Oct. 4, 1966 R. L. KEINATH 3,276,438

INTERNAL COMBUSTION ENGINE VALVING ARRANGEMENT

Filed Jan. 31, 1964 2 Sheets-Sheet 1

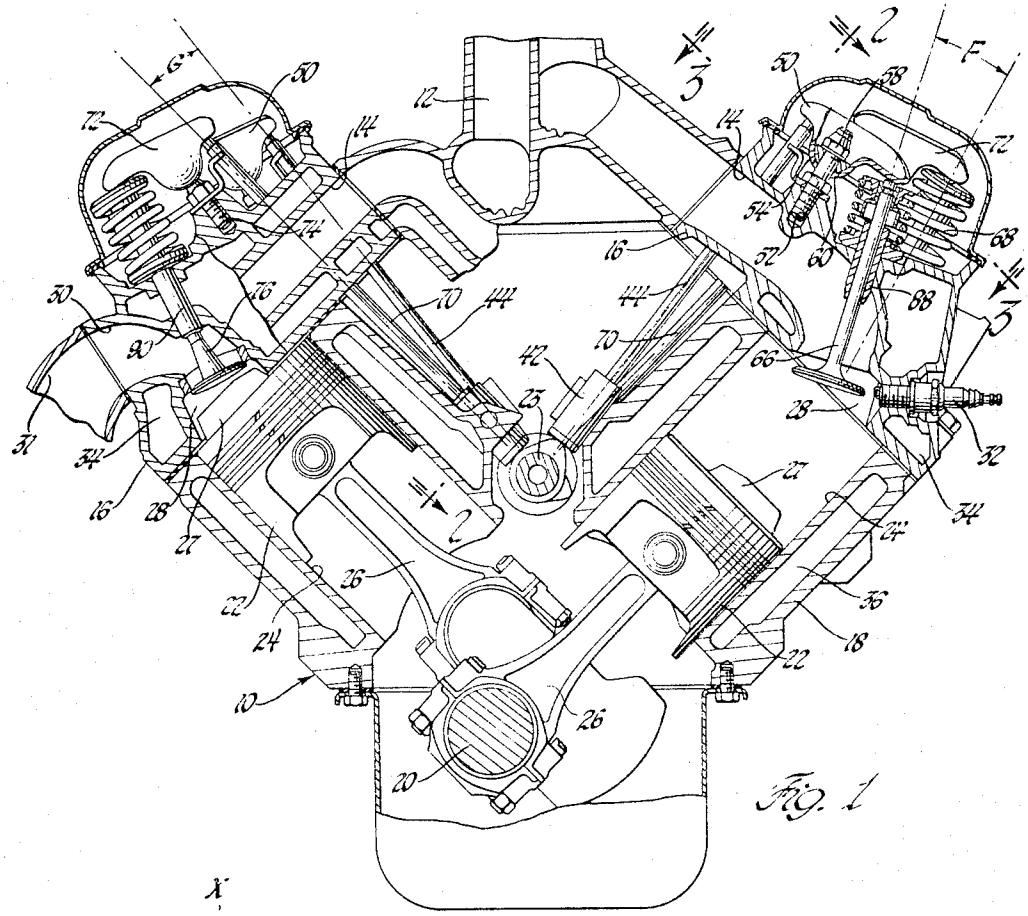

Fig. 1

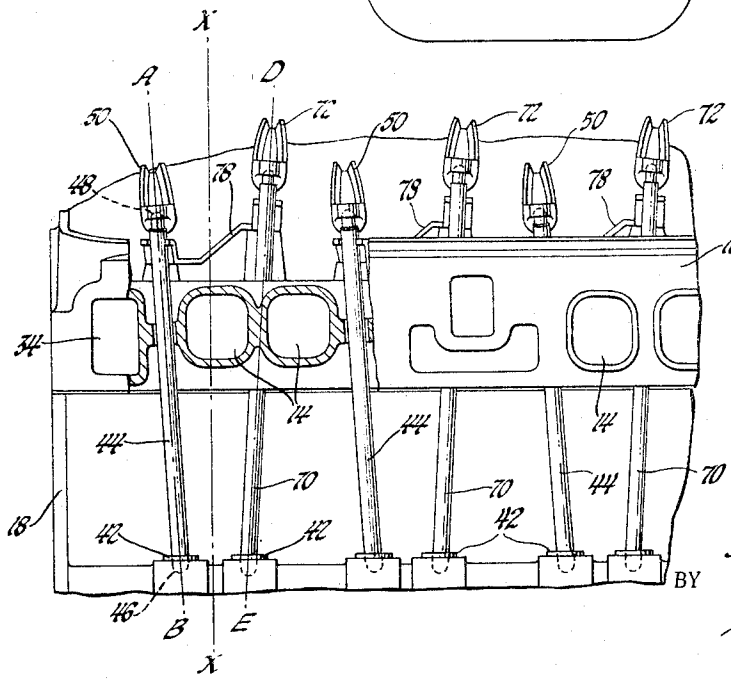

Fig. 2

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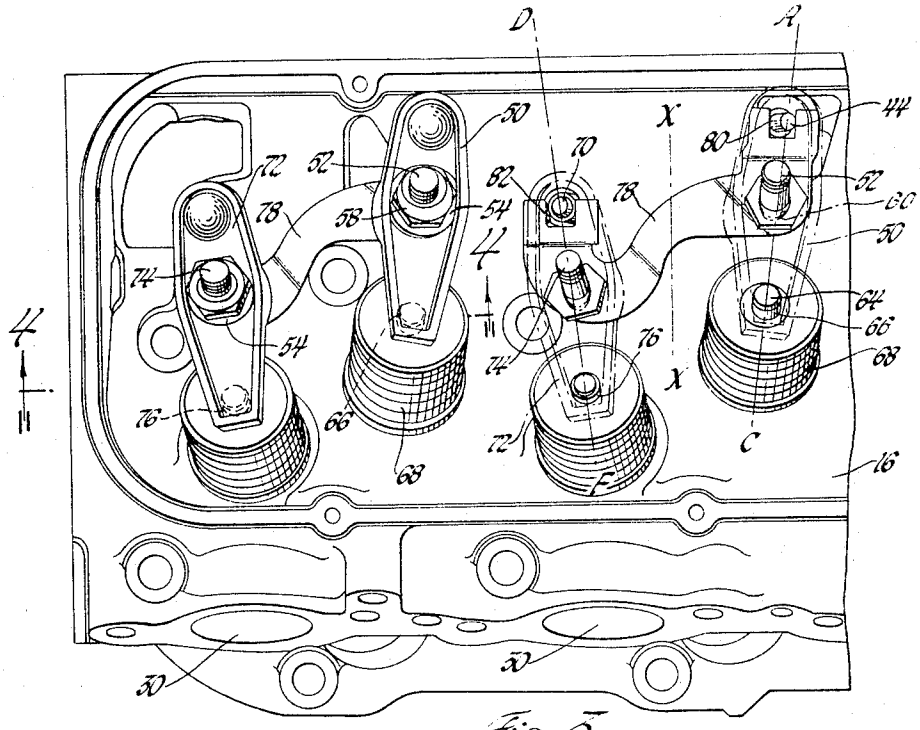

Fig. 3

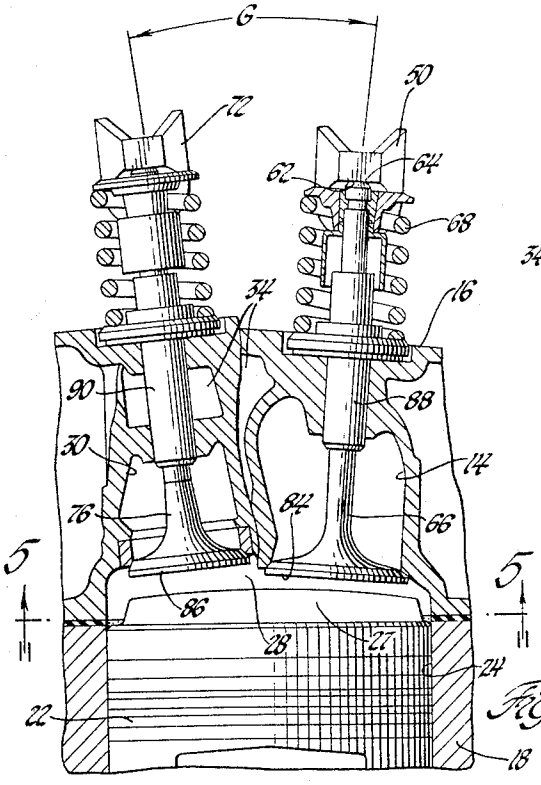

Fig. 4

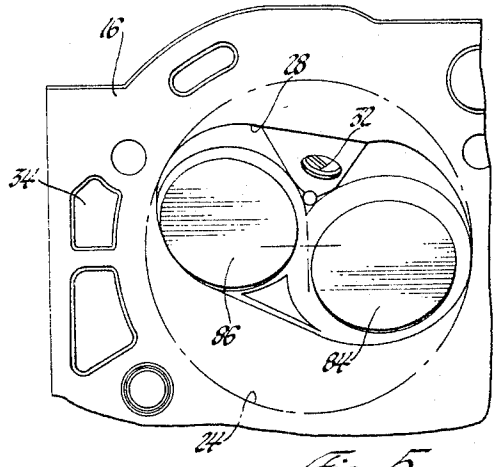

Fig. 5

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INTERNAL COMBUSTION ENGINE VALVING ARRANGEMENT

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10 Claims. (Cl. 123—59)

This invention relates to internal combustion engines and more particularly to internal combustion engines of the overhead valve type.

In designing the combustion chamber of an internal combustion engine, it is desirable that it be arranged compactly about the cylinder axis. It is also desirable that the cylinder head inlet and exhaust passages connecting with the combustion chamber be kept as short as possible. The combustion chamber must provide space for the intake and exhaust valves in their open position, hence, its size and shape is determined to a large degree by the size and shape of the valves and their kinematic arrangement.

Compactness of the combustion chamber can be achieved by locating the valve faces as close to each other as is possible and by angling them with respect to each other and the cylinder axis so that the valve faces can form much of the dome area of the chamber. The cylinder head inlet and exhaust passages can be kept short by locating the inlet valve face toward the inlet side of the head and the outlet valve face toward the outlet side.

The degree to which such combustion chamber design desirables or criteria can be followed depends upon the kinematic mechanism employed to operate the valves. It is inherently simpler to provide a valving arrangement that satisfies the design criteria for radial engines than it is for engines that have banks of cylinders in-line, particularly engines which employ single camshafts at the side of the bank or at the juncture of a pair of banks. To fully achieve such design criteria would in the latter types of engines involve complex and expensive valve train elements.

I have found, however, that simple and inexpensive valve train elements can be used with but insignificant departures from such design desirables in such types of single camshaft engines, albeit to achieve this I have been obliged to depart considerably from conventional valve train geometry arrangements as will be seen from the disclosure which follows.

In the drawings:

FIGURE 1 is a transverse section of a V-type internal combustion engine viewed from the front thereof and incorporating the inventive valving arrangement;

FIGURE 2 is a partial side view, partially broken away, of the rear portion of the right cylinder bank of the engine taken in the direction indicated by the line 2—2 of FIGURE 1;

FIGURE E3 is a partial plan view of the front portion of the right cylinder bank taken in the direction indicated by the line 3—3 of FIGURE 1;

FIGURE 4 is a partial section through the right front combustion chamber taken substantially as indicated by the line 4—4 of FIGURE 3; and

FIGURE 5 is a partial plan view of the cylinder head portion of the right front combustion chamber taken in the direction indicated by the line 5—5 of FIGURE 4.

Referring to the drawings, a V-type engine 10 is shown which includes an intake manifold 12 supplying a combustible charge to the intake passage 14 of the right and left cylinder heads 16 which are identical and assembled on the engine block in the customary fashion with the

front of the right cylinder head corresponding to the rear of the left cylinder head.

The cylinder heads 16 are bolted to a cylinder block 18 which journals a crankshaft 20 and which receives pistons 22 in cylinder bores 24 to drive the crankshaft 20 and camshaft 23 through connecting rods 26. The cylinder heads 16 and piston heads 27 form combustion chambers 28 and the heads form exhaust passages 30 which connect to side mounted exhaust manifolds 31, mount spark plugs 32 and form coolant passages 34 which communicate with cylinder block coolant passages 36.

The engine thus far described is conventional and the invention resides in the novel manner in which individually conventional elements of the valve train are kinematically and geometrically related to the engine, as will be seen.

The valve trains of the right and left cylinder bank are identical and are driven in the usual manner by the camshaft 23 which is longitudinally located at the juncture of the cylinder banks to reciprocate camshaft followers 42. Each cylinder of each bank has an intake valve train that includes a push hod 44 having a ball and socket connection 46 with its camshaft follower 42 and a ball and socket connection 48 with an intake rocker arm 50. The intake rocker arm 50 is mounted to the cylinder head 16 by a stud 52 which carries a semispherical bearing 54 that engages a complementary socket in the rocker arm. A nut 58 provides vertical adjustment for the rocker arm which has a slot 60 in the socket running in the plane of the valve train to permit the rocker arm to pivot relative the stud 52. The rocker arm 50 has a flat surface 62 that engages the flat end 64 of an intake valve 66 biased toward closing by a spring 68. The exhaust valve train elements for each cylinder are similar and include push rods 70, rocker arms 72, rocker arm mounting studs 74 and spring-biased exhaust valves 76. Each cylinder is also provided with brackets 78 mounted to the cylinder head by the studs 52 and 74 which are slotted in the planes of the valve trains at 80 and 82.

At this point is it appropriate to describe the geometric arrangement of the valve train which, to my knowledge, represents a considerable departure from the prior art. How this valve train arrangement encourages good combustion chamber design will be considered later. It should first be realized that it is essential in my arrangement to have the individual elements of each valve train so located that their kinematic axes are in a common plane. Thus the axes of a push rod and corresponding valve are in the same plane as the longitudinal axis of a corresponding rocker arm and its pivot point. Taking first the plane ABC of the intake valve train, it is seen as line AB in side elevation in FIGURE 2 and as line AC in plan elevation in FIGURE 3. The intake valve plane ABC diverges from the transverse plane XX of the engine when viewed in both side and plan elevations, it being understood that the transverse plane XX is normal to the axes of the crankshaft and camshaft and is parallel to the cylinder axes. The plane DEF defining the exhaust valve train likewise diverges from the transverse plane XX when seen in side elevation in FIGURE 2 and in plan elevation in FIGURE 3. Further examination of FIGURES 2 and 3 reveals that the planes ABC and DEF of the intake and exhaust valve trains of each cylinder converge toward each other in downward direction when seen in side elevation and converge toward each other in camshaft-to-cylinder direction when seen in plan elevation.

Inasmuch as the axes of the intake and exhaust valves 66 and 76 lie in their respective planes ABC and DEF, it is apparent that they are angled with respect to each other and the cylinder axis. The intake and exhaust

valves thus converge downwardly toward each other at an angle G when viewed in the side elevation of FIGURE 4 and the push rods likewise converge downwardly toward each other when seen in the side elevation of FIGURE 2. This angling of the valves with respect to each other and the cylinder axis permits the valve faces **84** and **86** to be located immediately adjacent each other so that they can form much of the dome area of the combustion chamber and thus provide a compact chamber.

The intake valve face **84** and exhaust valve face **86** are also offset in transverse direction with respect to the center of the cylinder **24** as is evident in FIGURES 1 and 5 to thus locate the exhaust valve close to the exhaust side of the cylinder head and the intake valve close to the intake side and thereby obtain short intake and exhaust passages. Offsetting the valve faces **84** and **86** transversely of the engine further assists in the achievement of a compact combustion chamber particularly when the valves are arranged to converge toward each other in donwnward direction when the cylinder bank is viewed in end elevation, as indicated by the angle F of FIGURE 1. The intake and exhaust valves are of like lengths and all of the rocker arms are purposely identical so as to be fully interchangeable. As a consequence of this and of the angling of the valves with respect to each other when viewed in the end elevation of the engine, the intake and exhaust push rods likewise converge downwardly toward each other when viewed in the end elevation of the engine, as indicated by the angle G of FIGURE 1, with the exhaust push rod being appreciably longer than the intake push rod.

An important feature of the arrangement is that it requires only a single camshaft with conventional camshaft followers that reciprocate on axes normal to the camshaft axis in the usual manner. Thus the camshaft followers **42**, while technically part of the valve trains, do not have their axes exactly in the planes ABC and DEF in the side view of FIGURE 2. Moreover, since the lower ends of the push rods socket in the camshaft followers **42**, their pivot points will, in fact, move perpendicular to the camshaft axis thus causing the push rods **44** and **70** to swing slightly at the bottom in FIGURE 2 from the planes ABC and DEF during valve operation. I have found, however, that these slight departures from the exact planes are insignificant and without perceptible effect on the operation of the valve trains. The valves **66** and **76** do not depart from the planes ABC and DEF at all, being firmly held therein by guide bushings **88** and **90**. The rocker arm studs **52** and **74** are fixed in the planes ABC and DEF and thus also the mounting pivot points for the rocker arms **50** and **72**. Since ball and sockets mount the rocker arms, they could have a rotative movement in plan elevation however any tendency toward such movement is prevented by the slots **80** and **82** of the guide brackets **78**. For all practical purposes, each valve train therefore lies in a common plane.

While the preferred embodiment of the invention has been described in detail, it is understood that modifications thereto apparent to those skilled in the art may be made that can fall within the scope of the claims which follow.

I claim:

1. In an internal combustion engine of the type comprising an engine block forming a longitudinal bank of cylinders, a camshaft in the block extending along the side of the cylinder bank, reciprocal camshaft followers in the block, a cylinder head on the block, intake and exhaust valve trains carried thereby for each cylinder in the bank, each valve train defining a plane and comprising a reciprocal valve in the head, a rocker arm engaged with the valve, a pivot connection between the rocker arm and the head and a reciprocal push rod having its ends engaged by the rocker arm and a respective camshaft follower; the improvement comprising arranging the planes of the intake and exhaust valve trains of each cylinder to converge toward the cylinder axis and toward each other in downward direction when the cylinder bank is seen in side elevation and arranging said planes to converge toward the cylinder axis and toward each other in camshaft-to-cylinder direction when the cylinder bank is seen in plan elevation.

2. The improvement set forth in claim **1** and including arranging the intake and exhaust valves to converge toward each other in downward direction when the cylinder bank is viewed in end elevation.

3. The improvement set forth in claim **2** and including arranging the intake and exhaust push rods to converge toward each other in downward direction when the cylinder bank is viewed in end elevation.

4. The improvement set forth in claim **3** and including locating the exhaust valves toward the exhaust side of the cylinder bank and the intake valves toward the intake side of the cylinder bank.

5. The improvement set forth in claim **4** and comprising having the intake and exhause valves of substantially the same length, having the intake and exhaust rocker arms identical and interchangeable and having the intake push rod of lesser length than the exhaust push rod.

6. In an internal combustion engine of the type comprising an engine block forming a longitudinal bank of cylinders, a camshaft in the block extending along the bottom of the cylinder bank, reciprocal camshaft followers in the block, a cylinder head on the block, intake and exhaust valve trains carried thereby for each cylinder in the bank, each valve train defining a plane and comprising a reciprocal valve in the head, a rocker arm engaged with the valve, a ball and socket pivot connection between the rocker arm and the head and a reciprocal push rod having its ends engaged by the rocker arm and a respective camshaft follower; the improvement comprising arranging the planes of the intake and exhaust valve trains of each cylinder to converge toward the cylinder axis and toward each other in downward direction when the cylinder bank is seen in side elevation, arranging said planes to converge toward the cylinder axis and toward each other in camshaft-to-cylinder direction when the cylinder bank is viewed in plan elevation, arranging the camshaft followers perpendicular to the camshaft axis and providing guide means on the cylinder head for the upper end of the push rods.

7. The improvement set forth in claim **6** and including arranging the intake and exhaust valves to converge toward each other in downward direction when the cylinder bank is viewed in end elevation.

8. The improvement set forth in claim **7** and including arranging the intake and exhaust push rods to converge toward each other in downward direction when the cylinder bank is viewed in end elevation.

9. The improvement set forth in claim **8** and including locating the exhaust valves toward the exhaust side of the cylinder bank and the intake valves toward the intake side of the cylinder bank.

10. The improvement set forth in claim **9** comprising having the intake and exhaust valves of substantially the same length, the intake and exhaust rocker arms interchangeable and having the intake push rod of lesser length than the exhaust push rod.

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