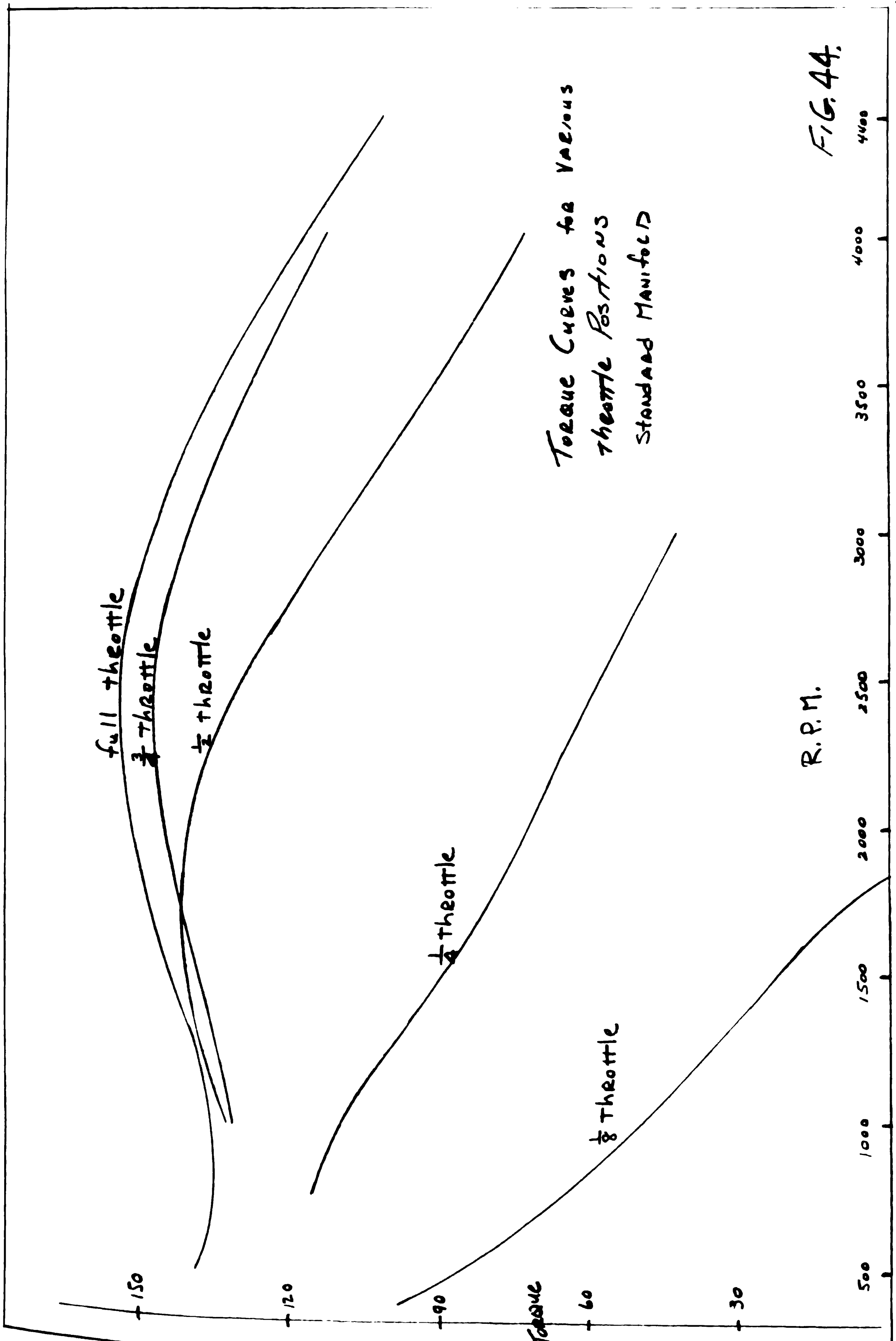

Torque Curves for Various
throttle Positions
Standard Manifold
full throttle
¾ throttle
½ throttle
¼ throttle
⅛ throttle
R.P.M.
Torque
150
120
90
60
30
500
1000
1500
2000
2500
3000
3500
4000
4400

FIG. 44.

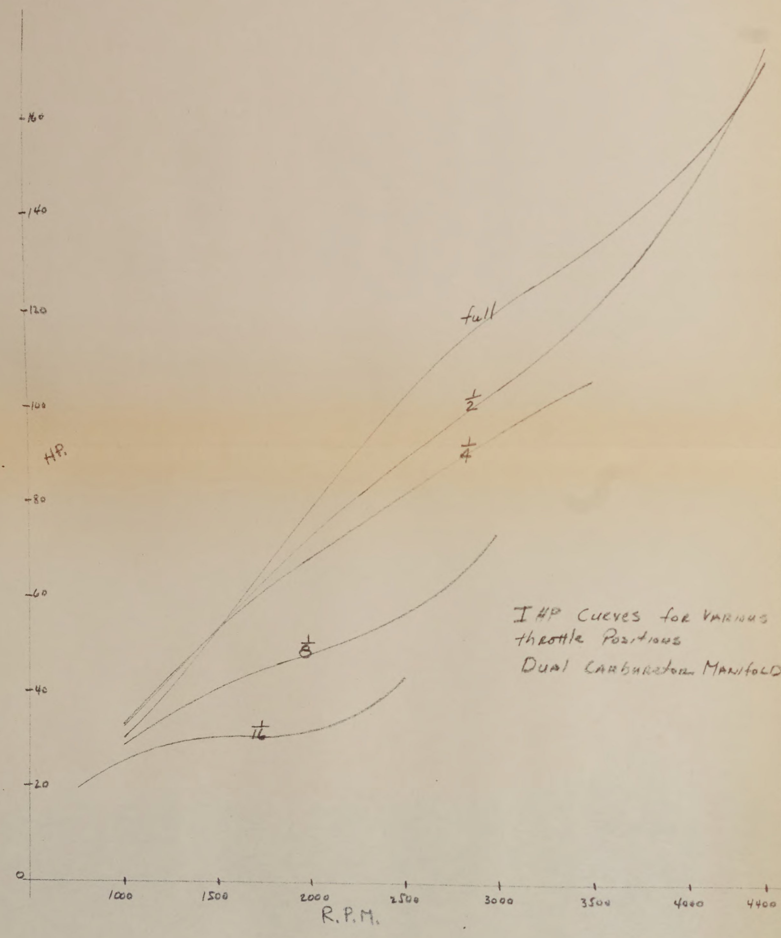

H.P.
160
140
120
100
80
60
40
20
0
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400
full
1/2
1/4
1/8
1/16
IHP Curves for various throttle Positions Dual Carburetor Manifold

FIG. 45.

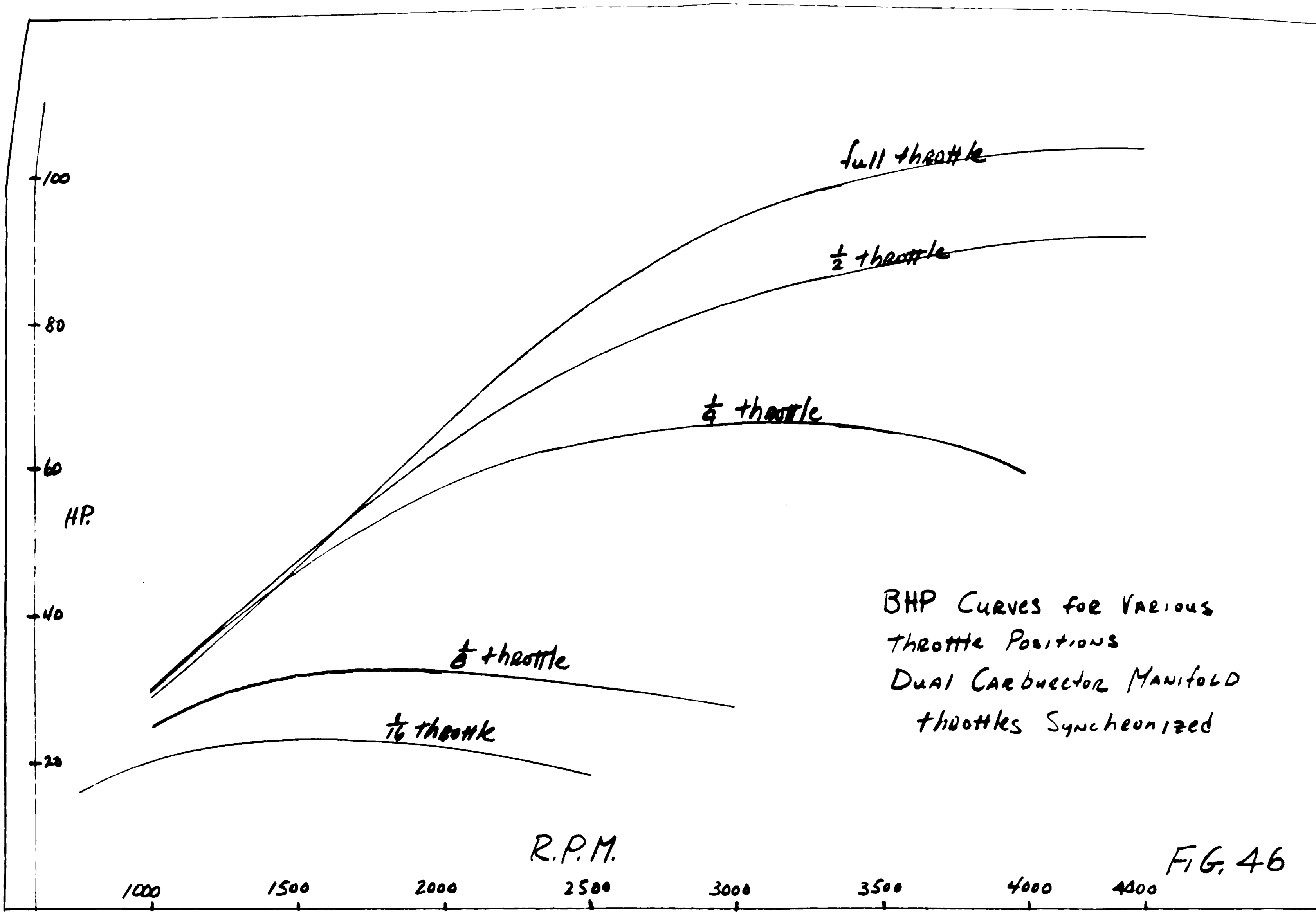
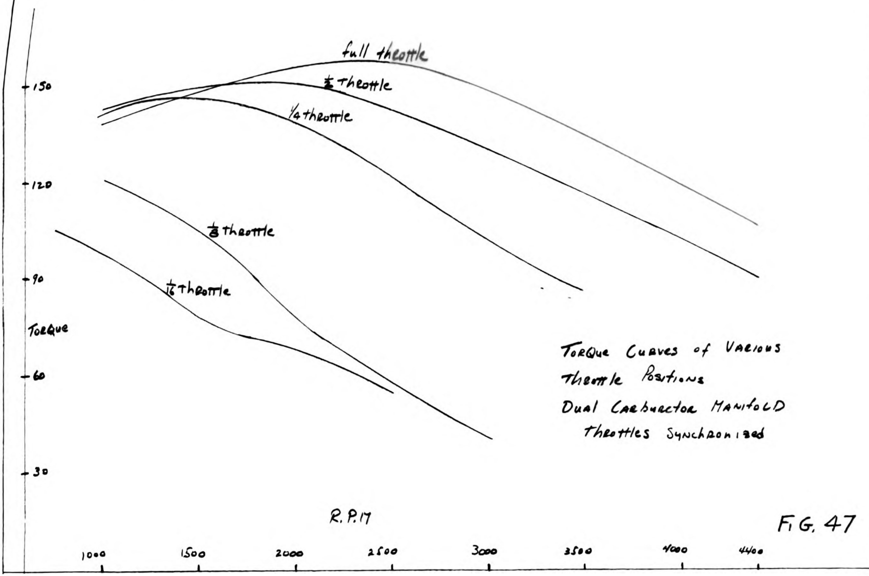

BHP Curves for Various
throttle Positions
Dual Carburetor Manifold
throttles Synchronized
full throttle
½ throttle
¼ throttle
⅛ throttle
1/16 throttle
H.P.
100
80
60
40
20
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400

FIG. 46



Torque Curves of Various Throttle Positions
Dual Carburetor Manifold
Throttles Synchronized

FIG. 47

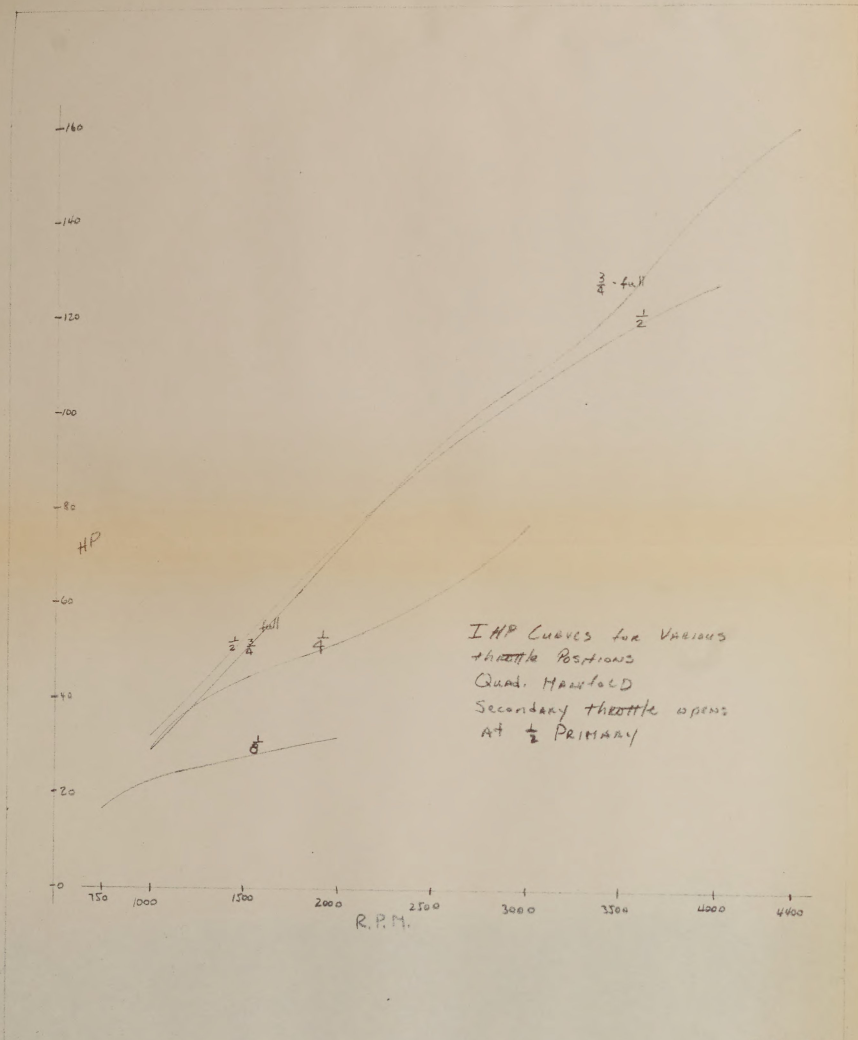

160
140
120
100
80
60
40
20
0
HP
750
1000
1500
2000
2500
3000
3500
4000
4400
R.P.M.
3/4 - full
1/2
full
1/2 3/4
1/4
1/8
IHP Curves for Various
throttle Positions
Quad. Manifold
Secondary throttle opens
At 1/2 Primary

FIG. 48.

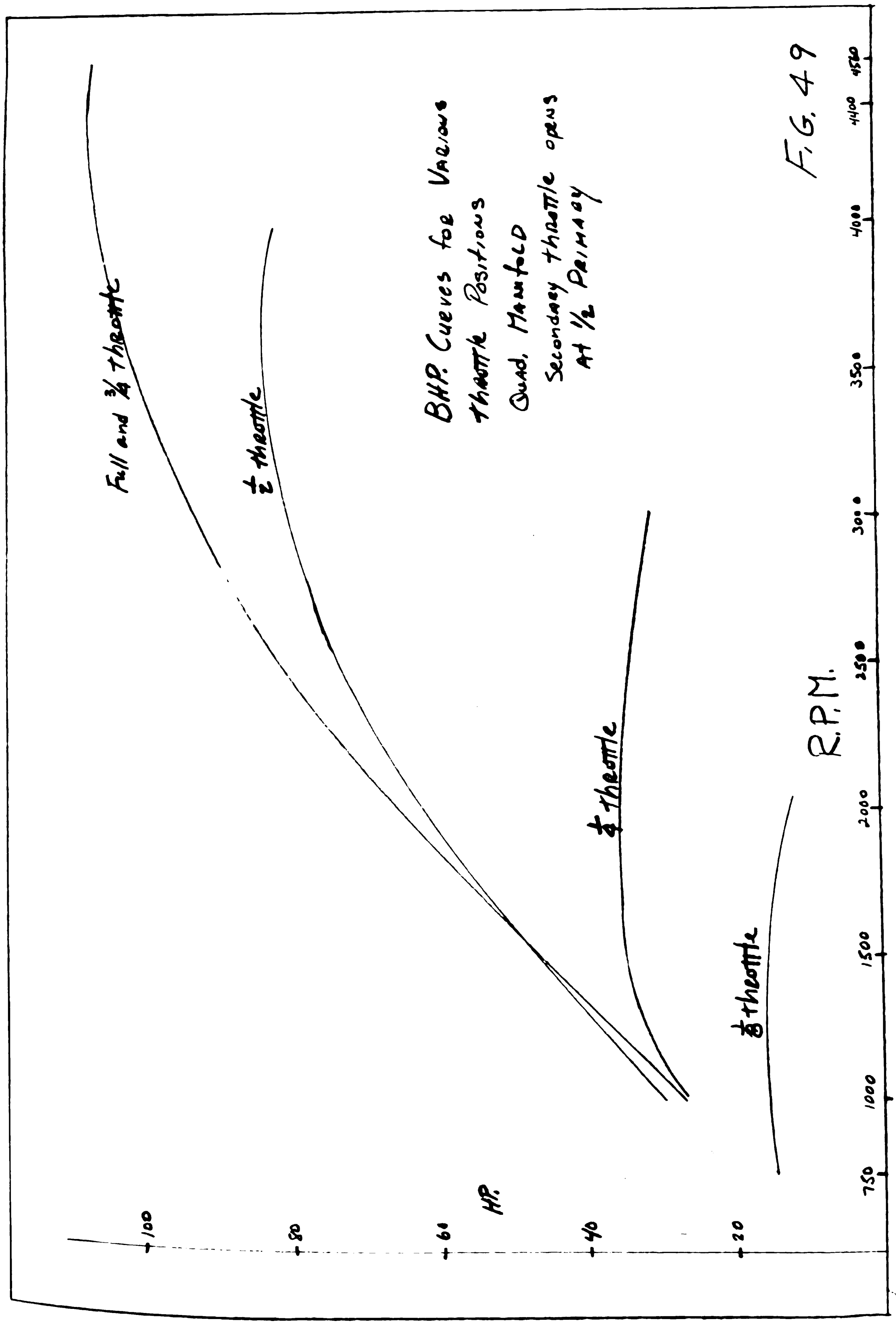

BHP. Curves for Various
throttle Positions
Quad. Manifold
Secondary throttle opens
At 1/2 Primary
Full and 3/4 throttle
1/2 throttle
1/4 throttle
1/8 throttle
R.P.M.
HP.
100
80
60
40
20
750
1000
1500
2000
2500
3000
3500
4000
4400
4500

FIG. 49

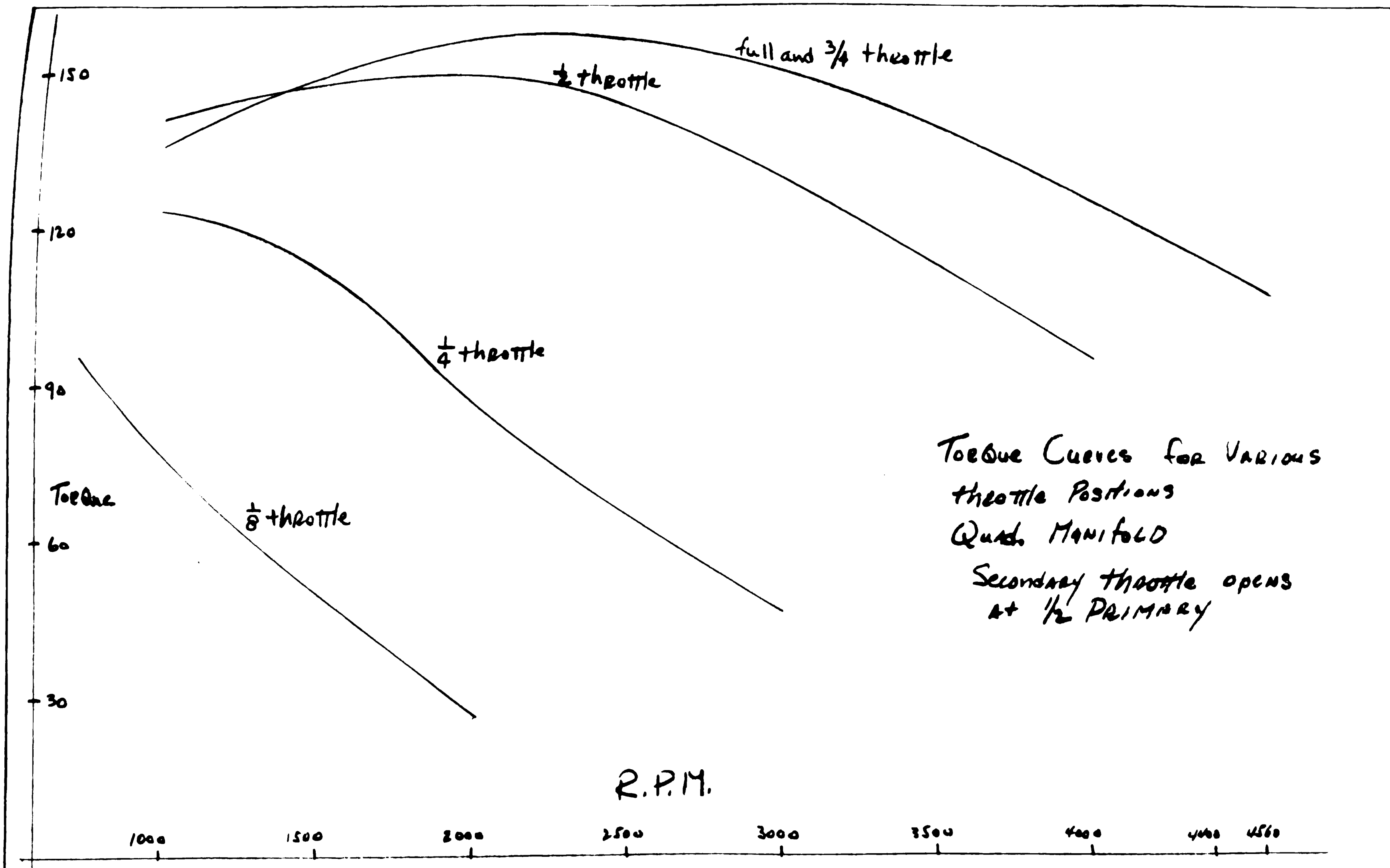

full and 3/4 throttle
1/2 throttle
1/4 throttle
1/8 throttle
Torque
150
120
90
60
30
R.P.M.
1000
1500
2000
2500
3000
3500
4000
Torque Curves for Various
throttle Positions
Quad. Manifold
Secondary throttle opens
at 1/2 Primary

FIG. 50

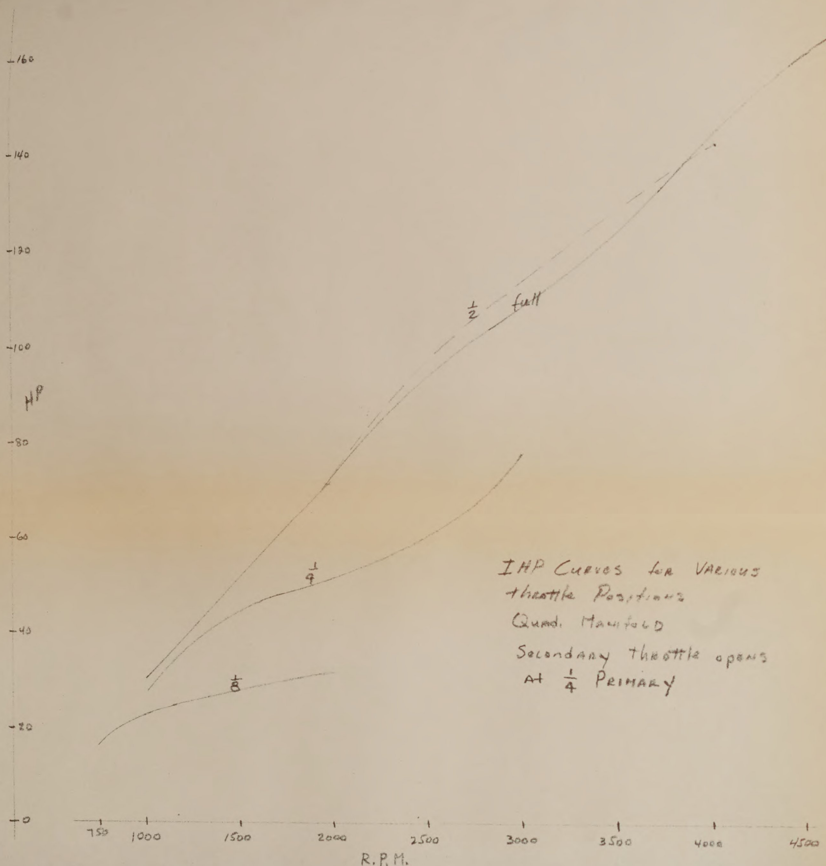

160
140
120
100
HP
80
60
40
20
0
750
1000
1500
2000
2500
3000
3500
4000
4500
R.P.M.
full
1/2
1/4
1/8
IHP Curves for Various
throttle Positions
Quad. Manifold
Secondary throttle opens
At 1/4 Primary

FIG. 51.

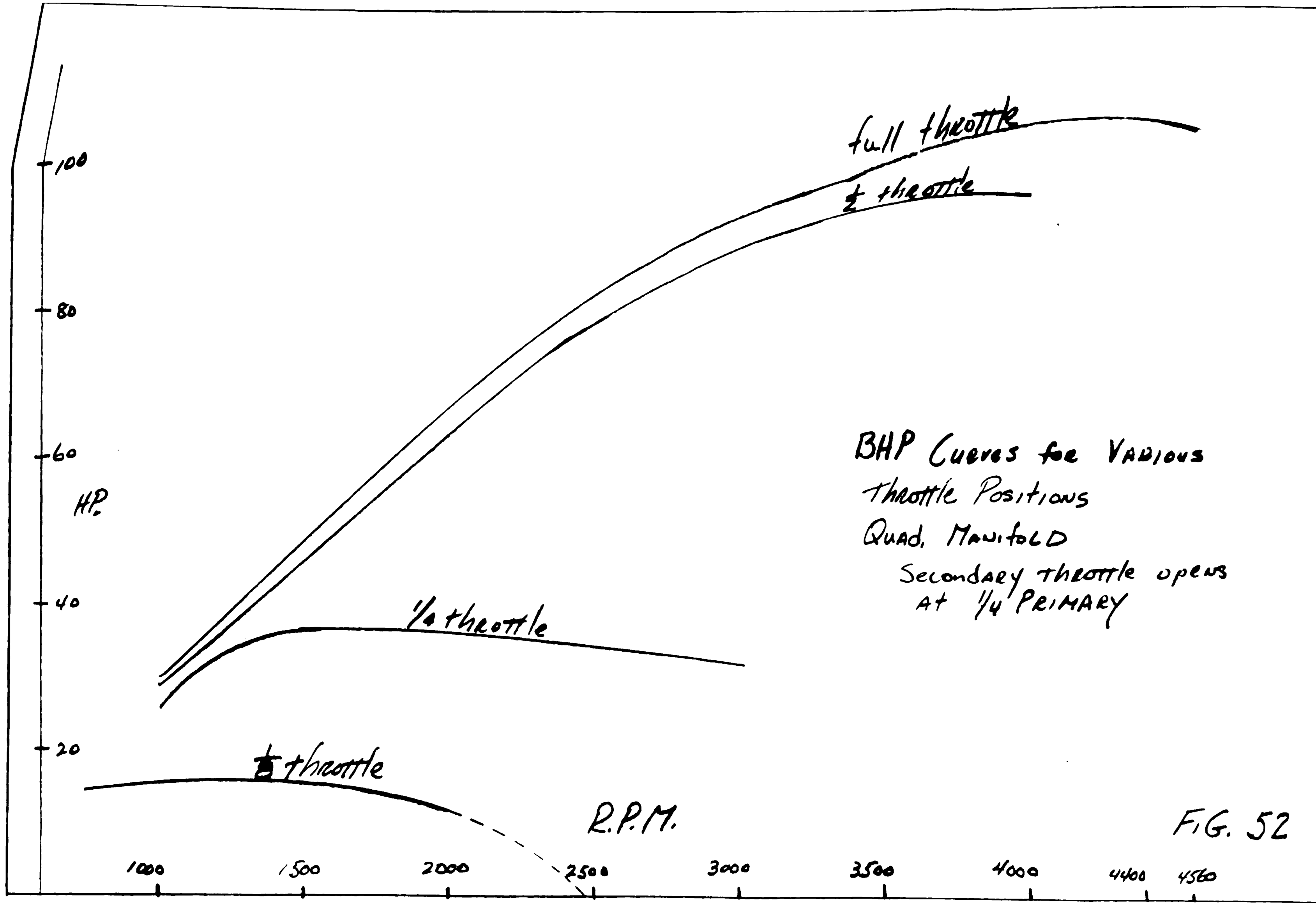

full throttle
½ throttle
¼ throttle
throttle
BHP Curves for Various
Throttle Positions
Quad. Manifold
Secondary throttle opens
at ¼ Primary
H.P.
100
80
60
40
20
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400
4560

FIG. 52

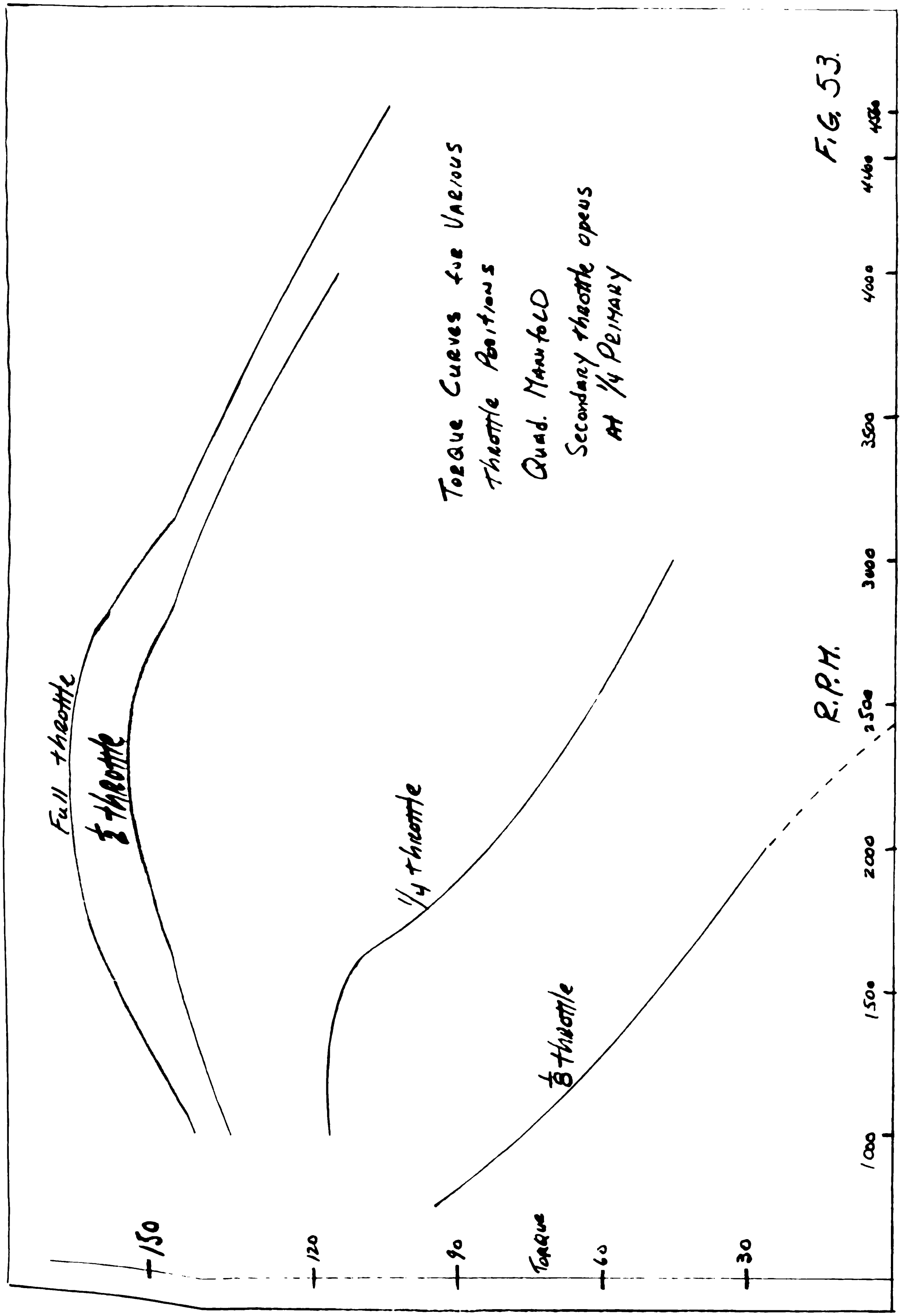
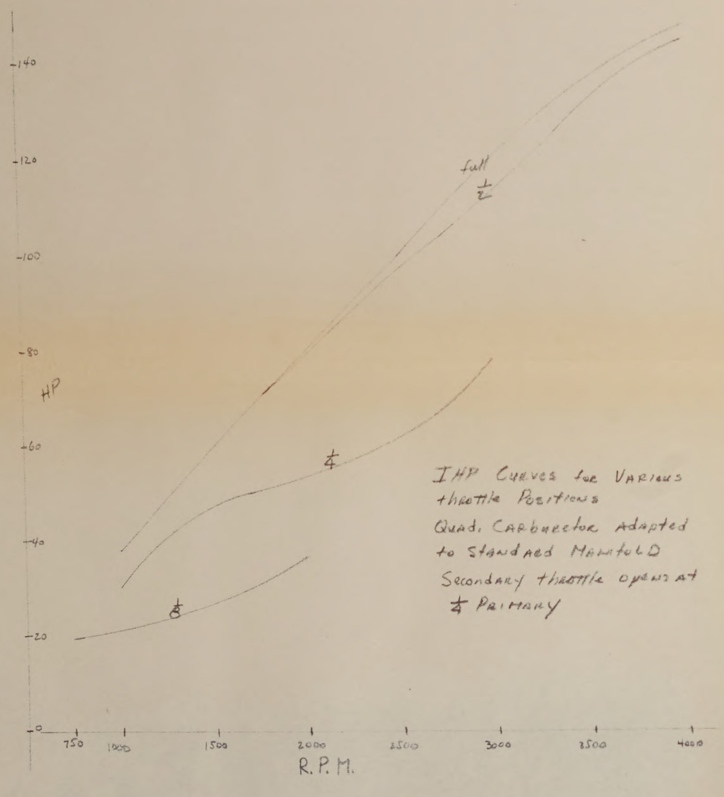

Torque Curves for Various
Throttle Positions
Quad. Manifold
Secondary throttle opens
At 1/4 Primary
Full throttle
½ throttle
1/4 throttle
1/8 throttle
Torque
150
120
90
60
30
R.P.M.
1000
1500
2000
2500
3000
3500
4000
4400
4500

FIG. 53



140
120
100
80
60
40
20
0
HP
750
1000
1500
2000
2500
3000
3500
4000
R.P.M.
full
1/2
1/4
1/8
IHP Curves for Various
throttle Positions
Quad. Carburetor adapted
to Standard Manifold
Secondary throttle opens at
1/4 Primary

FIG. 54.

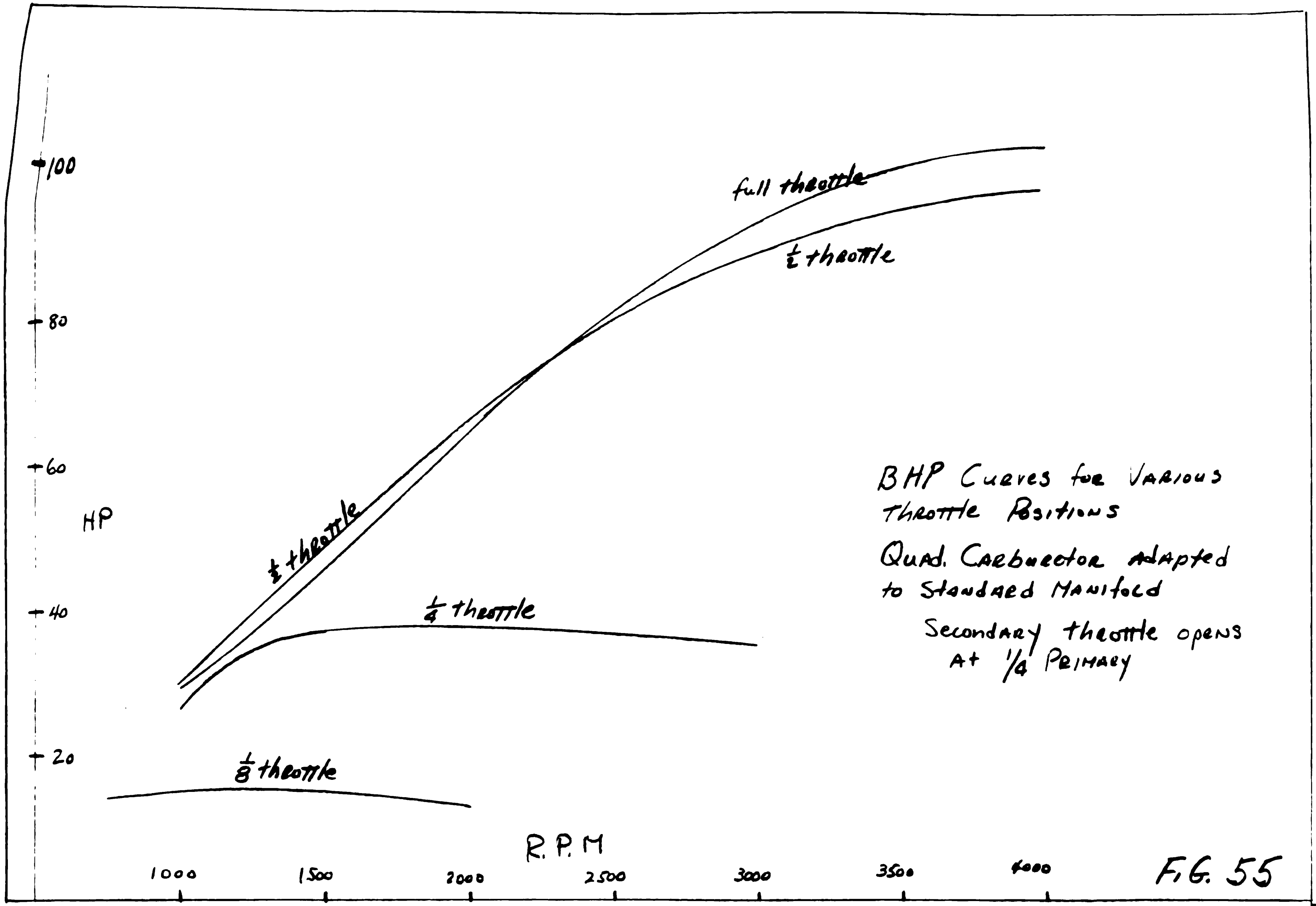

BHP Curves for Various Throttle Positions
Quad. Carburetor Adapted to Standard Manifold
Secondary throttle opens At 1/4 Primary
full throttle
1/2 throttle
1/2 throttle
1/4 throttle
1/8 throttle
HP
100
80
60
40
20
R.P.M
1000
1500
2000
2500
3000
3500
4000

FIG. 55

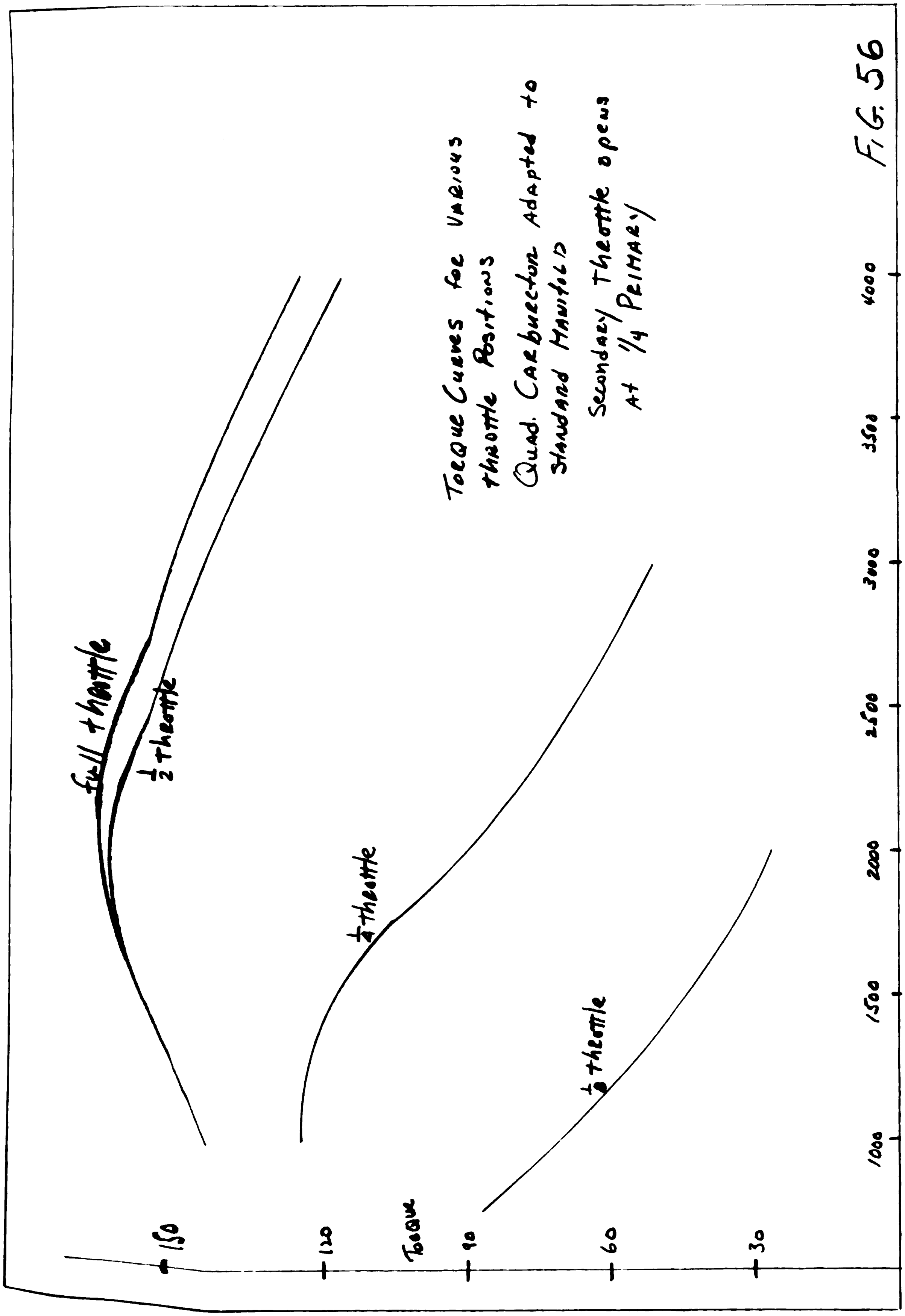

Torque Curves for Various
throttle Positions
Quad. Carburetor Adapted to
Standard Manifold
Secondary Throttle opens
at 1/4 Primary
full throttle
1/2 throttle
1/4 throttle
1/8 throttle
Torque
150
120
90
60
30
1000
1500
2000
2500
3000
3500
4000

FIG. 56

GRAPHS OF DIFFERENTIAL PRESSURES AND
INDICATED HORSEPOWER PER CYLINDER

Figures 57-100

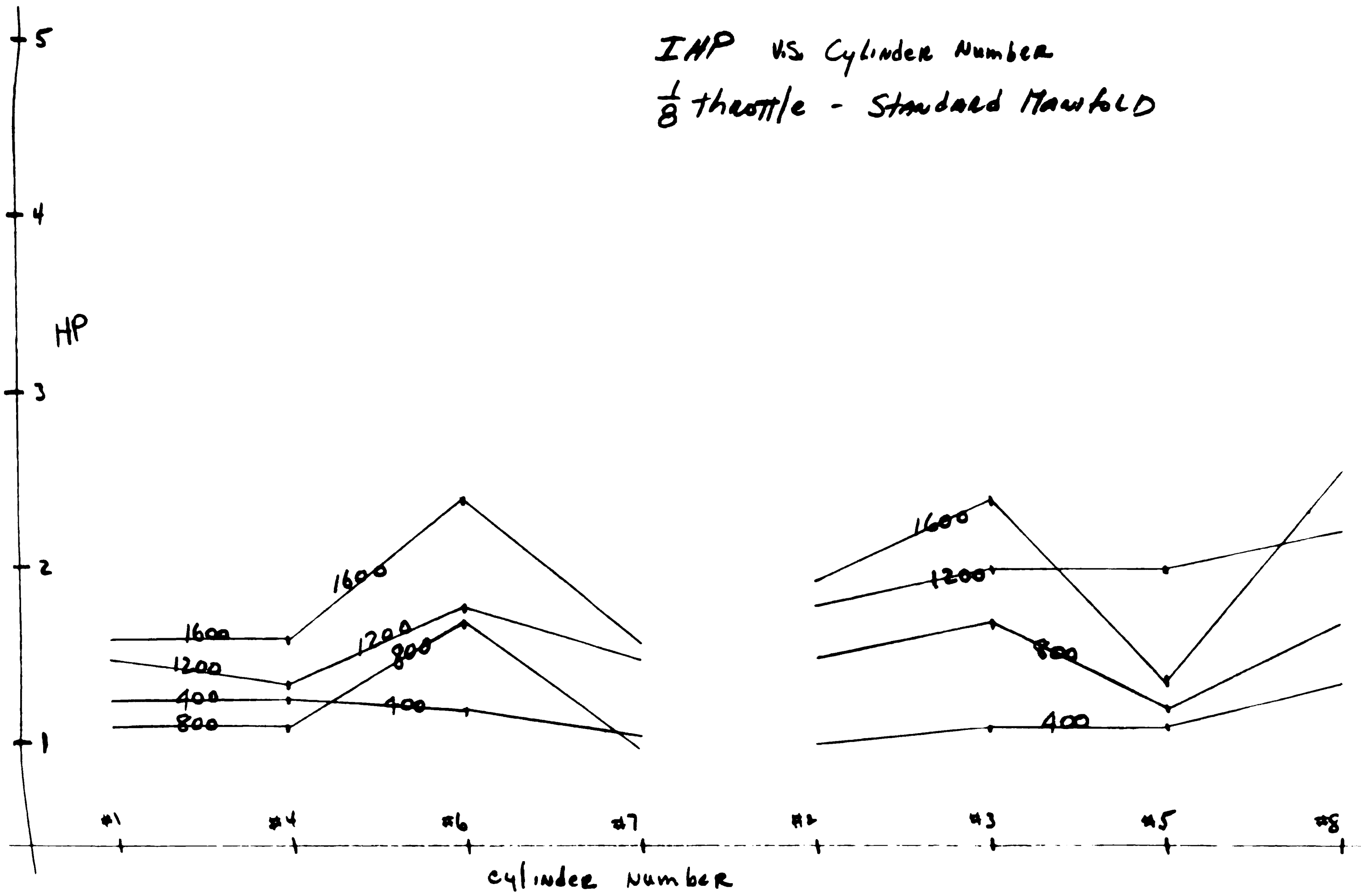
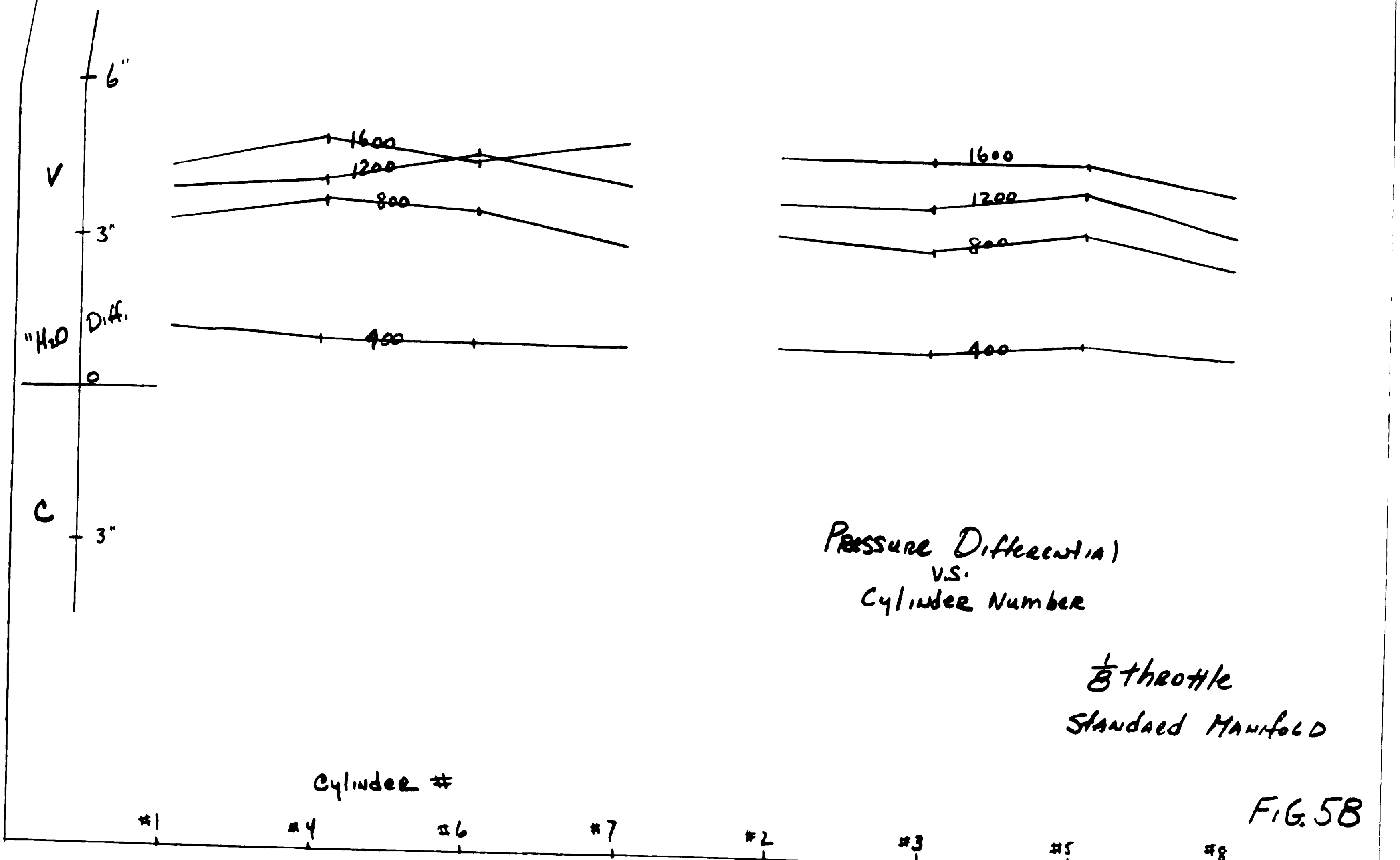

IHP vs. Cylinder Number
1/8 throttle - Standard Manifold
HP
5
4
3
2
1
1600
1200
400
800
1600
1200
800
400
1600
1200
800
400
#1
#4
#6
#7
#2
#3
#5
#8
cylinder number

FIG. 57



Pressure Differential
V.S.
Cylinder Number

$\frac{1}{8}$ throttle
Standard Manifold

FIG. 58

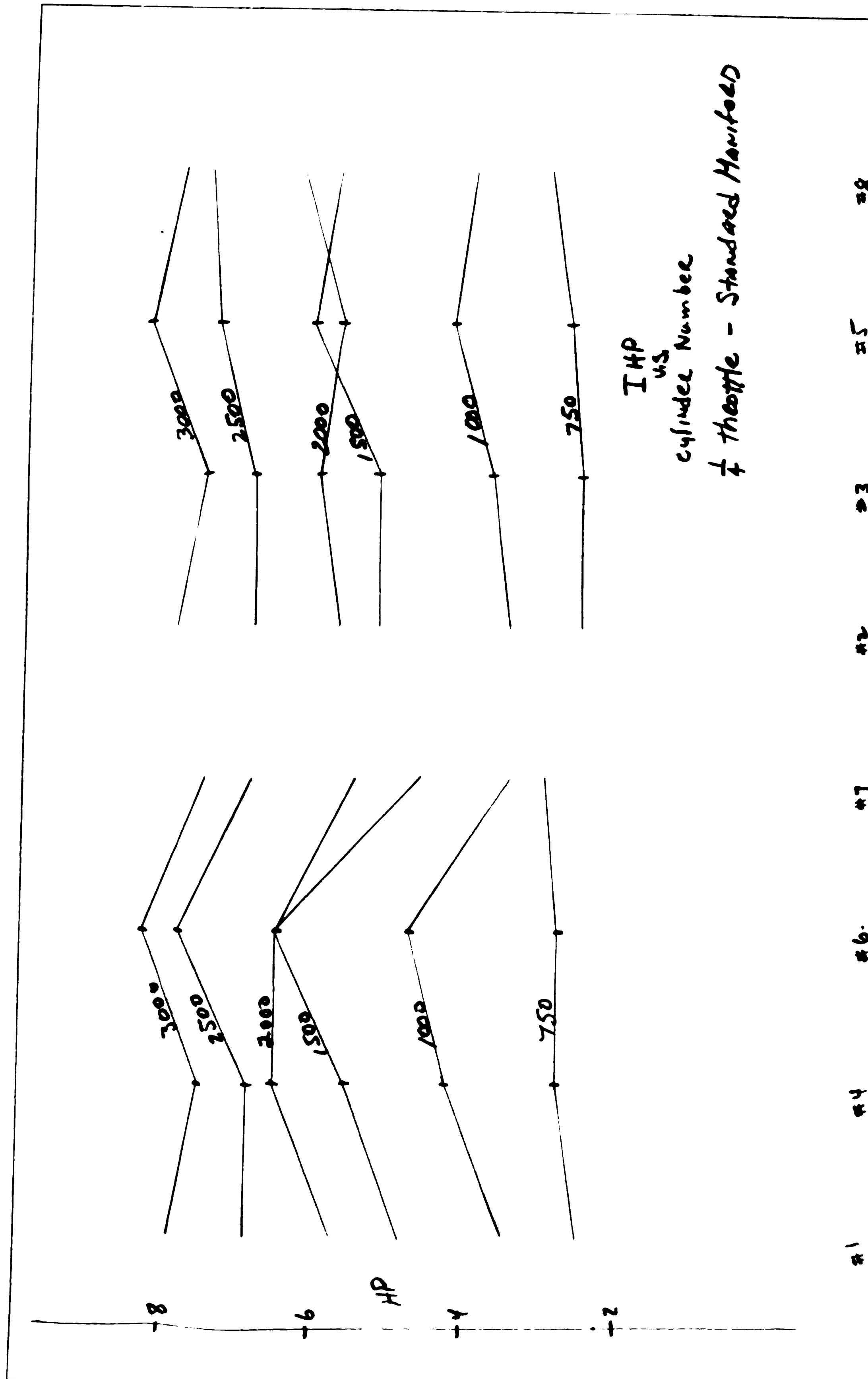

IHP
vs
cylinder Number
1/4 throttle - Standard Manifold
3000
2500
2000
1500
1000
750
HP
8
6
4
2
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG. 59

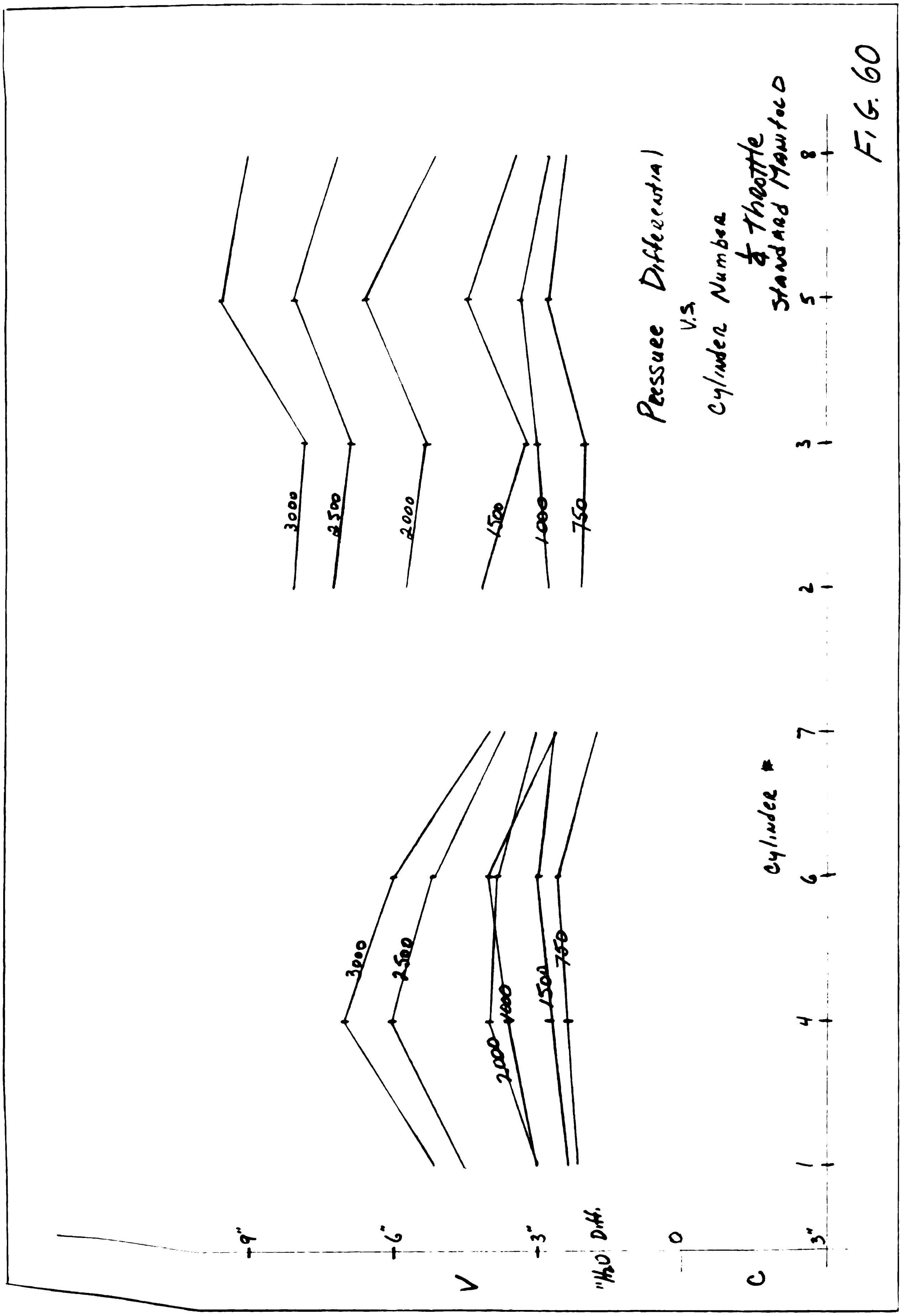

Pressure Differential
V.S.
Cylinder Number
¼ Throttle
Standard Manifold
V
"H2O Diff.
C
9"
6"
3"
0
3"
cylinder #
1
4
6
7
2
3
5
8
3000
2500
2000
1500
1000
750
3000
2500
2000
1500
1000
750

FIG. 60

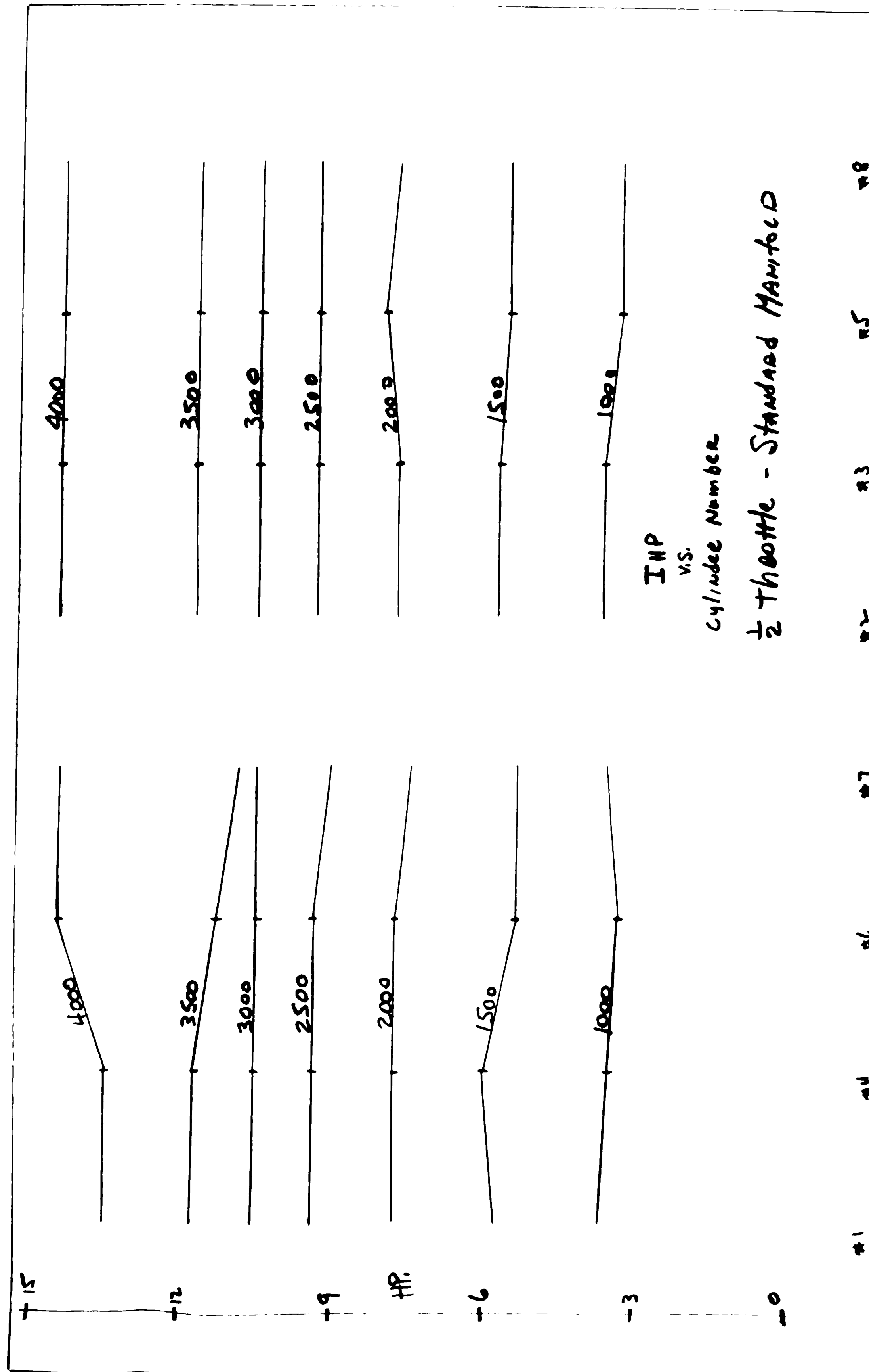

IHP
v.s.
Cylinder Number
1/2 Throttle - Standard Manifold
Cylinder Number
HP
0
3
6
9
12
15
#1
#4
#6
#7
#2
#3
#5
#8
4000
3500
3000
2500
2000
1500
1000

FIG. 61.

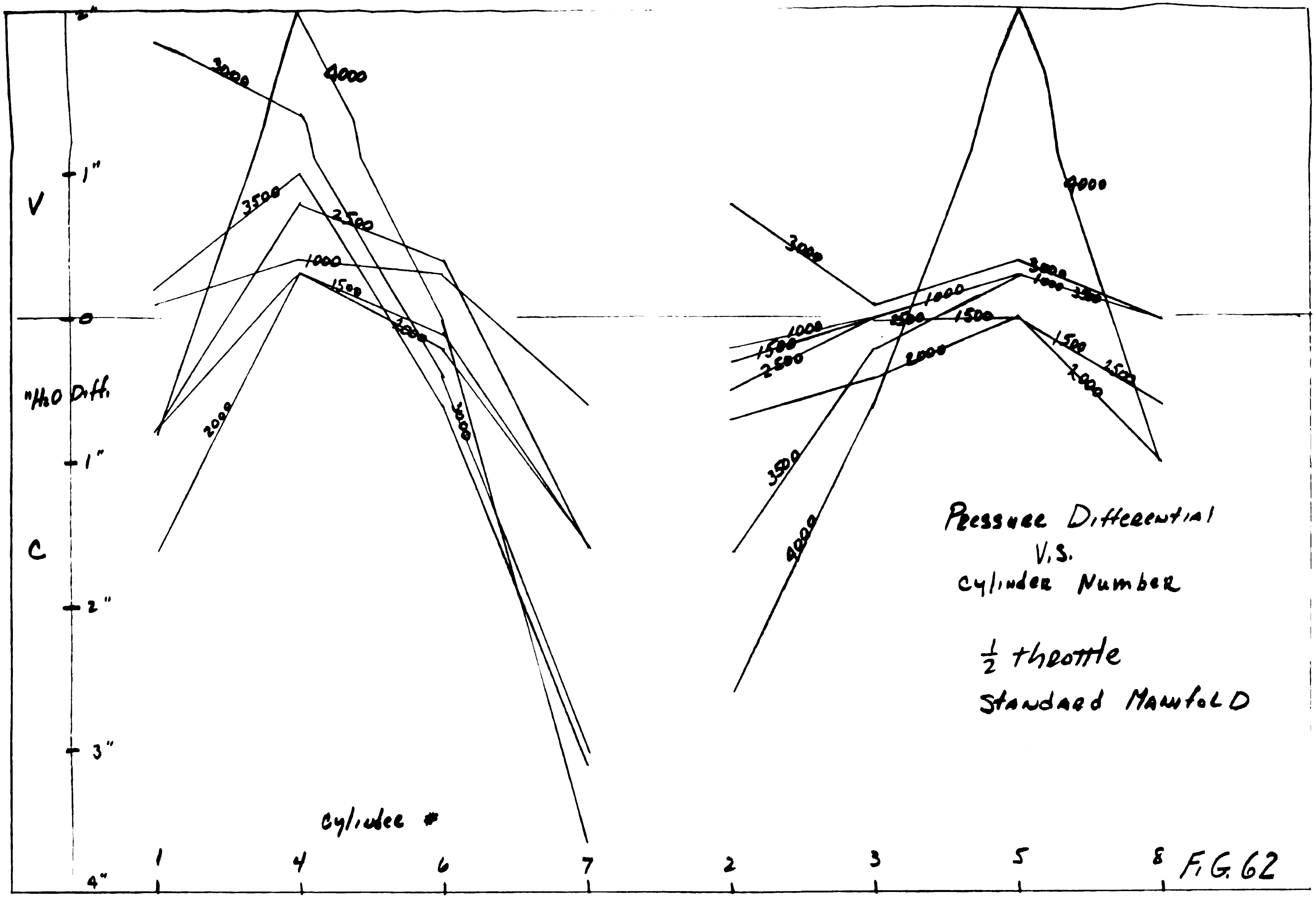
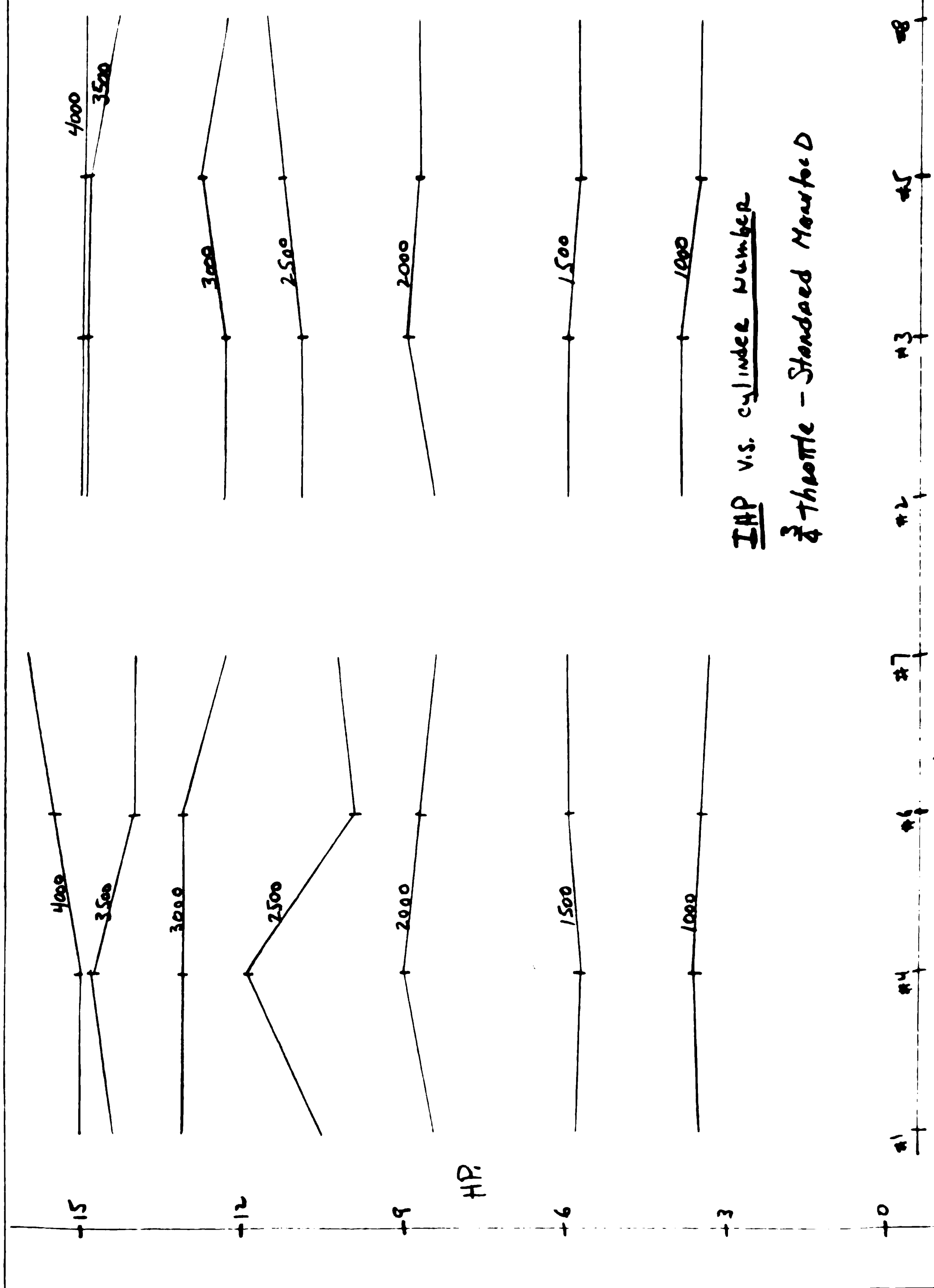
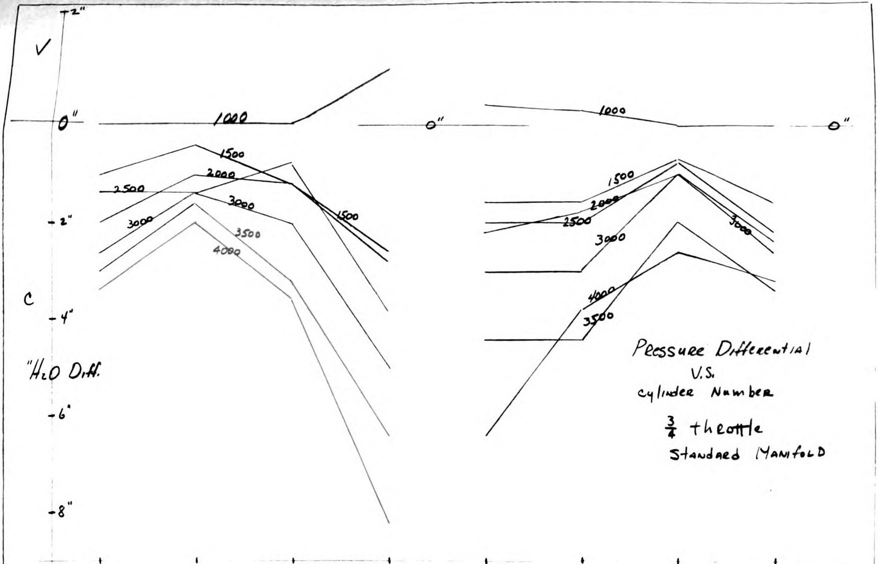

Pressure Differential
V.S.
cylinder Number
½ throttle
Standard Manifold
V
C
"H₂O Diff.
2"
1"
0
1"
2"
3"
4"
cylinder #
1
4
6
7
2
3
5
8
3000
4000
3500
2500
1000
1500
2000
3000

FIG. 62



IHP v.s. cylinder number
3/4 throttle - Standard Manifold
cylinder Number
HP.
0
3
6
9
12
15
#1
#4
#6
#7
#2
#3
#5
#8
4000
3500
3000
2500
2000
1500
1000

FIG. 63.



+2"
V
0"
-2"
C
-4"
"H₂O Diff.
-6"
-8"
1000
1500
2000
2500
3000
3500
4000
0"
0"
1 4 6 7 2 3 5 8
Cylinder Number
Pressure Differential
V.S.
cylinder Number
3/4 throttle
Standard Manifold

FIG. 64-

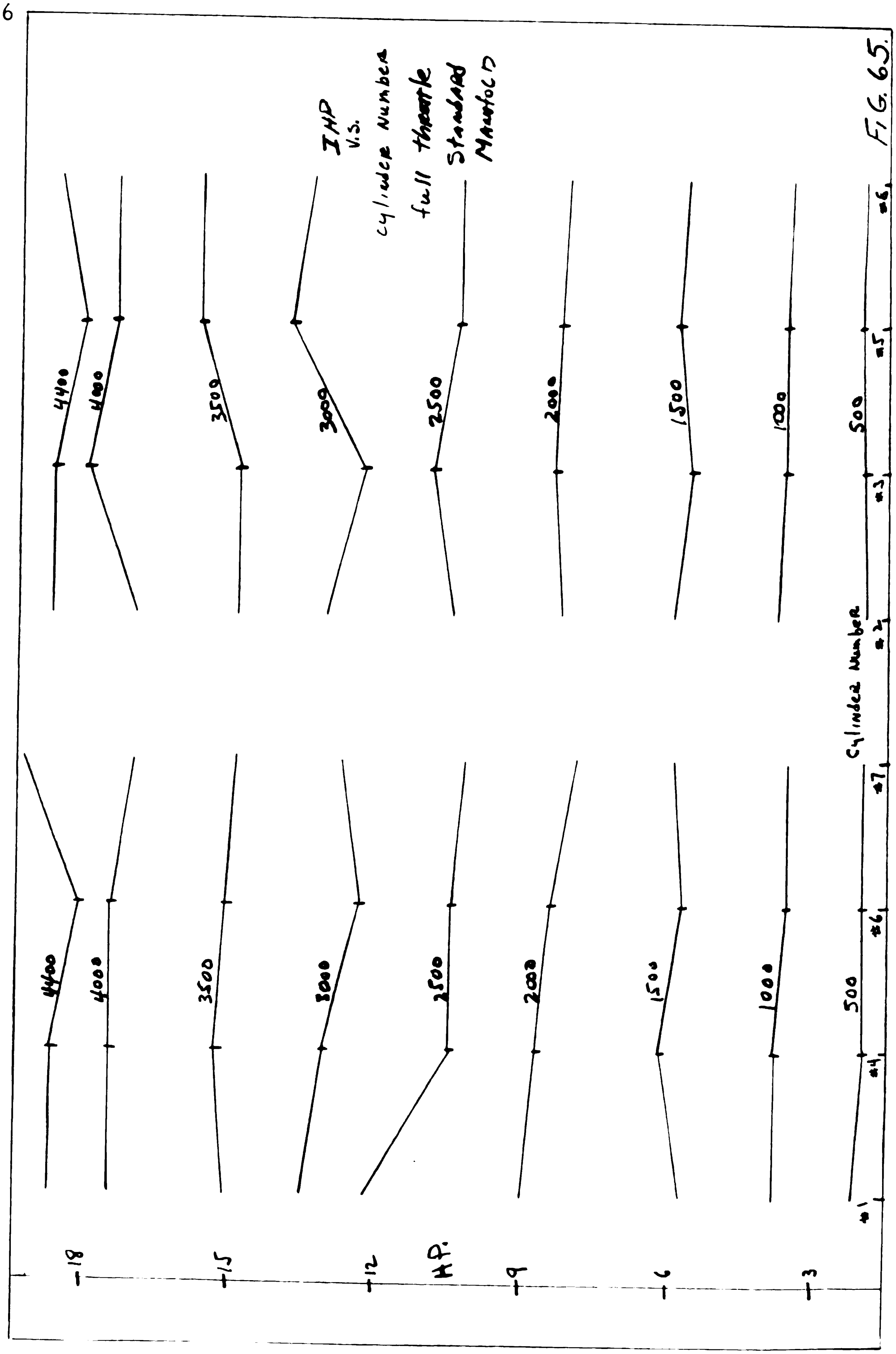

IHP
V.S.
cylinder Number
full throttle
Standard
Manifold
4400
4000
3500
3000
2500
2000
1500
1000
500
H.P.
18
15
12
9
6
3
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG. 65.

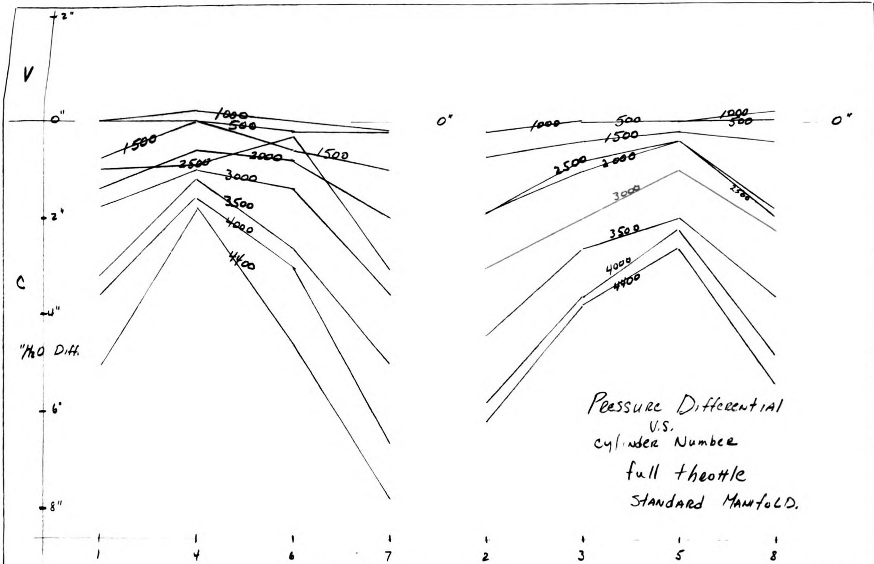
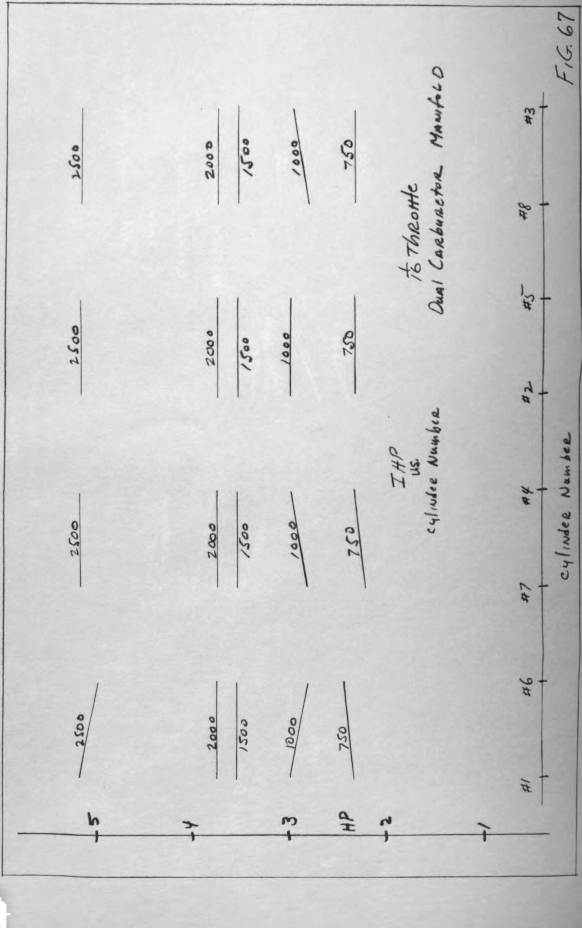
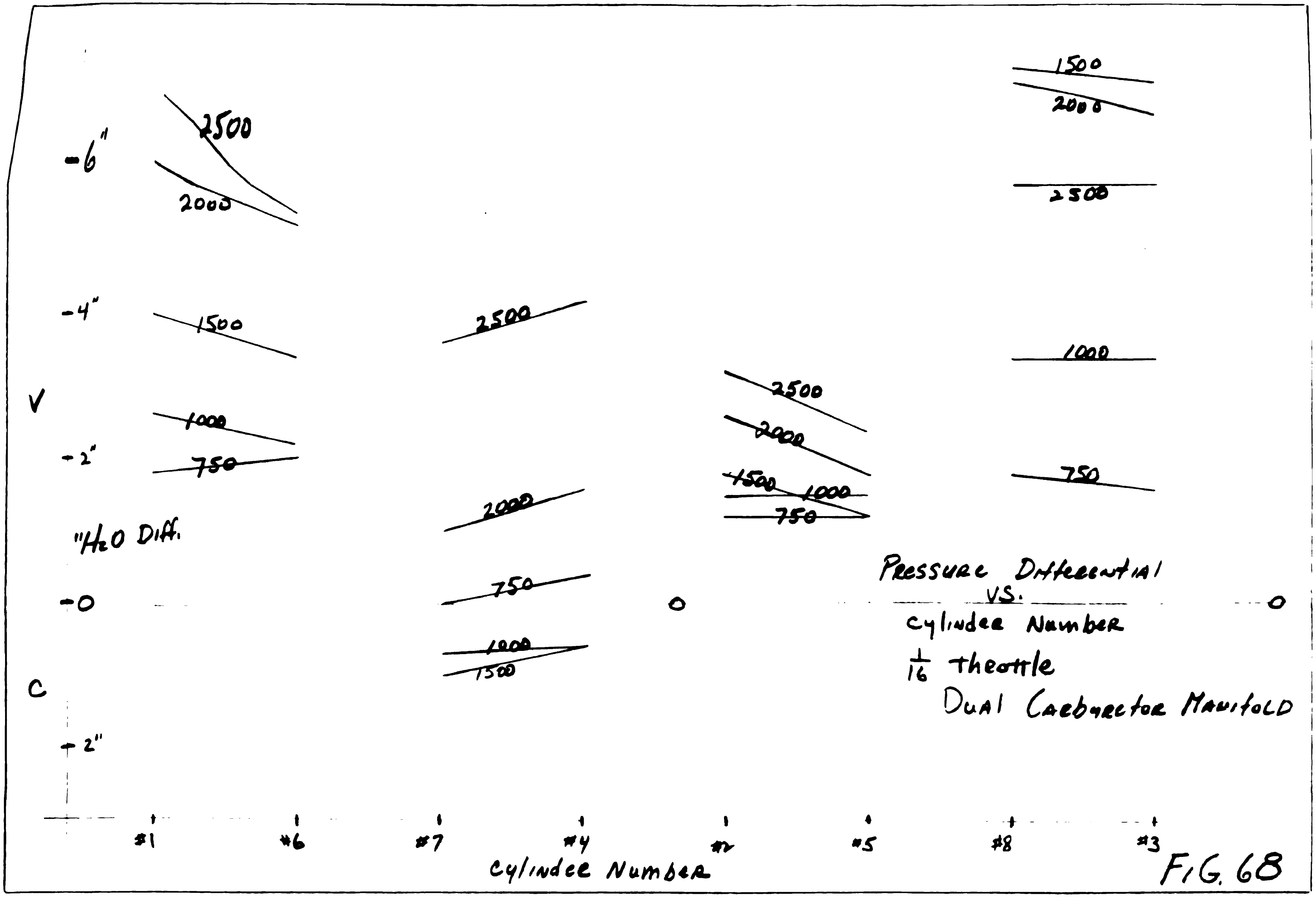

Pressure Differential
V.S.
cylinder Number
full throttle
Standard Manifold.
V
C
"H2O Diff.
+2"
0"
2"
4"
6"
8"
1
4
6
7
2
3
5
8
cylinder Number
1000
500
1500
2000
2500
3000
3500
4000
4400

FIG. 66



1/16 THROTTLE
Dual CARBURETOR MANIFOLD
IHP vs. cylinder Number
cylinder Number
HP
1
2
3
4
5
#1
#6
#7
#4
#2
#5
#8
#3
2500
2000
1500
1000
750

FIG. 67



Pressure Differential
vs.
cylinder Number
1/16 throttle
Dual Carburetor Manifold
-6"
-4"
-2"
"H2O Diff.
-0
+2"
V
C
2500
2000
1500
1000
750
0
#1
#6
#7
#4
#2
#5
#8
#3
cylinder Number

FIG. 68

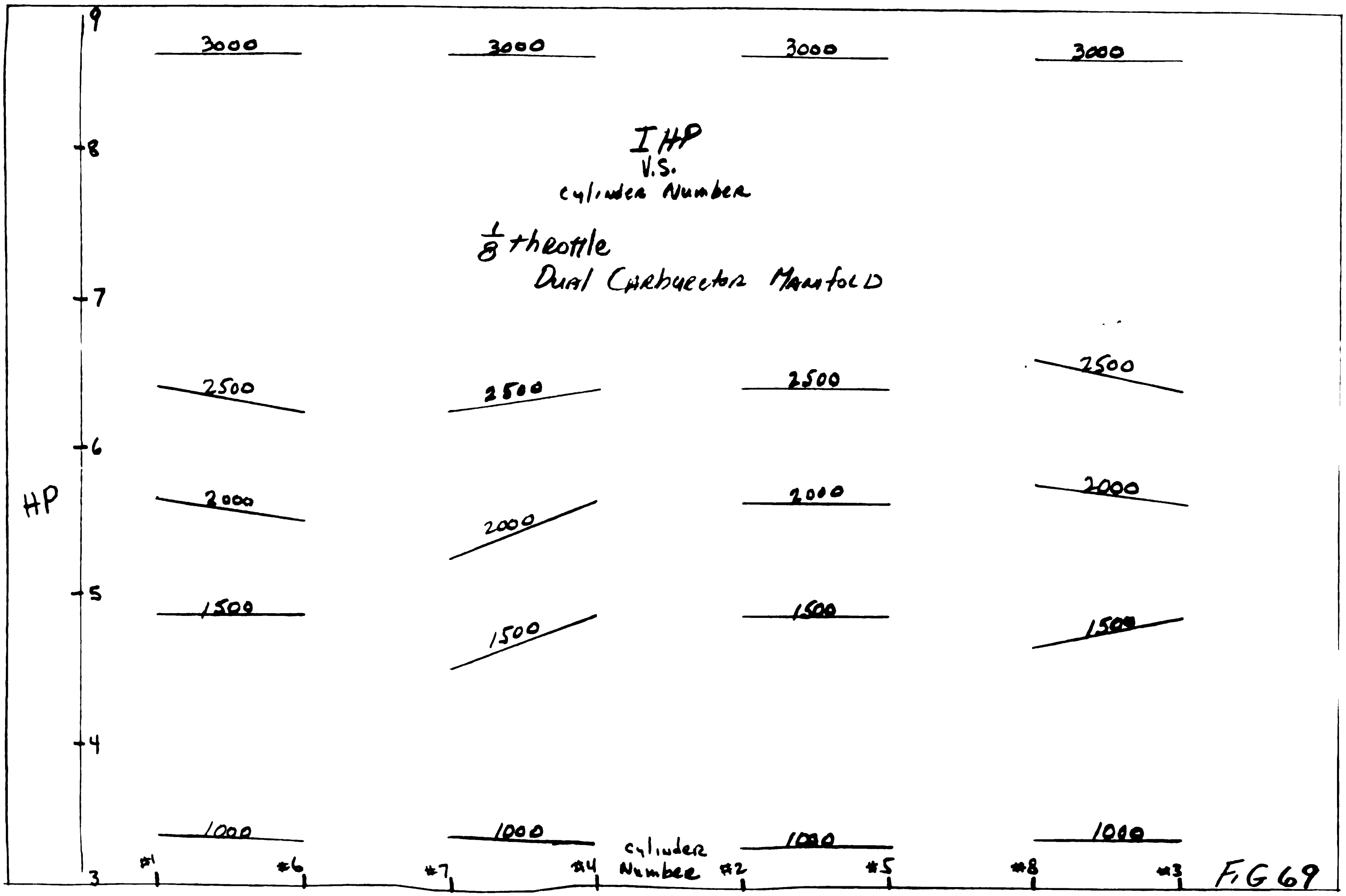

IHP
V.S.
cylinder Number
$\frac{1}{8}$ throttle
Dual Carburetor Manifold
HP
9
8
7
6
5
4
3
3000
2500
2000
1500
1000
#1
#6
#7
#4
#2
#5
#8
#3
cylinder
Number

FIG 69

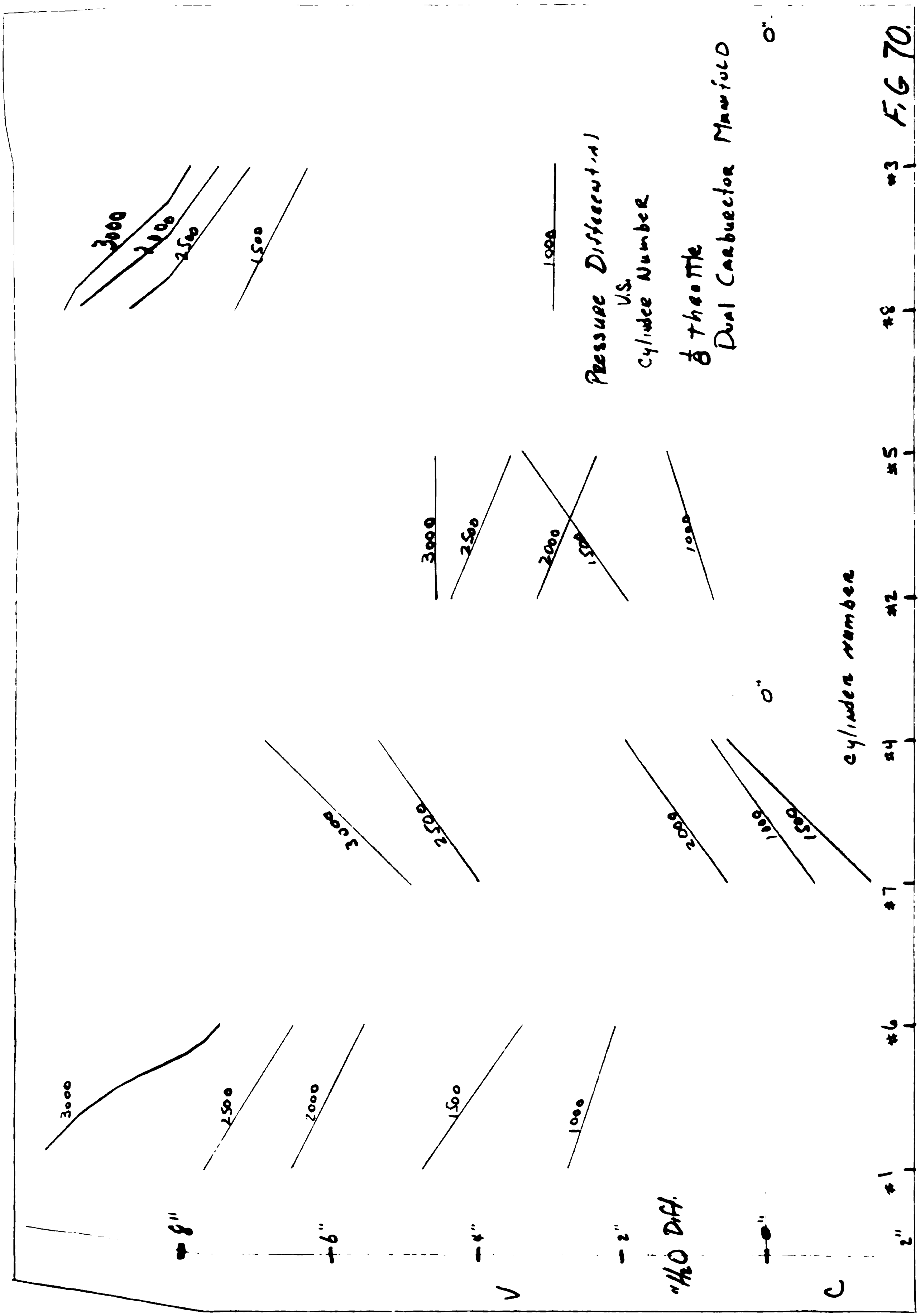

Pressure Differential
V.S.
Cylinder Number
1/8 throttle
Dual Carburetor Manifold
0"
cylinder number
"H2O Diff.
8"
6"
4"
2"
0"
2"
V
C
#1
#6
#7
#4
#2
#5
#8
#3
3000
2500
2000
1500
1000

FIG 70.

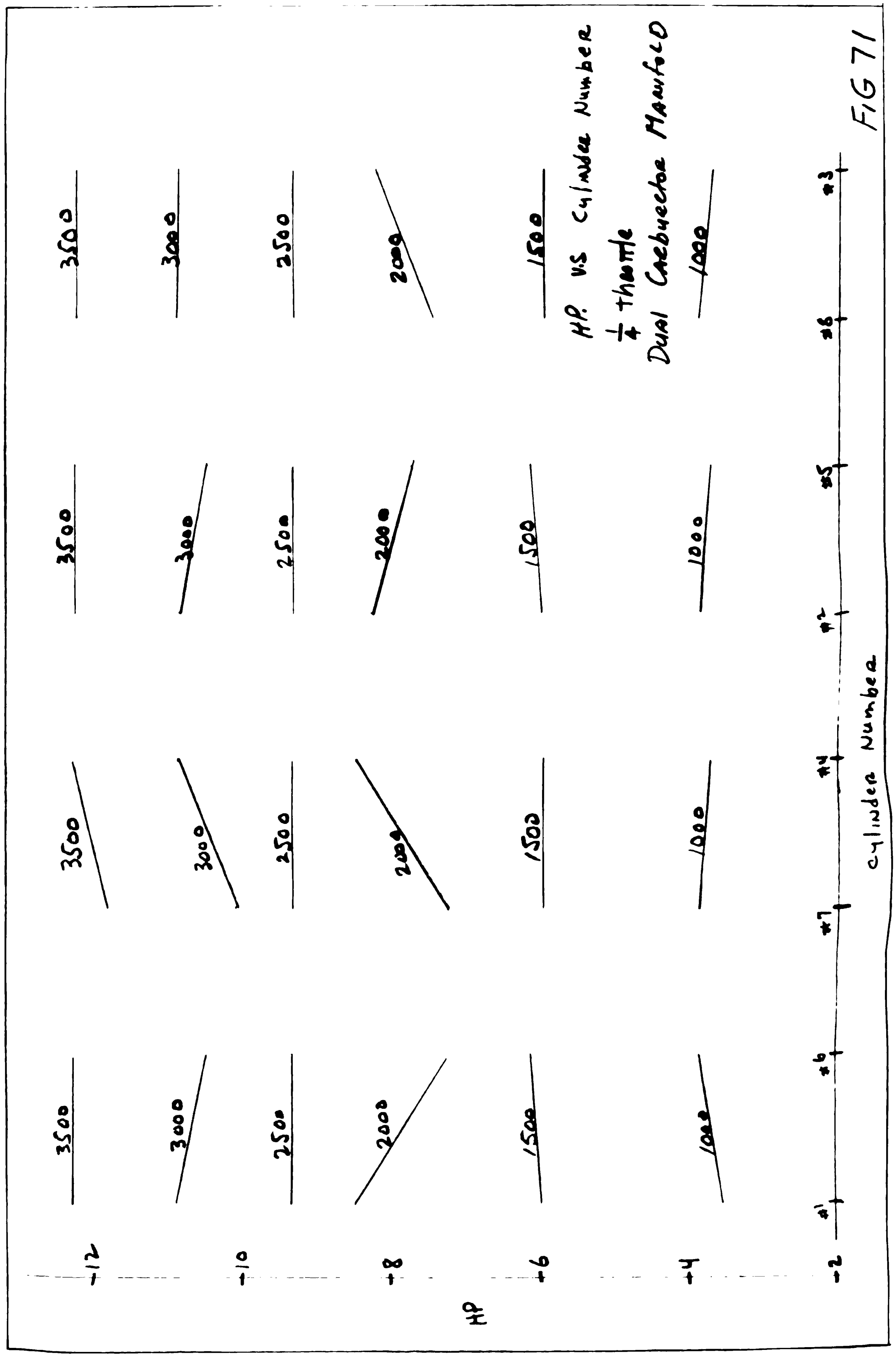

HP vs Cylinder Number
1/4 throttle
Dual Carburetor Manifold
HP
2
4
6
8
10
12
cylinder Number
#1
#6
#7
#4
#2
#5
#8
#3
3500
3000
2500
2000
1500
1000

FIG 71

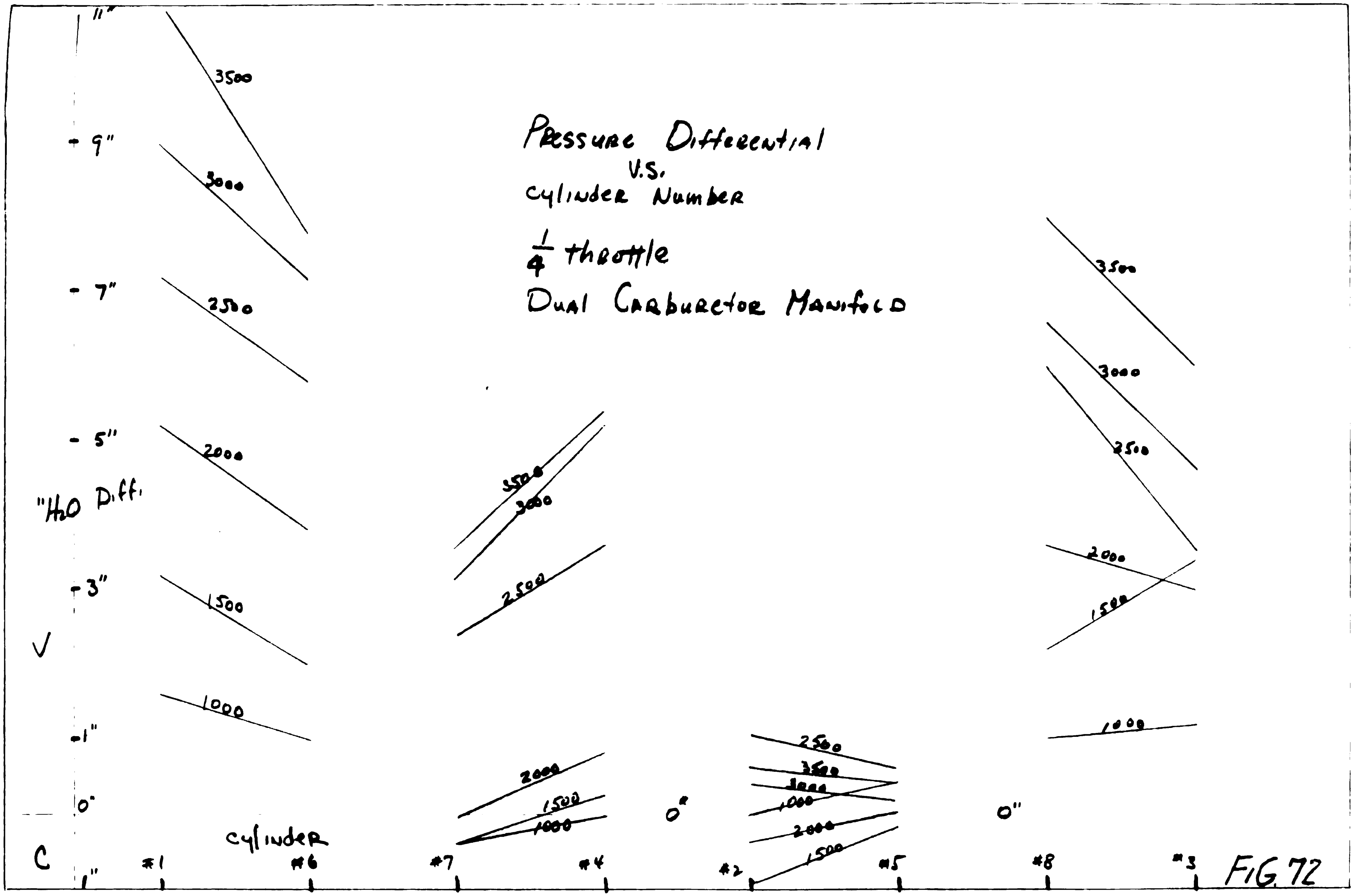
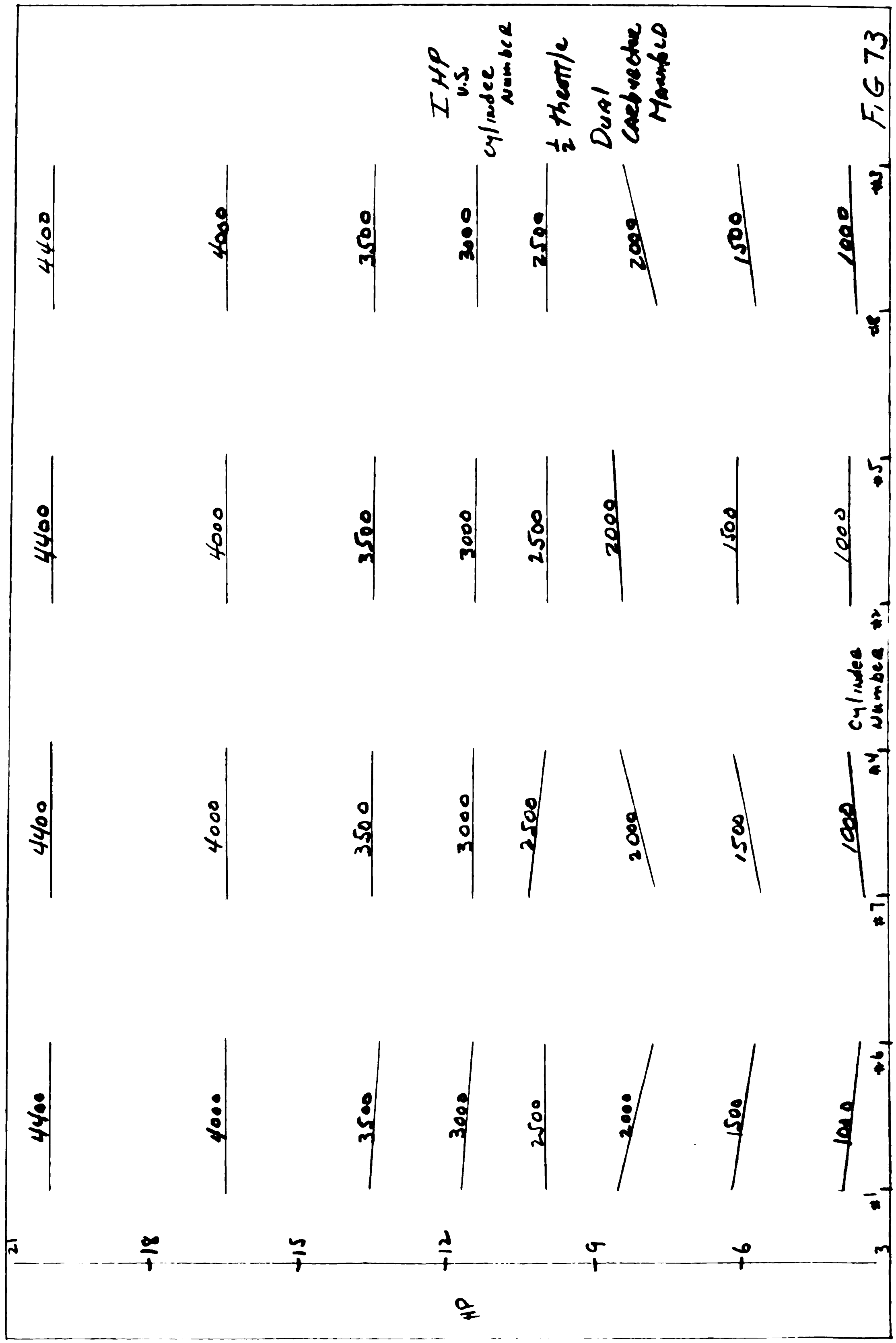

Pressure Differential
V.S.
cylinder Number
1/4 throttle
Dual Carburetor Manifold
"H_2O Diff.
11"
9"
7"
5"
3"
1"
0"
1"
C
V
cylinder
#1
#6
#7
#4
#2
#5
#8
#3
0"
0"
3500
3000
2500
2000
1500
1000

FIG 72


IHP v.s. Cylinder Number
½ Throttle
Dual Carburetor Manifold
FIG 73
HP
Cylinder Number

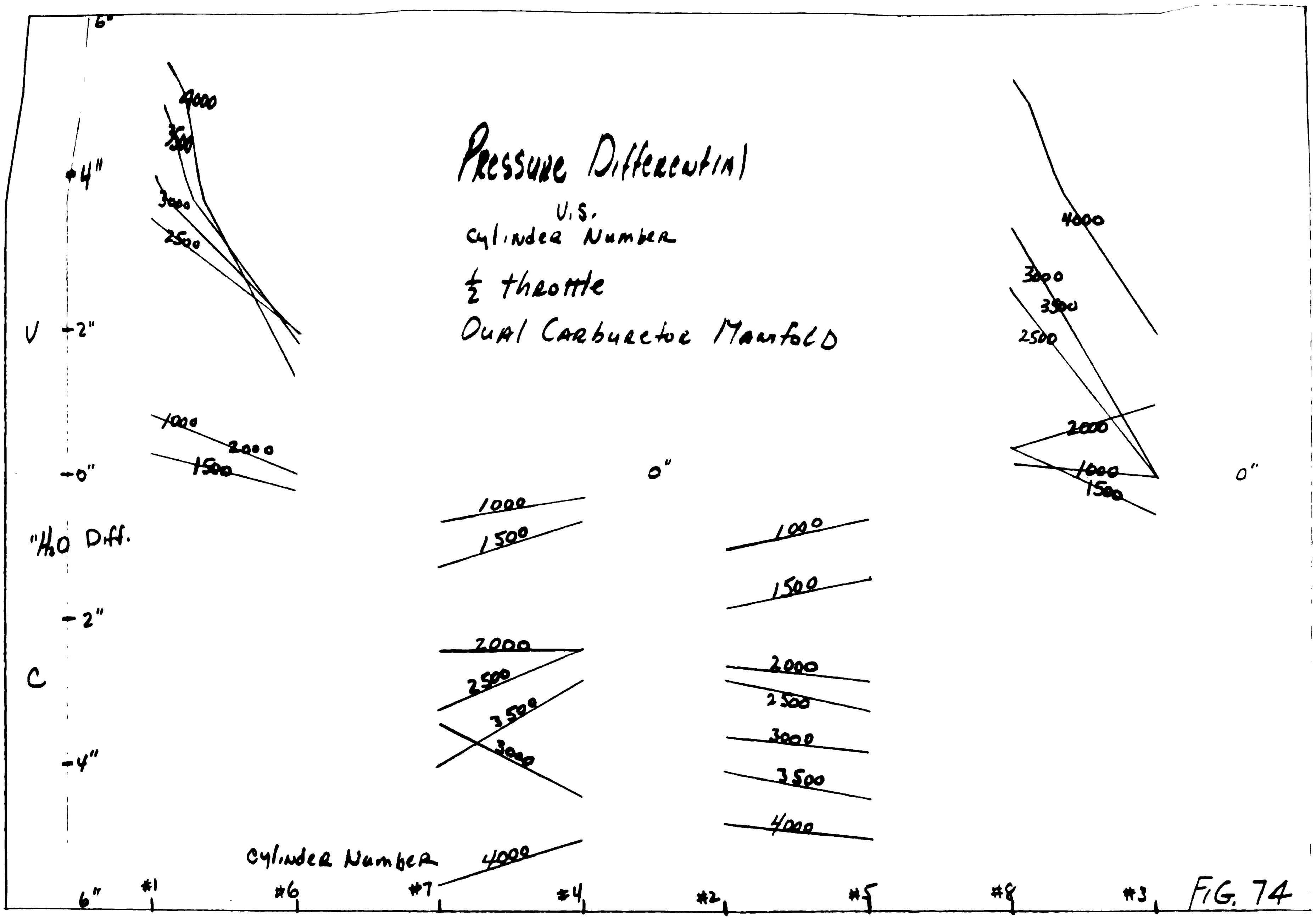

Pressure Differential
U.S.
Cylinder Number
½ throttle
Dual Carburetor Manifold
"H_2O Diff.
V
C
6"
4"
2"
0"
2"
4"
6"
0"
0"
Cylinder Number
#1
#6
#7
#4
#2
#5
#8
#3
1000
1500
2000
2500
3000
3500
4000

FIG. 74

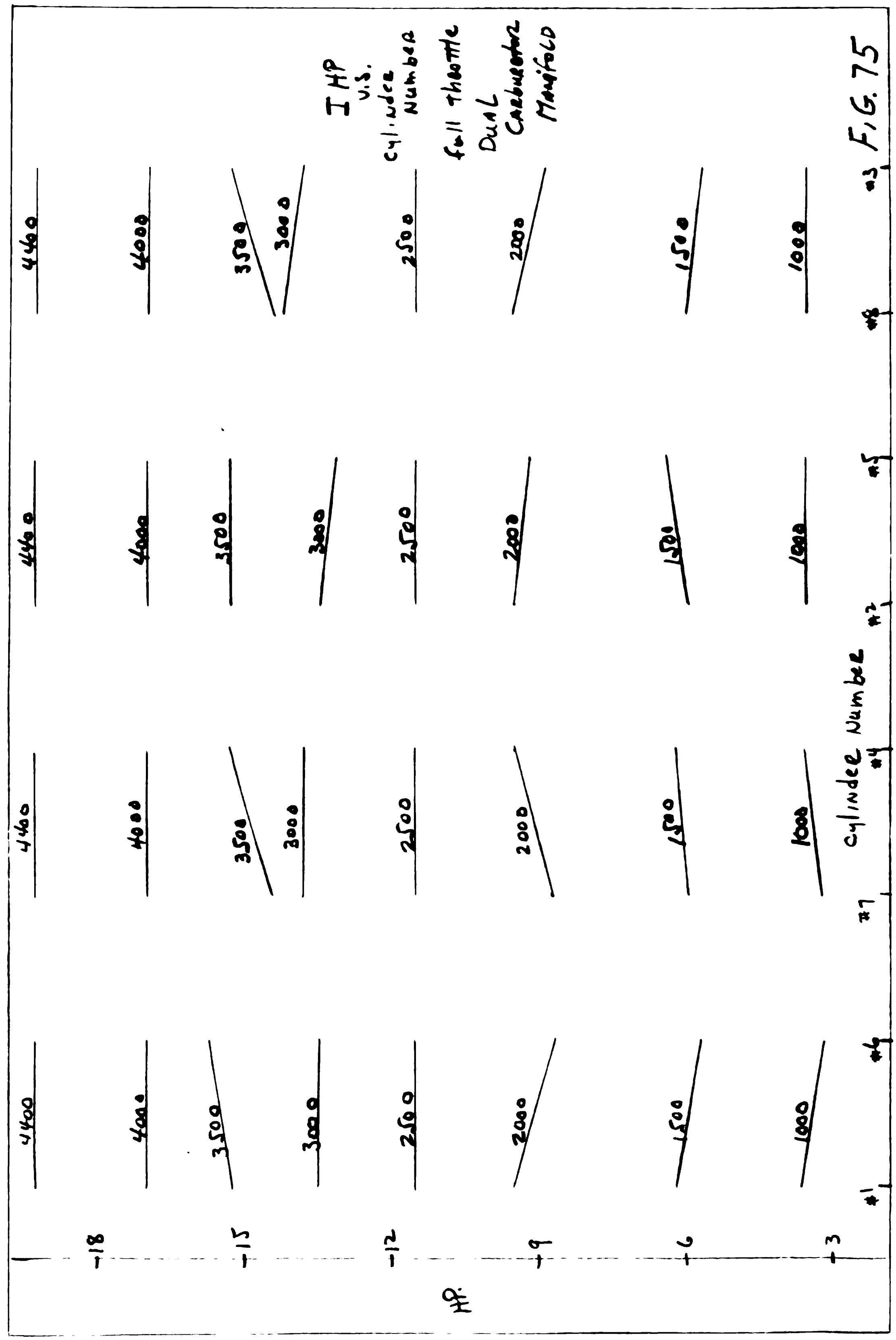

I HP
v.s.
cylinder Number
full throttle
Dual
Carburetor
Manifold
cylinder Number
HP

FIG. 75

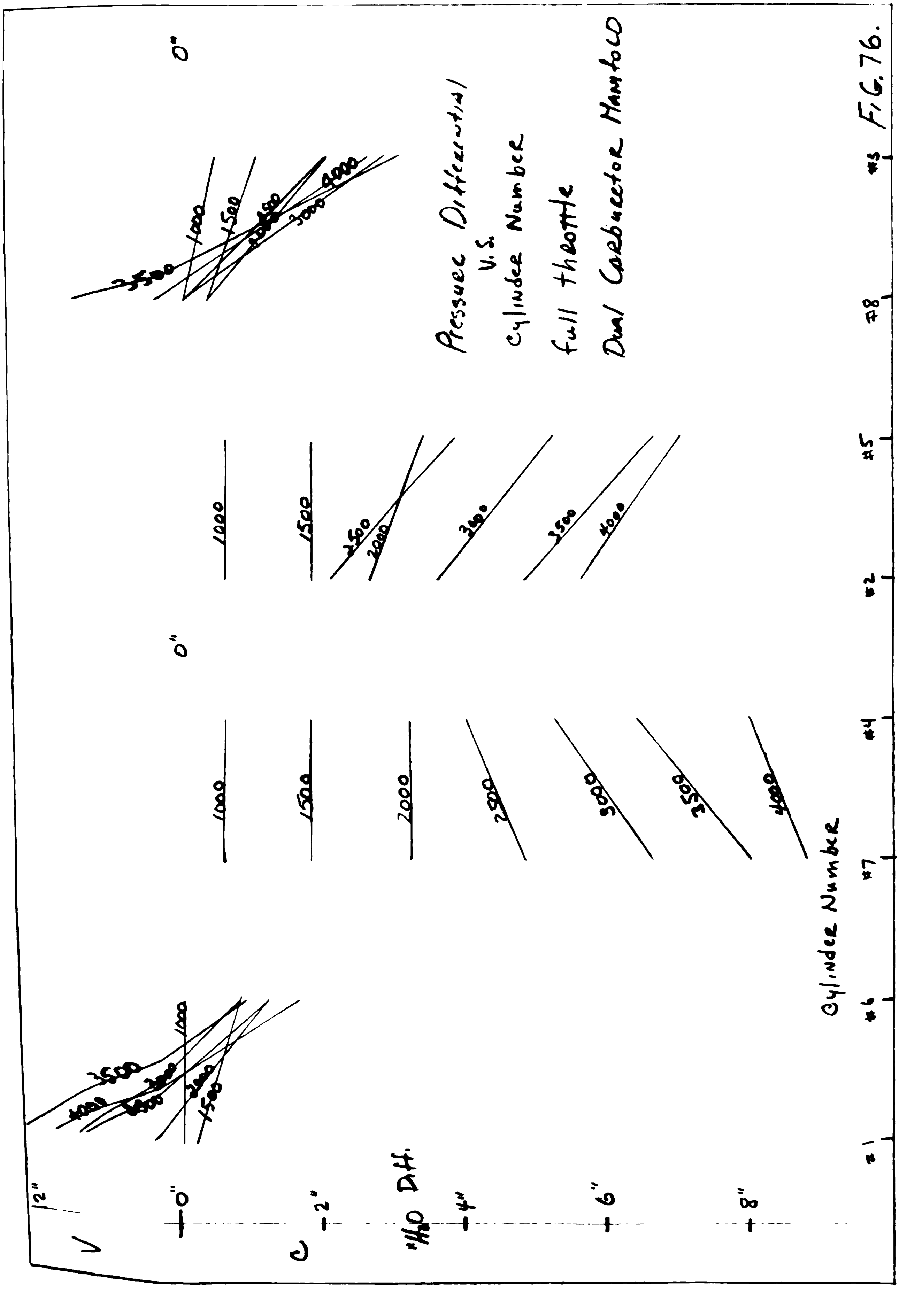

Pressure Differential
V.S.
Cylinder Number
Full throttle
Dual Carburetor Manifold
Cylinder Number
"H2O Dif.
V
C
2"
0"
-2"
-4"
-6"
-8"
#1
#6
#7
#4
#2
#5
#8
#3

FIG. 76.

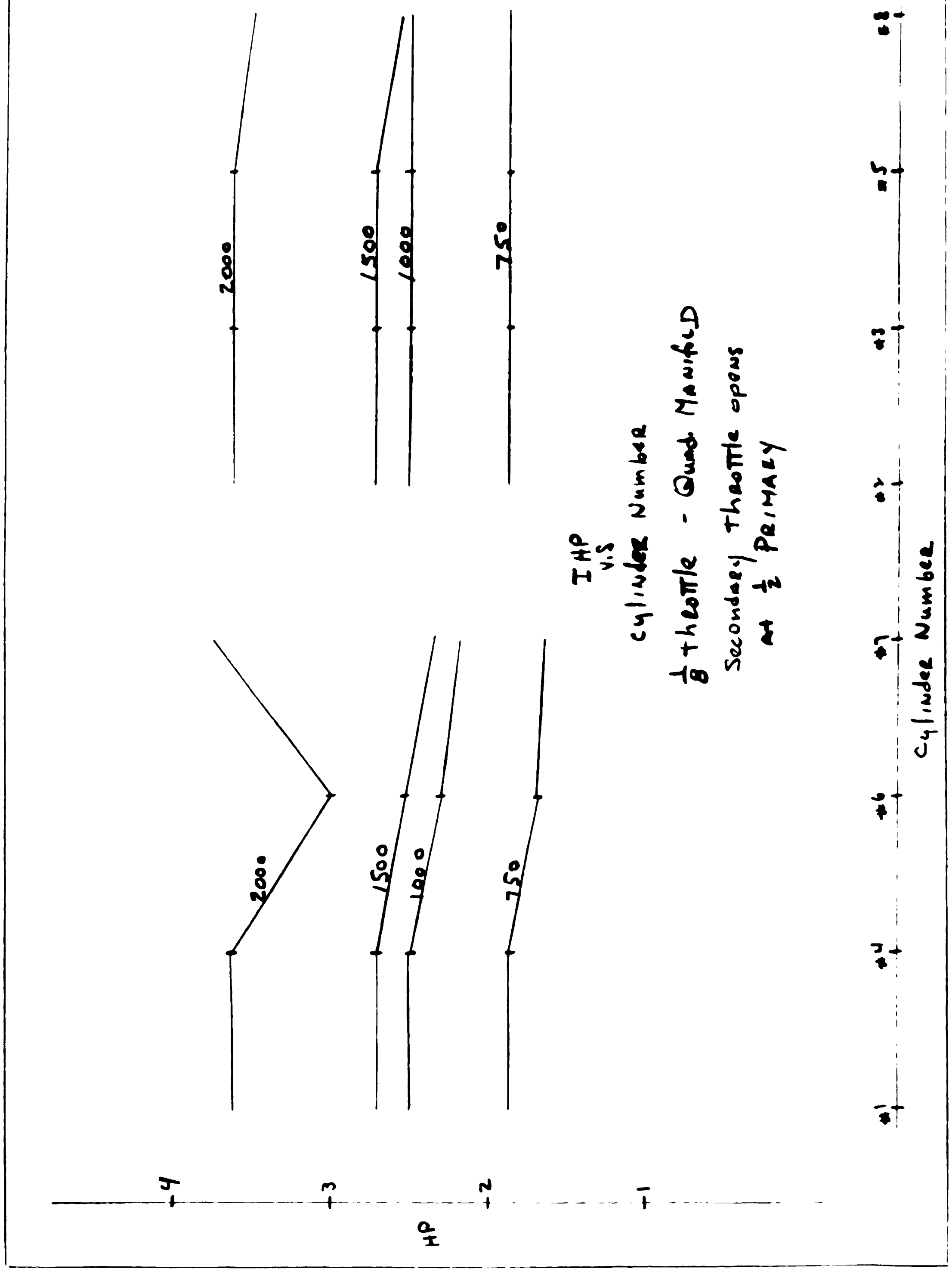

IHP
V.S
cylinder Number
1/8 throttle - Quad Manifold
Secondary throttle opens
at 1/2 PRIMARY
2000
1500
1000
750
HP
1
2
3
4
#1
#2
#6
#7
#4
#3
#5
#8
cylinder Number

FIG. 77

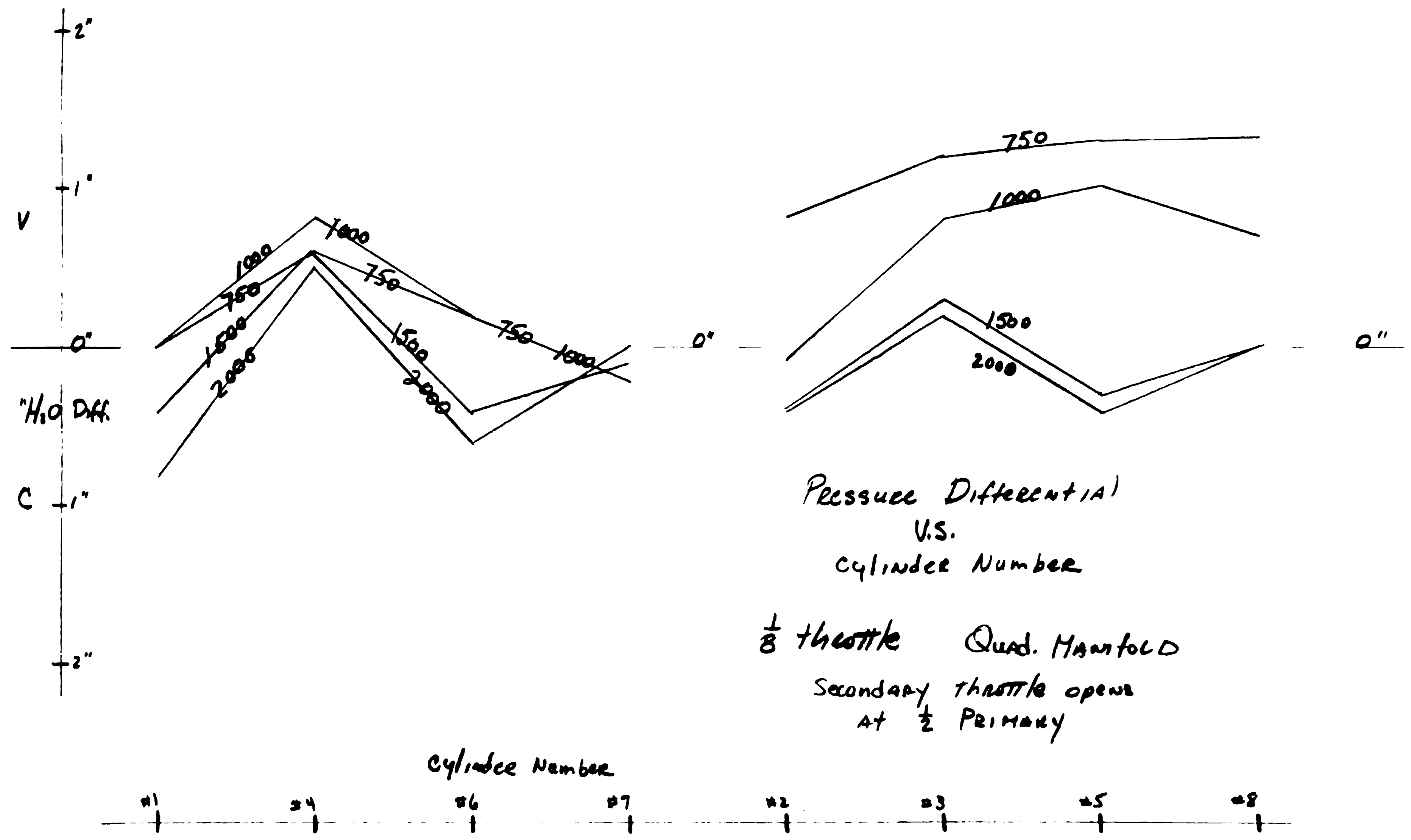

V
"H_2O Diff.
C
2"
1"
0"
1"
2"
1000
750
1500
2000
750
1000
1500
2000
0"
Pressure Differential
V.S.
Cylinder Number
$\frac{1}{8}$ throttle Quad. Manifold
Secondary throttle opens
At $\frac{1}{2}$ Primary
Cylinder Number
#1
#4
#6
#7
#2
#3
#5
#8

FIG. 78.

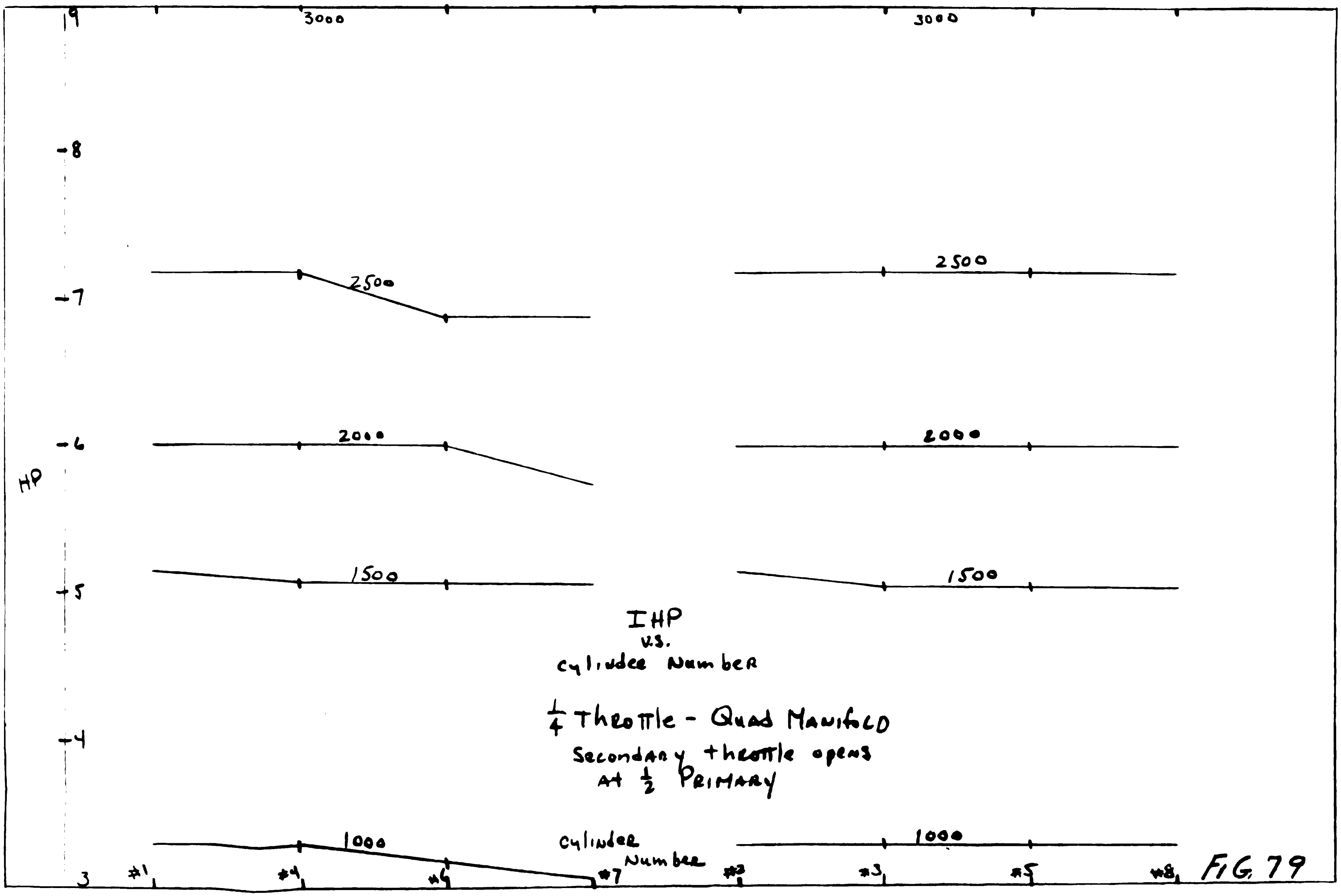
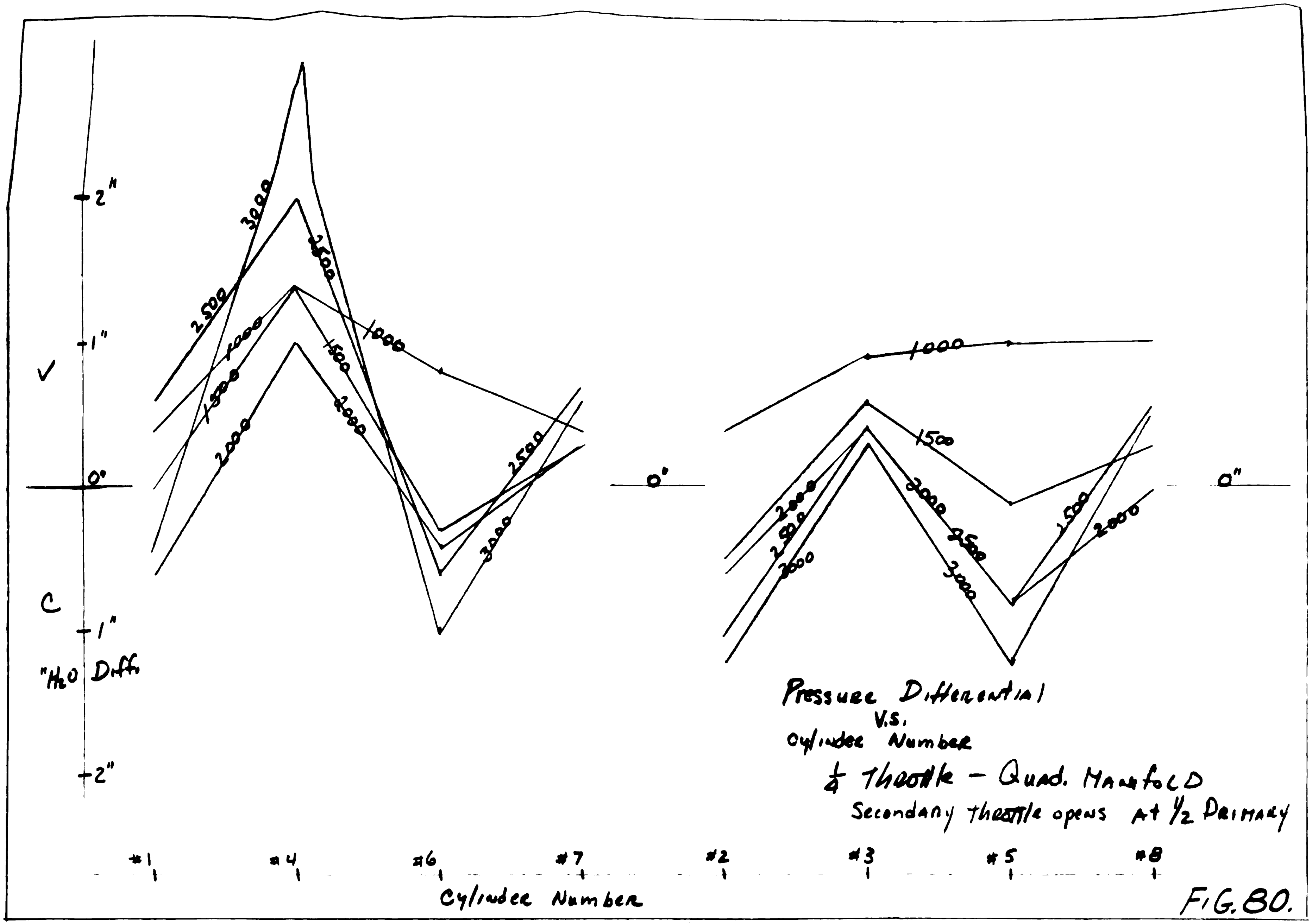

3000
3000
2500
2500
2000
2000
1500
1500
1000
1000
9
8
7
6
5
4
3
HP
IHP
v.s.
cylinder Number
$\frac{1}{4}$ Throttle - Quad Manifold
Secondary throttle opens
at $\frac{1}{2}$ Primary
cylinder
Number
#1
#4
#6
#7
#2
#3
#5
#8

FIG. 79



Pressure Differential
V.S.
Cylinder Number

$\frac{1}{4}$ Throttle – Quad. Manifold
Secondary throttle opens at $\frac{1}{2}$ Primary

FIG. 80.

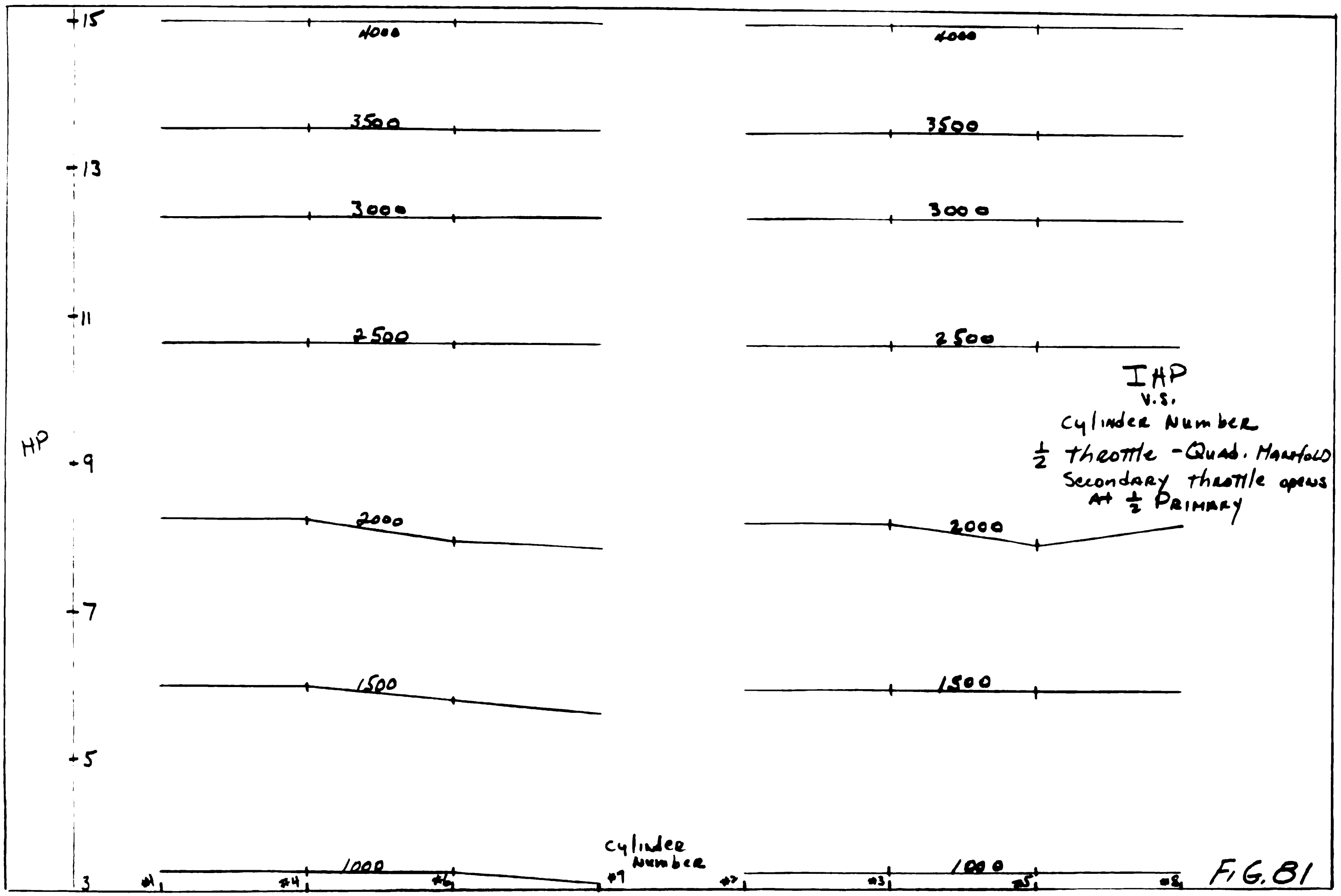
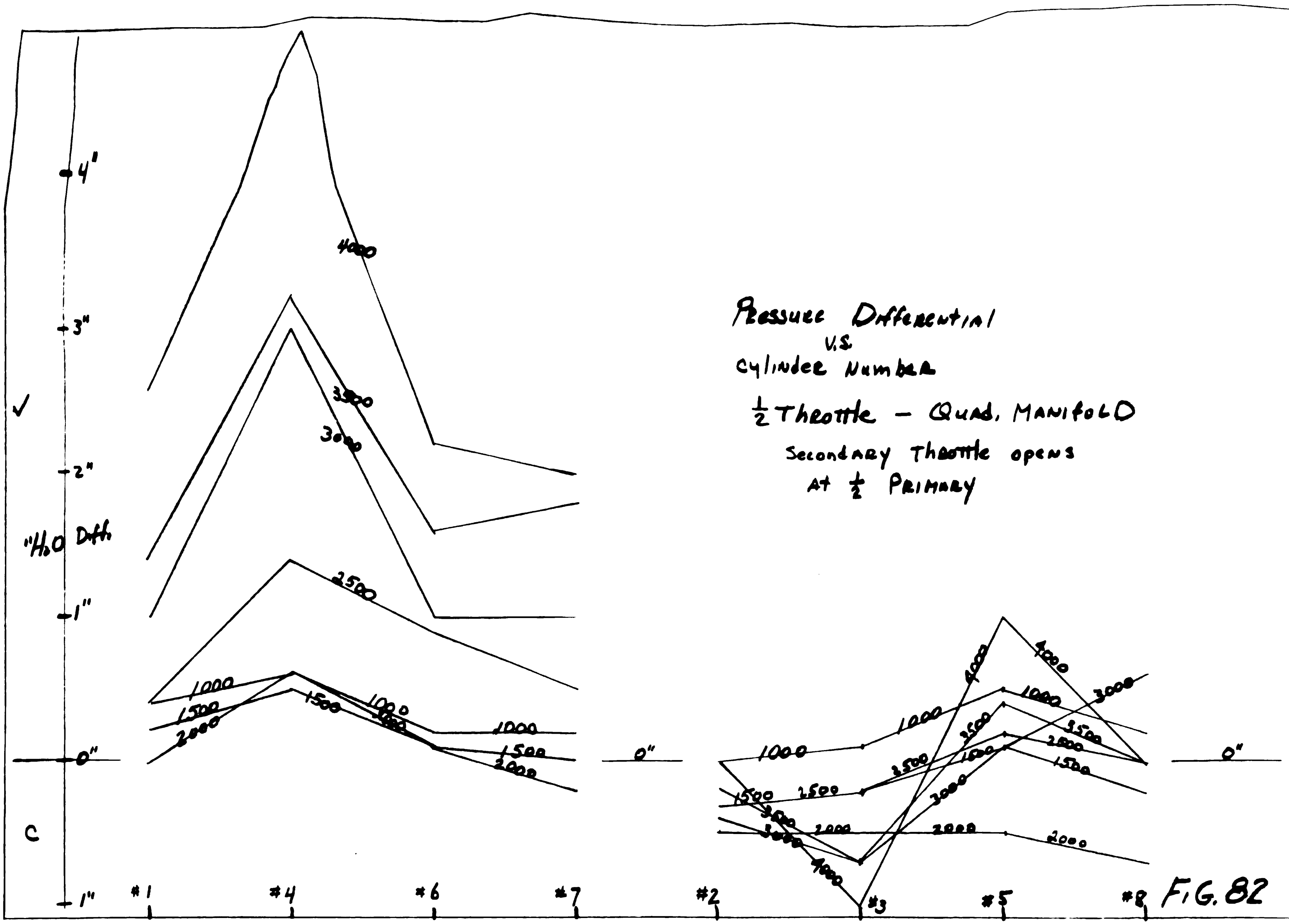

IHP
V.S.
Cylinder Number
½ throttle - Quad. Manifold
Secondary throttle opens
At ½ Primary
HP
15
13
11
9
7
5
3
4000
3500
3000
2500
2000
1500
1000
Cylinder Number
#1
#4
#6
#7
#3
#5
#8

FIG. B1



Pressure Differential
V.S.
Cylinder Number
½ Throttle – Quad. Manifold
Secondary Throttle opens
At ½ Primary
4"
3"
2"
1"
0"
1"
"H₂O Diff.
#1
#4
#6
#7
#2
#3
#5
#8
4000
3500
3000
2500
2000
1500
1000

FIG. 82

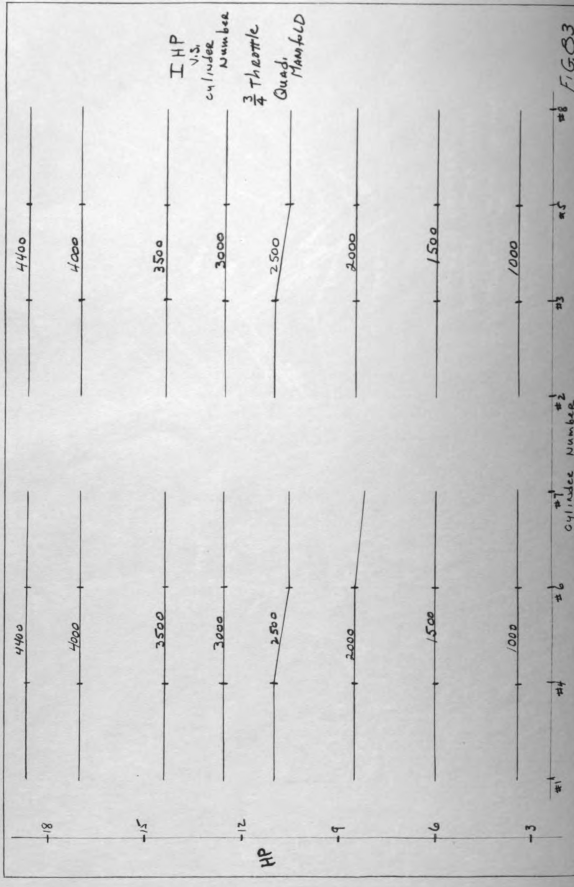

I HP v.s. cylinder Number
3/4 Throttle
Quad. Manifold
HP
18
15
12
9
6
3
#1
#4
#6
#7
#2
#3
#5
#8
cylinder Number
4400
4000
3500
3000
2500
2000
1500
1000

FIG. B3

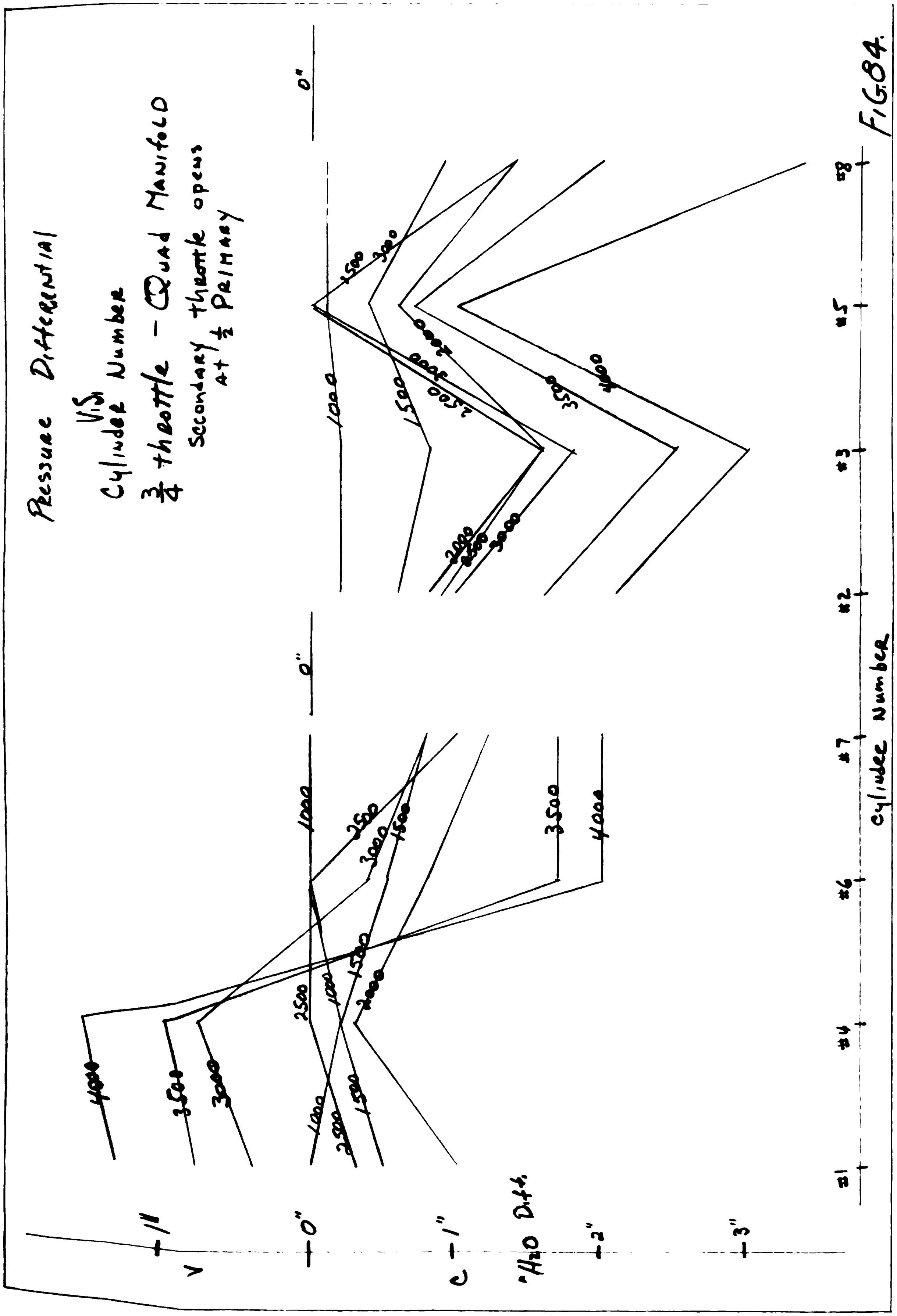

PRESSURE DIFFERENTIAL
V.S.
Cylinder Number
3/4 throttle - Quad Manifold
Secondary throttle opens at 1/2 PRIMARY
+1"
-0"
-1"
"H2O Diff.
-2"
-3"
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number
0"
1000
1500
2000
2500
3000
3500
4000

FIG. 84.

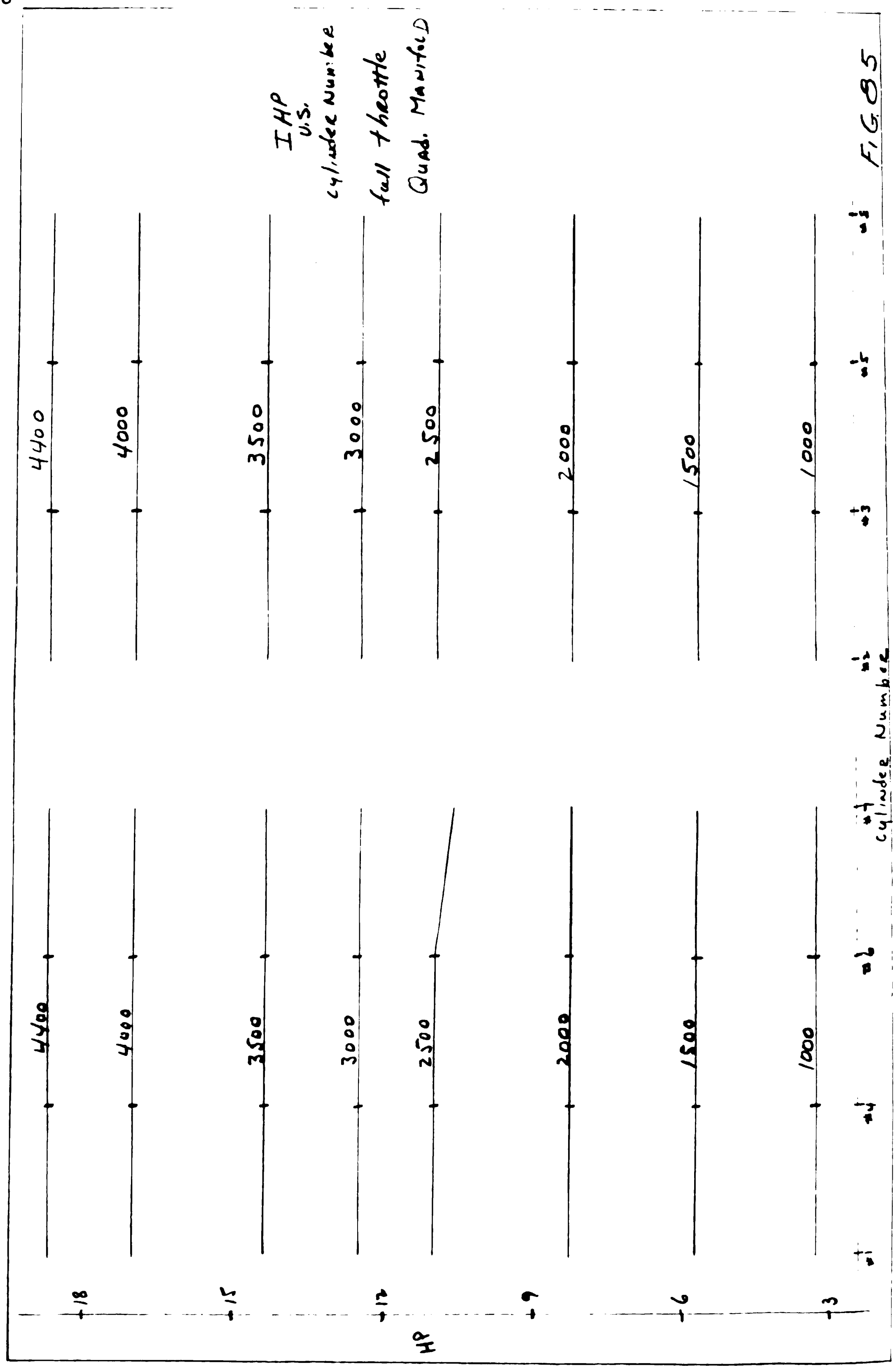

IHP v.s. cylinder Number
full throttle
Quad. Manifold
4400
4000
3500
3000
2500
2000
1500
1000
HP
18
15
12
9
6
3
cylinder Number

FIG 85

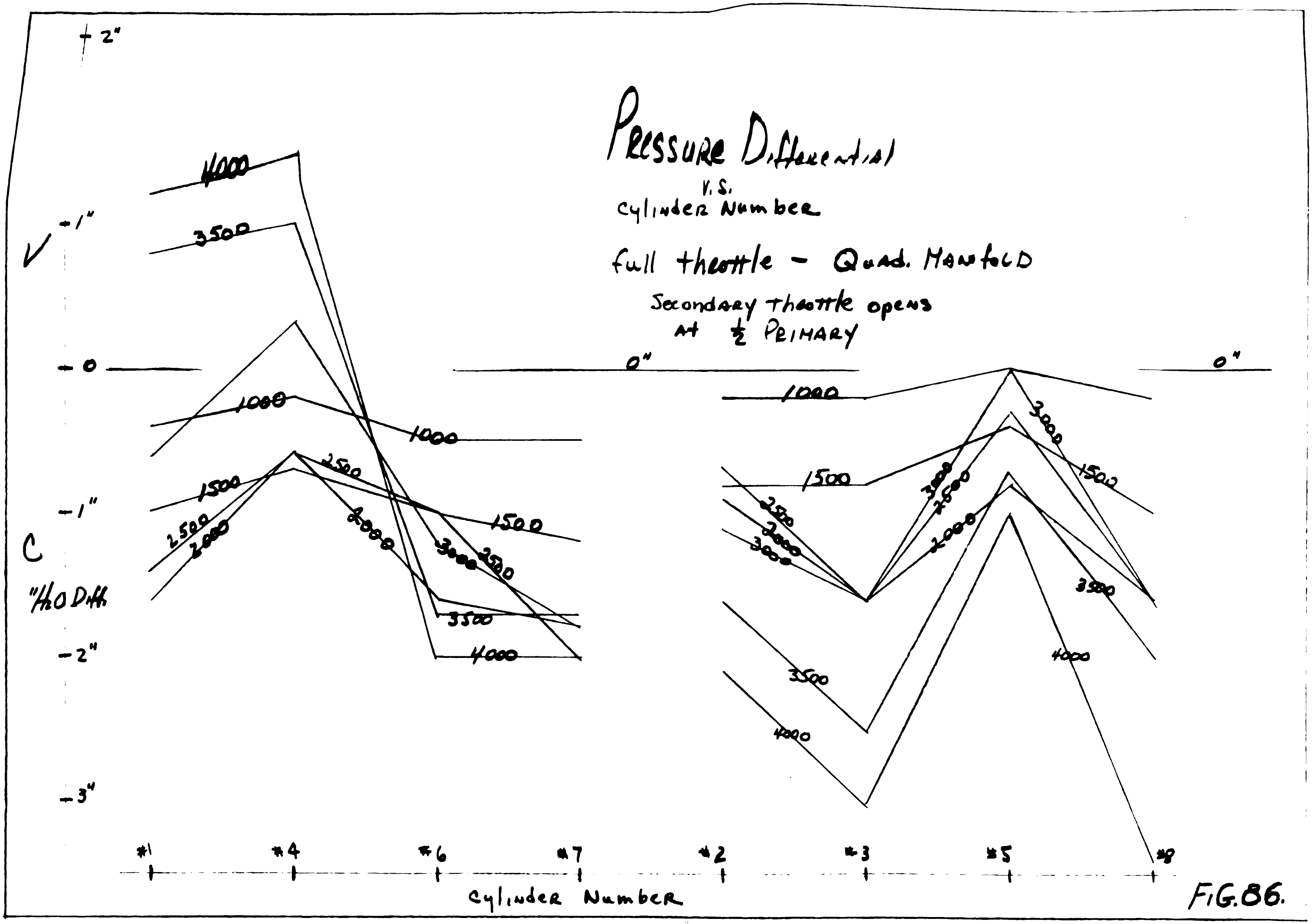

PRESSURE DIFFERENTIAL
V.S.
CYLINDER NUMBER
Full throttle - Quad. Manifold
Secondary throttle opens
At ½ Primary
+2"
+1"
0
-1"
-2"
-3"
V
C
"H2O Diff.
0"
0"
1000
1500
2000
2500
3000
3500
4000
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG. 86.

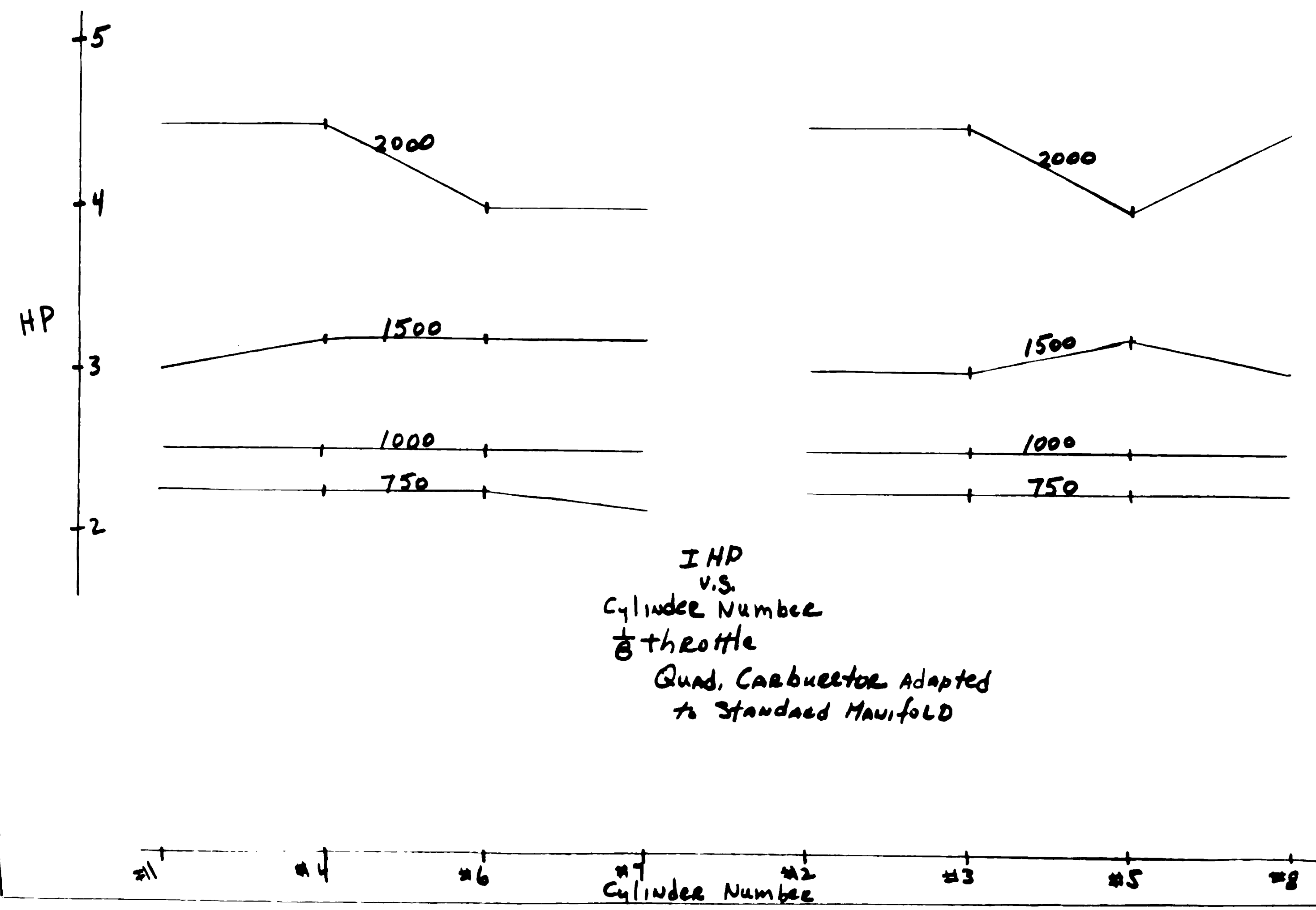

5
4
HP
3
2
2000
1500
1000
750
2000
1500
1000
750
IHP
v.s.
Cylinder Number
$\frac{1}{8}$ throttle
Quad. Carburetor Adapted
to Standard Manifold
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG.87

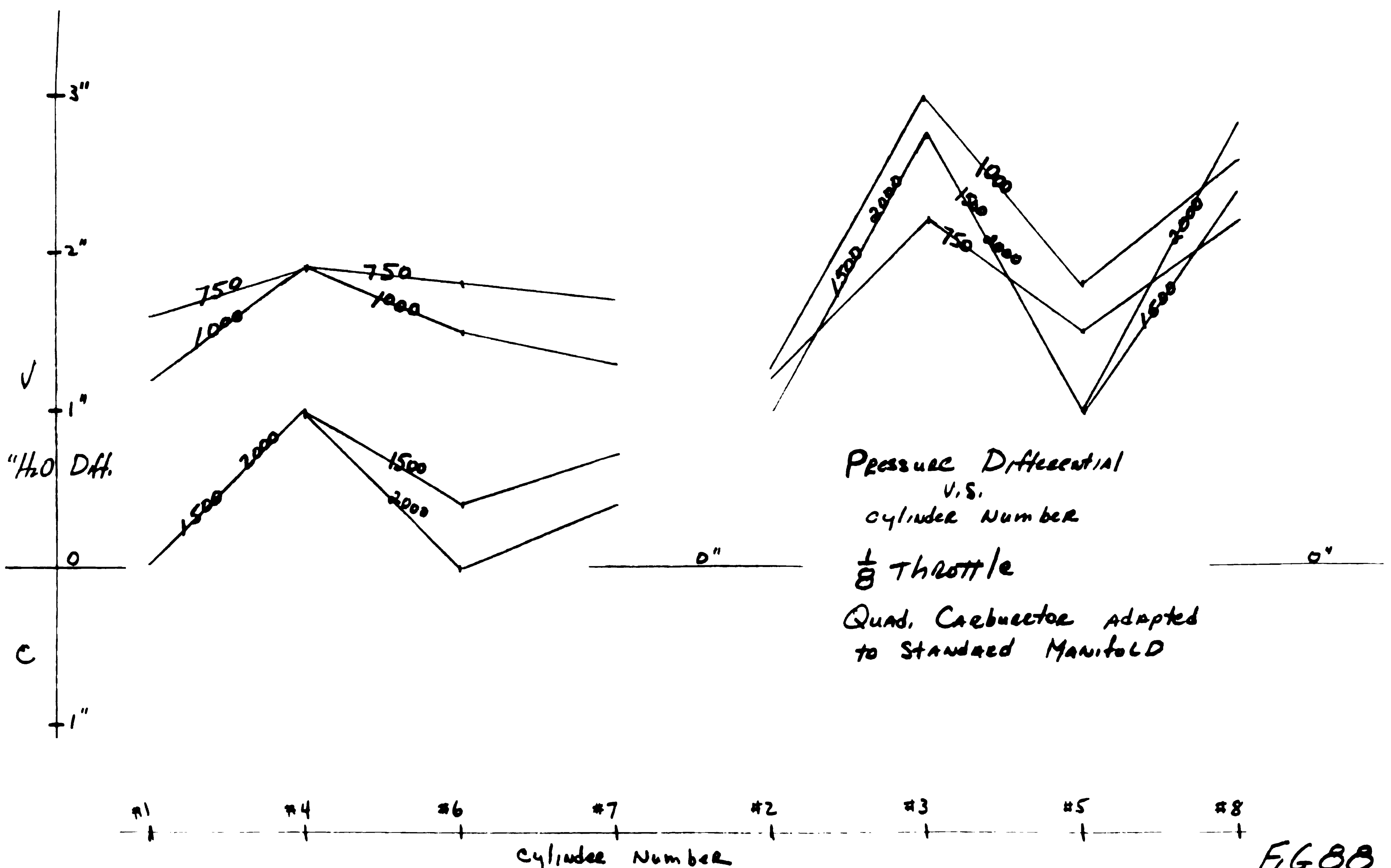

3"
2"
V
1"
"H₂O Diff.
0
C
1"
750
1000
750
1000
2000
1500
1500
2000
0"
1000
2000
1500
1500
750
2000
2000
1500
0"
Pressure Differential
V.S.
cylinder Number
1/8 Throttle
Quad. Carburetor adapted
to Standard Manifold
#1
#4
#6
#7
#2
#3
#5
#8
cylinder Number

FIG.88

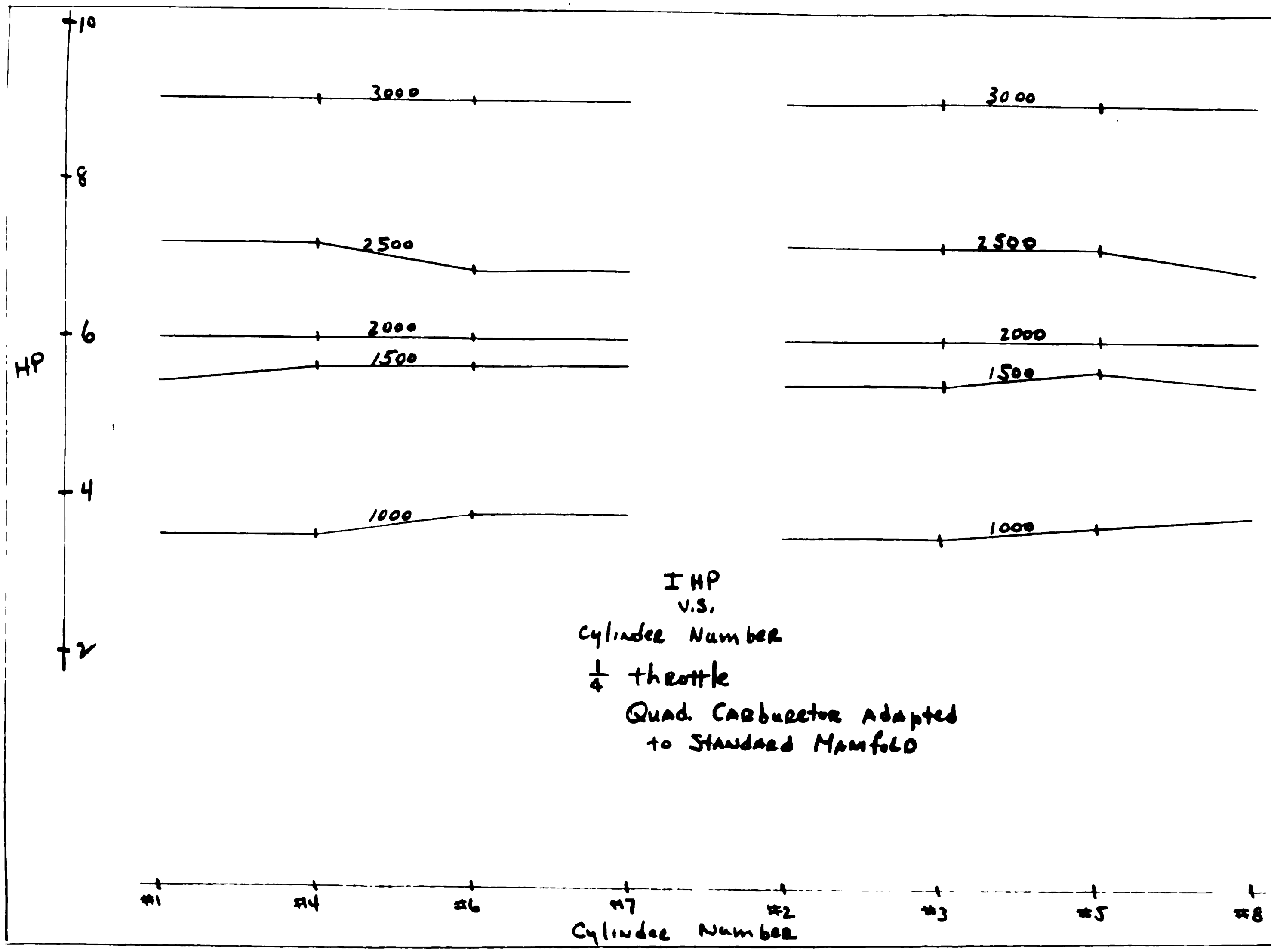

10
8
6
4
2
HP
3000
2500
2000
1500
1000
3000
2500
2000
1500
1000
IHP
V.S.
Cylinder Number
$\frac{1}{4}$ throttle
Quad Carburetor Adapted
to Standard Manifold
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG. 89

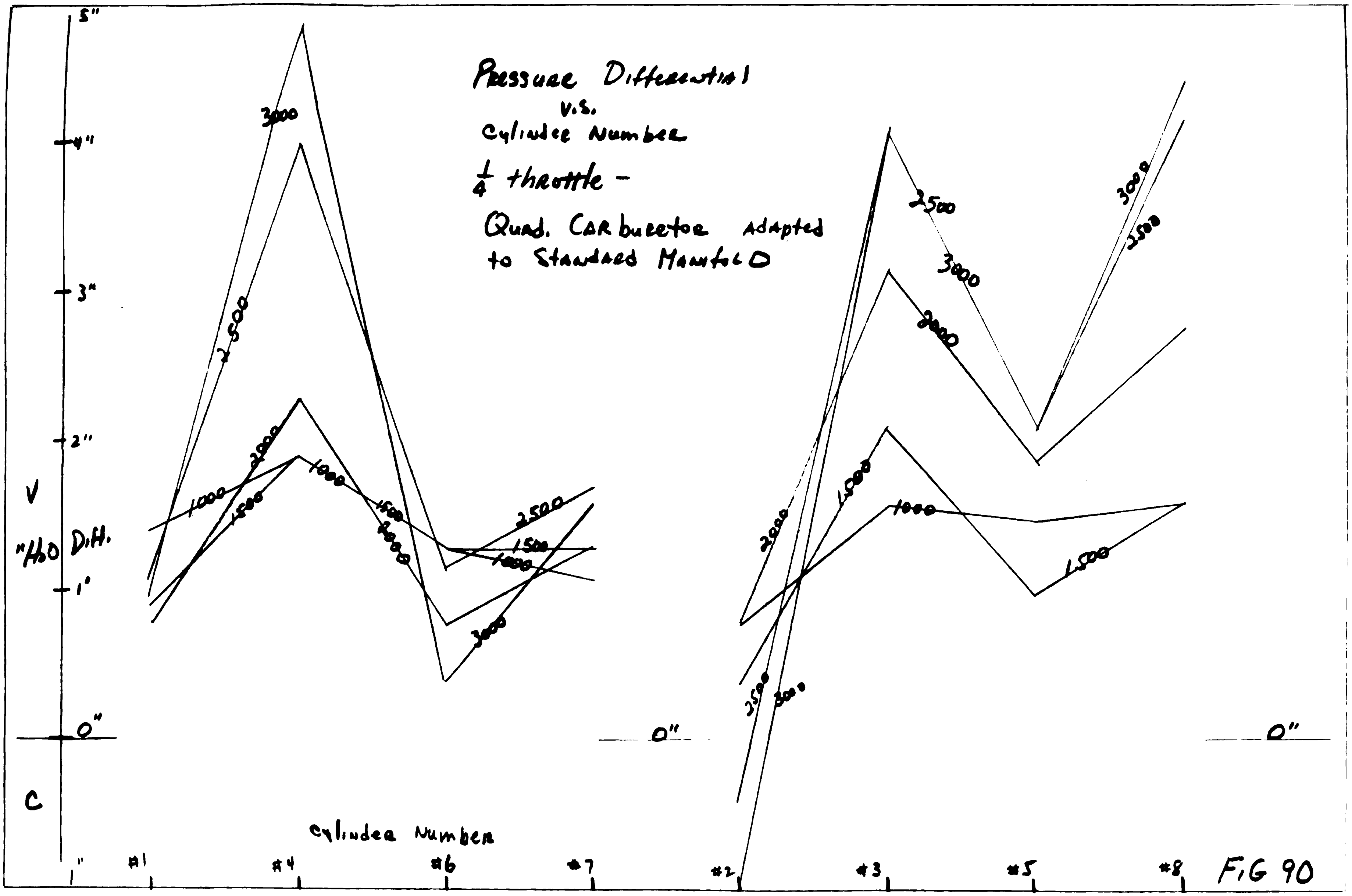

Pressure Differential
V.S.
Cylinder Number
$\frac{1}{4}$ throttle -
Quad. Carburetor Adapted
to Standard Manifold
V
"H_2O Diff.
C
5"
4"
3"
2"
1"
0"
1"
0"
0"
Cylinder Number
#1
#4
#6
#7
#2
#3
#5
#8
3000
2500
2000
1500
1000

FIG 90

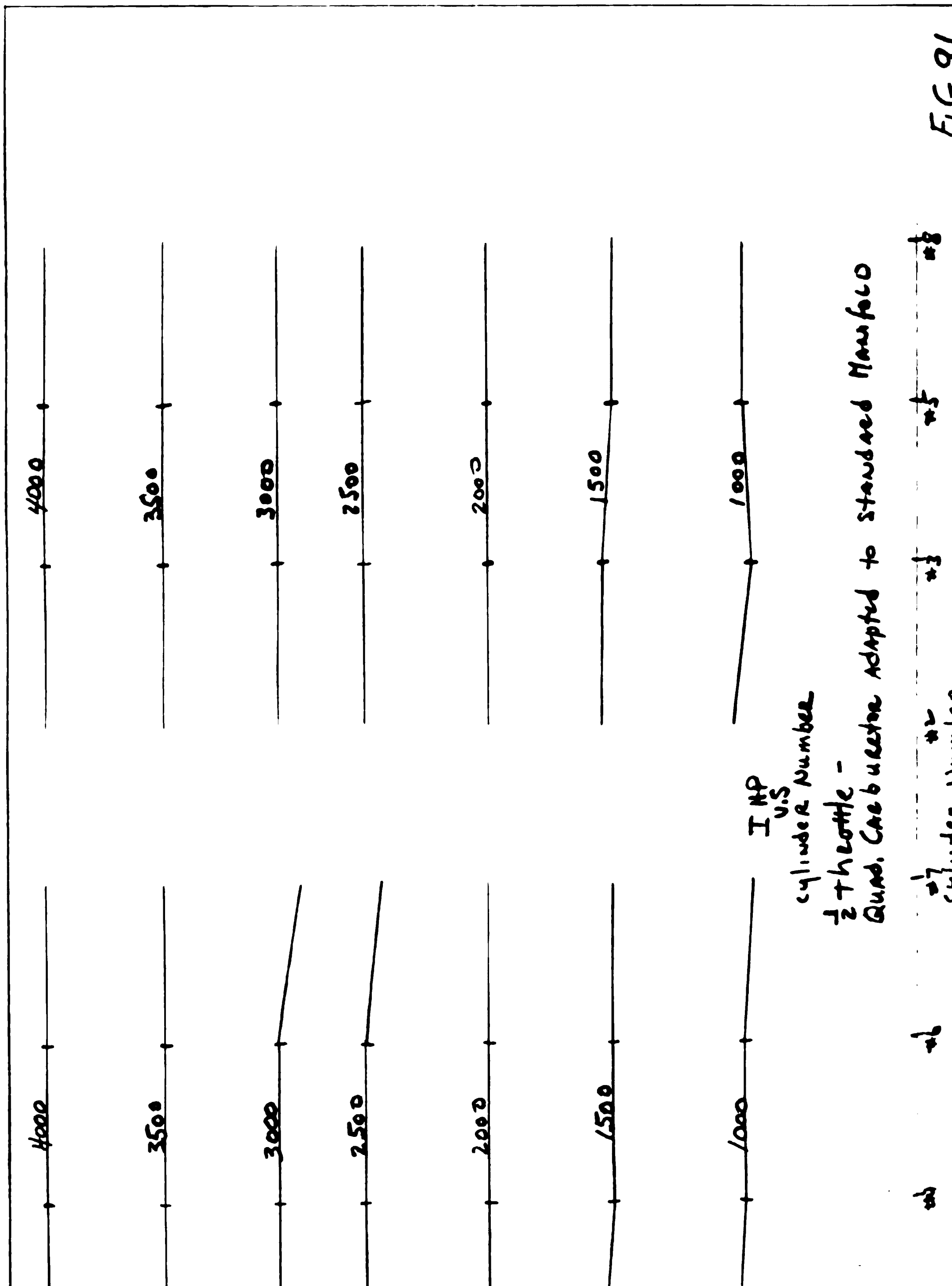

I HP
V.S
cylinder Number
½ Throttle -
Quad. Carburetor Adapted to Standard Manifold
cylinder Number
HP
3
6
9
12
15
18
#1
#4
#6
#7
#2
#3
#5
#8
1000
1500
2000
2500
3000
3500
4000

FIG 91

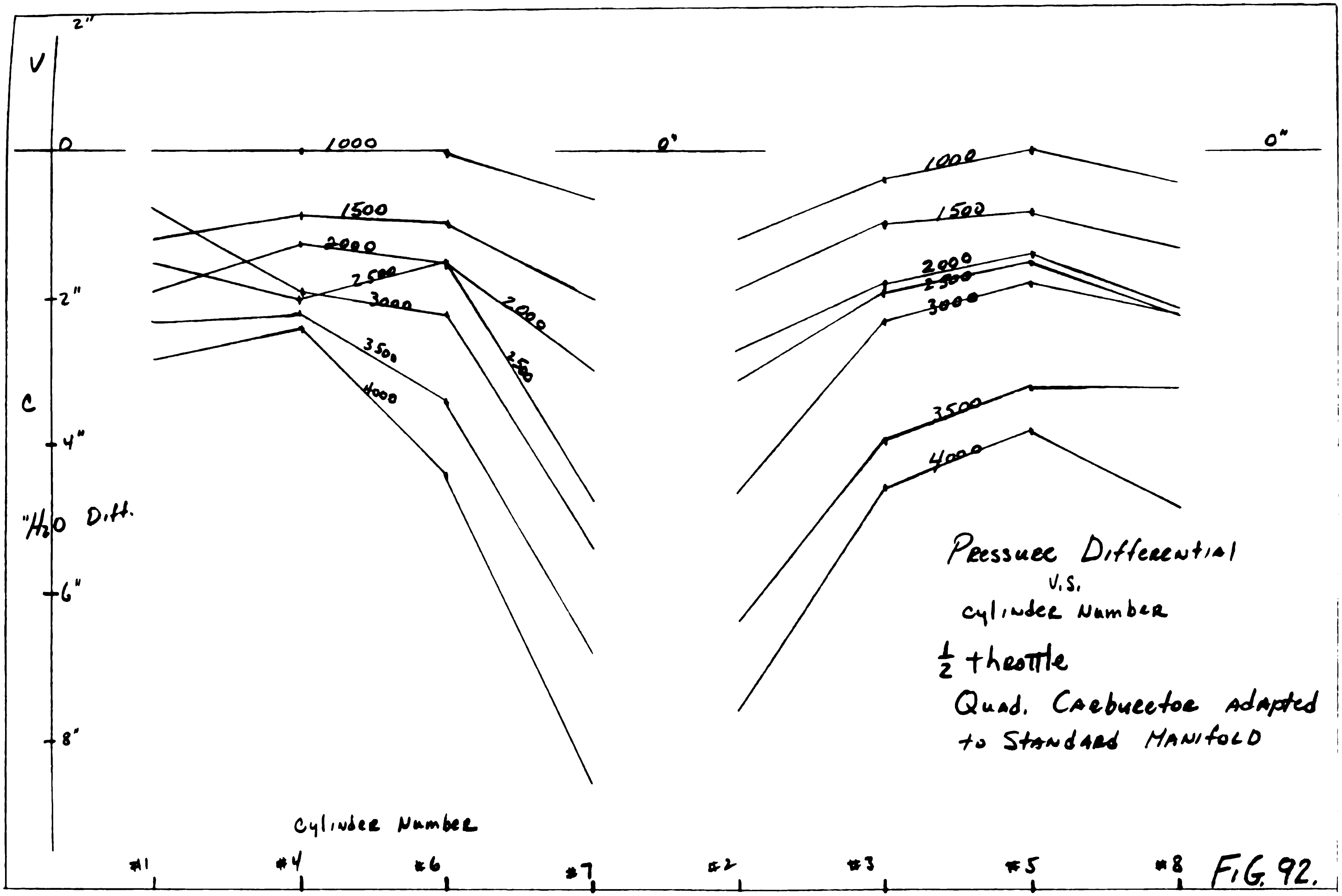

Pressure Differential
V.S.
cylinder Number
$\frac{1}{2}$ throttle
Quad. Carburetor adapted
to Standard Manifold
V
C
"H_2O Diff.
2"
0
2"
4"
6"
8"
0'
0"
1000
1500
2000
2500
3000
3500
4000
Cylinder Number
#1
#4
#6
#7
#2
#3
#5
#8

FIG. 92.

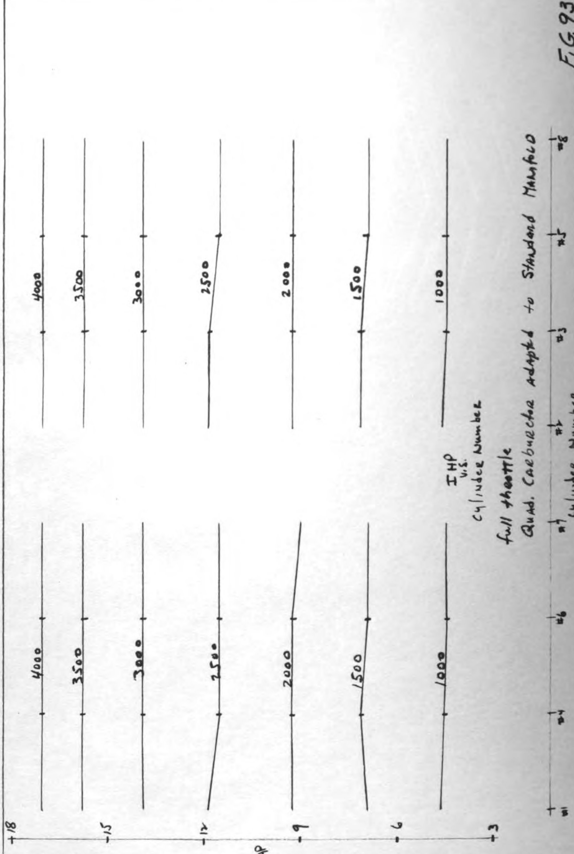
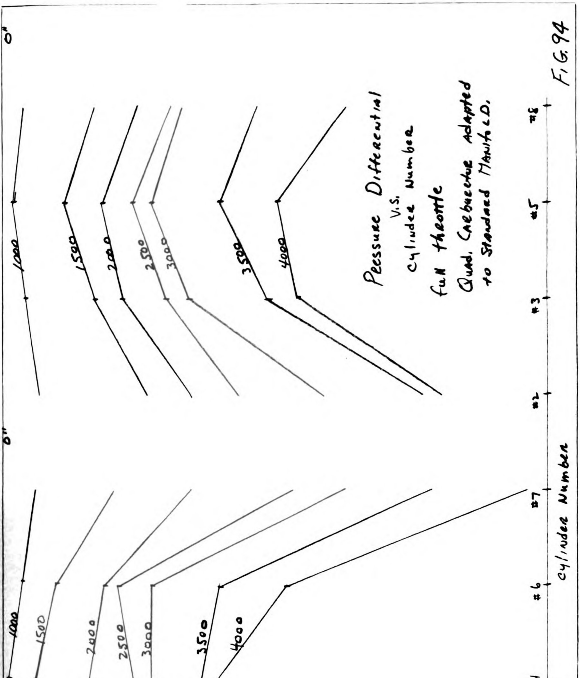
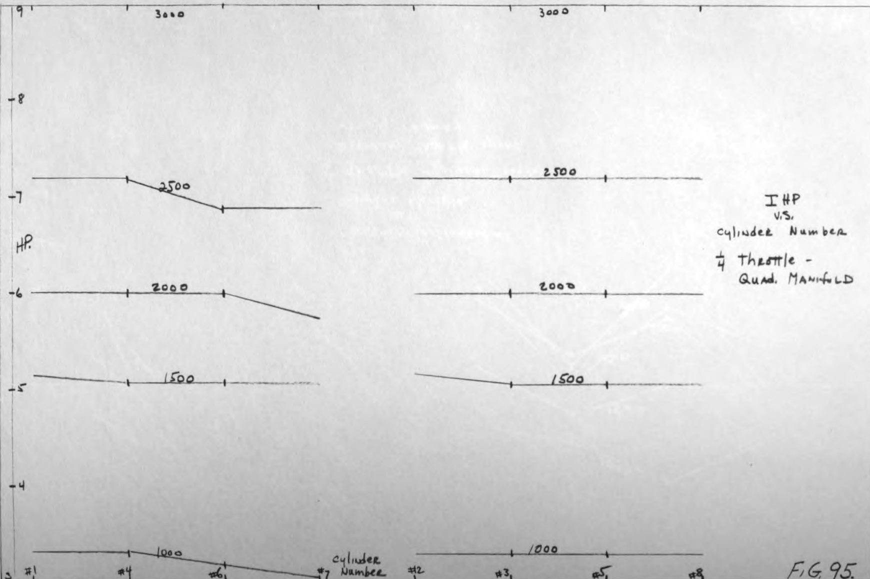

IHP
v.s.
Cylinder Number
full throttle
Quad. Carburetor adapted to Standard Manifold
Cylinder Number
HP
18
15
12
9
6
3
#1
#4
#6
#7
#2
#3
#5
#8
4000
3500
3000
2500
2000
1500
1000

FIG. 93



Pressure Differential
V.S.
cylinder Number
full throttle
Quad. Carburetor Adapted
to Standard Manifold.
"H2O Diff.
0"
2"
4"
6"
8"
10"
#1
#4
#6
#7
#2
#3
#5
#8
cylinder Number
1000
1500
2000
2500
3000
3500
4000

FIG. 94



I HP
vs.
cylinder Number

1/4 Throttle -
Quad. Manifold

FIG. 95.

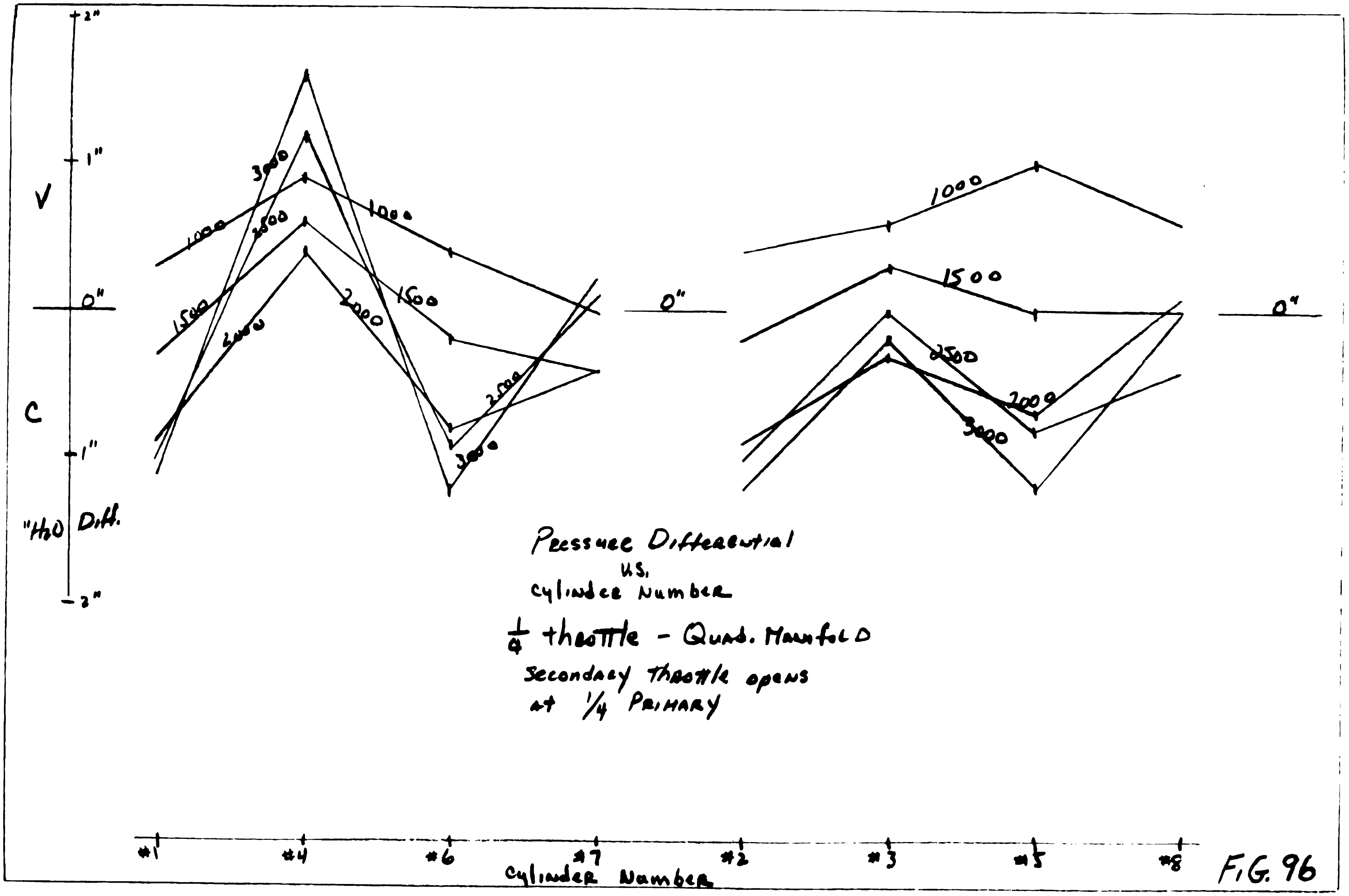
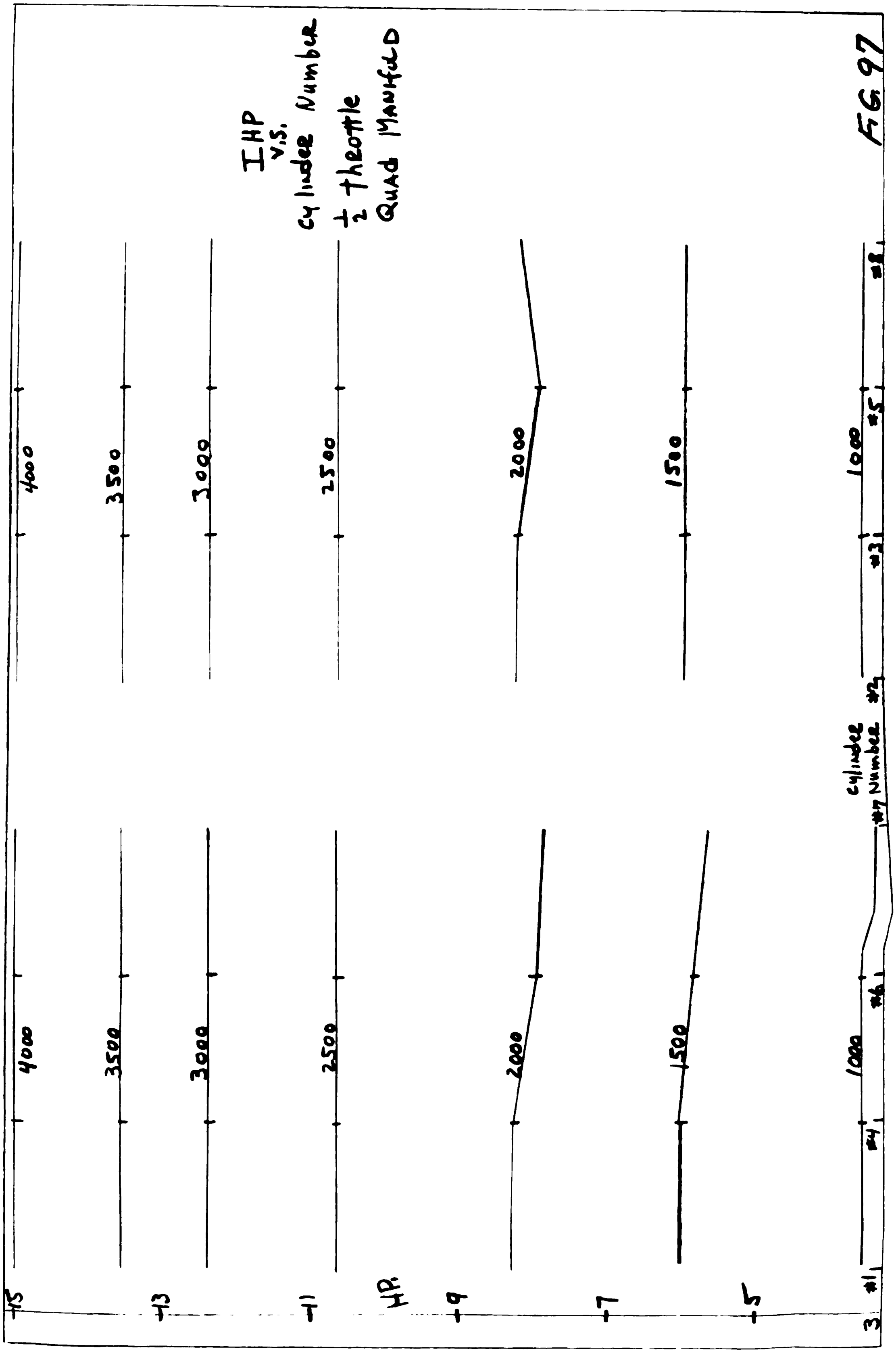
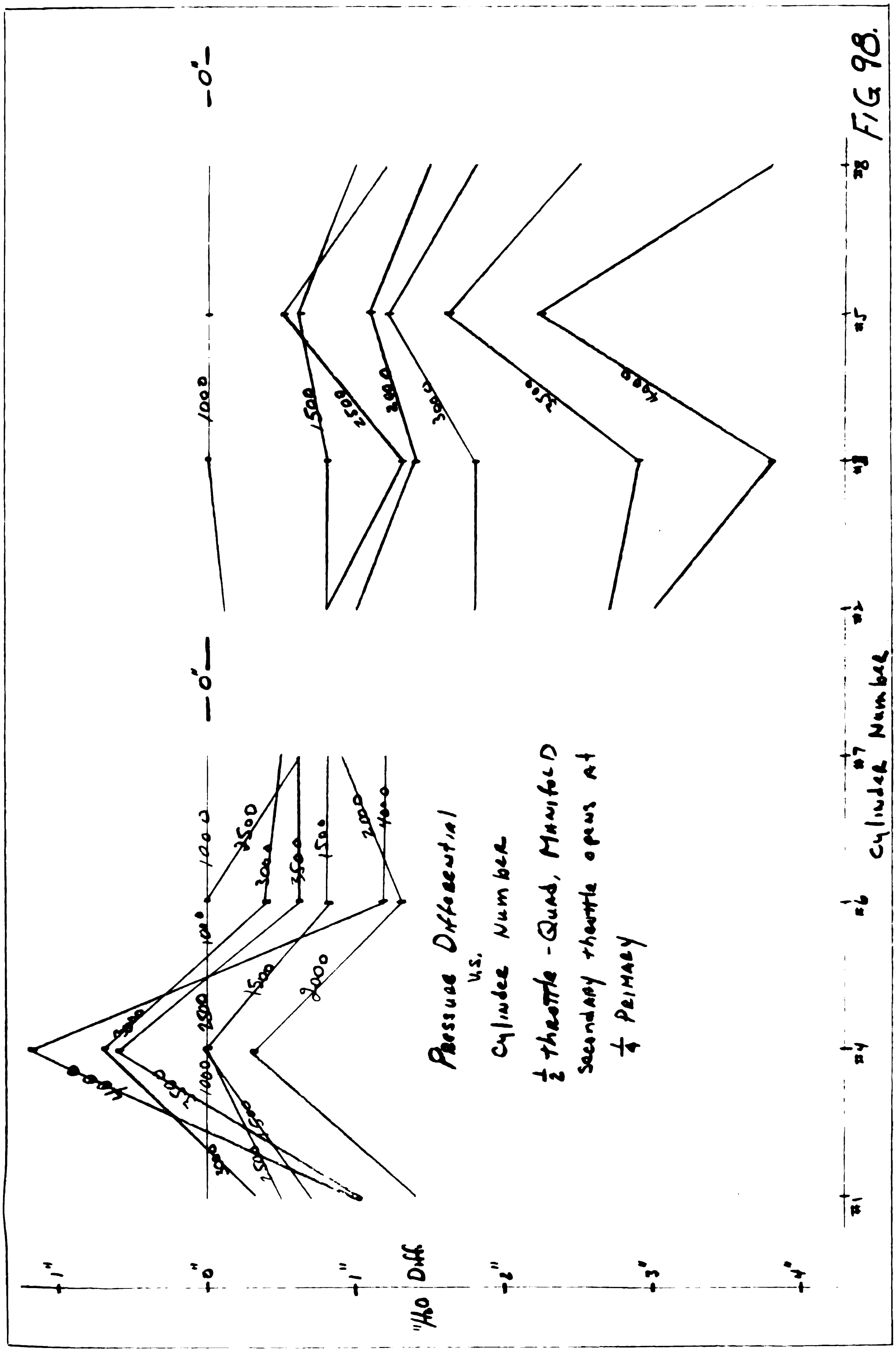

V
C
"H2O Diff.
+2"
+1"
0"
-1"
-2"
0"
0"
1000
1500
2000
2500
3000
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number
Pressure Differential
vs.
Cylinder Number
¼ throttle - Quad. Manifold
Secondary throttle opens
at ¼ Primary

FIG. 96


IHP
v.s.
Cylinder Number
1/2 Throttle
Quad Manifold
FIG 97
HP
15
13
11
9
7
5
3
Cylinder Number
#1
#4
#6
#7
#2
#3
#5
#8
4000
3500
3000
2500
2000
1500
1000



Pressure Differential
v.s.
Cylinder Number
½ throttle - Quad, Manifold
Secondary throttle opens at
¼ Primary
Cylinder Number
"H2O Diff
1"
0"
1"
2"
3"
4"
#1
#4
#6
#7
#2
#3
#5
#8
-0"-

FIG 98.

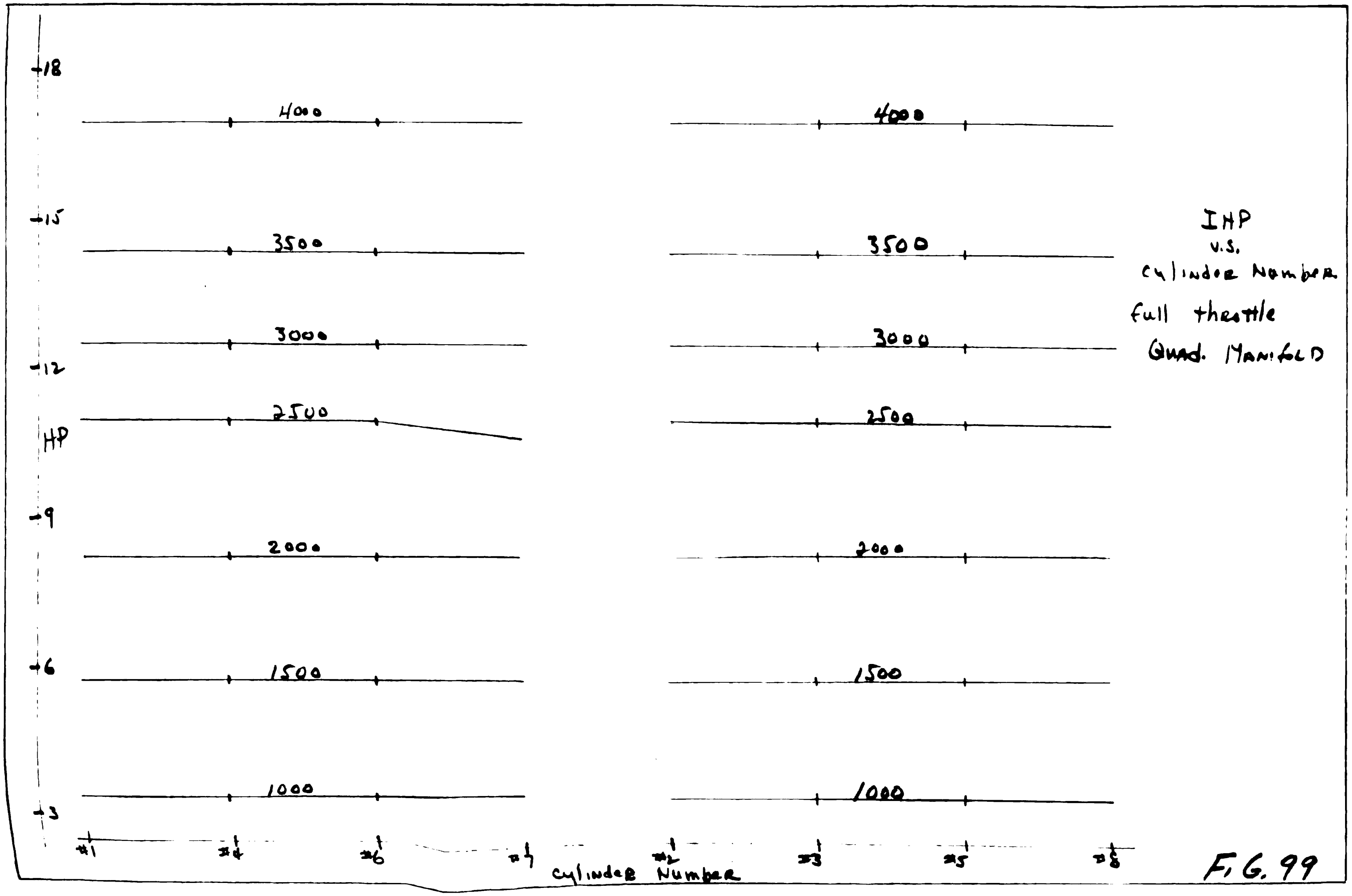

IHP
v.s.
Cylinder Number
Full throttle
Quad. Manifold
HP
18
15
12
9
6
3
4000
3500
3000
2500
2000
1500
1000
#1
#4
#6
#7
#2
#3
#5
#8
Cylinder Number

FIG. 99

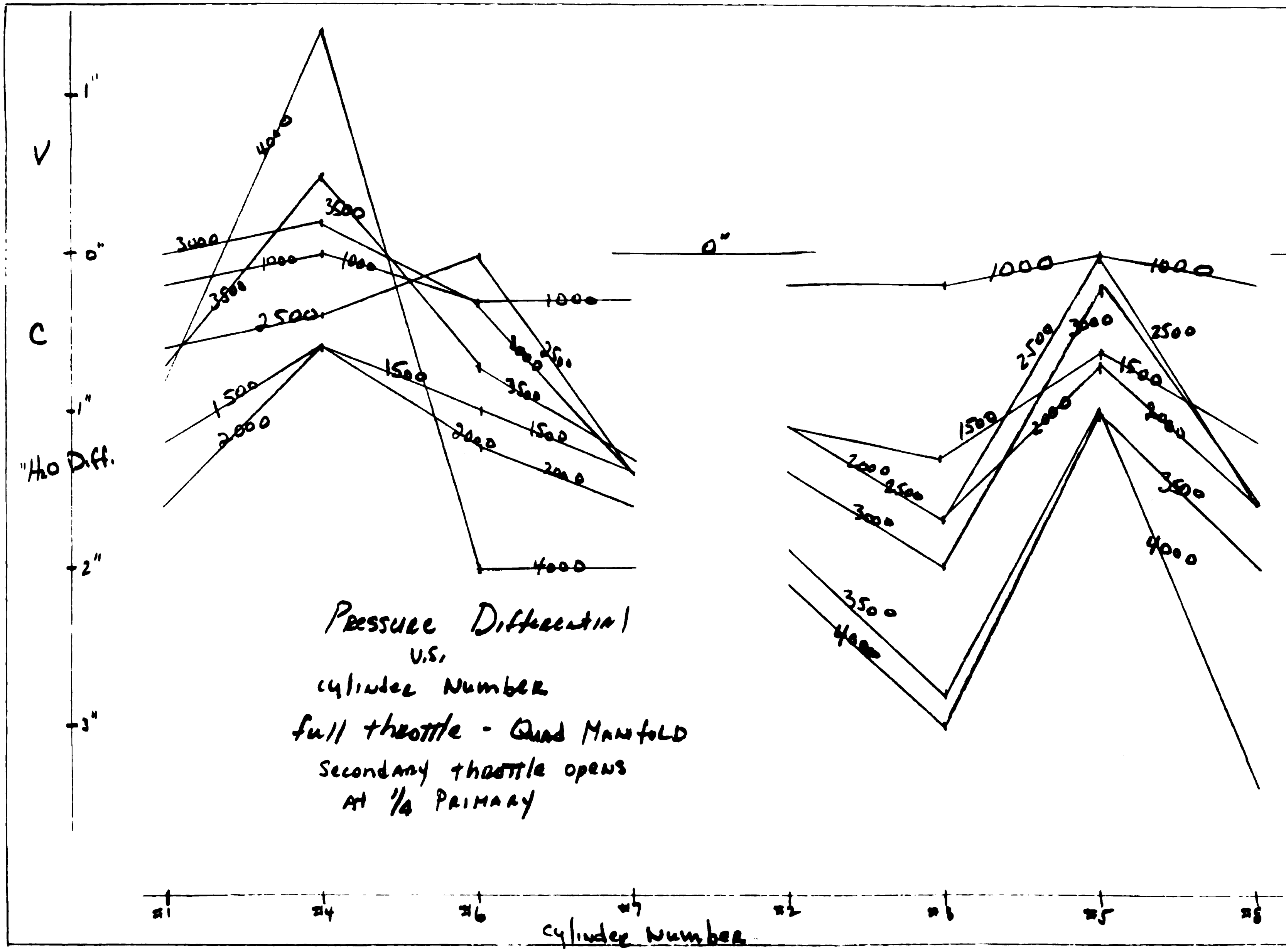

V
C
"H2O Diff.
1"
0"
1"
2"
3"
0"
0"
3000
1000
1000
3500
3500
4000
2500
1500
2000
1500
2000
3500
1500
2000
2500
3000
1000
4000
1000
1000
2500
3000
2500
1500
2000
1500
2000
3500
4000
2000
2500
3000
3500
4000
Pressure Differential
v.s.
cylinder Number
full throttle - Quad Manifold
Secondary throttle opens
At 1/4 Primary
#1
#4
#6
#7
#2
#3
#5
#8
cylinder Number

FIG. 100

APPENDIXES

APPENDIX A-1

Performance Data

STANDARD MANIFOLD

PERFORMANCE DATA

"H_2O All differential pressures will be at the point of lowest pressure - (V) valve

R.P.M.	Beam Load	#1	#4	#6	#7	#8	#3	#5	#2	Oil Press	Jacket Temp.	In. Vac. "Hg	Sp. Adv.	Ex. Press L.B.	Ex. Press. R.B.	Wt. of Fuel (oz)	Rev.	Time (Min.)	Fuel Temp.	Dry Bulb	Wet Bulb	Bar. Press.
		Cylinder Number																				
1/8 Throttle																						
400	150	1.2	1.	1.	1.	1.	1.	1.2	1.	15	160	2 3/4	4	1/4	1/4	1	223	.547		80	74	
800	61.5	3.4	3.8	3.6	3.	3.2	3.	3.4	2.8	20	160	8 1/4	4	1/4	1/4	1	250	.3		80	74	
1200	42	4.	4.2	4.7	4.2	3.8	4.2	4.2	3.4	20	160	14.	10	3/8	1/4	1	292	.246	70°F	80	74	29.12 "Hg
1600	27.5	4.4	5.	4.6	5.	4.8	4.8	4.8	4.2	25	160	18.	27	3/8	1/4	1	480	.297		80	74	
1850 Max.	0	4.6	5.2	5.	5.2	5.	5.	5.2	4.5	25	160	19 1/2	27	3/8	1/4	1	428	.233		80	74	
1/4 Throttle																						
750	175	2.2	2.4	2.6	1.8	2.1	2.	2.8	2.4	25	125	2 1/4	4	3/8	1/4	1	170	.230		85	75	
1000	166	3.	3.6	4.	2.6	2.8	3.	3.3	2.8	25	125	3 3/4	4	3/8	1/4	1	177	.172		85	75	
1500	133	2.4	2.8	3.	2.6	4.1	3.2	4.4	3.4	25	140	7 1/4	10	1/2	3/8	2	563	.360		90	77	
2000	110	3.	4.	3.8	3.	5.7	5.3	6.5	5.1	25	160	11 1/8	22	1/2	3/8	2	609	.300	70°F	100	80	29.15 "Hg
2500	87.5	4.5	6.	5.2	3.7	7.2	6.8	8.	7.1	25	160	13 1/2	27	3/4	1/2	2	646	.259		100	80	
3000	64	5.2	7.	6.	4.	8.	7.8	9.5	9	25	160	15 3/4	27	3/4	1/2	2	707	.232		100	80	
1/2 throttle																						
1000	200	.1	.4	.3	✓.6	✓.2	0	.3	0	25	160	3/4	4	5/16	1/4	2	397	.393		82	72	
1500	212	✓.8	.3	✓.1	✓1.6	✓.3	0	0	✓.6	25	160	1 1/2	8	11/16	1/2	3	549	.355		90	75	
2000	213	✓1.6	.3	✓.2	✓1.6	✓.7	✓.4	0	✓1.	25	160	2 7/16	17	1.	7/8	3	515	.256		90	75	
2500	198	✓.8	.8	.4	✓1.6	✓.5	0	0	✓.6	25	160	3 7/8	22	1 3/4	1 1/2	2	458	.184	70°F	90	75	29.03 "Hg
3000	166	1.8	1.3	✓.4	✓3.	.8	.1	.4	0	25	170	5 1/8	27	1 3/4	1 5/8	2	491	.162		95	77	
3500	138	.2	1.	✓.6	✓3.	✓1.6	✓.2	.3	0	25	180	6 1/2	27	2	1 3/4	3	770	.219		95	77	
4000	110	✓.8	2.	0	✓3.6	✓2.6	✓.6	2.	✓1.	30	180	7 1/8	27	2 1/4	2.	2	425	.106		95	77	
4400	80																					

STANDARD MANIFOLD
PERFORMANCE DATA.

R.P.M.	Beam Load	"H_2O Cylinder Number #1	#4	#6	#7	#2	#3	#5	#8	Oil Press	Jacket Temp.	In. Vac "Hg	Sp. Adv.	Ex. Press L.B.	Ex. Press R.B.	wt. of Fuel oz	Rev.	Time Min.	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press.
3/4 Throttle																						
1000	199	0	0	0	.8	.4	.3	0	0	25	140	1/4	4	1/2	3/8	2	342	.340		80	70	
1500	211	1.	.4	1.2	2.6	1.6	1.6	.7	1.6	30	140	1/2	4	1 3/16	5/8	2	342	.233		80	70	
2000	223.5	2.	1.	1.2	2.8	2.2	1.8	1.	2.4	30	160	1.	12	1 3/8	1 1/4	2	305	.152		80	70	
2500	223	1.4	1.4	.8	3.8	2.	2.	.8	2.2	25	160	1 1/2	18	2.	1 3/4	3	420	.168		80	70	29.17 "Hg.
3000	212	2.6	1.4	2.	5.	3.	3.	1	2.6	25	160	2.	27	2 1/2	2 1/4	3	512	.170	70 °F	80	70	
3500	193	3.	1.6	3.2	6.4	4.4	4.4	2.	3.4	30	160	2 1/2	27	3	2 3/4	3	567	.162		80	70	
4000	170	3.4	2.	3.6	8.2	6.4	3.8	2.6	3.2	30	170	3.	27	3 1/2	3 1/4	3	620	.155		80	70	
full throttle																						
500	212	0	0	.2	.2	.2	0	0	0	10	160	0	4	3/8	1/4	4	310	.693		87	73	29.30
1000	207	0	.2	0	.2	.2	0	0	.2	20	160	1/4	4	3/8	1/4	4	645	.651		87	73	29.30
1500	219	.8	0	.6	1.	.7	.4	.2	.4	25	160	1/2	10	5/8	3/8	4	770	.520		90	70	29.11
2000	230	1.4	.6	.8	2.	1.9	1.	.4	1.8	20	180	3/4	13	3/4	1/2	4	725	.362		100	75	29.11
2500	233	1.	.9	.3	3.	1.9	.8	.4	1.9	20	180	1 1/4	17	1 5/8	1 1/2	8	1475	.576	70 °F	100	75	29.11
3000	221	1.8	1.	1.4	3.6	3.	2.	1.	2.2	20	200	2	22	2	1 3/4	8	1655	.550		95	75	29.11
3500	205	3.2	1.2	2.6	5.	4.4	2.6	2.	3.6	20	200	2 1/4	27	2 1/2	2 1/4	8	1624	.457		75	65	29.30
4000	180	3.6	1.6	3.	6.6	5.8	3.6	2.2	4.8	20	200	2 1/2	27	3	2 3/4	8	1688	.420		80	65	29.30
4400	153	5.	1.8	4.6	7.8	6.2	3.8	2.6	5.4	20	220	—	27	—	—	—	—	—		90	70	29.30

Dual Carburetor Manifold

Throttles Synchronized

Performance Data

R.P.M.	Beam Load	"H_2O Differential — Cylinder # #1	#6	#2	#5	#7	#4	#8	#3	Oil Press	Jacket Temp.	In. Vac "Hg	Sp. Adv.	Ex. Press LB.	Ex. Press RB.	Wt. of Fuel oz.	Rev.	Time Min.	Fuel Temp.	Dry Bulb	Wet Bulb	Bar. Press.
1/16 throttle																						
750	160	1.8	2.	1.2	1.2	0	.4	1.8	1.6	25	160	3 3/4	4	1/4	3/16	1	272	.347		75	60	
1000	148	2.6	2.2	1.5	1.5	.7	.6	3.4	3.4	25	165	6 1/4	4	1/4	3/16	1	160	.157		75	60	
1500	114	4.	3.4	1.8	1.2	1.	.6	7.	6.8	25	180	10 7/8	10	1/2	3/8	2	468	.310	65°F	75	60	29.24 "Hg
2000	76	6.	5.2	2.6	1.8	1.	1.6	6.8	6.4	25	200	14	27	1/2	3/8	2	875	.437		75	60	
2500	53	6.6	5.4	3.2	2.4	3.6	4.2	5.8	5.8	25	180	16 1/8	27	1/2	3/8	2	1003	.401		75	60	
1/8 throttle																						
1000	184	2.8	2.1	.8	1.4	.6	.8	3	3	20	160	3 5/8	4	5/16	1/4	2	285	.281		85	64	
1500	158	4.8	3.4	2.	3.4	1.4	.6	7.4	6.4	25	160	6 3/4	4	5/8	1/2	2	493	.326		85	64	
2000	116	6.6	5.6	3.2	2.4	.6	2.	9.2	7.6	25	180	9 1/2	8	5/8	1/2	2	674	.335	65°F	86	64	29.24 "Hg
2500	88	7.8	6.6	4.4	3.6	4.	5.4	8.6	7.2	25	180	11 5/8	22	3/4	1/2	2	715	.330		86	64	
3000	62	9.4	7.6	4.6	4.6	5.	7.	9.	8.	25	180	13 3/8	27	3/4	1/2	2	550	.183		86	64	
1/4 throttle																						
1000	214	1.6	1.	0	.4	.4	0	1	1.2	20	160	15/16	4	3/8	3/8	2	366	.359		100	70	
1500	222	3.2	2.	1.	.2	.4	.2	2.2	3.4	25	160	1 3/4	6	5/8	5/8	2	281	.193		100	70	
2000	210	5.2	3.8	.4	0	0	.8	3.6	3.	25	160	2 7/8	10	1.	1.	2	471	.235		100	70	
2500	185	7.2	5.8	1.	.6	2.4	3.6	6.	3.6	25	170	4.	22	1 5/8	1 3/8	2	542	.218	63°F	102	70	29.37 "Hg
3000	156	9.	7.2	.4	.2	3.2	5.2	6.6	4.6	25	180	5 1/8	27	1 5/8	1 1/2	3	760	.254		110	75	
3500	131	11.	7.8	.6	.4	3.6	5.4	8.	6.	25	180	6.	27	1 7/8	1 7/8	3	807	.230		110	70	

Dual Carburetor Manifold

Throttles Synchronized

Performance Data

R.P.M.	Beam Load	"H2O Differential cylinder (#) #1	#6	#2	#5	#7	#4	#8	#3	Oil Press	Jacket Temp.	In. Vac. "Hg	Sp. Adv.	Ex. Press L.B.	Ex. Press R.B.	Wt. of Fuel oz	Rev.	Time Min.	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press
½ Throttle																						
1000	218	.8	0	1.	.6	.6	.3	.4	0	25	160	1/4	4	1/2	3/8	2	290	.281		90	73	29.24
1500	227	.3	.2	1.8	1.4	1.2	.6	.2	.5	25	160	1/2	8	3/4	5/8	2	203	.139		90	73	29.24
2000	231	.8	0	2.6	2.8	2.4	2.4	.4	1.	25	160	13/16	14	1 1/8	1	3	561	.280		90	73	29.11
2500	218	3.6	2.	2.8	3.2	3.2	2.4	2.6	0	25	180	1 3/8	20	2 1/8	2	4	687	.277	65°	90	73	29.11
3000	198.5	4.	2.	3.6	3.8	3.4	4.4	3.4	0	25	190	1 3/4	27	2 1/8	2	4	732	.244		107	78	29.11
3500	178	4.6	1.8	4.	4.4	4.	2.8	3.4	0	25	190	1 7/8	27	2 3/4	2 3/4	4	919	.261		90	73	29.11
4000	160	5.2	1.4	4.8	5.	5.6	5.	5.	2.	25	200	2 1/8	27	2 3/4	2 3/4	4	1033	.257		90	73	29.11
4400	140																					
full throttle																						
1000	210	0	0	.6	.6	.6	.6	0	.4	25	160	0	0	5/8	1/2	2	234	.229		80	73	29.11
1500	224	.2	.8	1.8	1.8	1.8	1.8	.3	1.	25	160	1/8	0	7/8	3/4	3	398	.261		80	73	29.11
2000	238	.4	1.2	2.6	3.4	3.2	3.2	.3	2.	25	160	1/4	4	1 5/8	1 1/4	3	471	.233		80	73	29.11
2500	239	1.1	1.2	2.1	3.8	4.8	4.	0	2.	25	180	5/16	6	2 1/2	2 1/4	4	628	.250	65°	95	75	29.16
3000	225	1.2	.8	3.6	5.2	6.6	5.5	0	2.8	25	180	7/16	8	3.	3.	4	649	.215		95	75	29.16
3500	203	2.	.8	4.8	6.6	8.	6.4	1.	3.	25	180	9/16	27	3 1/2	3 1/2	4	700	.200		95	75	29.16
4000	182	1.5	1.6	5.6	7.	8.8	8.	.4	2.6	25	180	3/4	27	4 1/2	4 1/2	4	682	.172		95	75	29.16
4400	160																				105	75	29.16

Dual Carburetor Manifold

Throttle on 2nd Carburetor opens at 2250 R.P.M.

Performance Data

R.P.M.	Beam Load	"H2O Differential — Cylinder # #1	#6	#2	#5	#7	#4	#8	#3	Oil Press	Jacket Temp	In Vac. "Hg.	Sp. Adv	Ex. Press LB	Ex Press RB	Wt. of Fuel oz	Rev.	Time Min.	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press
1/16 throttle																							
750	102	.4	.4	.4	.4	0	.4	5.	4.4	15	160	7 1/2	5	1/8	1/8	2	575	.686		90	70	29.30
1000	90	1.4	.8	0	.4	0	.3	7.6	7.4	25	160	11	12	1/4	1/4	1	336	.339		90	70	29.30
1500	48	1.6	.2	2.	2.6	0	.6	10.4	10.	25	160	16	27	3/8	1/4	1	231	.152	60°F	90	70	29.30
2000	7	2.8	1.	2.2	2.8	3.5	3.5	8.6	9.	25	160	18 1/4	27	3/8	1/4	2	1497	.740		90	70	29.30
2500	53	6.6	5.4	3.2	2.4	3.6	4.2	5.8	5.8	25	180	16 1/8	27	1/2	3/8	2	1003	.401	65	75	60	29.24
1/8 throttle																							
1000	126	2.	1.4	.6	.6	1.8	1.8	7.6	7.6	20	170	7 1/2	12	1/4	1/4	2	689	.678	68	105	75	29.30
1500	86	1.8	0	2.	2.8	2.6	2.2	12.	12.	25	170	12 1/8	27	3/8	1/4	2	778	.520	68	105	75	29.30
2000	54	2.4	0	2.	2.8	5.6	5.4	12.	12.	25	170	15 1/4	27	3/8	1/4	2	600	.300	68	105	75	29.30
2500	88	7.8	6.6	4.4	3.6	4.	5.4	8.6	7.2	25	180	11 5/8	27	3/4	1/2	2	715	.330	65	86	64	29.24
3000	62	9.4	7.6	4.6	4.6	5.	7.	9.	8	25	180	13 3/8	27	3/4	1/2	2	550	.183	65	86	64	29.24
1/4 throttle																							
1000	190	2.	.6	.8	1.2	2.8	2.6	4.6	4.4	20	160	2 3/4	6	3/8	1/4	2	460	.453	68	105	75	29.35
1500	169	2.	.8	2.8	4.	3.6	3.	8.8	8.8	25	160	4 7/8	17	1/2	3/8	2	600	.408	68	105	75	29.35
2000	136	3.4	0	3.4	5.2	7.2	6.4	12.4	12.4	25	160	7 7/16	25	5/8	1/2	2	734	.367	68	105	75	29.35

2nd Carburetor slightly open — very erratic Performance

Quad. Manifold

Secondary throttle opens at $\frac{1}{2}$ Primary

Performance Data.

RPM	Beam Load	"H_2O Differential. Cylinder # #1	#4	#6	#7	#5	#8	#2	#3	Oil Press	Jacket Temp	In. Vac "Hg	Sp. Adv.	Ex. Press LB	Ex. Press R.B.	wt. of Fuel	Rev.	Time	Fuel Temp.	Dry Bulb	Wet Bulb	Bar. Press.
$\frac{1}{8}$ throttle																						
750	145.5	0	.6	.2	.2	1.3	1.3	.8	1.2	25	160	5 3/4	6	1/8	1/8	1	267	.350		75	60	
1000	115	0	.8	.2	.2	1.	.7	.1	.8	25	160	8 3/4	13	3/16	1/8	1	363	.353	64°	75	60	29.40 "Hg.
1500	77	.4	.6	.4	.1	.3	0	.4	.3	25	160	14 1/4	27	1/4	1/8	1	477	.315		85	60	
2000	41	.8	.5	.6	0	.4	0	.4	.2	25	170	17 5/8	27	1/4	3/16	1	550	.273		75	60	
2350	No Load.	-	Max. R.P.M.	-																		
1/4 throttle																						
1000	186.5	.4	1.4	.8	.4	1.	1.	.4	.9	20	160	3 7/16	4	1/4	1/4	1	212	.208		96	60	
1500	172	0	1.4	.3	.3	.1	.3	.5	.6	25	160	7	16	1/2	3/8	1	259	.173		87	60	
2000	130	.6	1.	.4	.3	.8	0	.6	.4	25	160	10 1/8	27	9/16	7/16	2	712	.353	64°	82	60	29.40 "Hg.
2500	100	.6	2.	.6	.7	.8	.6	1.	.4	25	160	12 3/4	27	3/4	1/2	2	825	.331		85	60	
3000	72	.4	2.6	1.	.6	1.2	.5	1.2	.3	25	160	14 7/8	27	3/4	1/2	2	934	.310		85	60	
1/2 throttle																						
1000	215	.4	.6	.2	.2	.5	.2	0	.1	25	160	9/16	4	3/8	3/8	2	355	.345		105	68	
1500	225	.2	.5	.1	0	.1	.2	.3	.2	25	160	1 1/8	9	3/4	5/8	2	411	.274		97	68	
2000	230	0	.6	.1	.2	.5	.7	.5	.5	25	165	2	13	1 3/16	1 1/16	2	433	.217		97	68	
2500	218	.4	1.4	.9	.5	.2	0	.3	.2	25	160	2 7/8	17	1 7/8	1 5/8	3	543	.219		83	68	
3000	195	1.	3.	1.	1.	.1	.6	.4	.7	25	160	3 9/16	27	2	1 3/4	3	628	.212	64°	93	68	29.40 "Hg.
3500	171	1.4	3.2	1.6	1.8	.4	0	.2	.7	25	160	4 3/4	27	2 1/4	2 1/8	3	768	.218		97	68	
4000	147	2.6	4.8	2.2	2.	1.	0	0	1.	25	160	5 1/2	27	2 3/4	2 1/2	3	714	.180		90	68	

Quad. Manifold

Secondary Throttle opens at ½ Primary

Performance Data.

R.P.M.	Beam Load	"H_2O Differential cylinder # #1	#4	#6	#7	#5	#8	#2	#3	Oil Press	Jacket Temp	In. Vac "Hg	Sp. Adv.	Ex. Press L.B.	Ex. Press R.B.	Wt. of Fuel oz	Rev.	Time Min.	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press.
3/4 throttle																						
1000	207	0	.2	0	0	.1	.1	.2	.2	25	160	1/8	–	5/16	3/16	2	362	.357		102	70	
1500	229	.5	.2	.5	.8	.4	.9	.6	.8	25	160	1/4	–	3/4	1/2	2	347	.229		97	70	
2000	240	1.	.3	.8	1.2	.6	1.4	.8	1.6	25	160	7/16	–	1 1/8	1.	4	700	.352		97	70	
2500	240	.3	0	0	1.	0	1.4	.9	1.6	25	160	5/8	–	2	1 3/4	4	728	.291		97	70	
3000	222	.4	.8	.4	.8	0	1.4	1.	1.8	25	180	13/16	–	2 5/8	2 1/4	4	786	.258	64°F	97	70	29.30 "Hg.
3500	207	.8	1.	1.7	1.7	.7	2.	1.6	2.5	25	180	15/16	–	3 1/4	3 1/8	4	794	.225		97	70	
4000	188	1.2	1.4	2.	2.	1.	3.4	2.1	3.	25	190	1 1/16	–	4.	3 3/4	4	763	.191		97	70	
4400	174																					
4560	163																					
full throttle																						
1000	205	.4	.2	.5	.5	0	.2	.2	.2	25	160	1/16	4	5/16	1/4	2	375	.364		97	70	
1500	224	1.	.7	1.	1.2	.4	1.	.8	.8	25	160	3/16	4	11/16	1/2	2	328	.224		97	70	
2000	240	1.6	.6	1.6	1.8	.8	1.6	.9	1.6	25	160	5/16	6	1 3/16	1 3/16	4	720	.369		93	70	
2500	241	1.4	.6	1.	2.	.3	1.6	.9	1.6	25	160	7/16	8	1 7/8	1 3/4	4	715	.288		93	70	
3000	222	.6	.3	1.2	1.8	0	1.6	1.1	1.6	25	160	9/16	8	2 5/8	2 1/4	4	840	.277	64°F	93	70	29.30 "Hg.
3500	207	.8	1.	1.7	1.7	.7	2.	1.6	2.5	25	180	11/16	10	3 1/4	3 1/8	4	794	.225		93	70	
4000	188	1.2	1.4	2.	2.	1.	3.4	2.1	3.	25	180	13/16	16	4	3 3/4	4	763	.191		93	70	
4400	174																					
4560	163																					

QUAD. MANIFOLD

Secondary Throttle opens at 1/4 Primary

Performance Data.

R.P.M.	Beam Load	"H_2O Differential cylinder # 1	#4	#6	#7	#5	#8	#2	#3	Oil Press	Jacket Temp	In. Vac "Hg	Sp. Adv.	Ex. Press L.B.	Ex. Press R.B.	wt. of Fuel (oz)	Rev.	Time	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press
1/8 throttle																						
750	145.5	0	.6	.2	.2	1.3	1.3	.8	1.2	25	160	5 3/4	-	1/8	1/8	1	267	.350		75	60	
1000	115	0	.8	.2	.2	1.	.7	.7	.8	25	160	8 3/4	-	3/16	1/8	1	363	.353	64°F	75	60	29.40 "Hg
1500	77	.4	.6	.4	.1	.3	0	.4	.3	25	160	14 1/4	-	1/4	1/8	1	477	.315		85	60	
2000	41	.8	.5	.6	0	.4	0	.4	.2	25	170	17 5/8	-	1/4	3/16	1	550	.273		75	60	
1/4 throttle																						
1000	177.5	.3	.9	.4	0	1.	.6	.4	.6	25	160	2 1/2	-	5/16	3/16	1	253	.250		100	68	
1500	177.5	.3	.6	.2	.4	0	0	.2	.3	25	160	5 3/16	-	9/16	3/8	1	231	.153		100	68	
2000	126	.9	.4	.8	.3	.8	.4	.9	.3	25	160	9.	-	9/16	1/2	2	694	.345	64°F	100	68	29.40 "Hg
2500	95	1.	1.2	.9	0	.7	.1	1.	0	25	160	12 5/16	-	13/16	9/16	2	804	.320		100	68	
3000	70	1.1	1.6	1.2	.2	1.2	0	1.2	.2	25	160	14 5/16	-	13/16	9/16	2	985	.325		107	68	
1/2 throttle																						
1000	210	0	0	0	0	0	0	.1	0	25	160	1/4	-	7/16	1/4	1	191	.191		107	68	
1500	225.5	.7	0	.8	.8	.6	1.	.8	.8	25	160	1/2	-	3/4	1/2	1	163	.107		102	68	
2000	237	1.4	.3	1.3	.9	1.1	1.5	1.	1.4	25	160	7/8	-	1 5/16	1 1/4	2	336	.167		100	68	
2500	237	.5	0	0	.6	.5	1.2	.8	1.3	25	160	1 1/8	-	2	1 3/4	4	757	.305	64°F	88	68	29.40 "Hg
3000	216	.3	.7	.4	.5	1.2	1.3	1.8	1.8	25	180	1 5/8	-	2 3/8	2 1/8	4	779	.263		88	68	
3500	198	1.	.6	.6	.6	1.6	2.5	2.7	2.9	25	180	2.	-	3	2 3/4	4	858	.245		88	68	
4000	176	1.	1.2	1.2	1.2	2.2	3.8	3.	3.8	25	180	2 3/16		3 3/4	3 1/2	4	916	.228		88	68	
full throttle																						
1000	221	.2	0	.3	.3	0	.2	.2	.2	25	160	1/8	-	1/2	5/16	1	166	.164		85	64	
1500	238	1.2	.6	1.	1.4	.6	1.2	1.1	1.3	25	160	1/4	-	1.	3/4	1	155	.102		85	64	
2000	247	1.6	.6	1.2	1.6	.7	1.6	1.1	1.7	25	160	3/8	-	1 7/16	1 1/4	2	320	.163		93	64	
2500	248	.6	.4	0	1.4	0	1.6	1.	1.7	25	160	1/2	-	2	1 5/8	2	271	.107	64°F	93	64	29.40 "Hg
3000	224	0	.2	.3	1.4	.2	1.6	1.4	2.	25	160	3/4	-	2 11/16	2 5/16	4	749	.251		93	64	
3500	205	.7	.5	.7	1.3	1.	2.	1.9	2.8	25	170	1 5/16	-	3 1/2	3 1/8	4	754	.214		93	64	
4000	187	.8	1.4	2.	2.	1.	3.4	2.1	3.	25	190	1 1/2	-	4	3 3/4	4	763	.191		93	64	
4400	163			Beam Load at 4560 RPM - 163.																		

Quad Carburetor Adapted to Standard Manifold

Secondary throttle opens at 1/4 Primary

Performance Data

R.P.M.	Beam Load	#1	#4	#6	#7	#5	#8	#2	#3	Oil Press	Jacket Temp	In. Vac "Hg	Sp. Adv.	Ex. Press L.B.	Ex Press R.B.	Wt. of Fuel oz.	Rev.	Time	Fuel Temp	Dry Bulb	Wet Bulb	Bar. Press.
1/8 throttle																						
750	133	1.6	1.9	1.8	1.7	1.5	2.2	1.2	2.2	25	160	4 1/16	–	1/4	3/16	1	241	.320		85	65	
1000	107	1.2	1.9	1.5	1.3	1.8	2.6	1.3	3.	25	160	9 7/16	–	3/8	1/4	1	358	.348	62°F	85	65	28.84" Hg
1500	69	0	1.	.4	.7	1.	2.4	1.	2.8	25	160	13 7/8	–	1/2−	5/16	1	410	.268		85	65	
2000	42	0	1.	0	.4	1.	2.8	1.	2.8	25	160	17.	–	1/2+	3/8	1	597	.297		85	65	
1/4 throttle																						
1000	188	1.4	1.9	1.3	1.1	1.5	1.6	.8	1.6	25	160	2 1/2	–	1/2	3/8	1	238	.234		85	65	
1500	181	.9	1.9	1.3	1.3	1.	1.6	.4	2.1	25	160	5 1/8	–	3/4	9/16	3	760	.500		85	65	
2000	134	.8	2.3	.8	1.3	1.9	2.8	.8	3.2	25	170	8 1/4	–	3/4	9/16	2	692	.345	62°F	85	65	28.84" Hg
2500	103	1.1	4.	1.2	1.7	2.1	4.2	.4	4.1	25	170	11.	–	3/4	9/16	2	788	.315		85	65	
3000	77	1.	4.8	.4	1.6	2.1	4.4	1.	4.1	25	160	13.	–	13/16	9/16	2	915	.305		85	65	
1/2 throttle																						
1000	220	0	0	0	.6	0	.2	.6	.2	25	160	1/4	–	5/16	7/16	2	410	.411		90	60	
1500	236	1.2	.9	1.	2.	.8	1.3	1.9	1.	25	160	7/16	–	9/16	7/16	2	361	.237		90	60	
2000	242	1.9	1.3	1.5	3.	1.4	2.1	2.7	1.8	25	160	13/16	–	1 1/4	1 1/16	2	376	.190		90	60	
2500	237	1.5	2.	1.5	4.7	1.5	2.2	3.1	1.9	25	160	1 1/8	–	2	1 3/4	4	765	.304	62°F	97	60	29.20" Hg
3000	214	.8	1.9	2.2	5.4	1.8	2.2	4.6	2.3	25	170	1 7/16	–	2 1/2	2 3/16	4	828	.273		97	60	
3500	197	2.3	2.2	3.4	6.8	3.2	3.2	6.4	3.9	25	180	1 7/8	–	3 1/4	2 7/8	4	869	.247		97	60	
4000	177	2.8	2.4	4.4	8.6	3.8	4.8	7.6	4.6	25	190	2 3/16	–	3 3/4	3 3/8	4	874	.218		97	60	
full throttle																						
1000	220	.5	.2	.5	.8	.3	.5	.9	.6	25	160	3/16−	–	3/8	3/8	2	378	.375		90	60	
1500	236	1.2	.8	1.2	2.4	1.4	2.	3.1	2.	25	160	3/16+	–	9/16	9/16	2	359	.235		90	60	
2000	242	2.3	1.9	2.2	4.	2.2	2.9	4.	2.6	25	160	5/16	–	1 3/8	1 1/4	2	374	.167		90	60	29.20" Hg
2500	243	2.6	2.8	2.5	6.1	2.8	3.6	5.	3.5	25	160	7/16	–	2	1 3/4	4	722	.291	62°F	90	60	
3000	230	2.9	3.2	3.2	7.2	3.2	3.8	6.8	4.	25	170	9/16	–	2 3/4	2 3/8	4	767	.253		90	60	
3500	210	3.2	4.2	4.6	9.	4.6	5.4	8.8	5.6	25	170	3/4	–	3 1/2	3.	4	779	.222		97	67	29.23
4000	188	4.	4.5	6.	11.	5.8	7.2	9.2	6.2	25	170	7/8	–	4 1/4	3 3/4	4	878	.217		97	67	29.23

APPENDIX A-2

Data for I.HP./Cyl. and Friction

STANDARD MANIFOLD

DATA FOR IHP/cyl. and FRICTION

R.P.M.	Beam Loads									
		All cylinders Fire except								
	All	#1	#2	#3	#4	#5	#6	#7	#8	All
1/8 Throttle										
400	150	127	130	128	127	128	126	129	123	150
800	65	54	50	48	55	53	48	55	48	66
1200	42	32	29	26	33	33	30	32	25	41
1600	23	15	14	13	15	13	11	15	12	24
(MAX.)	1850	1790	1800	1760	1750	1730	1750	1770	1740	1850
1/4 Throttle										
750	182	155	155	155	152	153	152	150	152	182
1000	176	148	148	146	142	142	138	148	144	176
1500	148	122	120	120	118	115.5	113.5	123	117	148
2000	120	97	97	96	94	97	94	98	95	120
2500	90	68	68	68	68	66.5	65	68	66	90
3000	64	43	43	44	44	42	42	44	43	64
1/2 Throttle										
1000	204	175	175	175	176	177	177	176	177	205
1500	212	181	181	181	180	182	183	183	182	213
2000	216	185	185	185	185	184	185	186	185	215
2500	200	170	170	170	170	170	170	171	170	201
3000	173	145	145	145	145	145	145	145	145	173
3500	147	120	120	120	120	120	121	122	120	148
4000	117	90	88	88	90	88	88	88	88	117

Standard Manifold

Data for Ind HP/cyl and Friction

R.P.M.	Beam Loads: All	All cylinders Fire Except: #1	#2	#3	#4	#5	#6	#7	#8	All
3/4 throttle										
1000	201	173	170	170	172	173	173	174	173	201
1500	207	176	175	175	176	176	175	175	176	208
2000	229	195	195	193	193	194	194	195	194	229
2500	226	192	191	191	188	193	194	193	192	226
3000	210	175	177	177	175	176	175	177	177	210
3500	197	164	163	163	163	163	165	165	164	197
4000	170	140	140	140	143	142	139	138	140	169
full throttle										
500	212	177	180	179	179	177	179	179	178	212
1000	202	171	171	172	171	172	173	173	173	202
1500	222	191	190	191.5	189	190	191	190	191	222
2000	232.5	196.5	198	198.5	197.5	199	198.5	200.5	199.5	233.5
2500	234	195	198	199	200.5	200.5	200.5	201	200.5	234
3000	222	186	187	189	187	185	189	188	186	222
3500	202	167.5	168	168	167	166	167.5	168	166	202
4000	180	145	146	144	145	145	145	146	145	180
4400	153	119	119	119	119	120	120	118	118	154

Dual Carburetur Manifold

Throttles Synchronized

Data for Ind HP/cyl. and Friction

	Beam Loads									
		All cylinders Fire Except								
R.P.M.	All	#1	#2	#3	#4	#5	#6	#7	#8	All
1/16 throttle										
750	160	135	135	135	135	135	134	136	135	160
1000	148	124	124	124	124	124	125.5	125.5	125.5	148
1500	114	95	95	95	95	95	95	95	95	114
2000	76	61	61	61	61	61	61	61	61	76
2500	53	36.5	36.5	36.5	36.5	36.5	37	36.5	36.5	53
1/8 throttle										
1000	184	157	157.5	157	157.5	157.5	158	157	157	184
1500	158	132	132	132	132	132	132	134	133	157.5
2000	116	93.5	93.5	93.5	93.5	93.5	94	95	93	116
2500	88	67.5	67.5	67.5	67.5	67.5	68	68	67	87
3000	62	39	39	39	39	39	39	39	39	62
1/4 throttle										
1000	214	184	183	184	184	184	183	183	183	214
1500	222	190	190	190	190	189	189	190	190	222
2000	210	176	177	177	176	179	181	181	180	210
2500	185	155	155	155	155	155	155	155	155	185
3000	156	127	127	127	127	128	128	129	127	156
3500	131	103	103	103	103	103	103	104	103	131

Dual Carburetor Manifold

Throttles Synchronized

Data for IHP/cyl and Friction

R.P.M.	← Beam Loads									→
		← All cylinders Fire Except							→	
	All	#1	#2	#3	#4	#5	#6	#7	#8	All
½ throttle										
1000	218	186.5	187	187	187	187	187	190	188	218
1500	227	194	194	194	194	194	196	197	196	227
2000	231	197	197	197	197	196.5	200	200	200	230
2500	218	186	186	186	186	186	186	187	186	218
3000	198.5	167.5	167.5	167.5	167.5	167.5	168	167.5	167.5	198.5
3500	178	147	147	147	147	147	147.5	147	147	178
4000	160	127	127	127	127	127	127	127	127	160
4400	140	103.5	103.5	103.5	103.5	103.5	103.5	103.5	103.5	140
full throttle										
1000	210	181	181	181	181	181	184	184	181	210
1500	224	191	192	193	191	190	193	192	191.5	225
2000	238	200	200	202.5	200	201	203	203	200	238
2500	239	202	202	202	202	202	202	202	202	239
3000	225	189	189	188	188	190	190	188	187	225
3500	203	167.5	167.5	167.5	167.5	167.5	167	170	170	203
4000	182	148	148	148	148	148	148	148	148	182
4400	160	124	124	124	124	124	124	124	124	160

Quad. Manifold

Data for Ihp/cyl. and Friction

	Beam Loads									
		All cylinders Fire except								
R.P.M	All	#1	#2	#3	#4	#5	#6	#7	#8	All
$\frac{1}{8}$ throttle										
750	132	112	112	112	112	112	114	114.5	112	133
1000	102.5	82.5	82.5	82.5	82.5	82.5	84	85	82.5	103
1500	66.5	52	52	52	52	52	53	54	53	66.5
2000	32.	17.5	17.5	17.5	17.5	17.5	20	21	18	32
1/4 throttle										
1000	177.5	151	151	151	151	151	152	153	151	177.5
1500	165	137.5	137.5	138	138	138	138	138	138	165
2000	125	101	101	101	101	101	101	102	101	124
2500	96	73	73	73	73	73	74	74	73	97
3000	68	44	44	44	44	44	44	44	44	68
1/2 throttle										
1000	205	177	177	177	177	177	177	178	177	205
1500	219	187	187	187	187	187	188	189	187	219
2000	223	190	190	190	190	191	191	191.5	190	223
2500	217	183	183	183	183	183	183	183	183	217
3000	195	162	162	162	162	162	162	162	162	195
3500	172	141	141	141	141	141	141	141	141	173
4000	148	118	118	118	118	118	118	118	118	148

Quad Manifold

Data for IHP/cyl. and Friction

R.P.M.	All	#1	#2	#3	#4	#5	#6	#7	#8	All
	Beam Loads									
		All cylinders Fire except								
3/4 Throttle										
1000	205	177.5	177.5	177.5	177.5	177.5	177.5	177.5	177.5	204
1500	229	197	197	197	197	197	197	197	197	229
2000	240	206	206	206	206	206	206	207	206	240
2500	240	205	205	205	205	206	206	206	206	240
3000	222	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	222
3500	207	174	174	174	174	174	174	174	174	207
4000	188	154	154	154	154	154	154	154	154	188
4400	174	140	140	140	140	140	140	140	No	174
Full throttle										
1000	205	178	178	178	178	178	178	178	178	205
1500	224	193	193	193	193	193	193	193	193	225
2000	240	207	207	207	207	207	207	207	207	240
2500	241	206	206	206	206	206	206	207	206	240
3000	222	188.5	188.5	188.5	188.5	188.5	188.5	188.5	188.5	222
3500	207	174	174	174	174	174	174	174	174	207
4000	188	154	154	154	154	154	154	154	154	188
4400	174	140	140	140	140	140	140	140	140	174

Quad Carburetor adapted to Standard Manifold

Secondary throttle opens at 1/4 Primary

Data for IHP/cyl. and Friction

	Beam Loads									
		All cylinders Fire Except								
R.P.M.	All	#1	#2	#3	#4	#5	#6	#7	#8	All
1/8 throttle										
750	133	109	109	109	109	109	109	108	109	133
1000	107	87	87	87	87	87	87	87	87	107
1500	69	53	53	53	52	52	52	52	53	69
2000	42	24	24	24	24	26	26	26	24	42.5
1/4 throttle										
1000	188	160	160	160	160	159	158	158	158	187
1500	181	152	152	152	151	151	151	151	152	182
2000	134	110	110	110	110	110	110	110	110	133.5
2500	103	80	80	80	80	80	81	81	81	103
3000	77	53	53	53	53	53	53	53	53	77
1/2 throttle										
1000	220	183	183	185	184	184	184	185	184	220
1500	236	198	198	198	199	199	199	199	199	236
2000	242	205	205	205	205	205	205	205	205	242
2500	237	200	200	200	200	200	200	201	200	236
3000	214	179	179	179	179	179	179	180	179	214
3500	197	162	162	162	162	162	162	162	162	197
4000	177	142	142	142	142	142	142	142	142	177
full throttle										
1000	220	183	183	184	184	184	185	185	184	220
1500	236	199	198	198	198	199	199	199	199	236
2000	242	205	205	205	205	205	205	206	205	242
2500	243	205	205	205	206	206	206	206	206	242
3000	230	193	193	193	193	193	193	193	193	230
3500	210	174	174	174	174	174	174	174	174	210
4000	188	154	154	154	154	154	154	154	154	188

APPENDIX B-1

The Determination of Engine Characteristics

Standard Manifold

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	FHP	IHP	C.F.	Corr. IHP	Corr. BHP	Torque	M.E.	Fuel oz/Min	Fuel #/Hr	B.S.F.C.	M.P.H.	6.1 × M.P.H	M/Gal.	B.M.E.P.
1/8 throttle															
400	7.5	1.8	9.3		10.+	8.2	98.3	82.	1.83	6.86	.837	9.76	59.5	8.7	53
800	6.75	4.4	11.15	1.077	12.	7.6	44.3	63.	3.33	12.5	.608	19.52	119	9.5	24.6
1200	6.3	8.1	14.4		15.5	7.4	27.6	47.7	4.07	15.25	.485	29.28	178.5	11.7	16.0
1600	5.5	10.6	16.1		17.4	6.8	18.0	39.1	3.36	12.6	.540	39.04	238.	18.9	11.0
1/4 throttle															
750	16.4	4.7	21.1	1.08	22.8	18.1	115	79.3	4.35	16.3	.901	18.3	111.5	6.85	62.5
1000	20.8	9.5	30.3	1.08	32.7	23.2	109	71.0	5.82	21.8	.94	24.4	148.8	6.83	60.
1500	25.0	16.3	41.3	1.085	44.8	28.5	87.3	63.7	5.56	20.8	.73	36.6	223.2	10.7	49.2
2000	27.4	18.0	45.4	1.095	49.7	31.7	72.1	63.7	6.67	25.0	.79	48.8	297.6	11.9	41
2500	27.3	28.8	56.1	1.095	61.4	32.6	57.3	53.0	7.72	29.0	.89	61.0	372.	12.85	33.8
3000	24.0	38.6	62.6	1.095	68.5	29.9	42.0	43.7	8.62	32.3	1.11	73.2	446.4	13.8	25.1
1/2 throttle															
1000	25	2.5	27.5	1.078	29.6	27.1	131.2	91.6	5.1	19.1	.705	24.4	148.8	7.8	70.2
1500	39.7	5.9	45.6	1.09	49.7	43.8	139	88.0	8.45	31.6	.72	36.6	223.2	7.07	75.8
2000	53.3	8.	61.3	1.09	66.8	58.8	1388	88.	11.7	43.8	.745	48.8	297.6	6.8	76.2
2500	61.8	12.17	73.97	1.09	80.7	68.5	129.2	85	10.9	40.7	.595	61.0	372.	9.15	71.0
3000	62.3	19.	81.3	1.093	89.0	70.	109.	78.7	12.3	46.1	.657	73.2	446.4	9.7	60.4
3500	60.3	29.	89.3	1.093	97.6	68.6	90.7	70.4	13.7	51.3	.750	85.5	520.8	10.15	50.7
4000	55.	55.5	110.5	1.093	121	65.5	72.2	54.2	18.85	70.7	1.08	97.6	595.2	8.4	42.3
4400	44.					56.?	52.4					107.4			33.?

Standard Manifold

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	FHP	IHP	C.F.	Corr. IHP	Corr BHP	Torque	M.E.	Fuel (oz/Min)	Fuel #/Hr.	B.S.F.C.	M.P.H.	6.1 x M.P.H.	M/Gal	B.MEP
3/4 throttle															
1000	24.9	3.27	28.17		30.1	26.83	131	89.2	5.88	22.	.82	24.4	148.8	6.77	69.2
1500	39.6	8.5	48.1		51.4	42.9	138	82.5	8.58	32.2	.75	36.6	223.2	6.93	74.
2000	55.8	12.45	68.25		73.0	60.55	146.5	83.	13.15	49.2	.812	48.8	297.6	6.05	78
2500	69.5	14.0	83.5	1.068	89.3	75.3	146.	84.2	17.85	67.	.89	61.	372.	5.55	77.7
3000	79.5	23.	102.5		109.5	86.5	139	79.	17.65	66.2	.765	73.2	446.4	6.70	74.4
3500	84.4	30.06	114.46		122.5	92.44	126.5	75.2	18.5	69.5	.752	85.5	520.8	7.5	68.3
4000	85.	36.5	121.5		130.	93.5	111.5	72.	19.35	72.5	.777	97.6	595.2	8.2	60.2
full throttle															
500	13.25	3.5	16.75	1.071	17.96	14.46	139	80.6	5.77	21.6	1.5	12.2	74.4	3.45	75
1000	25.9	4.8	30.7	1.071	32.9	28.1	135.8	85.5	6.15	23.05	.821	24.4	148.8	6.45	72.7
1500	41.1	5.7	46.8	1.078	50.4	44.7	143.5	88.6	7.70	28.9	.648	36.6	223.2	7.72	77.2
2000	57.5	9.6	67.1	1.092	73.4	63.8	151	87.0	11.05	41.5	.650	48.8	297.6	7.17	82.7
2500	72.7	14.0	86.7	1.092	94.7	80.7	153	85.2	13.9	52.2	.650	61.	372.0	7.13	83.8
3000	83.0	21.4	104.4	1.088	113.5	92.1	145	81.2	14.5	54.5	.592	73.2	446.4	8.2	79.5
3500	89.7	33.26	123	1.056	130.	96.74	134.5	74.5	17.5	65.7	.680	85.5	520.8	7.94	71.6
4000	90.	49.5	139.5	1.058	147.5	98.0	118.	66.4	19.05	71.5	.730	97.6	595.2	8.33	63.4
4400	84.2	65.4	149.6	1.070	160.0	94.6	100.	59.1							

Dual Carburetor Manifold

Throttles Synchronized

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M	BHP	FHP	IHP	C.F.	CORR. IHP	CORR BHP	Torque	M.E.	Fuel oz Min	Fuel # HR	B.S.F.C.	M.P.H	6.1 x MPH	Mi gal.	BMEP
$\frac{1}{16}$ throttle															
750	15	3.72	18.72		19.72	16	105	81	2.88	10.8	.676	18.3	111.5	12.0	55
1000	18.5	5.10	23.6		24.83	19.73	97	79.7	6.37	23.9	1.21	24.4	148.8	6.22	51
1500	21.4	7.08	28.48	1.057	30.	22.92	75	76.2	6.45	24.2	1.06	36.6	223.2	9.25	39.6
2000	19	11.0	30.		31.6	20.6	49.7	65.2	4.6	17.2	.835	48.8	297.6	17.3	26.7
2500	16.55	24.64	41.19		43.3	18.66	34.7	42.2	5.0	18.7	1.0	61.	372	19.9	19.3
$\frac{1}{8}$ throttle															
1000	23.	3.73	26.73		28.35	24.62	121	87	7.12	26.7	1.08	24.4	148.8	5.6	63.7
1500	29.6	8.85	38.45		40.8	31.95	104	78.3	6.13	23.	.72	36.6	223.2	9.7	55.
2000	29.	15.65	44.65	1.062	47.5	31.85	76	67	5.97	22.4	.704	48.8	297.6	13.3	41.3
2500	27.5	24.10	51.6		54.7	30.6	57.7	56	6.05	22.7	.742	61	372	16.4	31.6
3000	23.2	45.76	68.96		73.2	27.44	40.7	37.5	10.9	40.8	1.48	73.2	446.4	10.9	23.7
$\frac{1}{4}$ throttle															
1000	26.8	3.76	30.56	1.077	32.9	29.14	141	88.5	5.57	20.8	.715	24.4	148.8	7.15	75.5
1500	42	6.34	48.34	1.077	52.2	45.86	146	87.8	10.35	38.8	.845	36.6	223.2	5.75	79.3
2000	52.5	10.75	63.25	1.077	68.1	57.35	139	84.2	8.5	31.8	.554	48.8	297.6	9.37	74.5
2500	57.8	17.1	74.88	1.078	80.6	63.5	122	79.0	9.17	34.4	.542	61.	372	10.8	65.7
3000	58.5	27.1	85.6	1.086	93.	65.9	102.5	71.0	11.8	44.3	.672	73.2	446.4	10.+	57.
3500	57.25	40.3	97.55	1.077	105.2	64.9	86	61.7	13.	48.7	.75	85.5	520.8	10.7	48.

Dual Carburetor Manifold

Throttles Synchronized

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	F.HP	I.HP	C.F.	CORR IHP	CORR BHP	TORQUE	M.E.	Fuel oz/Min	Fuel #/HR	BSFC	MPH	6.1× MPH	Mi/gal	BMEP
	1/2 throttle														
1000	27.2	3.09	30.29	1.078	32.7	29.6	143	90.4	7.12	26.6	.900	24.4	148.8	5.6	77
1500	42.5	5.62	48.12	1.078	54.9	46.3	148.5	89.2	14.4	54.	1.17	36.6	223.2	4.1	80
2000	57.8	8.23	66.03	1.082	71.4	63.2	152.5	88.5	10.7	40.	.682	48.8	297.6	7.4	82.⁻
2500	68.	12.3	80.3	1.082	86.9	74.6	143	86.0	14.4	54.	.724	61.	372.	6.9	77.⁺
3000	74.5	18.5	93.	1.100	102.2	83.7	130	81.8	16.4	61.5	.735	73.2	446.4	7.25	72.
3500	78.	30.2	108.2	1.082	117.2	87.	116.5	74.2	15.3	57.4	.66	85.5	520.8	9.1	64.5
4000	80.	52.	132.	1.082	143.	91.	105	63.7	15.5	58.2	.64	97.6	595.2	10.2	59
4400	78.	82.	160.	1.082	173.	91.	92.	52.6							
	full throttle														
1000	26.24	2.	28.24	1.076	30.4	28.4	138	93.4	8.72	32.7	1.15	24.4	146.8	4.55	73.6
1500	42.	6.54	48.54	1.076	52.25	45.7	147	87.5	11.5	43.2	.947	36.6	223.2	5.17	79.
2000	59.5	14.15	73.65	1.076	79.3	65.2	156	82.2	12.9	48.4	.742	48.8	297.6	6.15	84.3
2500	74.75	17.65	92.4	1.087	100.5	82.9	157.⁻	82.	16.	60.	.725	61.	372	6.20	85.7
3000	84.4	25.05	109.45	1.087	119.	94.	147.5	82.⁻	18.6⁻	69.5	.74	73.2	446.4	6.42	81.
3500	87.5	33.65	121.15	1.087	132.	98.4	133.	79.	20.	75	.762	85.5	520.8	6.94	72.7
4000	91.	45.	136.	1.087	147.7	102.7	119.5	69.5	23.2	87	.848	97.6	595.2	6.85	66.5
4400	88	66.	154.	1.10	169.5	103.5	105.	61.⁺							

Dual Carburetor Manifold

Throttle on Second Carburetor opens at 2250 R.P.M.

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP

R.P.M.	BHP	FHP	IHP	C.F.	Corr IHP	Corr BHP	Torque	M.E.	Fuel oz/Min	Fuel #/HR	BSFC	M.P.H.	6.1 × MPH	Mi/gal	BMEP
	$\frac{1}{16}$ throttle														
750	9.56	3.72	13.28	1.07	14.2	10.5	67	74.	2.92	10.9	1.04	18.3	111.5	10.2	36.3
1000	11.25	5.10	16.35	1.07	17.5	12.4	59	71.	2.95	11.1	.895	24.4	148.8	13.4	21.4
1500	9.0	7.08	16.08	1.07	17.2	10.1	31.4	58.7	6.58	24.6	2.42	36.6	223.2	9.1	17.3
2000	1.75	11.0	12.75	1.07	13.62	2.6	4.6	19.0	2.70	10.1	3.9	48.8	297.6	29.5	33.6
2500	16.55	24.64	41.19	1.052	43.3	18.66	34.7	42.2	5.0	18.7	1.0	61.	372	19.9	19.3
	$\frac{1}{8}$ throttle														
1000	15.75	3.73	19.5	1.084	21.15	17.4	82.7	82.4	2.98	11.2	.643	24.4	148.8	13.3	45
1500	16.1†	8.85	24.95	1.084	27.1	18.3	57.2	67.5	3.85	14.4	.788	36.6	223.2	15.5	31.6
2000	13.5	15.65	29.15	1.084	31.6	15.9	35.3	50.3	6.67	25.	1.57	48.8	297.6	11.9	20.6
2500	27.5	24.10	51.6	1.062	54.7	30.6	57.7	56.	6.05	22.7	.742	61.	372	16.4	31.6
3000	23.2	45.76	68.96	1.062	73.2	27.44	40.7	37.5	10.9	40.8	1.48	73.2	446.4	10.9	23.7
	$\frac{1}{4}$ throttle														
1000	23.75	3.76	27.5	1.084	29.8	26.	124.	87.2	4.42	16.6	.64	24.4	148.8	9.	67.4
1500	31.7	8.85	38.04	1.084	41.2	34.9	111.	85.	4.9	18.4	.527	36.6	223.2	12.1	60.2
2000	34.	15.65	44.75	1.084	48.5	37.7	89.	77.7	5.45	20.4	.54	48.8	297.6	14.6	48.8

erratic Performance —

From this throttle position and further opening — operation is the same as when the throttles are synchronized.

Quad. Manifold

Secondary throttle opens at ½ Primary

Determination of Engine Characteristics.

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	FHP	IHP	C.F.	Corr. IHP	Corr BHP	Torque	M.E.	Fuel oz/Min	Fuel #/HR.	BSFC.	M.P.H.	6.1 × M.P.H.	Mi/gal.	BMEP
1/8 throttle															
750	13.62	2.2	15.82	1.046	16.58	14.38	95.6	87.	2.86	10.7	.745	18.3	111.5	10.4	49.6
1000	14.4	7.2	21.6	1.046	22.6	15.4	75.6	68.2	2.83	10.6	.688	24.4	148.8	14.1	40.
1500	14.4	11.25	25.65	1.051	27.0	15.75	50.5	58.3	3.17	11.9	.756	36.6	223.2	18.8	27.2
2000	10.25	20.4	30.65	1.046	32.05	11.65	27.	36.4	3.66	13.7	1.17	48.8	297.6	21.7	15.1
1/4 throttle															
1000	23.3	3.91	27.21	1.057	28.8	24.9	123	86.5	4.8	18.	.722	24.4	148.8	8.3	64.6
1500	32.2	9.77	41.97	1.052	44.2	34.43	113	78.	5.77	21.6	.628	36.6	223.2	10.3	59.3
2000	32.25	16.5	48.75	1.052	51.25	34.75	85	68.	5.77	21.6	.621	48.8	297.6	13.8	45.
2500	31.25	26.84	58.09	1.052	61.0	34.16	65.6	56.	6.04	22.6	.662	61.	372.	16.5	35.3
3000	27.0	46.5	73.5	1.052	77.25	30.75	47.2	40.	6.45	24.2	.787	73.2	446.4	18.5	26.6
1/2 throttle															
1000	26.9	2.28	29.18	1.072	32.3	30.	141	93	5.8	21.7	.722	24.4	148.8	6.9	77.7
1500	42.2	6.55	48.75	1.070	52.2	45.7	148	87.6	7.3	27.4	.600	36.6	223.2	8.2	79.
2000	57.5	9.43	66.93	1.070	71.6	62.2	151	86.8	9.2	34.5	.554	48.8	297.6	8.6+	80.7
2500	68.2	17.3	85.5	1.058	90.4	73.1	143	81.0	13.7	51.3	.702	61	372.	7.2	75.8
3000	73.2	25.8	98.9	1.065	105.2	79.4	128	75.2	14.1	52.8	.665	73.2	446.4	8.5	69.5
3500	74.7	33.7	108.4	1.070	116.	82.3	112	71.0	13.7	51.3	.624	85.5	520.8	10.2	61.
4000	73.5	46.	119.5	1.062	127.2	81.2	96.3	64.	16.6	62.2	.77	97.6	595.2	9.55	52.6

Quad. Manifold
Secondary throttle opens at $\frac{1}{2}$ Primary

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	FHP	IHP	C.F.	Corr. IHP	Corr BHP	Torque	M.E.	Fuel oz/min	Fuel #/HR	BSFC	M.P.H	6.1 x MPH.	Mi/gal	BMep
3/4 throttle															
1000	25.9	1.92	27.82	1.072	30.	28.1	136	93.6	5.7	21.4	.762	24.4	148.8	6.95	72.5
1500	43.	5.0	48	1.072	51.5	46.5	150	90.2	8.74	32.8	.706	36.6	223.2	6.82	80.2
2000	60.	7.75	67.75	1.072	72.75	65.	157.5	89.2	11.35	42.6	.655	48.8	297.6	7.	84.1
2500	75.	11.3	86.3	1.072	92.7	81.4	157.5	88.0	13.7	51.4	.632	61.	372	7.25	84.4
3000	83.3	17.1	100.4	1.072	107.5	90.4	145.5	84.	15.5	58.2	.645	73.2	446.4	7.55	78
3500	90.5	24.7	115.2	1.072	123.8	99.1	136	80.	17.75	66.6	.672	85.5	520.8	7.82	73.4
4000	94.	42	136.	1.072	146.	104.	123.2	71.4	20.9	78.4	.755	97.6	595.2	7.60	67.3
4400	95.7	53.9	149.6	1.072	160.5	106.6	114.2	67.5							
4560	93.	—	—	1.072+		105(?)	107								
full throttle															
1000	25.6	1.44	27.04	1.072	29.	27.56	136	95.	5.5	20.6	.747	24.4	148.8	7.2	71.5
1500	42	4.56	46.56	1.072	50.	45.5	147	91.	8.92	33.5	.737	36.6	223.2	6.72	78.5
2000	60.	6.	66.	1.072	70.8	64.8	157.5	91.5	11.8	44.2	.683	48.8	297.6	6.72	84
2500	75.3	12.	87.3	1.072	93.7	81.7	158	87.4	13.9	52.2	.64	61.	372	7.1	84.7
3000	83.3	17.1	100.4	1.072	107.5	90.4	145.5	84	14.4	54.	.597	73.2	446.4	8.3	78
3500	90.5	24.7	115.2	1.072	123.8	99.1	136	80	17.8	66.8	.673	85.5	520.8	7.8	73.5
4000	94	42.	136	1.072	146.	104.	123.2	71.4	20.9	78.5	.754	97.6	595.2	7.6	67.3
4400	95.7	53.9	149.6	1.072	160.5	106.6	114.2	67.5							
4560	93	—		1.072		105 !	107								

Quad. Manifold

Secondary throttle opens at $\frac{1}{4}$ Primary

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP.

R.P.M.	BHP	FHP	IHP	C.F.	Corr. IHP	Corr. BHP	Torque	M.E.	Fuel oz/Min	Fuel #/HR.	B.S.F.C.	M.P.H.	6.1 x M.P.H.	MI/gal.	BMEP
$\frac{1}{8}$ throttle															
750	13.62	2.2	15.82	1.046	16.58	14.38	95.6	87.	2.86	10.7	.745	18.3	111.5	10.4	49.6
1000	14.4	7.2	21.6	1.046	22.6	15.4	75.6	68.2	2.83	10.6	.688	24.4	148.8	14.1	40.
1500	14.4	11.25	25.65	1.051	27.0	15.75	50.5	58.3	3.17	11.9	.756	36.6	223.2	18.8	27.2
2000	10.25	20.4	30.65	1.046	32.05	11.65	27.	36.4	3.66	13.7	1.17	48.8	297.6	21.7	15.1
$\frac{1}{4}$ throttle															
1000	22.2	3.91	26.11	1.071	28.	24.1	116.5	86	4	15	.622	24.4	148.8	9.95	62.5
1500	33.3	9.77	43.07	1.071	46.2	36.4	116.5	79.‾	6.54	24.5	.673	36.6	223.2	9.2	62.8
2000	31.5	16.5	48.	1.071	51.5	35.	82.6	68.	5.8	21.8	.623	48.8	297.6	13.7	45.2
2500	29.7	26.84	56.54	1.072	60.6	33.8	62.2	55.8	6.25	23.3	.69	61.	372.	16.	35
3000	26.25	46.5	72.75	1.072	78.	31.5	45.9	40.5	6.15	23.1	.732	73.2	446.4	19.3	27.1
$\frac{1}{2}$ throttle															
1000	26.25	2.28	28.53	1.072	30.6	28.3	137.5	92.4	5.23	19.6	.692	24.4	148.8	7.6	73.2
1500	42.4	6.55	48.95	1.071	52.5	45.9	148.	87.5	9.34	35.	.762	36.6	223.2	6.4	79.2
2000	58.3	9.43	67.73	1.071	72.6	63.2	155	87.2	12.	45.	.712	48.8	297.6	6.6	82.
2500	74.2	17.3	91.5	1.062	97.2	79.9	155	82.2	13.1	49.2	.617	61.	372.	7.55	82.8
3000	81.0	25.84	106.84	1.062	113.3	87.5	141.5	77.2	15.2	57.	.652	73.2	446.4	7.8	75.5
3500	86.7	33.7	120.4	1.062	127.7	94.	130	73.8	16.3	61.2	.652	85.5	520.8	8.5	69.5
4000	88.0	46.0	134.0	1.062	142.2	96.2	115.5	67.6	17.5	65.7	.682	97.6	595.2	9.1	62.2
full throttle															
1000	27.7	1.44	29.14	1.055	30.8	29.4	145.	95.4	6.1	22.9	.777	24.4	148.8	6.5	76.2
1500	44.7	4.56	49.26	1.055	52.	47.5	156.	91.9	9.8	36.8	.777	36.6	223.2	6.1	82.
2000	61.8	6.0	67.8	1.061	72.	66.	162.	91.8	12.25	46.	.698	48.8	297.6	6.5	85.2
2500	77.‾	12.0	89.‾	1.061	94.5	82.5	162.5	87.2	18.7	70.2	.851	61.	372.	5.3	85.4
3000	84.	17.1	101.1	1.061	107.2	90.1	147	84.0	15.9	59.7	.664	73.2	446.4	7.5	77.6
3500	89.7	24.7	114.4	1.061	121.5	96.8	134.5	79.7	18.7	70.2	.727	85.5	520.8	7.4	71.6
4000	93.5	42.	135.5	1.061	144.	102.	122.5	70.8	20.9	78.5	.770	97.6	595.2	7.6	66.
4400	95.2	53.9	149.1	1.061	158.4	104.5	113.5	66.0							

Quad. Carburetor Adapted to Standard Manifold
Secondary throttle opens at 1/4 Primary.

Determination of Engine Characteristics

Data for Calculations taken from Performance Tests except for FHP

R.P.M.	BHP	FHP	IHP	C.F.	CORR IHP	CORR BHP	Torque	M.E.	Fuel OZ/MIN	Fuel #/HR	BSFC	M.P.H.	6.1× M.P.H.	Mi/Gal.	BMep
1/8 throttle															
750	12.5	5.4	17.9		19.3	13.9	87.2	72.1	3.12	11.7	.842	18.3	111.5	9.5	48.2
1000	13.4	6.6	20.	1.075	21.5	14.9	70.2	69.2	2.88	10.8	.724	24.4	148.8	13.8	38.6
1500	12.95	11.81	24.76		26.6+	14.8	45.2	55.7	3.73	14.	.946	36.6	223.2	15.9	25.6
2000	10.5	24.	34.5		37.1	13.1	27.6	35.3	3.37	12.6+	.962	48.8	297.6	23.6	17.
1/4 throttle															
1000	23.5	5.4	28.88	1.075	31.1	25.7	123	82.8	4.27	16.	.622	24.4	148.8	9.3	66.5
1500	34.	10.24	44.24	1.075	47.6	37.4	118.5	78.6	6.	22.5	.602	36.6	223.2	9.9	64.5
2000	33.5	14.5	48.	1.075	51.6	37.1	88.	72.	5.8	21.8-	.602	48.8	297.6	13.7	48.
2500	32.2	24.3	56.5	1.082	61.3	37.	67.5	60.2	6.35	23.8	.644	61.	372	15.7	38.4
3000	28.8	43.2	72.	1.082	78.	34.8	50.5	44.6	6.56	24.6	.707	73.2	446.4	18.2	30.
1/2 throttle															
1000	27.5	8.5	36.	1.062	38.25	29.75	144	77.7	4.87	18.3	.615	24.4	148.8	8.2-	77.
1500	44.2	11.86	56.06	1.062	59.6	47.74	155	80.2	8.43	31.6	.662	36.6	223.2	7.1	82.5
2000	60.5	13.50	74.	1.062	78.7	65.2	158	83.	10.5	39.4	.604	48.8	297.6	7.56	84.5
2500	74.	17.1	91.1	1.065	97.	79.9	155	82.	13.15	49.4	.618	61.	372	7.52	82.8
3000	80.2	24.6	104.8	1.065	111.6	87.0	140	78.	14.65	55.	.632	73.2	446.4	8.12	75.
3500	86.2	36.2	122.4	1.065	130.5	94.3	129	72.2	16.2-	60.7	.643	85.5	520.8	8.57	70-
4000	88.5	51.5	140.	1.065	149.2	97.7	116	65.4	18.3+	68.8	.704	97.6	595.2	8.67	63.3
full throttle															
1000	27.5	8.5	36.	1.062	38.25	29.75	144	77.7	5.32	20.	.673	24.4	148.8	7.45	77.-
1500	44.2	11.86	56.06	1.062	59.6	47.74	155	80.2	8.51	31.9	.671	36.6	223.2	7.0	82.2
2000	60.5	13.25	73.75	1.062	78.3	65.1	158	83.2	12.-	45.	.692	48.8	297.6	6.62	84.2
2500	76.	17.3	93.30	1.062	99.1	81.8	159	82.7	13.73	51.5	.630	61.	372	7.22	84.8
3000	86.	24.8	110.8	1.062	117.5	92.7	151	79.-	15.8	59.2	.640	73.2	446.4	7.54	80.
3500	92.	34.	126	1.070	135.	101.	138	75.	18.	67.5	.668	85.5	520.8	7.72	74.5
4000	94.	42.	136	1.070	145.5	103.5	123	71.2	18.4	69.	.670	97.6	595.2	8.62	62.7

APPENDIX B-2

The Determination of I.HP./Cyl. and Total Friction

STANDARD MANIFOLD

Determination of Ind HP/cyl and Total Friction

R.P.M	BHP	IHP per Cylinder #1	#2	#3	#4	#5	#6	#7	#8	Total IHP	Total FHP.
$\frac{1}{8}$ Throttle											
400	7.5	1.25	1.0	1.1	1.25	1.1	1.2	1.05	1.35	9.3	1.8
800	6.5	1.1	1.5	1.7	1.0	1.2	1.7	1.0	1.7	10.9	4.4
1200	6.3	1.5	1.95	2.4	1.35	1.35	1.8	1.5	2.55	14.4	8.1
1600	4.6	1.6	1.8	2.0	1.6	2.0	2.4	1.6	2.2	15.2	10.6
1/4 throttle											
750	17.05	2.53	2.53	2.53	2.81	2.72	2.81	3.00	2.81	21.74	4.7
1000	22.0	3.5	3.5	3.75	4.25	4.25	4.75	3.5	4.00	31.5	9.5
1500	27.7	4.65	5.25	5.25	5.60	6.10	6.45	4.7	5.8	44.	16.3
2000	30.0	5.75	5.75	6.00	6.50	5.75	6.50	5.5	6.25	48.	18.0
2500	28.1	6.85	6.85	6.85	6.85	7.35	7.80	6.85	7.50	56.9	28.8
3000	24.0	7.87	7.87	7.5	7.5	8.25	8.25	7.5	7.87	62.6	38.6
1/2 throttle											
1000	25.5	3.63^{-}	3.63^{-}	3.63^{-}	3.5	3.37^{+}	3.37^{+}	3.5	3.37^{+}	28.0	2.5
1500	39.7	5.82	5.82	5.82	6.0	5.63	5.44	5.44	5.63	45.6	5.9
2000	54	7.75	7.75	7.75	7.75	8.0	7.75	7.5	7.75	62.0	8.0
2500	62.4	9.36	9.36	9.36	9.36	9.36	9.36	9.05	9.36	74.57	12.17
3000	65.	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	84.0	19.0
3500	64.2	11.82	11.82	11.82	11.82	11.82	11.38	10.9	11.82	93.2	29.0
4000	58.5	13.5	14.5	14.5	13.5	14.5	14.5	14.5	14.5	114.	55.5

STANDARD MANIFOLD

Determination of IHP/cyl and Friction

R.P.M	B.H.P.	← IHP. for Cylinder #1	#2	#3	#4	#5	#6	#7	#8 →	Total IHP	Total FHP
3/4 throttle											
1000	25.5	3.5	3.88	3.88	3.63	3.5	3.5	3.38	3.5	28.77	3.27
1500	38.8	5.82	6.0	6.0	5.82	5.82	6.0	6.0	5.82	49.28	8.5
2000	57.3	8.5	8.5	9.0	9.0	8.75	8.75	8.5	8.75	69.75	12.45
2500	70.6	10.62	10.93	10.93	11.88	10.31	10.0	10.31	10.62	84.6	14.0
3000	78.75	13.13	12.4	12.4	13.13	12.76	13.13	12.4	12.4	101.75	23.0
3500	86.3	14.42	14.88	14.88	14.88	14.88	14.0	14.0	14.42	116.36	30.06
4000	85.	15.	15.	15.	15.	15	15.5	16.	15.	121.5	36.5
full throttle											
500	13.25	2.18+	2.0	2.06	2.06	2.18+	2.06	2.06	2.12+	16.72	3.5
1000	25.2	3.88	3.88	3.75	3.88	3.75	3.62+	3.62+	3.62+	30.0	4.8
1500	41.7	5.82	6.0	5.72	6.18	6.0	5.82	6.0	5.82	47.36	5.7
2000	58.13	9.0	8.33	8.5	8.75	8.38	8.5	8.0	8.25	67.71	9.6
2500	73.0	12.2	11.58	10.95	10.48	10.48	10.48	10.3	10.48	87.0	14.0
3000	83.25	13.5	13.12	12.37	13.12	13.88	12.37	12.75	13.5	104.6	21.4−
3500	88.4	15.1	14.88	14.88	15.32	15.75	15.1	14.88	15.75	121.66	33.26
4000	90.0	17.5	17.	18.	17.5	17.5	17.5	17.	17.5	139.5	49.5
4400	84.2	18.7	18.7	18.7	18.7	18.15	18.15	19.25	19.25	149.6	65.4

Dual Carburetor Manifold
Throttles Synchronized
Determination of Ind. HP/cyl. and Total FHP.

R.P.M.	BHP	#1	#2	#3	#4	#5	#6	#7	#8	Total IHP	FHP
		← Ind. HP for cylinder →									
1/16 throttle											
750	15.	2.34	2.34	2.34	2.34	2.34	2.44	2.24	2.34	18.72	3.72
1000	18.5	3.0	3.0	3.0	3.0	3.0	2.85	2.85	2.82	23.6	5.1
1500	21.4	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	28.48	7.08
2000	19.	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	30.0	11.0
2500	16.55	5.17	5.17	5.17	5.17	5.17	5.0	5.17	5.17	41.19	24.64
1/8 throttle											
1000	23.0	3.38	3.32	3.38	3.32	3.32	3.25	3.38	3.38	26.73	3.73
1500	29.6	4.88	4.88	4.88	4.88	4.88	4.88	4.5	4.67	38.45	8.85
2000	29.	5.63	5.63	5.63	5.63	5.63	5.5	5.25	5.75	44.65	15.65
2500	27.5	6.4	6.4	6.4	6.4	6.4	6.25	6.25	6.6	51.6	24.1
3000	23.2	8.62	8.62	8.62	8.62	8.62	8.62	8.62	8.62	68.96	45.76
1/4 throttle											
1000	26.8	3.76	3.88	3.76	3.76	3.76	3.88	3.88	3.88	30.56	3.76
1500	42.	6.0	6.0	6.0	6.0	6.17	6.17	6.0	6.0	48.34	6.34
2000	52.5	8.5	8.25	8.25	8.5	7.75	7.25	7.25	7.5	63.25	10.75
2500	57.8	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	74.88	17.1
3000	58.5	10.9	10.9	10.9	10.9	10.5	10.5	10.1	10.9	85.6	27.1
3500	57.25	12.25	12.25	12.25	12.25	12.25	12.25	11.8	12.25	97.55	40.3

Dual Carburetor Manifold
Throttles Synchronized

Determination of IHP/cyl. and FHP.

		← Ind. HP for cylinder							→		
R.P.M.	BHP	#1	#2	#3	#4	#5	#6	#7	#8	Total IHP	FHP
½	throttle										
1000	27.2	3.94	3.87	3.87	3.87	3.87	3.62	3.50	3.75	30.29	3.09
1500	42.5	6.18	6.18	6.18	6.18	6.18	5.80	5.62	5.80	48.12	5.62
2000	57.8	8.5	8.5	8.5	8.5	8.63	7.8	7.8	7.8	66.03	8.23
2500	68.0	10.0	10.0	10.0	10.0	10.0	10.0	10.3	10.0	80.3	12.3
3000	74.5	11.65	11.65	11.65	11.65	11.65	11.45	11.65	11.65	93.0	18.5
3500	78.0	13.55	13.55	13.55	13.55	13.55	13.35	13.55	13.55	108.2	30.2
4000	80.0	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	132.	52.
4400	78.0	20.	20.	20.	20.	20.	20.	20.	20.	160	82.
full	throttle										
1000	26.24	3.62	3.62	3.62	3.62	3.62	3.26	3.26	3.62	28.24	2.0
1500	42.0	6.2	6.0	5.82	6.2	6.38	5.82	6.0	6.1	48.54	6.54
2000	59.5	9.5	9.5	8.9	9.5	9.25	8.75	8.75	9.5	73.65	14.15
2500	7475	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55	92.4	17.65
3000	84.4	13.5	13.5	13.85	13.85	13.15	13.5	13.85	14.25	109.45	25.05
3500	87.5	15.3	15.3	15.3	15.3	15.3	15.75	14.45	14.45	121.15	33.65
4000	91.0	17.	17.	17.	17.	17.	17.	17.	17.	136.0	45.0
4400	88.0	19.25	19.25	19.25	19.25	19.25	19.25	19.25	19.25	154.0	66.0

Quad. Manifold
Secondary throttle opens at 1/2 Primary

Determination of IHP/cyl. and Total Friction HP.

R.P.M.	BHP	IHP for cylinder #1	#2	#3	#4	#5	#6	#7	#8	Total IHP	FHP
1/8 throttle											
750	12.38	1.875	1.875	1.875	1.875	1.875	1.69	1.64	1.875	14.58	2.2
1000	12.8	2.5	2.5	2.5	2.5	2.5	2.31	2.19	2.5	20.0	7.2
1500	9.75	2.72	2.72	2.72	2.72	2.72	2.53	2.35	2.53	21.0	11.25
2000	8.0	3.63	3.63	3.63	3.63	3.63	3.0	3.75	3.5	28.4	20.4
1/4 throttle											
1000	22.2	3.31	3.31	3.31	3.31	3.31	3.19	3.06	3.31	26.11	3.91
1500	30.95	5.15	5.15	5.07	5.07	5.07	5.07	5.07	5.07	40.73	9.77
2000	31.25	6.0	6.0	6.0	6.0	6.0	6.0	5.75	6.0	47.75	16.5
2500	30.0	7.18	7.18	7.18	7.18	7.18	6.88	6.88	7.18	56.84	26.84
3000	25.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	72.0	46.5
1/2 throttle											
1000	25.6	3.5	3.5	3.5	3.5	3.5	3.5	3.38	3.5	27.88	2.28
1500	40.9	6.0	6.0	6.0	6.0	6.0	5.82	5.63	6.0	47.45	6.55
2000	55.7	8.25	8.25	8.25	8.25	8.0	8.0	7.88	8.25	65.13	9.43
2500	67.9	10.65	10.65	10.65	10.65	1065	10.65	10.65	10.65	85.2	17.3
3000	73.2	12.38	12.38	12.38	12.38	12.38	12.38	12.38	12.38	99.04	25.84
3500	74.7	13.55	13.55	13.55	13.55	13.55	13.55	13.55	13.55	108.4	33.7
4000	74.	15.	15.	15.	15.	15.	15.	15.	15.	120.	46.

Quad. Manifold
Secondary throttle opens at ½ Primary
Determination of IHP/cyl. and Total FHP.

R.P.M.	BHP	Ind. HP for cylinder #1	#2	#3	#4	#5	#6	#7	#8	Total IHP	FHP
¾ throttle											
1000	25.6	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	27.52	1.92
1500	43.	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	48.0	5.0
2000	60.	8.5	8.5	8.5	8.5	8.5	8.5	8.25	8.5	67.75	7.75
2500	75.	10.95	10.95	10.95	10.95	10.62	10.62	10.62	10.62	86.3	11.3
3000	83.3	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	100.4	17.1
3500	90.5	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	115.2	24.7
4000	94.	17.	17.	17.	17.	17.	17.	17.	17.	136	42
4400	95.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	149.6	53.9
full throttle											
1000	25.6	3.38	3.38	3.38	3.38	3.38	3.38	3.38	3.38	27.04	1.44
1500	42.	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	46.56	4.56
2000	60.	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25	66.0	6.0
2500	75.3	10.95	10.95	10.95	10.95	10.95	10.95	10.65	10.95	87.3	12.0
3000	83.3	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	100.4	17.1
3500	90.5	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	115.2	24.7
4000	94.	17.	17.	17.	17.	17.	17.	17.	17.	136.	42
4400	95.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	149.6	53.9

Quad. Carburetor Adapted to Standard Manifold
Secondary throttle opens at 1/4 Primary

Determination of IHP/cyl. and Total FHP

R.P.M.	BHP	← Ind. HP. for cylinder #1	#2	#3	#4	#5	#6	#7	#8 →	Total IHP	FHP
1/8 throttle											
750	12.5	2.25	2.25	2.25	2.25	2.25	2.25	2.16	2.25	17.91	5.4
1000	13.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	20.	6.6
1500	12.95	3.	3.	3.	3.19	3.19	3.19	3.19	3.	24.76	11.81
2000	10.5	4.5	4.5	4.5	4.5	4.	4.	4.	4.5	34.5	24.
1/4 throttle											
1000	23.5	3.5	3.5	3.5	3.5	3.63	3.75	3.75	3.75	28.88	5.4
1500	34.	5.44	5.44	5.44	5.62	5.62	5.62	5.62	5.44	44.24	10.24
2000	33.5	6.	6.	6.	6.	6.	6.	6.	6.	48.	14.5
2500	32.2	7.18	7.18	7.18	7.18	7.18	6.87	6.87	6.87	56.5	24.3
3000	28.8	9.	9.	9.	9.	9.	9.	9.	9.	72.	43.2
1/2 throttle											
1000	27.5	4.625	4.625	4.375	4.5	4.5	4.5	4.375	4.5	36.	8.5
1500	44.2	7.12	7.12	7.12	6.94	6.94	6.94	6.94	6.94	56.06	11.86
2000	60.5	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	74.	13.50
2500	74.	11.55	11.55	11.55	11.55	11.55	11.55	11.25	11.55	91.1	17.1
3000	80.2	13.15	13.15	13.15	13.15	13.15	13.15	12.75	13.15	104.8	24.6
3500	86.2	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	122.4	36.2
4000	88.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	140	51.5
full throttle											
1000	27.5	4.625	4.625	4.5	4.5	4.5	4.375	4.375	4.5	36.	8.5
1500	44.2	6.94	7.12	7.12	7.12	6.94	6.94	6.94	6.94	56.06	11.86
2000	60.5	9.25	9.25	9.25	9.25	9.25	9.25	9.0	9.25	73.75	13.25
2500	76.	11.85	11.85	11.85	11.55	11.55	11.55	11.55	11.55	93.30	17.3
3000	86.	13.85	13.65	13.85	13.65	13.65	13.85	13.65	13.85	110.8	24.8
3500	92.	15.75	15.75	15.75	15.75	15.75	15.75	15.75	15.75	126.	34.
4000	94.	17.	17.	17.	17.	17.	17.	17.	17.	136.	42.

APPENDIX C

Engine Dimensions and Tolerance
Assumed Constants

APPENDIX C

Engine Dimensions and Tolerance
Assumed Constants

C. R.	7.15 - 1	
Bore	3.2675 in. ± .0004 in.	
Stroke	3.75 in.	
Displacement	255 cu. in.	
cl. vol.	41.5 cu. in.	
Crankshaft	Mains	2.499 in. (.001 in. -.002 in.)
	Rods	2.139 in. (.0005 in. -.0015 in.)
Valve Clearances		Intake .009 in. Exhaust .011 in.
Valve Spring Pressures		42-45# at 1.890 in. 52-55# at 1.790 in.
Valve Seat Angles		45°
Piston Skirt Clearances		.001 in. ± .0005 in.
Area of Head Gasket		15.1 sq. in.
	Thickness .0625 in. when compressed	
	Vol. .945 cu. in.	

Clearances in Cylinder Head

	Cylinder Number							
	1	2	3	4	5	6	7	8
Above Piston	.125''	.125''	.125''	.125''	.125''	.125''	.125''	.125''
Above Ex. Valve	.156''	.156''	.156''	.171''	.1094''	.1875''	.1875''	.141''
Above In. Valve	.156''	.156''	.156''	.156''	.141''	.171''	.141''	.1875''
Vol. in Ml.	85	85	85	85	85	83	86	85

Minimum clearance - Ex. Valve of cylinder 5 - .1094''.

Standard Camshaft		New Camshaft	
I.O.	0° T.D.C.	I.O.	20° B.T.D.C.
Ex. C.	6° A.T.D.C.	Ex. C.	18° A.T.D.C.
I. C.	44° A.B.D.C.	I. C.	64° A.B.D.C.
Ex. O.	48° B.B.D.C.	Ex. O.	66° B.B.D.C.
In. Dur.	224°	In. Dur.	264°
Ex. Dur.	234°	Ex. Dur.	264°
Overlap	6°	Overlap	38°

Constants for Calculations:

Mean tire rolling radius	14.5''
Rear axle ratio	3.54:1

APPENDIX D

Selected References

SELECTED REFERENCES

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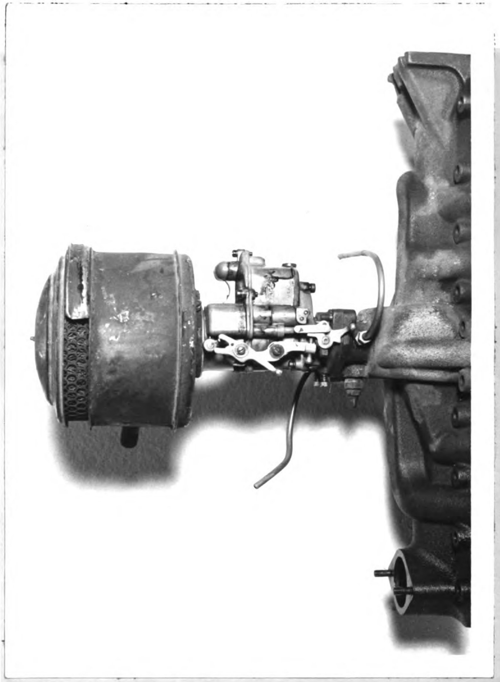
High Speed Combustion Engines, Heldt, 14th Edition.

Heat Transfer and Fluid Flow, Brown and Marcs.

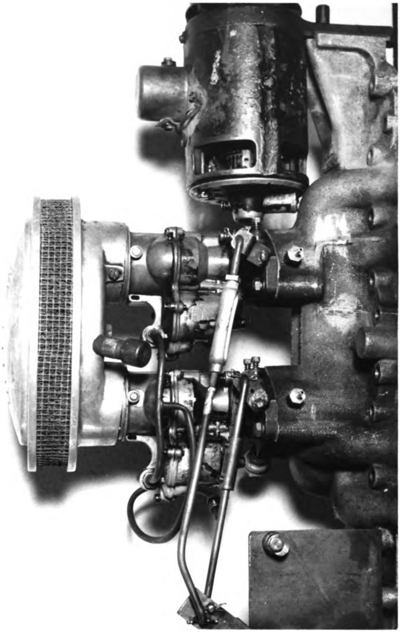
Elementary Mechanics of Fluids, Rouse.

APPENDIX E

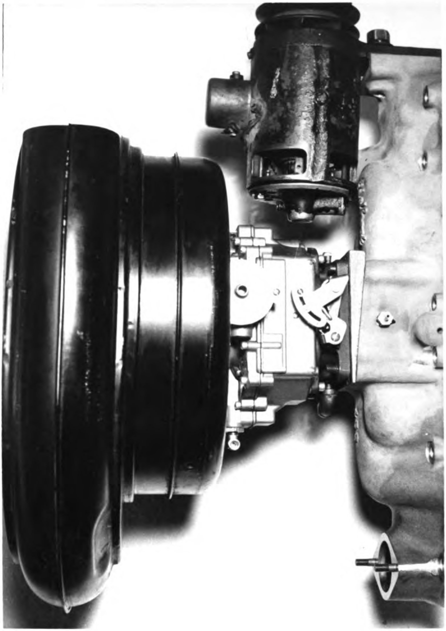
Pictures



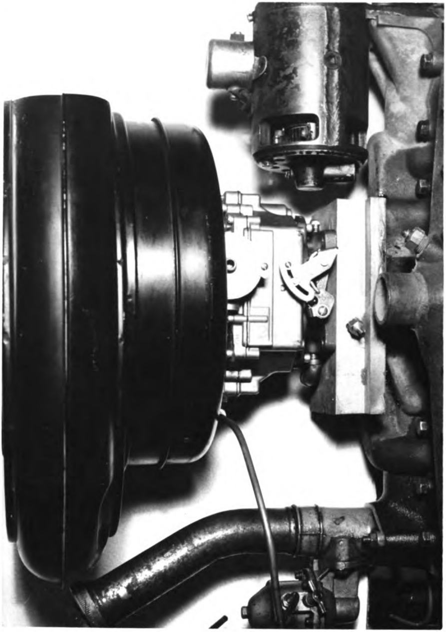
Standard Intake Manifold



Dual Carburetor Intake Manifold

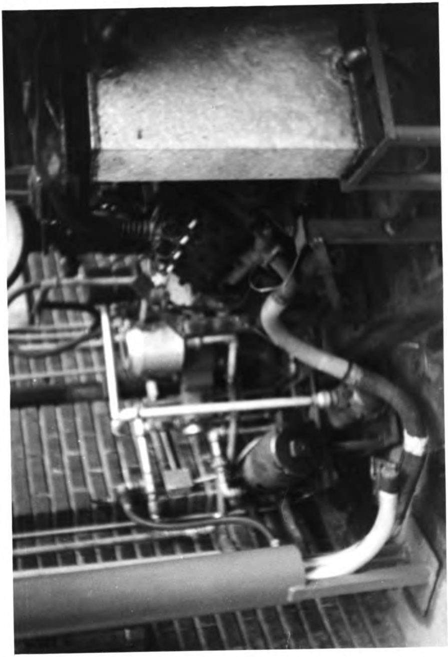


Quad. Carburetor Intake Manifold

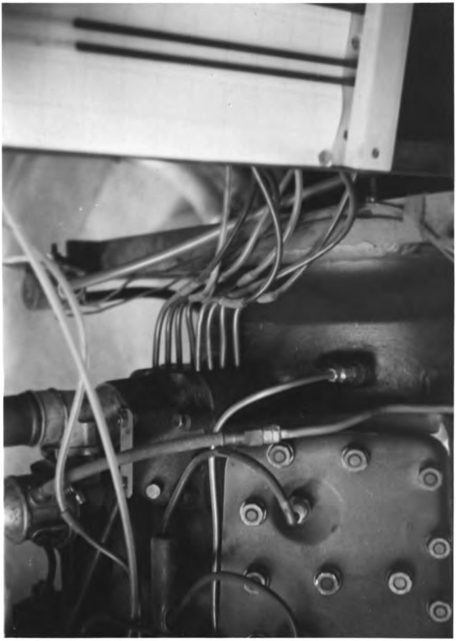


Quad. Carburetor Adapted to a Standard Intake Manifold

Engine Installation and Testing Equipment (left side)

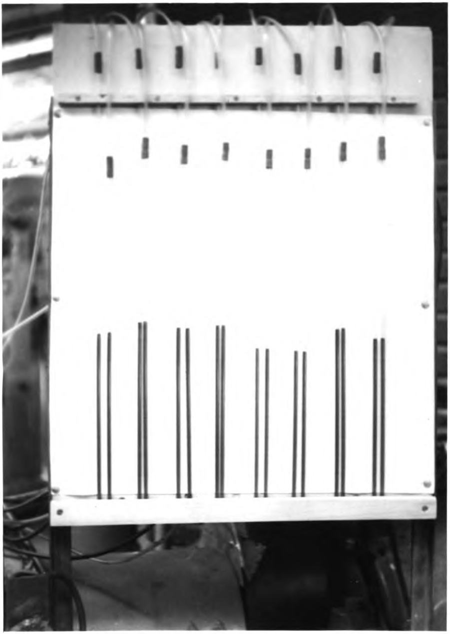


Engine Installation and Testing Equipment (right side)



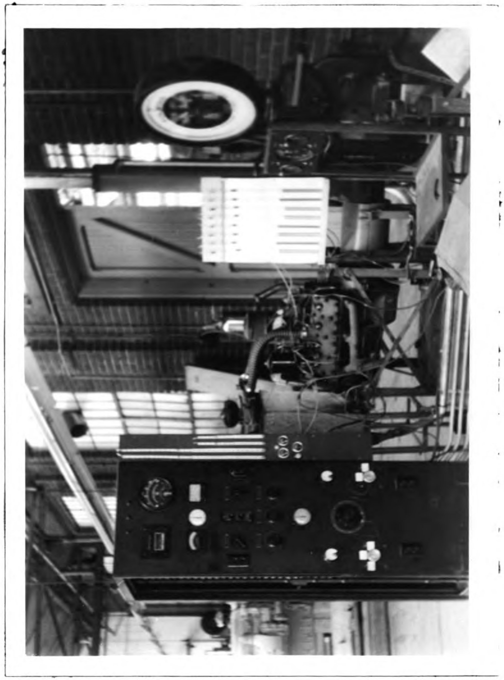
Exit of Pressure Tubes from Intake Ports

Engine and Accessories



Manometer Panel

R. P. M. Indicator and Synchronous Clock with Revolution Counter



Engine Installation and Testing Equipment (left side)