

Aug. 21, 1956

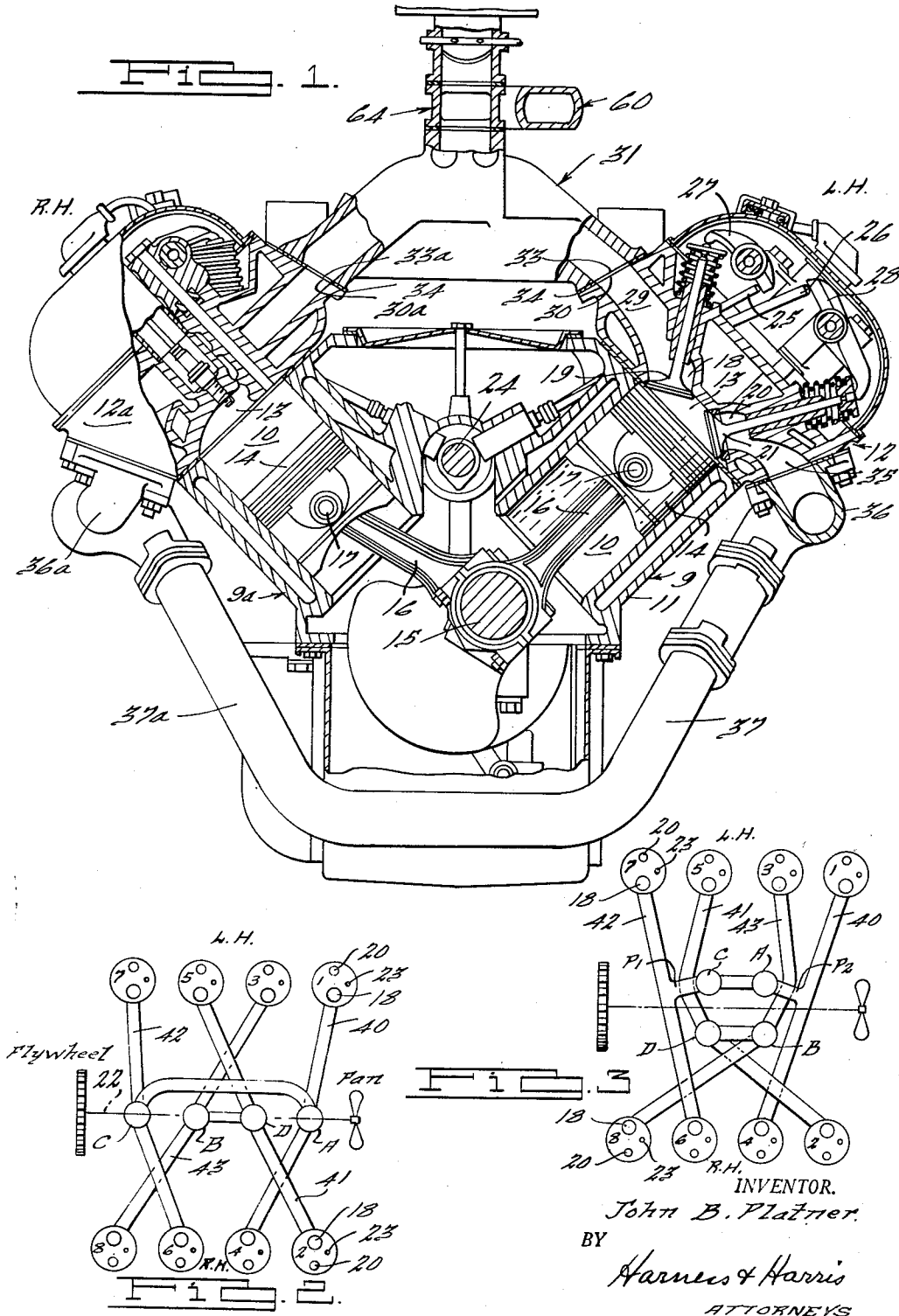
J. B. PLATNER

2,759,463

HIGH TORQUE V-8 ENGINES

Filed Jan. 8, 1954

4 Sheets-Sheet 1



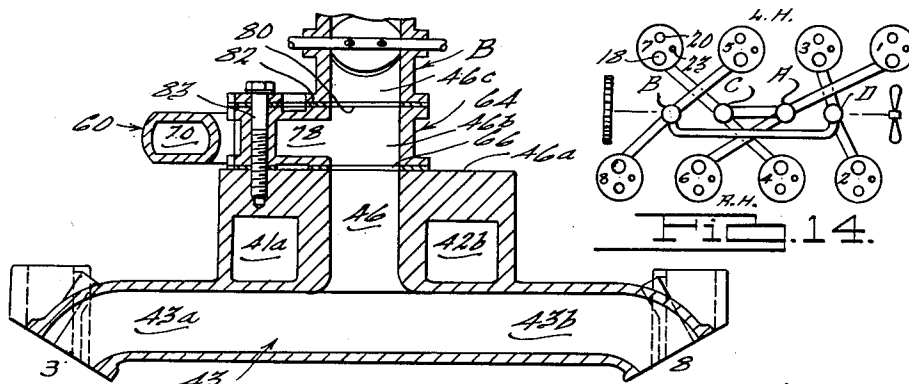
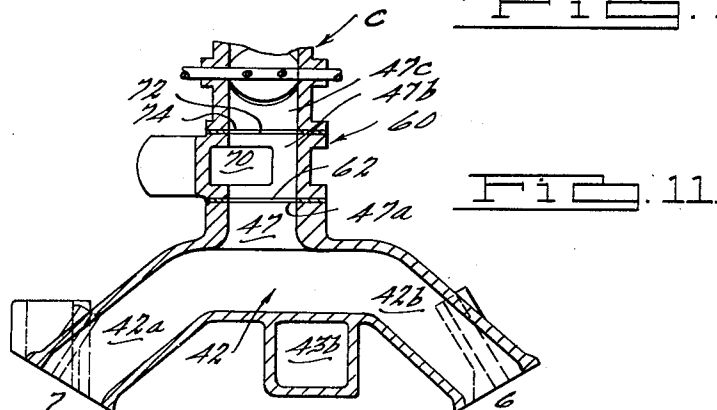
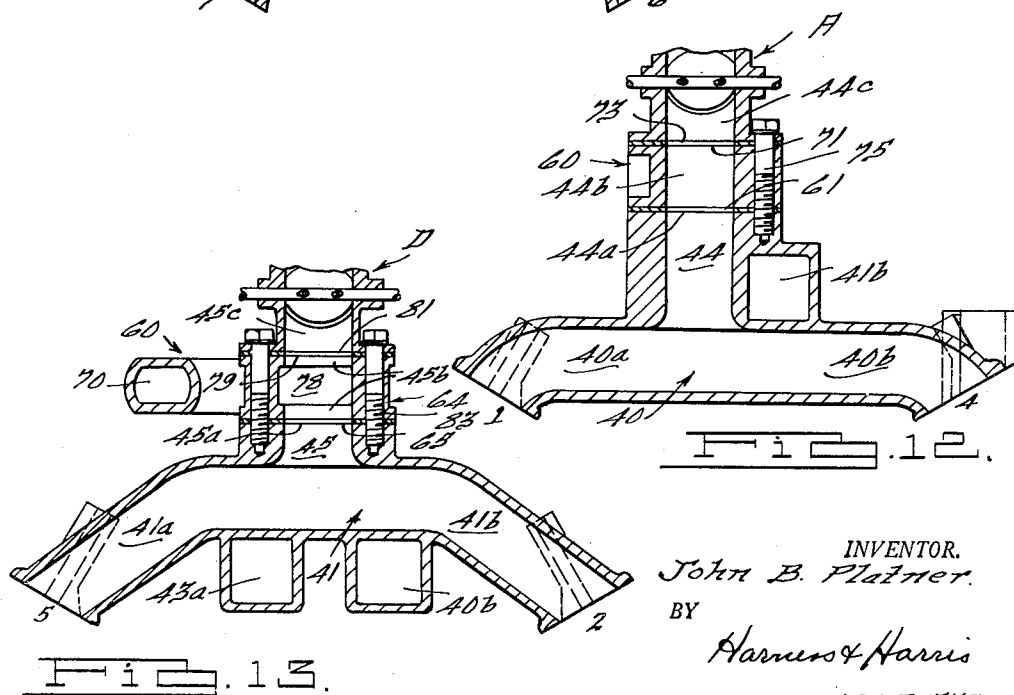
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J. B. PLATNER
HIGH TORQUE V-8 ENGINES

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4 Sheets-Sheet 2



INVENTOR.
John B. Platner.

BY

Harnes & Harris

ATTORNEYS.

Aug. 21, 1956

J. B. PLATNER

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HIGH TORQUE V-8 ENGINES

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4 Sheets-Sheet 3

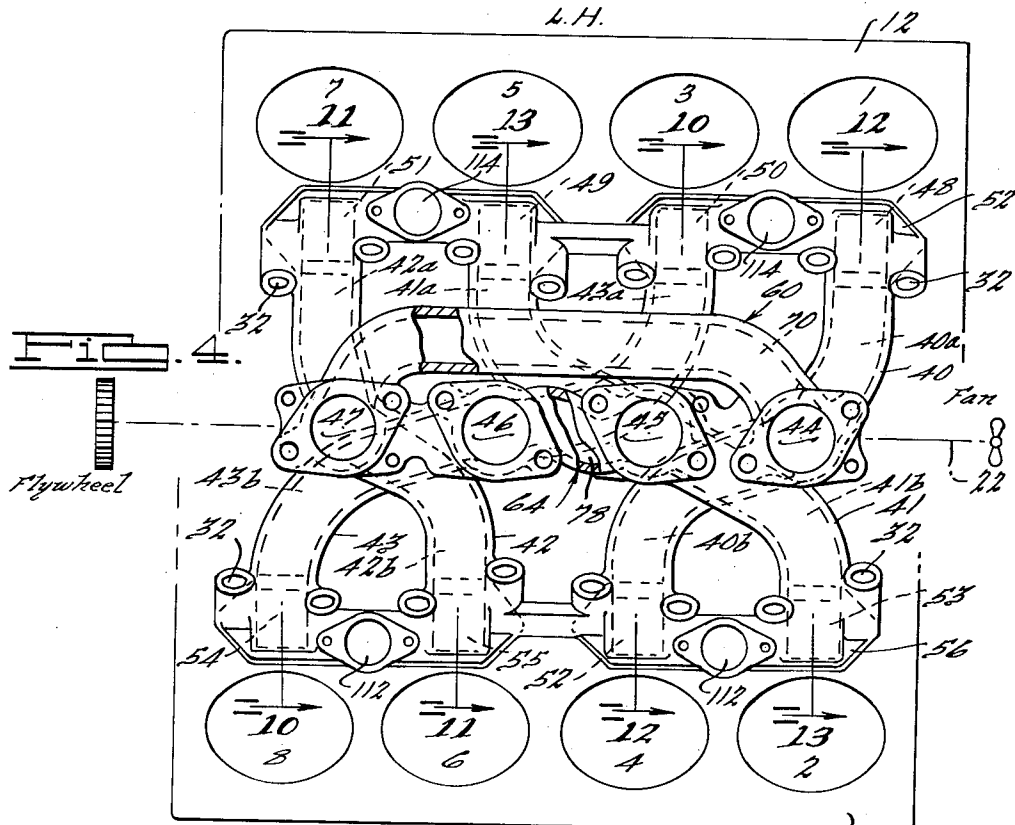


FIG. 4.

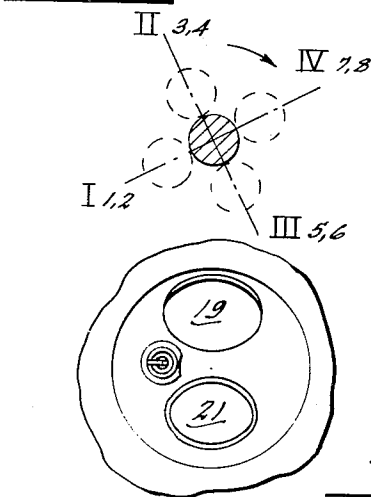


FIG. 5.

R.H.

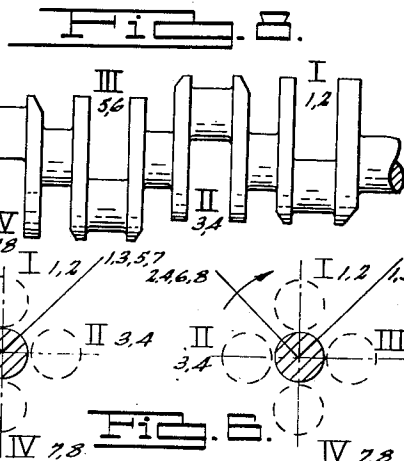


FIG. 6.

INVENTOR.
John B. Platner.

BY

Warner & Harris

ATTORNEYS

Aug. 21, 1956

J. B. PLATNER

2,759,463

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4 Sheets-Sheet 4

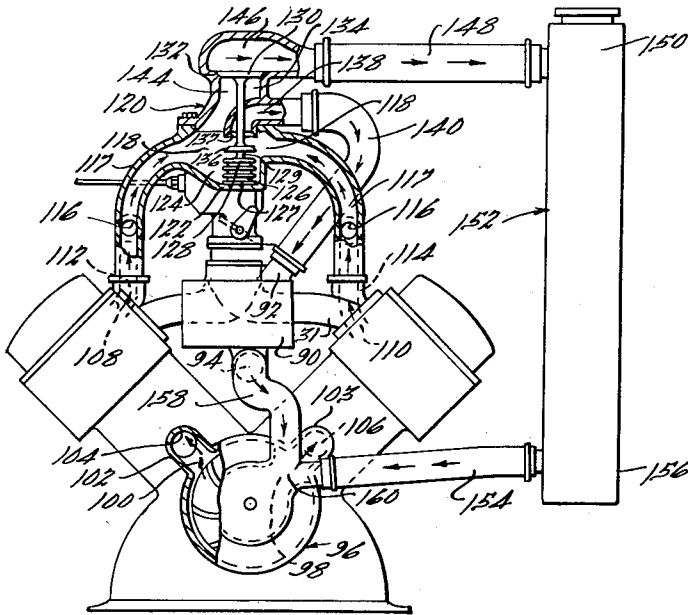


FIG. 15.

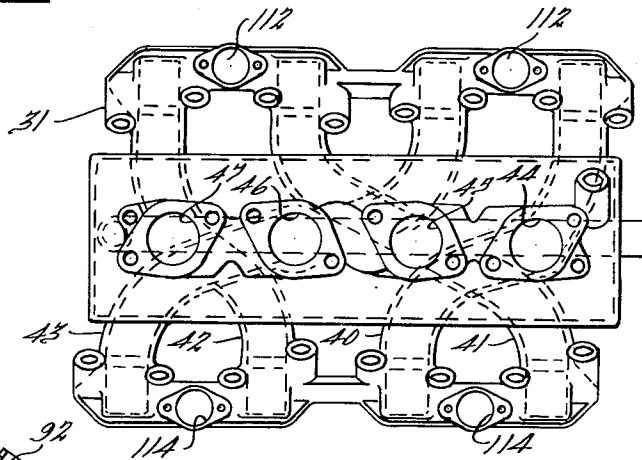


FIG. 16.

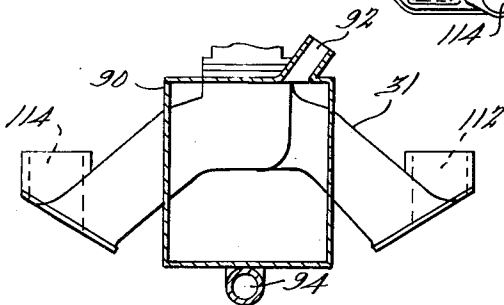


FIG. 17.

INVENTOR.
John B. Platner
BY
Harnes & Harnes
ATTORNEYS.

1

2,759,463

HIGH TORQUE V-8 ENGINES

John B. Platner, Detroit, Mich., assignor to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

Application January 8, 1954, Serial No. 402,876

15 Claims. (Cl. 123—52)

This invention relates to V-8 engines for driving motor vehicles, particularly passenger cars, and to such engines combining the features of high torque and high power output. It especially relates to V-8 engines having improved intake manifolds operable in conjunction with suitable two-plane crank arrangements to provide a combination of high torque output, particularly in the mid speed range (2500 to 3500 R. P. M.) and substantial high power output in the upper speed range (4,000 to 5,000 R. P. M.).

While it has been found as described in the copending applications of C. O. Moore and myself Serial Nos. 297,318 and 373,376, filed July 5, 1952, and August 10, 1953, respectively, that manifold systems may be designed to reinforce the cylinder charging in the high speed range (4,000–5,000 R. P. M.) of operation to obtain improved power output, it is found that when such methods are employed on such manifolds or others to reinforce the charging in the medium or low speed ranges, improved torque output results but there generally has been a substantial reduction in the high speed range power output. A problem therefore has been to find a way of obtaining optimum torque and good power in the mid speed range while also making high power available in the high speed end of operation.

I have discovered that it is possible to secure the beneficial effects of reinforced charging in the mid speed range and also obtain improved power (i. e., high power) in the high speed range of operation through the use of the hereinafter described manifold system in conjunction with a 90° two-plane crank arrangement.

I have found this possible by an arrangement of structure utilizing in combination a two-plane or so-called 90° crank and an intake manifold system providing two non-communicating groups of passage means, each group comprising two interconnected passage means each of which includes a pair of opposed lateral branch passages and a central riser; the risers being connected with individual sources of supply of air-fuel mixture, these primarily feeding the branches directly connecting the risers they serve and each passage means of said groups having one of its branches connected with an inner cylinder of one bank of cylinders and having its other branch connecting with an outer cylinder of the opposite bank; the inner cylinders connecting with the branch passages of one of said groups being those nearest the opposite end cylinders connecting with the other branch passages of the same group and the inner cylinders connecting with the branch passages of the other of said groups being those most remote from the opposite end cylinders connecting with the other branch passages of this other group.

The stated combination of structure makes possible an operation:

1. In which the eight cylinders of the engine are grouped to form four pairs of cylinders and the four pair of cylinders are re-grouped into two couples each consisting of two pairs and wherein each cylinder of each

2

pair of the pairs constituting each couple has its suction stroke 360° out of phase from the other cylinder of its own pair and each pair of the pairs forming each couple draws its charge from a primary induction system which is the primary system for that pair only and is the secondary system of the other pair forming such couple and incidentally draws from a secondary system which is the secondary system for that pair only but is the primary system of the said other pair forming such couple.

2. In which the suction impulses of the groups of manifold passage means are such that each passage means of a connected pair or group thereof is 180° out of phase from the other member of that pair or group and wherein the suction impulses of each supply source feeding one group follows that of a different supply source of the other group such that the suction impulses of all the supply sources follow each other in a cyclic pattern with the impulses alternating back and forth between the supply sources of the groups and between the supply sources of the members of each group.

3. In which successively firing cylinders are supplied with air-fuel mixture from a different branch passage of the induction manifold system and with an interval of 360° between the suction strokes of the cylinders fed from the same induction passage means.

4. In which the passage lengths between the air intake of each supply source and the intake valves of the cylinders it feeds are characteristic of a system substantially harmonically tuned for mid speed range of operation and wherein by virtue of the passage interconnection between the passage means of a group or pair thereof, an improved effect, believed a substantial ram effect, is obtained conducive of improvement in the power output in the high speed end of operation without reducing the torque output possible in the mid range speed and in spite of any theoretically possible charging of the cylinders by the secondary induction system.

It will also be evident from the foregoing that in a V-8 engine having the cylinders of one bank numbered 1, 3, 5, 7 and those of the other bank numbered 2, 4, 6, 8 and having typical firing sequence 1-8, 4-3, 6-5, 7-2, individual sources of primary supply of fuel and air are provided for each pair of cylinders selected to have 360° crank interval between suction strokes. In addition two interconnecting passage means are provided, one linking pair of cylinders 1-6, 4-7; and the other, pairs 2-3, 5-8.

Accordingly, it is the principal object of my invention to provide a V-8 engine with an intake manifold system and crank operation facilitating the obtaining of high torque outputs in the mid speed range of the engine while also obtaining high power in the high speed range.

Another object is to provide a V-8 engine with a two-plane so-called 90° crank and with an intake manifold system utilizing four sources of supply of air-fuel mixture which sources are paired by charge improving passage interconnections, these paired sources each primarily feeding a pair of cylinders through a primary induction passage, and there being an interval of 360° between the suction strokes of the cylinders supplied by the same primary induction passage and an interval of 180° between such suction strokes effective on the primary passages whose mixture sources are paired.

A further object is to provide a V-8 engine with an intake manifold having a pair of air-fuel induction passage systems each adapted to distribute air-fuel mixture to a pair of inner cylinders of one bank and a pair of outer cylinders of the opposite bank and in which manifold one passage system has the general formation of an H figure and the other that of a combined X-A figure.

The foregoing as well as other objects and advantages

of our invention will be more apparent from the drawings taken in conjunction with the following description.

In the accompanying drawings:

Figure 1 is an end elevational view partly in section of a current V-8 type overhead valve engine embodying my invention and which engine is provided with down-draft carburetion;

Figure 2 is a schematic view illustrating the intake manifold of my invention as applied to a V-8 engine having a crank arrangement as in Figure 6 and utilizing four in line single carburetors as sources of supply of air-fuel mixture and provided with interconnector tubes between the inner pair of air-fuel riser passages and between the outer pair thereof respectively;

Figure 3 is a schematic view illustrating a modification of my manifold of Figure 2 as applied to a crank arrangement as in Figure 6 and utilizing four sources of supply of air-fuel mixture which may be a four-barrel carburetor and using interconnectors between pairs of the air-fuel mixture risers;

Figure 4 is a detailed plan view of the inlet manifold of my invention shown schematically in Figure 2, the opposed cylinder blocks being schematically shown, and parts of the manifold being broken away to illustrate the interconnector passages;

Figures 5 and 6 are schematic views of two suggested two-plane 90° crank pin arrangements for an engine utilizing my invention, the Roman numerals in the figures indicating the positioning of the crank throws counting from the front or fan end of the engine and the numerals indicating cylinder numbers whose pistons are connected with the crank throws;

Figures 7 and 8 are respectively end and side elevational views of the 90° crank of Figure 5;

Figure 9 is a plan view looking upwardly into the hemispherical combustion chamber of one cylinder of the engine of Figure 1 and showing the relative location of the intake and exhaust valves and the sparking means therein;

Figure 10 is a developed transverse sectional elevation of the manifold structure of Figure 4 taken at 10-10 of Figure 4 and showing part of a carburetor and the riser and branch passage means connecting same with a pair of cylinders;

Figure 11 is a similar developed transverse sectional elevation taken at 11-11 of Figure 4 illustrating part of another carburetor and associated passage means connecting with another pair of cylinders;

Figure 12 is a similar developed sectional elevation taken at 12-12 of Figure 4 showing a third carburetor and associated passage means connecting with a third pair of cylinders;

Figure 13 is a similar developed sectional elevation taken at 13-13 of Figure 4 showing a fourth carburetor and associated passage means connecting with a fourth pair of cylinders;

Figure 14 is a schematic view of a manifold arrangement similar to that of Figure 2 but which is a mirror image thereof and corresponds to that used with the crank arrangement of Figure 5;

Figure 15 is an elevational view of the engine of Figure 1 illustrating my invention provided with a hot water system and means for preheating the fuel-air conducting passages of the manifold of Figure 4, portions of the system being shown in section;

Figure 16 is a plan view showing the manner of applying hot water to the exterior of the passages of the manifold of Figure 4; and

Figure 17 is an end elevational view of the structure of Figure 16, the heat supply structure being shown in section, to illustrate the hot water inlet and outlet passages.

For the purposes of illustration, our invention will be described relative to a 90° V-8 engine of current manufacture having a so-called 90° crankshaft, hemispherical

combustion chambers and provided with four single down-draft carburetors each arranged to feed an end cylinder of one bank and an inner cylinder of the opposite bank at intervals of 360° of crank rotation and having interconnections between the risers of pairs of the carburetors feeding the inner cylinders of the same bank.

It will be understood, however, that my invention is applicable to other V-8 engines, for example to V-8 engines utilizing as fuel-air supply sources a single or plurality of quadruple barrel carburetors or a pair or multiple of dual barrel carburetors or combinations of the foregoing. Moreover, the carburetors may be of the downdraft, updraft or horizontal types.

Referring now to the drawings wherein similar numerals are used to designate similar parts of the structure, Figure 1 shows a cross section of a V-8 engine of current manufacture, for example one having a 3.812 inch bore, a 3.625 piston stroke, and a 331 cu. in. displacement, to which my invention has been applied.

As seen in Figures 1 and 4, the engine has two banks 9 and 9^a of cylinders 10 four in each bank, arranged at 90° in a cylinder block 11 to which cylinder heads 12 and 12^a are secured and provided with hemispherical combustion chambers 13 immediately over each cylinder 10. The cylinders of each bank are aligned longitudinally of the axis of the engine and the cylinders of the opposite banks are offset longitudinally relative to each other. For convenient reference, the cylinders of the left hand cylinders bank which is to the left looking forwardly from the flywheel end of the engine are numbered 1, 3, 5, and 7 respectively, starting such numbering at the opposite or fan end of the engine, and those of the right cylinder bank are numbered 2, 4, 6, and 8 respectively, these numerals appearing internally of the cylinder representations in Figures 2, 3, 4, and 14.

Each cylinder is provided with a piston 14 reciprocable therein and operably connected to a crankshaft 15 through a connecting rod 16 and wrist pin 17. Crankshaft 15 is a 90° crankshaft as seen, for example in Figures 5, 6, 7, and 8 wherein the double crank throws identified by the Roman numerals I, II, III, and IV are arranged 90° apart as viewed in Figures 5, 6, and 7 with throws I and II being respectively opposite throws IV and III. As noted in Figure 8, throw No. I connects with the pistons of cylinders 1 and 2, throw No. II with the pistons of cylinders 3 and 4, throw No. III with the pistons of cylinders 5 and 6, and throw No. IV with the pistons of cylinders 7 and 8. It will be seen that throw III may be 90° of crank rotation counting clockwise in Figure 5 from throw I or by interchanging throws II and III throw II may be arranged 90° of clockwise rotation from throw I.

Various firing orders are possible for the two described crank arrangements while affording the feeding intervals essential in the manifold for high torque in the mid speed range of operation and high power in the high speed range of operation. Thus firing orders

1-5-7-3-6-8-4-2
1-5-4-3-6-8-7-2
1-8-7-3-6-5-4-2
1-8-4-3-6-5-7-2
1-8-4-2-6-5-7-3
1-8-7-2-6-5-4-3
1-5-4-2-6-8-7-3
1-5-7-2-6-8-4-3

would be used with the crank of Figures 5, 7, and 8 and manifold of Figure 14; and firing orders

1-3-7-5-4-8-6-2
1-3-6-5-4-8-7-2
1-8-7-5-4-3-6-2
1-8-6-5-4-3-7-2
1-8-6-2-4-3-7-5
1-8-7-2-4-3-6-5
1-3-6-2-4-8-7-5
1-3-7-2-4-8-6-5

5

used with the crank arrangement of Figure 6 and manifold of Figures 2, 3, and 4.

With any of these firing orders each of the two cylinders primarily fed by the supply sources A, B, C, and D respectively will have their suction strokes 360° out of phase with each other. Thus for example with the firing order 1—3—7—5—4—8—6—2 the cylinders 1 and 4 drawing from the supply source A of Figure 2 and 3 will have their suction strokes at regular intervals and 360° out of phase. The same will be true of the cylinders 3 and 8 drawing from the supply source B; the cylinders 7 and 6 drawing from the supply source C and the cylinders 5 and 2 drawing from the supply source D. Moreover, there will be regular intervals of 180° between the suction strokes of cylinders feeding from the connected supply sources A and C or B and D and regular intervals of 90° between the suction strokes of cylinders feeding from the non-connected sources A and B, primary-secondary pair A and C, the primary-secondary pair B and D and between the non-connected sources C and D of these pairs.

Thus it is to be noted that in the exemplified firing order aforesaid the suction cycle starts with the cylinder 1 drawing from A—C (A being the primary source and C the secondary) and is followed in sequence by cylinder 3 drawing from B—D; 7 drawing from C—A; 5 drawing from D—B; 4 drawing from A—C; 8 drawing from B—D; 6 drawing from C—A and 2 from D—B. Repetition occurs only at 360° intervals. The same is true of all other firing orders referred to above.

The hemispherical combustion chambers or cavities 13 of the cylinders 10 are by preference each provided with a single inlet opening 18 closed by an inlet valve 19 and with a single smaller exhaust outlet 20 closed by an exhaust valve 21, these valves being arranged transversely of the longitudinal axis 22 of the engine and at a substantial angle, for instance 60° to each other, and on a great arc of the spherical segment forming the combustion chamber 13. As seen in Figures 2, 3, and 14, all of the inlet openings 18 are in longitudinal alignment and all of the exhaust openings 20 are similarly arranged. Moreover, a single sparking means 23 is positioned in each chamber intermediate the valves thereof on a great arc of the chamber, all of the sparking means of each bank being in longitudinal alignment.

The inlet and exhaust valves of both banks of the engine are operable from a single camshaft 24 located above the crankshaft 15, the camshaft actuating suitable tappet mechanism associated with the push rods 25 and 26 of the inlet and exhaust valve mechanism which in turn actuate respectively the inlet valve rocker arm 27 and exhaust valve rocker arm 28, these rocker arms actuating in turn the normally spring held closed valves 19 and 21. By preference, the camshaft 24 is arranged to open the respective inlet valves 19 before top dead center position of the piston and to close the exhaust valves after top dead center position of the piston so as to maintain the intake valve open during a large portion of crank rotation and to maintain the exhaust valve open long enough to obtain an overlap between opening of the inlet valve and closing of the exhaust valve of each cylinder. By preference a camshaft having a 270° intake cycle, a 260° exhaust cycle, and 50° of overlap will be employed.

As seen in Figure 1, the intake valve openings 18 and the intake valves 19 for the cylinders of each bank are located at the inner terminus of air intake passages or ducts 29 leading transversely from the angularly disposed manifold mounting faces 30, 30^a of the cylinder heads 12, 12^a respectively upon which the intake manifold of my invention generally designated by the numeral 31 is mounted through bolt holes 32 (see Figure 4) by suitable bolts (not shown). The manifold has mounting faces 33, 33^a complementary to the head faces 30, 30^a respectively, and which seat on the latter through intervening gaskets 34.

6

The heads 12, 12^a are also provided with exhaust passages 35 leading transversely from the exhaust inlets 20 and connecting with longitudinally extending exhaust manifolds 36, 36^a which connect with suitable conduits 37, 37^a that conduct the exhaust gases to the atmosphere by means not shown.

Suitable means shown in Figures 15–17 inclusive and hereafter described, are provided for initial hot water preheating of a predetermined section of the intake manifold 31 passages when such heating is deemed desirable, for example, as is usual in the case of passenger car engines.

The intake manifold structure or system of Figures 2 and 4 comprises four individual passage means, ducts or conduits preferably of generally rectangular section, extending generally transversely of the engine axis 22. These conduits are generally designated by the numerals 40, 41, 42, 43, and as seen in Figures 4, 10, 11, 12, and 13 are each by preference provided at their top sides with circular inlet apertures or short vertical cylindrical riser passages, ducts, or conduits 44, 45, 46, and 47 respectively all of which by preference intersect with their respective transverse conduits on the axis 22 of the engine. These risers in effect divide each conduit into two branches extending to cylinders of opposite banks.

Thus branch passages, conduits or ducts 40^a, 41^a, 43^a and 42^a extend from the risers 44, 45, 46, 47 respectively to conduit the air-fuel mixture to the intake passages 29 of the cylinders 1, 5, 3 and 7 respectively of the left hand bank 12 of cylinders, these branch ducts terminating in rectangular outlet apertures 48, 49, 50, and 51 in the face 33 of the elongated mounting flange 52 of the manifold 31 and which apertures coincide with the rectangular inlets of the passages 29.

Similarly the branch passages, conduits or ducts 40^b, 41^b, 43^b, and 42^b extend from the risers 44, 45, 46, 47 respectively to the intake passages 29 of the cylinders 4, 2, 8, and 6 respectively of the right hand bank 12^a of cylinders, these branch ducts terminating respectively in rectangular outlets 52, 53, 54, 55 the face 33^a of the elongated mounting flange 56 of the manifold 31.

The conduits 40, 41, 42, 43 as seen in the plane of Figure 4, do not connect with directly opposite cylinders but preferably connect with diagonally adjacent disposed opposite cylinders, and preferably such that the pair of branches of each conduit are of substantially the same length. Thus the conduits 40 and 42 extend from inner cylinders of the right hand bank to the nearest adjacent end cylinder of the opposite bank, while the conduits 41 and 43 extend from inner cylinders of the left hand bank to the most remote cylinder of the opposite bank. Moreover, the branches are preferably similarly but oppositely curved such that the conduits as a whole are shaped in the form of a reverse curve having congruent branches leading from the engine axis 22.

The shaping is advantageous since it permits the branches to be made of suitable length for obtaining harmonic resonant tuning in the intake passages as described in the copending applications of Platner et al. Serial Nos. 297,318 and 373,376, filed July 5, 1952, and August 10, 1953, respectively, where there is provided an empirical formula

$$L=72\frac{C}{N}$$

as the tool for approximately determining the length of the intake system. As there shown, L represents the intake passage length in inches from the air entrance of the air horn of the fuel mixing means to the intake valve of the cylinder it feeds measured on the axes of the passages, ports, risers, etc. comprising the intake or inlet system. N is the engine speed in R. P. M. at which the engine output is to peak, and C is the velocity of sound in feet per second in the intake passage under the particular temperature and pressure conditions expected

therein. Also there described is an alternate more practical formula for determining L, to wit,

$$L=72\frac{C}{N}\pm 3$$

where all values for a carburetted engine as here disclosed are the same as above.

As seen in Figure 4 the conduits 41 and 43 cross each other adjacent the left hand bank 12 of the engine (left hand side of axis 22) and intermediate the inner pair of cylinders 3 and 5 of that bank to form in effect a letter X, the branch 43^a underlying the branch 41^a where the conduits cross (see Figures 10 and 13). Moreover, the conduit 40 crosses the conduit 41 adjacent the right hand bank side of the axis 22 and intermediate the pair of adjacent cylinders 2 and 4 of the right hand bank 12^a to form a letter X and the conduit 42 crosses the conduit 43 at the same side of the axis 22 and intermediate the cylinders 6 and 8 of right hand bank 12^a to form a letter X. In these latter crossings the branch conduit 43^b underlies the branch conduit 42^b (see Figures 10 and 11) and the branch conduit 40^b underlies the branch conduit 41^b (see Figures 12 and 13).

In each instance the overlying conduit in the transverse vertical plane is substantially of an inverted U shape and has a short horizontal portion where it crosses the underlying conduit whereas the underlying conduit is generally horizontal and straight curving down at the ends to meet the entrances of the passages 29. Where the cross conduits intersect, their wall portions preferably provide common walls for the conduits.

In some cases, as in Figure 3, where two dual carburetors or a four-barrel carburetor are employed, the individual barrels may not conveniently, as in the preferred form of manifold of Figure 4, arrange themselves such that they are located at the intersections of the side branches of the manifold which they feed. In such cases short primary branches P₁, P₂ are provided leading from the vertical carburetor risers to the intersections of the main branches and these primary branches preferably are at substantially right angles to the direction of the main branches to assure uniform air-fuel mixture distribution, and preferably are in the same plane as the intersection of the main branches.

In Figure 3 only two primary passages P₁ and P₂ are shown, these leading from the vertical riser passages corresponding to the risers 44 and 47 of Figure 4 which connect with the air-fuel sources A and C, as seen in Figures 12 and 11 respectively. It will be understood that similar primary passages may be provided leading from the vertical risers 45, 46 connecting with the sources D and B respectively. Moreover, in connection with the Figure 3 manifold arrangement using two dual or a four-barrel carburetor it will be observed that the main branch passages form three letters X as with the Figure 2 form of manifold but differ in that the branch passages from the sources B and D to the cylinders 8 and 2 respectively, more suitably cross each other at the right hand bank side of the engine, that is to say, at the same side that the other two letters X are formed.

It has been stated above that the power output of the engine in the high speed range of operation may be improved substantially without adversely effecting the optimum torque output in the mid speed range of operation by interconnector passages between certain pairs of sources of supply of air-fuel mixture. This is shown schematically in Figures 2, 3, and 14 and structurally in Figures 1, 4, and 10 to 13 inclusive.

Thus as seen in Figure 4, an interconnector conduit or pipe, generally designated by the numeral 60, of generally inverted U shape, seats upon the faces 44^a and 47^a of the risers 44 and 47 of the manifold 31 through intervening gaskets 61, 62 and interconnects these risers. Similarly, an interconnector conduit or pipe 64 seats upon

the faces 45^a and 46^a of the risers 45 and 46 through intervening gaskets 65, 66 and interconnects them.

The interconnector member 60 includes a horizontal passage 70, preferably of generally rectangular section, which opens at each end into vertical circular riser passages 44^b, 47^b forming continuations of the manifold riser passages 44 and 47 respectively, and these passages 44^b and 47^b connect respectively with the air-fuel mixture chambers or barrels 44^c and 47^c of the sources A and C shown here as downdraft carburetors which seat upon faces 71, 72 of the interconnector member 60 through intervening gaskets 73, 74 respectively, and are held together with the interconnector member 60 to the manifold 31 by bolts 75 (Figure 12).

The interconnector member 64 includes a horizontal passage 78 which opens at each end with vertical riser passages 45^b and 46^b forming continuations of the manifold riser passages 45 and 46 respectively and these passages 45^b and 46^b connect respectively with the air-fuel mixture chambers or barrels 45^c and 46^c of the sources D and B also shown as downdraft carburetors which seat upon faces 79, 80 of the interconnector member 64 through intervening gaskets 81, 82 respectively and are held together with the interconnector member 64 to the manifold 31 by bolts 83 (Figures 10, 13).

The interconnector passages 70 and 78 are preferably of the same cross-sectional shape and area as the branch conduit passages of the manifold. Preferably the cross-sectional area of these passages will not be under 25% of that of the branch conduit passages such that the full advantage of the interconnector members in improving induction charging will be obtained.

It will be observed that the passages in Figure 14 have an arrangement which is substantially a mirror image of that in Figure 2 making it necessary that they connect with differently numbered cylinders of the opposite banks and with the crank arrangement of Figure 5 will utilize firing orders set forth for such crank arrangement above whereas the manifold arrangement of Figures 2 and 3 using the crank arrangement of Figure 6 will employ the firing orders set forth above for such crank arrangement.

With the interconnector members in use it will be noted that one pair of conduits, for example 40 and 42 in Figures 2, 3, and 4 form in effect a letter H whereas the other pair of conduits 41 and 43 form in effect a combined letter X and letter A. These configurations, that is to say a letter H and A combined letter X and A, serve to identify manifolds capable of carrying out the features of my invention.

Taking a typical operation of the manifold of Figures 2 and 4 of my invention with a 90° crank as in Figure 6 and a firing order of 1-3-7-5-4-8-6-2 described above, it will be evident that each of the sources A, B, C, D, respectively will receive equal regular suction impulses every 360° of crank rotation and that the spacing of the suction impulses of the connected sources A and C will be 180° of crank rotation and the same will be true of the connected sources B and D. Moreover, the paired cylinders connecting any one source, for instance the cylinders 1 and 4 connected to the source A will provide suction impulses on the source A at regular equal spaced intervals of 180° of crank rotation between them so that no connected sources for instance A and C or B and D will have immediately succeeding suction impulses.

The foregoing conditions will occur with each of the firing orders described above using the crank arrangements of Figure 5 or Figure 6, as the case may be, and each will provide the advantages of optimum torque output in the mid speed range and high power in the high speed range of operation, which will only be obtained when these relationships are met.

In certain arrangements where the manifold of the invention is employed in connection with passenger car

engines, it may be desirable to provide some means for assuring a minimum of power loss at full throttle output operation. For this purpose I have provided a novel arrangement which utilizes hot water of the circulatory system as the source of heat and which is controlled to furnish heat to the manifold passages surrounding the sources of supply of air-fuel mixture during the initial warm-up period and thereafter to be cut off when a predetermined temperature of the water has been reached.

Figures 15 to 17 show the manner of associating such a mechanism with the manifold of my invention. In these figures the numeral 90 represents a hollow chamber attached by suitable means such as welding to the manifold 31 and which in effect boxes in, the central portions of the conduits 40 through 43 inclusive as well as a portion of the vertical risers 44 through 47 inclusive. This chamber is provided with a water inlet 92 and a water outlet 94 and these are connected with the usual water cooling system of the engine which will be first described.

Thus a pump 96 having an intake or suction side 98 and a pressure or output side 100 pumps water to water conduits 102, 103 which conducts the cold water to the inlets 104, 106 of the opposite cylinder blocks of the engine where the water circulates about the cylinder walls and is heated. The water then leaves the cylinder blocks at points 108, 110, passes through the water passages 112, 114 of the manifold 31 (see Figure 16) there being four of these passages. These passages connect with water return headers 116 which extend by conduits 117 to the inlet side 118 of a bellows-type thermostatic valve generally designated by the numeral 120.

The thermostatic valve includes a casing 122 forming a chamber 124 wherein hot water may circulate around and past the conventional bi-metallic bellows 126. One end 127 of the bellows is anchored to the casing 122 and the opposite end 128 connected with a valve operating rod 129 which in Figure 15 is movable up and down in response to contraction and expansion of the accordion section of the bellows 126. The rod 129 carries at one end a tapered poppet valve member 130 which normally seats on a valve seat 132 and closes a water outlet port 134. The rod 128 also includes a poppet valve member 136 which on upward movement of the rod 129 to open port 134 is adapted to seat against a valve seat 137 to close a port 138 which connects by a suitable water conduit 130 with the water inlet 92 of the hot water chamber 90. The hot water may pass from the chamber 124 into the space 144 between the valves 130 and 136. Above the valve 130 is a water chamber 146 which connects by a suitable water conduit 148 with the top 150 of the vehicle water cooling radiator generally designated by the numeral 152. A return line 154 connects the bottom 156 of the radiator 152 with the pump inlet 98. Moreover, a water return is provided between the water discharge outlet 94 of the chamber 90 and the pump inlet 98 by a conduit 158 which cuts into the conduit 154 adjacent the water inlet 98 of the pump as at 160.

In operation of the control device the poppet valve 130 is normally held closed on its seat 132 and when the pump is operated by the engine by means not shown for instance the engine crankshaft, water from the radiator is circulated by the pump through the conduits 102, 103 to the right and left cylinder blocks of the engine entering at the inlets 104, 106 and discharging through the manifold water passages 112, 114 into the return headers 116. In passing through the engine cylinder blocks the water becomes heated, then enters the thermostatic valve structure at the inlet 118, passes through the space 124 and out the outlet 138 through the conduit 140 to the chamber inlet 92 and into the chamber 90 where it circulates around the manifold passages 40 through 43 inclusive and the risers 44 to 47 inclusive after which it discharges through the outlet 94 and returns to the pump by the conduit 158. At this time no water is returned

to the radiator by the conduit 148 since the valve 130 is closed. Hence such water as exists in the radiator and cylinder blocks is circulated between the cylinder blocks, the thermostatic valve and the chamber 90 by the pump 96. As the temperature of the water increases, i. e., becomes hotter, it acts upon the bi-metallic bellows 126 which causes the valve members 130, 136 to rise gradually until the temperature of the water is at a point where the valve 136 has moved sufficiently to close off the port 138 and completely open the port 134 of the valve mechanism whereupon circulation of water through the chamber 90 is stopped and water passes through the port 134 into the conduit 148 to the radiator from which it is returned to the pump by the conduit 154 and circulated by the pump through the cylinder block and back to the radiator through the thermostatic mechanism while bypassing the chamber 90.

From the above description it will be evident that I have provided a novel manifolding system whereby high torque is feasible in the mid range speeds of a V engine while still obtaining high power outputs in this range and at higher speeds.

To illustrate the possibilities of my invention, it may be noted that a 331 cu. in. engine having a 90° crank and the foregoing novel manifold system and using experimental interconnector passages provided with shut-off valves, gave, when operated at a 7.6 compression ratio, 350.3 lb. ft. torque at 2,800 R. P. M. and 227.6 H. P. at 4,400 R. P. M. with the interconnector passages out of use, and with the interconnections in operation gave 350.1 lb. ft. torque at 2,800 R. P. M., 250.9 H. P. at 4,400 R. P. M. and 251.3 H. P. at 4,800 R. P. M. From these figures it will be evident that a substantial increase in power in the high speed range was obtained without loss of torque output in the mid speed range. The same engine provided with cast interconnection passages without valve control operated at 8.1 compression ratio, gave 366 lb. ft. torque at 2,800 R. P. M. and 278.8 H. P. at 5,000 R. P. M.

I have further provided a novel arrangement for heating the manifold intake passages during cold starting and that will assure a minimum of power loss at full throttle output operation.

It will be understood that various modifications, changes and departures from the specific illustrated forms of the invention disclosed herein may be made and will occur to those skilled in the art without deviating from the letter and spirit of the present invention. For example, it will be understood that the invention is operable in connection with engines having updraft, downdraft or horizontal carburetors and slide valves may be employed in place of one or both poppet valves in the water heating system. It will be understood that all such modifications, changes, and equivalent structures within the scope of the appended claims are contemplated herein.

I claim:

1. The combination with an internal combustion engine having eight cylinders; of a manifolding system comprising four passage means each respectively connecting with a pair of said cylinders, each pair being two different cylinders of said eight cylinders, two further passage means one interconnecting one pair of said four passage means and the other interconnecting the remaining pair of said four passage means, said one pair of passage means being non-communicating with the said remaining pair of said passage means, and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same passage means.

2. The combination with an internal combustion engine having eight cylinders; of a manifolding system comprising four passage means each respectively connecting with a pair of said cylinders, each pair being two different cylinders of said eight cylinders, two further passage means one interconnecting one pair of said four passage means and the other interconnecting the remaining pair of said four passage means, said one pair of passage means being

non-communicating with the said remaining pair of said passage means, crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same passage means, and carbureting means for conducting fuel mixture to each of said four passage means.

3. The combination with an internal combustion engine having eight cylinders arranged in two opposite banks of four cylinders each; of a manifolding system comprising four passage means each of one pair of which connects an end cylinder of one of said banks with the nearest inner cylinder of the other of said banks and each of the other pair of which connects an end cylinder of the said other bank with the more remote of the inner cylinders of the said one bank, and two further passage means, one interconnecting said one pair of passage means and the second interconnecting the other pair of said passage means, said one pair of passage means being non-communicating with the said other pair of passage means, and crank means providing each cylinder connecting with said four passage means with a suction stroke 360° out of phase from the other cylinder connected with the same passage means.

4. The combination with an internal combustion engine having eight cylinders arranged in a V in two opposite banks of four cylinders each; of a manifolding system comprising four passage means each of which connects an end cylinder of the four cylinders of one bank with an inner cylinder of the four cylinders of the opposite bank, and two further passage means, one interconnecting one pair of said four passage means and the other interconnecting the remaining pair of said four passage means, said one pair of connected passage means having the general appearance of a letter H and the other interconnected pair having the general appearance of a letter X, said one pair of passage means being non-communicating with the said remaining pair of passage means and crank means providing each cylinder connecting with said four passage means with a suction stroke 360° out of phase from the other cylinder connected with the same passage means.

5. The combination with an internal combustion engine having eight cylinders arranged in a V in two opposite banks of four cylinders each; of a manifolding system comprising four passage means each of which connects an end cylinder of the four cylinders of one bank with an inner cylinder of the four cylinders of the opposite bank, and two further passage means, one interconnecting one pair of said four passage means and the other interconnecting the remaining pair of said four passage means, said one pair of connected passage means having the general appearance of a letter H and the other interconnected pair having the general appearance of a combined letter A and X, said one pair of passage means being non-communicating with the said remaining pair of passage means and crank means providing each cylinder connecting with said four passage means with a suction stroke 360° out of phase from the other cylinder connected with the same passage means.

6. The combination with an internal combustion engine having eight cylinders; of a manifolding system comprising four passage means each respectively connecting with a pair of said cylinders, each pair being two different cylinders of said eight cylinders, two further passage means one interconnecting one pair of said four passage means and the other interconnecting the remaining pair of said four passage means, said one pair of passage means being non-communicating with the said remaining pair of said passage means, and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same passage means, and providing each of said four manifold passage means with a suction impulse 180° out of phase with that of the passage means with which it is interconnected.

7. The combination with the internal combustion engine having eight cylinders arranged in two opposite

banks of four cylinders each; of a manifolding system comprising four passage means each of one pair of which connects an end cylinder of one of said banks with the nearest inner cylinder of the other of said banks and each of the other pair of which connects an end cylinder of the said other bank with the more remote of the inner cylinders of the said one bank, and two further passage means, one interconnecting said one pair of passage means and the second interconnecting the other pair of said passage means, said one pair of passage means being non-communicating with the said other pair of passage means, and crank means providing each cylinder connecting with said four passage means with a suction stroke 360° out of phase from the other cylinder connected with the same passage means, and providing each of said four manifold passage means with a suction impulse 180° out of phase with that of the passage means with which it is interconnected.

8. The combination with an internal combustion engine having eight cylinders; of a manifolding system comprising four primary passage means, four secondary passage means each connected by one of said primary passage means and each divided by its connecting primary passage means into two branch passage means, each of said branch passage means of said secondary passage means connecting with a different cylinder, a first connection passage means interconnecting one pair of said four primary passage means and a second connection passage means interconnecting the remaining pair of said four primary passage means, said one pair of primary passage means being non-communicating with the said remaining pair of said primary passage means, an independent fuel mixing means for feeding each primary passage means, and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same secondary passage means.

9. The combination with an internal combustion engine having eight cylinders; of a manifolding system comprising four primary passage means, four secondary passage means each connected by one of said primary passage means and each divided by its connecting primary passage means into two branch passage means, each of said branch passage means of said secondary passage means connecting with a different cylinder, a first connection passage means interconnecting one pair of said four primary passage means and a second connection passage means interconnecting the remaining pair of said four primary passage means, said one pair of primary passage means being non-communicating with the said remaining pair of said primary passage means, a four-barrel fuel mixing means for feeding said primary passage means and having each of its barrels connected with a different primary passage means, and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same secondary passage means.

10. The combination with an internal combustion engine having eight cylinders arranged in two opposite banks of four cylinders each; of a manifolding means positioned between said banks and comprising four primary passage means, four secondary passage means each connected by one of said primary passage means and each divided by its connecting primary passage means into two branch passage means, one branch passage means of each of one pair of said four secondary passage means connecting with an end cylinder of one of said banks and the other branch passage means of each of this pair of secondary passage means connecting with the nearest inner cylinder of the other of said banks, and one branch passage means of each of the remaining pair of said secondary passage means connecting with an end cylinder of the said other bank and the other branch passage means of each of this remaining pair of said secondary passage means connecting with the more remote of the inner

13

cylinders of said one bank, a first connection passage means interconnecting the primary passage means connecting with said one pair of secondary passage means, and a second connection passage means interconnecting the primary passage means connecting with the said remaining pair of said secondary passage means, said first and second connection passage means being non-communicating, a fuel mixture feeding means communicating with each said primary passage means and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same secondary passage means, and providing each primary passage means with a suction impulse 180° out of phase with that of the primary passage means with which it is interconnected.

11. The combination as claimed in claim 10 wherein the said branch passage means are approximately of the same length.

12. The combination as claimed in claim 10 wherein each cylinder has an intake valve and an intake passage means connecting with the branch passage means connecting the cylinder and said fuel mixture feeding means has an air horn provided with an air entrance and wherein the distance from the said air entrance of the said fuel feeding means to the intake valve of the cylinder it feeds measured along the said connecting passage means is substantially

$$72 \frac{C}{N} \pm 3$$

where N is the engine speed in R. P. M. at which the engine output is to peak and C is the velocity of sound in air in feet per second in the manifold passage means at the expected temperature and pressure conditions prevailing when the engine is to be operated.

13. The combination is claimed in claim 10 wherein the crank means is a 90° crank.

14. The combination with an internal combustion engine having eight cylinders arranged in two opposite banks of four cylinders each; of a manifold member positioned between said banks and comprising four primary passage means, four secondary passage means each connected by one of said primary passage means and each divided by its connecting primary passage means into two branch passage means, one branch passage means of each

14

of one pair of said four secondary passage means connecting with an end cylinder of one of said banks and the other branch passage means of each of this pair of secondary passage means connecting with the nearest inner cylinder of the other of said banks, one branch passage means of each of the remaining pair of said secondary passage means connecting with an end cylinder of the said other bank and the other branch passage means of each of this remaining pair of said secondary passage means connecting with the more remote of the inner cylinders of said one bank, a first connection conduit member seated on said manifold member and including a pair of generally vertical passage means one each connecting with a primary passage means of said one pair of secondary passage means and including a generally horizontal passage means interconnecting said vertical passage means of this conduit member, a second connection conduit member seated on said manifold member and including a pair of generally vertical passage means one each connecting with a primary passage means of said remaining pair of said secondary passage means, and including a generally horizontal passage means interconnecting said vertical passage means of this second conduit member, said first and second connection conduit members being non-communicating, a fuel mixture feeding means communicating with each of said vertical passage means of said connection conduit members, and crank means providing each cylinder with a suction stroke 360° out of phase with the other cylinder connected with the same secondary passage means, and providing each primary passage means with a suction impulse 180° out of phase with that of the primary passage means with which it is interconnected by a conduit member through the said passage means of the latter.

15. The combination as claimed in claim 1 including intake and exhaust valves for each cylinder and valve timing mechanism providing between 260° to 280° of intake and exhaust valve opening duration and between 45° to 60° overlap of intake and exhaust valve events.

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