April 23, 1935. D. J. CAMPBELL 1,998,706

INTERNAL COMBUSTION ENGINE

Filed Nov. 2, 1931 3 Sheets-Sheet 1

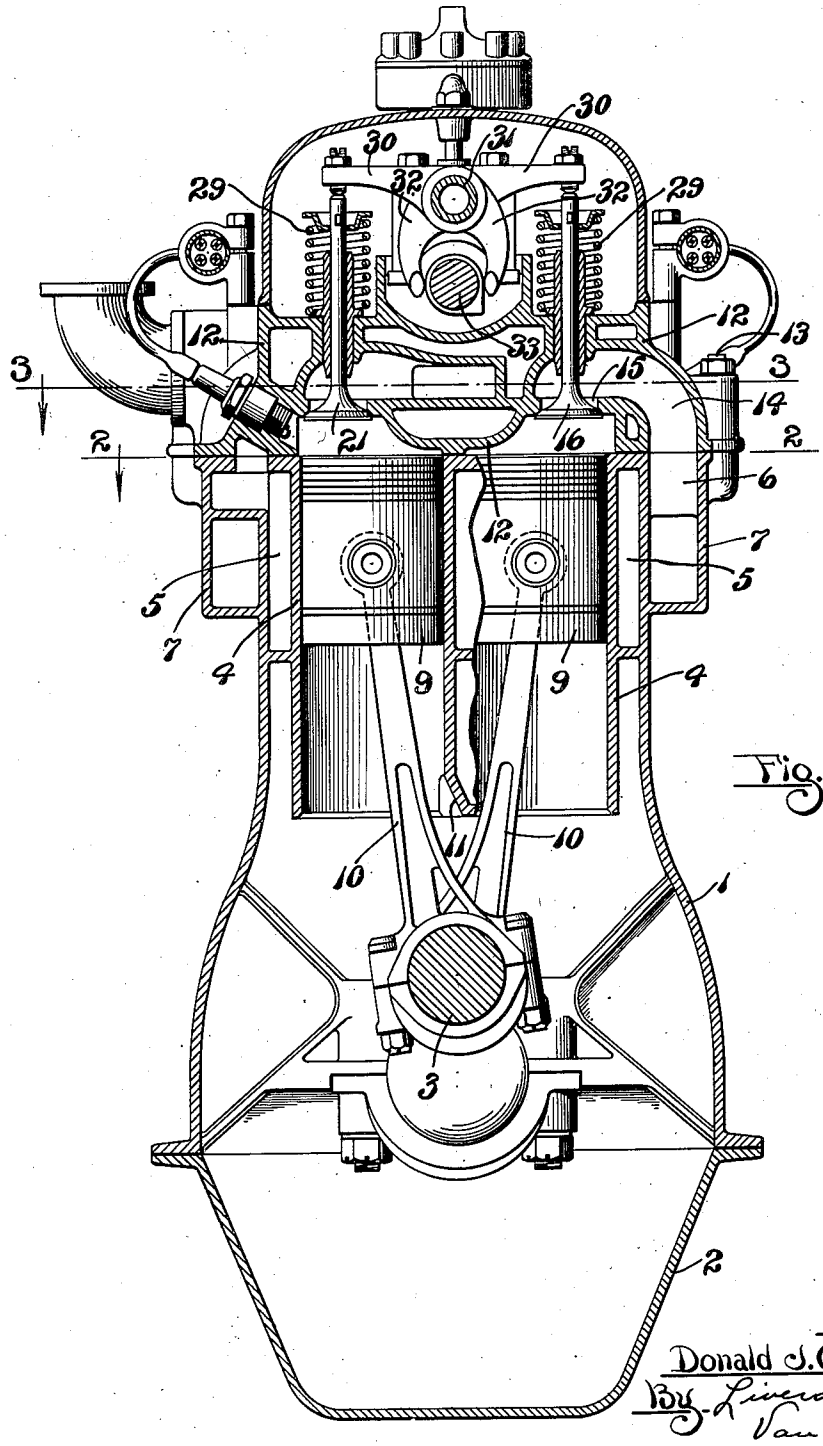

Fig. 1.

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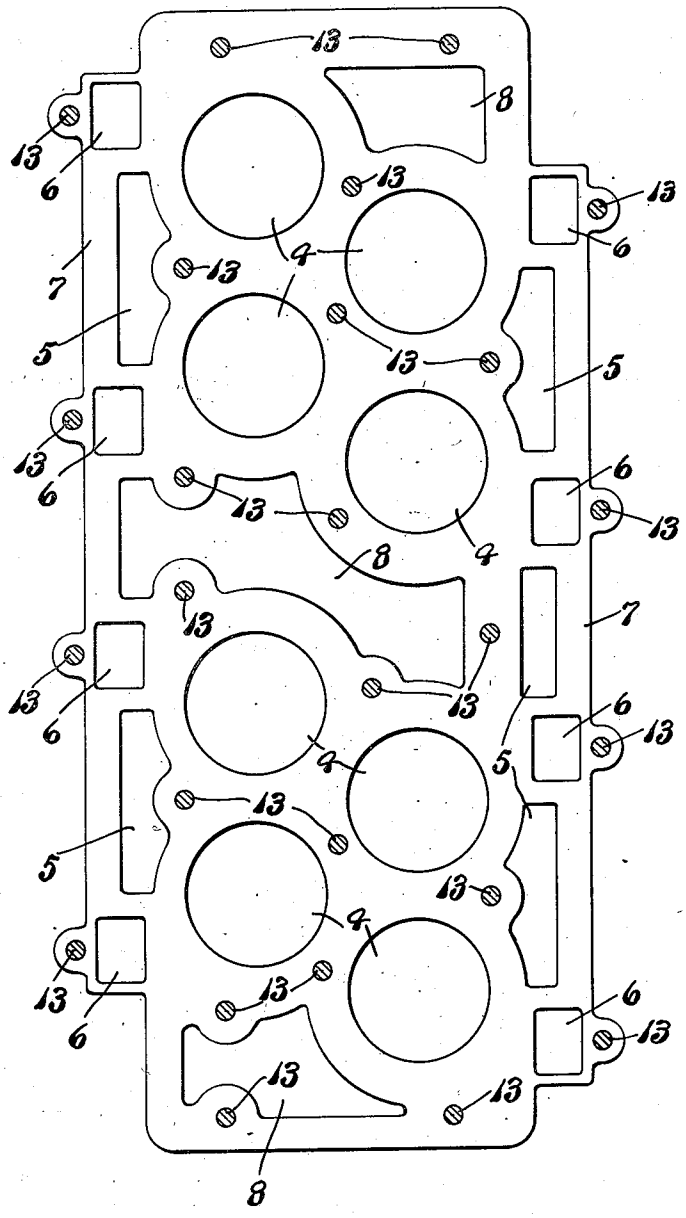

Fig. 2.

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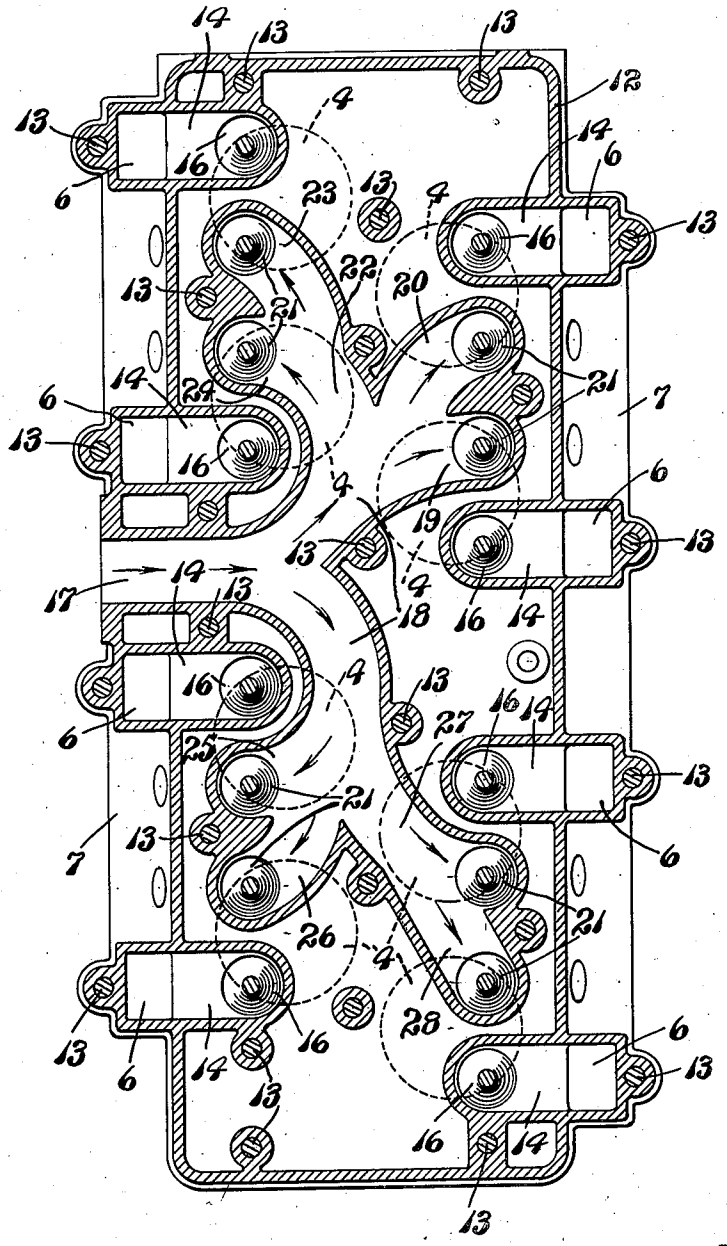

Fig. 3.

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UNITED STATES PATENT OFFICE

1,998,706

INTERNAL COMBUSTION ENGINE

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Application November 2, 1931, Serial No. 572,554

6 Claims. (Cl. 123—54)

The present invention relates to internal combustion engines and is more particularly concerned with internal combustion engines of the multiple cylinder type. Internal combustion engines, as at present utilized in motor vehicles, are substantially of two well defined types. In one the cylinders are located one in front of the other or in a line, and in the other two banks of cylinders, one at each side of a vertical plane, are disposed at an angle to each other and also at an angle to the vertical plane in what is commonly known as the V-type of motor.

The multiplication of cylinders for the power plants of motor vehicles is increasing and engines of eight or more cylinders are very common. Such multiplication of cylinders splits up the power impulses into a greater number, more frequent and less severe impulses than when a lesser number of cylinders are used, whereby there is an imparting of a more uniform flow of power to the crank shaft, this being equally true in all multiple cylinders either of the straight line or the V-type, or engines made in accordance with my invention.

The present invention is designed for the production of vertical cylinders, not in a line, but in banks alongside each other whereby a much more compact and smaller construction is provided in an engine having the same power, with an elimination of a considerable portion of the chance for torsional strains being set up while the engine is in operation, and with a saving in material weight, the compact construction which I have invented permitting thinner metal being used without sacrifice of strength or durability.

A further advantage of a vertical and parallel bore construction of engine is that in molding the same the parallel and vertical lines of the engine casting makes it much easier for molding and much more adaptable to rapid quantity production methods in its manufacture. It is also true that in machining the engine castings, a block having the parallel bore construction is much more accessible for machining than the V-type and can be machined with standard equipment largely rather than requiring the use of special machine tools; whereby both for production of the castings and the machining thereof the construction of my invention is the simplest and the most easily machined of any design of engine using multiple cylinders.

In engines where the number of cylinders exceeds six, placing the same in a line one back of the other causes an undue length to the engine and raises complications in fuel distribution to the cylinders, while placing the cylinders in two banks at an angle to each other, and thus making a V-type engine, widens the engine at its upper portion and requires a wider hood than is required with the narrow width multiple cylinder construction of engine which I have devised. The engine of the present invention permits a considerable decrease in the width of the hood over the motor, with a consequent decrease in wind resistance to the driving of a motor vehicle equipped with the engine, while the shorter length of the engine over those in which the cylinders are in a line permits shorter chassis frames, better handling and economies in the chassis cost.

With the multiple type and vertical bore cylinders in engines made in accordance with my invention, an overhead type of valve mechanism is readily adaptable, thus enabling the engines to be located very low in the chassis frame, with a lowering the center of gravity of the automobile equipped with such engine and with resultant greater road ability in driving, while at the same time the valve mechanism is readily accessible under the hood for adjustment or repair, located as it is at the uppermost part of the engine.

With these and other objects and purposes in view, as will be apparent upon a full understanding of the invention, the description of the invention may be considered in connection with the accompanying drawings, in which,

Fig. 1 is a transverse vertical section through an internal combustion engine made in accordance with my invention.

Fig. 2 is a plan of the engine block substantially on the plane of line 2—2 of Fig. 1, and

Fig. 3 is a horizontal section on the plane of line 3—3 of Fig. 1, illustrating the intake and exhaust valves and their locations in the engine and the manner in which the fuel charges are carried to the cylinders without undue length of travel for said charges to any cylinder.

Like reference characters refer to like parts in the different figures of the drawings.

In the construction illustrated, the engine block 1 is of cast iron open at its lower side to be closed in the usual manner by a crank case 2. The crank shaft 3 is mounted in the lower part of the engine block, the specific detail of which is not of specific importance in the present invention.

The upper part of the engine block is cast to provide a plurality of cylinders 4. These cylinders are located with their vertical axes in two vertical planes parallel to and spaced from each other. In other words the cylinders provide two

banks of cylinders in the length of the engine located, as best shown in Fig. 2, with the cylinders of one bank in a somewhat staggered and nested relation with respect to the others, this permitting a narrowing of the engine block inasmuch as the upper cylinder shown in Fig. 2 at the right is staggered and moved in with respect to the two adjacent cylinders of the bank at the left, and this staggered relation appears throughout the location of the cylinders with respect to each other. The cylinders 4 are suitably water jacketed by outer walls of the casting enclosing water jacket spaces 5 which open at their upper ends to join with the water jacketed spaces of the engine head which is applied to and secured above the block, as will later appear.

At each side of the upper portion of the engine block, integral exhaust manifolds 7 are cast with entrance openings 6, one for each cylinder, leading to the adjacent manifold. The cylinders at a side of the engine block exhaust their exhaust gases into the exhaust manifold 7 at the same side of the block; and it will be noted that the exhaust manifolds are also partly water jacketed. There are also other water spaces indicated at 8, open at their upper ends, in the cylinder block, as best shown in Fig. 2, around and between various of the cylinders for the purpose of securing an effective cooling of the engine.

Pistons 9 are adapted to be installed in the cylinders and are connected by rods 10 to the crank shaft 3. The design of the crank shaft is subject to a wide variation and I have numerous designs thereof which may be used with the vertical pistons 9 operating in the nested and staggered cylinders 4. As shown in Fig. 1 the lower inner side of a cylinder 4 may be cast with an inclined recess or groove 11 so as to afford space for the piston rod 10 in its angular movements during the engine operation.

A head 12 covers the upper end of the cylinder described and is detachably secured thereto by bolts 13. In said head four exhaust conduits 14 are made adjacent each side thereof to join with the four entrance openings 6 to each exhaust manifold 7 as shown in Fig. 3 and also at the right in Fig. 1. One of these conduits 14 leads over the upper end of each of the cylinders 4 and there is an opening 15 through a part of the head forming the lower side of each conduit 14, which is closed by an exhaust valve 16 as shown in Fig. 1, said valve being periodically movable to an open position to permit the escape of exhaust gases.

At one side of the head there is an entrance passage 17 for the incoming fuel mixture after it has passed by the carburetor and the fuel and air has been mixed. The passage 17 divides into two oppositely extending branches 18. From one of said branches two terminal branches 19 and 20 extend therefrom, associated with which are intake valves 21, one over each of two of the cylinders 4 (see Fig. 3). Opposite the passages 19 and 20 a branch passage 22 leads from the same branch 18 and terminates in two other terminal passages 23 and 24 which extend over two of the other cylinders 4 and likewise have like intake valves 21 associated therewith.

The other branch 18 of the main intake passage 17 has two terminal passages 25 and 26 at one side thereof which terminate above two of the remaining cylinders 4 and which also have intake valves 21 associated therewith; and the remaining cylinders 4 have a passage 27 leading from the second branch passage 18 in one side of which an intake valve 21 is located over one of said cylinders 4, while an extension 28 to the passage 27 leads to and over the last cylinder 4 and has an intake valve 21 at its end. It is, of course, to be understood that the valves 21 are seated below openings made in a part of the head 8 which forms the lower side or wall of the fuel intake passages described, and that when a valve is opened by forcing the same downwardly communication is then made between the intake passage and any cylinder which is opened by the opening movement of its associated valve.

The head constructed as described with the intake manifold formed integrally therein provides for a very uniform distribution of the fuel mixture to the cylinders. The travel which the fuel has to make to the farthermost cylinder is but slightly greater than the travel which it has to make to the cylinder nearest the main intake passage 17, whereby an elimination of the possibility of condensation or attenuating of the mixture by reason of heat applied thereto from warm or hot water which circulates through the head is avoided in any one cylinder over another, and the mixture going to any cylinder is supplied with a desired amount of heat to warm and better vaporize it, said heat coming from the water which is used as a cooling medium for cooling the engine. It is, of course, understood that the head has water carrying passages around and over the intake passage construction described, this being indicated and shown in Fig. 1, also in Fig. 3.

Both the intake and the exhaust valves are normally held in an upper closed position by coiled compression springs 29 (see Fig. 1). The vertical stems of the valves extend upwardly through suitable guide sleeves carried by the engine head, and the upper ends of said stems are located underneath actuating arms 30 mounted loosely on a supporting rod or shaft 31. Each of the arms 30 is equipped with a downwardly extending cam engaging arm 32 to engage with its proper cam on a cam shaft 33 which is driven by suitable timing gears or other timing drive mechanism from the crank shaft 3 so that the cams on the cam shaft 33 will come to the arms 32 which they actuate and open and close the intake and exhaust valves at the proper times. The specific detail of the timed drive of the cam shaft need not be entered into as such feature is common and well known in internal combustion engines; and the present invention is in no sense limited to the location of the cam shaft at the upper end of the engine though it is very convenient and in many ways very desirable that it shall be located at said upper end of the engine.

The engine described and which includes vertical cylinders in parallel banks and in staggered relation equally distributed or spaced at each side of the plane of the vertical center of the crank shaft, and equally distant at both top and bottom of each cylinder from the vertical plane of the center of the crank shaft provides a very practical and commercial construction of internal combustion engine. It provides a more substantial and rigid cylinder block with less weight for horse power developed, permitting a shorter chassis frame in automobiles and a narrower motor hood. It permits both the intake and the exhaust manifolds being cast in the body of the engine, the intake manifold in the head and the exhaust manifolds in the cylinder block.

The distribution of the fuel charge to the cyl-

inders is substantially alike to all cylinders and with the shortest possible distance to any cylinder, thus avoiding undue condensation of liquid fuel when the engine is cold or undue rarification of the fuel charge when the engine is hot.

It permits the production of cylinder blocks and their machining in the most economical manner. It has all of the advantages in both molding and machine production that are present in engines in which the cylinders are in a line and at the same time eliminates the disadvantages of engines having cylinders in a line, particularly where a large number of cylinders are used, in that the length of the engine is cut down nearly fifty percent with lessening in weight for equal power developed and the permitting of much lighter weight, shorter wheel base and the like in the chassis design of automobiles in which the engine is installed.

It likewise secures all the advantages of the V-type internal combustion engine and eliminates the disadvantages thereof in the matter of cost of production, extra width, distribution of fuel charges to the cylinders and inconvenience in repair or service. It eliminates the separate exhaust and intake manifolds with the numerous gaskets used therewith. It provides amply sufficient and generous water spaces above all essential points for cooling. Ample water is allowed around the valve ports and the cylinder walls and the heat from the water is utilized in warming and better vaporizing the liquid fuel used.

While the disclosure has shown the overhead type of motor, the invention is equally applicable to the L-head type of motor in which case the motor will be slightly wider but of a lesser height than where the overhead valves are used. As previously stated various types of crank shaft may be used to advantage. Single throw crank shafts may be used in eight or twelve cylinder engines by slightly increasing the length of the motor block, or two of the substantially opposite but staggered twin pistons may be connected to the same crank throw.

The invention is one of very practical importance. It is defined in the appended claims and is to be considered comprehensive of all forms of structure coming within their scope.

I claim:

1. An internal combustion engine comprising, an integrally cast engine block having a plurality of vertical cylinders parallel to each other and disposed in two banks one at each side of a vertical plane equidistant from the banks of cylinders, a single crank shaft the axis of rotation of which lies in said vertical plane, a piston in each cylinder, connections between the pistons and crank shaft, an integrally cast exhaust manifold at each side of and adjacent the upper end of the cylinder block, and a head over the block having a plurality of passages one for each cylinder, said passages at opposed sides of the engine leading to the oppositely disposed exhaust manifolds.

2. An internal combustion engine comprising a cylinder block having a plurality of vertical cylinders disposed in two equal banks, the cylinders of each bank being in alinement one ahead of the other, and the two banks of cylinders being symmetrically disposed with respect to the central vertical longitudinal plane of the block, a head covering the cylinder block, said head having a single fuel inlet passage at one side thereof and substantially midway between the ends of the engine and with branches leading to and over the upper end of each cylinder.

3. An internal combustion engine comprising, an integral engine block having a plurality of vertical cylinders disposed in two vertical banks in parallel relation alongside of each other, a head covering said block, said head enclosing an intake manifold having a single entrance passage thereto at one side and substantially midway between the ends of said head and with branches from said entrance passage to and over the upper end of each cylinder, combined with an intake valve at the inner end of each of said branches between the same and the upper end of a cylinder.

4. An internal combustion engine comprising, an engine block having a plurality of parallel vertical cylinders disposed in two banks alongside of each other, each bank having an equal number of cylinders, and a head covering said block having an intake manifold integrally cast within the head and over the upper ends of the cylinder, said intake manifold having a single entrance passage at one side of the head substantially midway between the ends thereof and with branch passages leading in opposite directions from the single entrance passage, said branch passages having parts extending to and over the upper ends of each of said cylinders, the lower wall of the manifold over each cylinder having an opening therethrough, and a normally closed intake valve closing each opening.

5. In an internal combustion engine comprising, an engine block having a plurality of cylinders, a head covering for said block, said block having a water chamber and a common exhaust chamber for two cylinders, the chamber being integrally cast in the said block and separated by a common wall for the purpose described.

6. In an internal combustion engine of the class described, an engine block integrally formed and having two vertically positioned rows of cylinders spaced immediately adjacent to each other, exhaust manifolds positioned along each side of said casting and extending substantially the full length of the said casting, said casting having passageways located between the cylinders and the said exhaust manifolds and a cylinder head for the said casting, said head having exhaust passageways leading downwardly into the exhaust manifolds at spaced apart points, for the purpose described.

DONALD J. CAMPBELL.