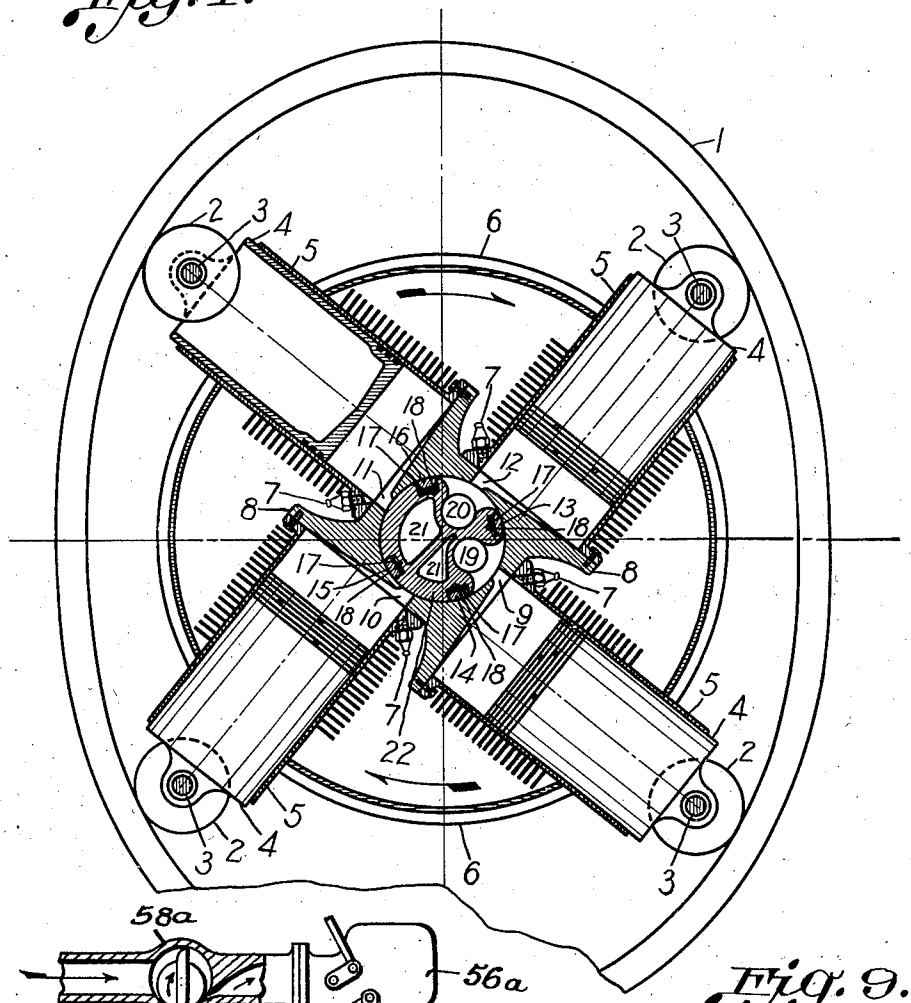
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RADIAL INTERNAL COMBUSTION ENGINE

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Fig. 1.



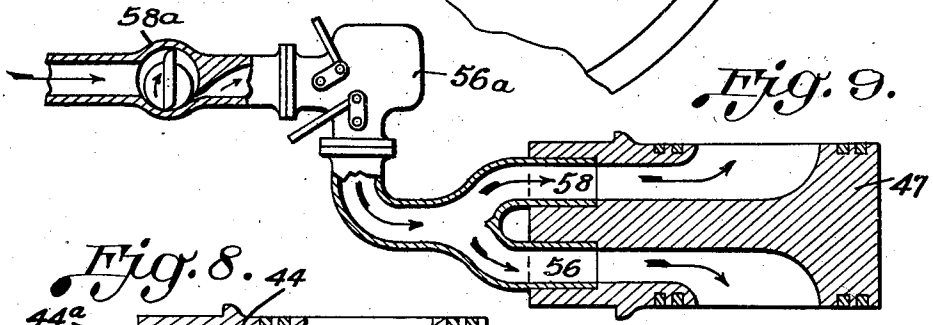
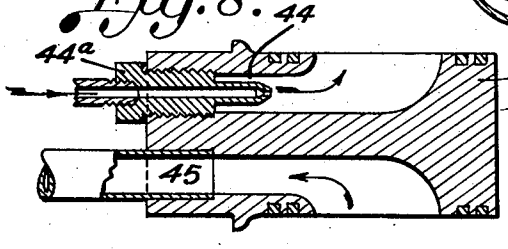


Fig. 9.

Fig. 8.



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RADIAL INTERNAL COMBUSTION ENGINE

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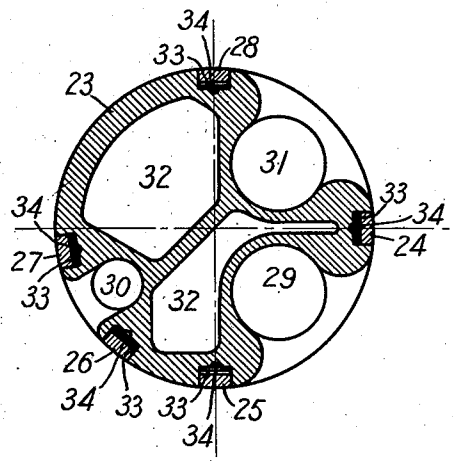


Fig. 2

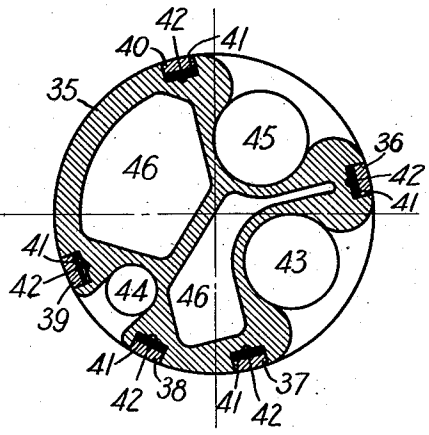


Fig. 3

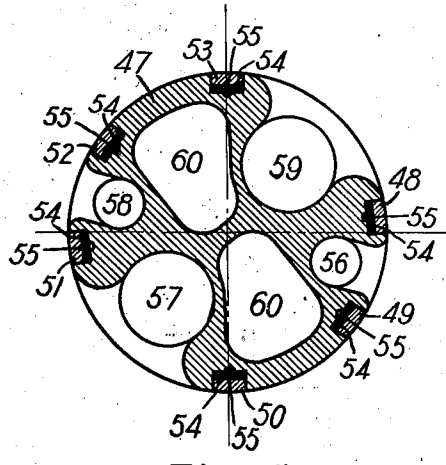


Fig. 4

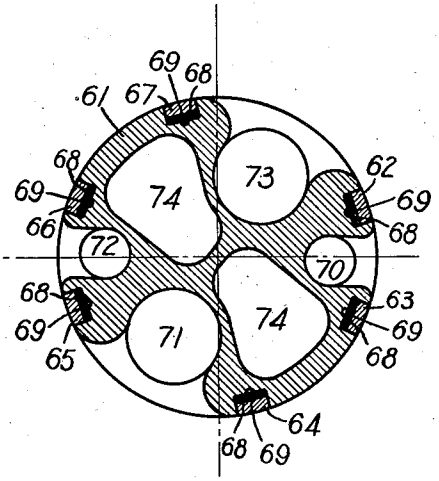


Fig. 5

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RADIAL INTERNAL COMBUSTION ENGINE

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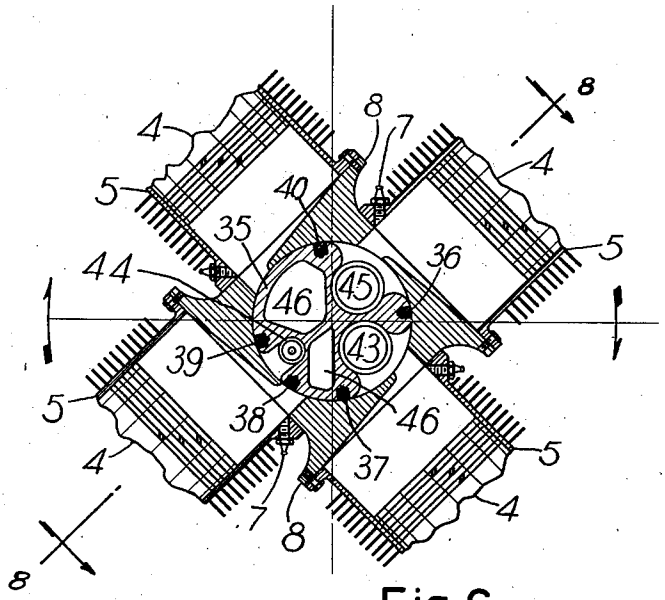


Fig.6

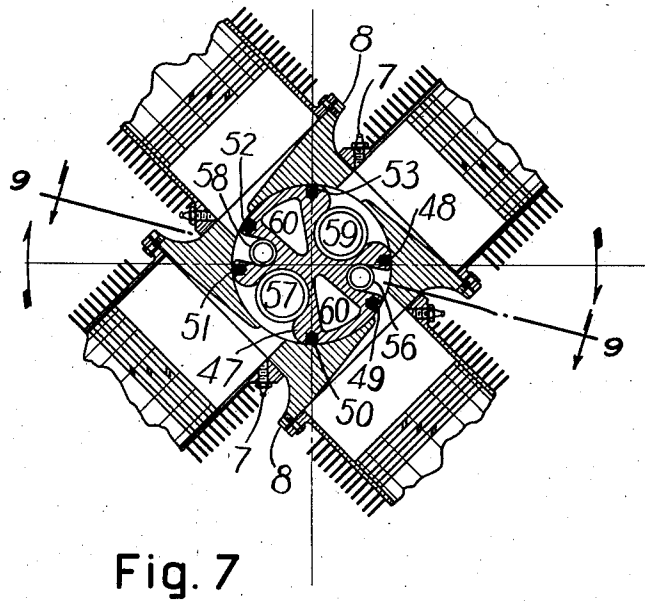


Fig. 7

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Patented Feb. 12, 1935 1,990,660

UNITED STATES PATENT OFFICE

1,990,660

RADIAL INTERNAL COMBUSTION ENGINE

Charles S. McCann, Oakwood, Ohio, assignor of one-half to George B. McCann, Montgomery County, Ohio

Application December 14, 1931, Serial No. 580,875

3 Claims. (Cl. 123—21)

This invention relates to new and useful improvements in radial internal combustion engines, and more particularly to radial internal combustion engines of the type illustrated and described in my United States Letters Patent No. 1,827,094, granted October 13th, 1931.

It is one of the principal objects of my invention to provide a radial internal combustion engine in which the cylinders are offset from a true radial disposition so as to improve the torque characteristics of the engine.

It is another object of my invention to provide a radial internal combustion engine in which a spark plug is placed in each cylinder to facilitate the obtaining of variations in the timing of the ignition.

Still another object of my invention is to provide liquid cooling means for the stationary valve member.

It is another object of my invention to provide means for easily converting my radial internal combustion engine from a gas type to one which is operated on the Diesel principle.

Still another object of my invention is to provide means for easily converting this radial internal combustion engine from one operating on the four cycle principle to one operating on the two cycle principle.

Other important and incidental objects will be brought out in the following specification and particularly set forth in the subjoined claims.

In the accompanying drawings illustrating the different forms of embodiment of my invention, Figure 1 is an end view of the assembled engine, partly in section, with the end plates, supporting frame and rocker arms removed. Figure 2 is an end sectional view of the stationary valve member adapted for use on the Diesel principle when employed with a square rotating hub block.

Figure 3 is an end sectional view of the stationary valve member as designed for use on the Diesel principle when employed with an offset rotating hub block. Figure 4 is an end sectional view of the stationary valve member as designed for operation on the two cycle principle when employing a square rotating hub block. Figure 5 is an end sectional view of the stationary valve member as designed for operation on the two cycle principle, when employing an offset rotating hub block.

Figure 6 is an end view, partly in section, of the central portion of the assembled engine, showing the Diesel valve member within the rotating hub block, with the fuel injection jet inserted in its proper opening in said valve member. Figure 7 is an end view, partly in section, of the central portion of the assembled engine, showing the two-cycle valve member within the rotating hub block, with the high pressure fuel supply pipes inserted in their proper openings in said valve member. Figure 8 is a longitudinal, sectional view of the stationary valve member shown in Figure 3, taken on the line 8—8 of Figure 6. And Figure 9 is a longitudinal, sectional view of the stationary valve member shown in Figure 4, taken on the line 9—9 of Figure 7.

Referring to the accompanying drawings for a detailed description of the different forms of embodiment of my invention illustrated therein, the numeral 1 in Figure 1 designates the main outer cam. This cam is shaped from the polar co-ordinate formula $\rho = c\cos^2\theta - b\sin^2\theta$, in which formula the radius of the cam, rho (ρ), at its shortest radius, or in other words, on its horizontal axis, equals "c", and at its longest radius, or in other words, on its vertical axis, equals "b". Rollers 2 mounted on piston pins 3 secured to the outer ends of pistons 4, roll on the inner surface of the main cam 1.

The pistons 4 reciprocate within finned cylinders 5 which project through a supporting ring 6, and which cylinders are bolted or otherwise attached to the offset rotating hub block 8. Within the bottom portion of each cylinder a spark plug 7 is located for the purpose of igniting the compressed charge of fuel within it. (See Figure 1).

The numerals 9, 10, 11 and 12 designate communicating ports in the rotating hub block 8. Through these ports the gases pass during the intake and exhaust portions of the cycle. The intake portion of the cycle is segregated by means of sealing bars 13 and 14; the compression portion by sealing bars 14 and 15; the expansion portion by means of sealing bars 15 and 16; while the exhaust portion is segregated by means of sealing bars 16 and 13.

Th ends of the four sealing bars 13, 14, 15 and 16 butt up against two of four expanding sealing rings such as the two center sealing rings 28, 28, illustrated and described in my United States Letters Patent No. 1,827,094, granted October 13th, 1931.

The four sealing bars 13, 14, 15, and 16 are forced outwardly into sealing contact with the inner periphery of the rotating hub block 8 by means of sine shaped springs 17, 17, 17, 17 in the bottom portions of the slots, as in the structure disclosed in my aforesaid patent. These sealing bars are lubricated in their respective slots

by means of four oil pressure lines 18, 18, 18, 18, also as shown in said patent.

The fresh gas is fed to the cylinders through the intake opening 19 in Figure 1. The exhaust gases are released from the cylinders through the exhaust opening 20. Both of the openings 19 and 20 are the same as shown in my aforesaid patent.

The two liquid cooling passages 21, 21 as shown in Figure 1 are connected together at one end, so that the liquid may be pumped into one of these openings and out the other opening. In said figure the stationary valve member is designated by the numeral 22.

The only change in design in this motor, except for proportions, to convert it to one of the Diesel type, is to change the stationary valve member to the design illustrated in Figure 2. In this valve member, which will be designated by the numeral 23, there are the two sealing bars 24 and 25 bounding the intake section. Sealing bars 25 and 26 bound the compression division.

The sealing bars which bound the fuel injection section are numbered 26 and 27. Sealing bars 27 and 28 bound the expansion section of the cycle while the sealing bars 28 and 24 bound the exhaust section.

Back of these five sealing bars are outward pressing sine springs 33, 33, 33, 33 and 33. These bars and the inner face of the rotating hub block are lubricated by the pressure oil lines 34, 34, 34, 34 and 34. (See Figure 2). Fresh air is fed to the cylinders through the air intake opening 29.

The fuel is injected by means of a jet, the location for which is designated by the numeral 30. It is not the object of this invention to cover any particular type of fuel injection jet, nor its means of attachment to the stationary valve member. The exhaust outlet is designated by the numeral 31.

The numerals 32, 32 designate liquid cooling chambers similar to the liquid cooling passages in Figure 1.

All of the details of design shown in Figure 2 relate to an engine in which the square rotating hub block is used, the vertical and horizontal center lines coinciding with those of the main cam 1 in Figure 1.

All the details of design shown in Figure 3 are for a case where an offset rotating hub block is used, and are identical in each instance with the design shown in Figure 2. The difference between the structures shown in Figures 2 and 3 is that in Figure 3 the whole assembly is rotated a small amount in a counter-clockwise direction with respect to the fixed center lines, which again correspond with the center lines of the main cam 1 in Figure 1.

In Figure 3, the numeral 35 designates the stationary valve member; the numerals 36, 37, 38, 39 and 40 are the sealing bars; 41, 41, 41, 41, and 41 are the sine pressure springs; 42, 42, 42, 42 and 42 are the oil pressure lines and 43 is the intake opening. The numeral 44 is the space to receive a fuel injection jet 44^a; 45 the exhaust opening and the numerals 46, 46 the liquid cooling passages.

The only change in the design of this motor to convert it to one of the two-cycle type is to substitute for the stationary valve member 35, the stationary valve member 47 in Figure 4. In this figure the numerals 48 and 49 designate the sealing bars bounding the intake portion of the cycle. The sealing bars 49 and 50 bound the expansion section of the cycle, there being no compression portion in this type, the gas pressure being obtained from an outside source. The sealing bars 50 and 51 bound the exhaust division of the cycle, while the sealing bars 51 and 52 bound the second intake portion. The sealing bars 52, 53 bound the second expansion section; and 53 and 48 the second exhaust section. Thus it is seen that in one revolution of the rotating assembly two power impulses are received.

The numerals 54, 54, 54, 54, 54 and 54 designate the outward pressing sine springs in Figure 4, while the numerals 55, 55, 55, 55, 55 and 55 designate the oil pressure lines. The function of these parts has been previously explained.

The numeral 56 designates the intake opening through which the fresh gases pass under fairly high pressure from an outside source; 57 denotes the opening through which the exhaust gases are passed, and 58 refers to the second intake opening. The numeral 59 designates the second exhaust opening; while the numerals 60, 60 refer to the liquid cooling passages.

All of the details of design shown in Figure 4 are for a case where the square rotating hub block is used, and the vertical and horizontal center lines coincide with those of the main cam 1 of Figure 1.

All of the details of design shown in Figure 5 relate to a motor in which the offset rotating hub block is used, and are identical in each instance with the design shown in Figure 4. The difference between the structures of Figure 5 and Figure 4 is that in Figure 5 the whole assembly is rotated a small amount in a counter-clockwise direction with respect to the fixed center lines, which again correspond with the center lines of the main cam 1. (See Figure 1).

In Figure 5 the numeral 61 designates the stationary valve member; the numerals 62, 63, 64, 65, 66 and 67 the sealing bars; 68, 68, 68, 68, 68 and 68 the sine pressure springs; and 69, 69, 69, 69, 69 and 69 the oil pressure lines. The numerals 70, and 72 designate the intake openings; 71 and 73 the exhaust openings and 74, 74 the liquid cooling passages.

Referring to Figure 6, in which the Deisel type valve member is shown inserted within the rotating hub block, in the advanced position of said valve member 35, we will assume the rotating assembly is turning in a clockwise direction as indicated by the arrows in Figure 1. When each cylinder in its turn passes through the lower right quadrant, the air is drawn into it from the air intake passage 43, while the port of the cylinder in the hub block passes from sealing bar 36 to sealing bar 37.

When each cylinder in its turn rotates through the lower left quadrant, the cylinder port in the hub block passes successively from sealing bar 37 to 38, and then to sealing bar 39. Through this whole quadrant, the charge within the cylinder is being compressed by the curvature of the cam 1 moving radially inward. At the proper time in the cylinder rotation through this quadrant, the fuel is injected as shown in Figure 8 into the compressed air within the cylinder by means of the fuel injection jet, which is located within the opening 44 in the valve member 35. Following this, and after the cylinder port has passed the sealing bar 39, the charge is fired at the correct position of the cylinder in its rotation by the spark plugs 7. This occurs while the cylinder is near the horizontal center line, on the left side of the vertical center line.

This fired charge then expands against the

piston head through what is termed the power stroke, while the cylinders are rotating through the third or upper left quadrant, and while the cylinder ports in the hub block are passing from sealing bar 39 to sealing bar 40. The reaction to the force acting against the piston head and thence to the piston roller and against the cam 1, passes in an imaginary line over the intersection of the horizontal and vertical center lines of the engine, and thus causes the rotating assembly to turn in a clockwise direction.

When the cylinders rotate through the fourth or upper right quadrant, the cylinder port in the hub block passes from the sealing bar 40 to the sealing bar 36, and the curvature of the cam 1 forcing the pistons radially inward, causes the burned gases to be exhausted through the exhaust port opening 45 in the stationary valve member 35. This completes the cycle of operation for the engine operating on the Deisel principle. It is understood that a hot point could be substituted for the spark plugs in the cylinders should it be desired not to use spark ignition.

Referring to Figure 7 in which the two cycle valve member 47 is shown inserted within the rotating hub block 8, we will assume the direction of rotation to be clockwise as before.

When each cylinder rotates through the first or lower right quadrant, its hub block port passes successively from the sealing bar 48 to the sealing bar 49, and thence to the sealing bar 50. A combustible gas mixture (Figure 9) under pressure is present in the opening 56, and hence when the port openings in the hub block pass from the sealing bar 48 to the sealing bar 49, a charge of this gas is forced into each cylinder during this part of its rotation. The piston completes its outward stroke when finishing its rotation through this first quadrant. Immediately after the ports pass the sealing bar 49, the charge is fired by the cylinder spark plugs 7, and the rest of the stroke in this quadrant is termed the power stroke.

When the cylinders rotate through the second or lower left quadrant, their hub block ports pass from the sealing bar 50 to the sealing bar 51. Through this quadrant, due to the curvature of the cam 1, the pistons are forced inward radially, and the fired charge is exhausted through the opening 57 in the valve member 47.

When each cylinder rotates through the third or upper left quadrant, its hub block ports pass from the sealing bar 51 to the sealing bar 52, and thence to the sealing bar 53. When these ports pass from the sealing bar 51 to the sealing bar 52, the cylinders receive a charge of combustible gas from the opening 58, where this gas is present under an initial pressure, as is the case in the opening 56. This gas under pressure in the openings 56 and 58 is obtained from a carburetor 56a and the vane type super-charger 58a, which are connected to the stationary valve member 47 as shown in Figure 9. As soon as the ports pass the sealing bar 52, the charge in the cylinders is fired by the spark plugs 7, and the rest of the stroke of the pistons in this quadrant is called the power stroke, as was the case in the latter part of the second quadrant.

During the rotation of the cylinders through the fourth or upper right quadrant, their hub block ports pass from the sealing bar 53 to the sealing bar 48, while the curvature of the cam 1 is forcing the pistons radially inward and the burned gases are exhausted through the opening 59 in the stationary valve member 47.

It is thus seen that when the cylinders rotate through the first and third quadrants, they receive a charge of gas which is fired, producing a power stroke. When the cylinders rotate through the second and fourth quadrants, the burned gases are exhausted.

I do not wish to be limited to the details of construction and arrangement herein shown and described, and any changes or modifications may be made therein within the scope of the subjoined claims.

Having described my invention, I claim:

1. In an engine of the type described, an axial valve member of the combustible gas type, a hub block rotatable around said valve member, cylinders radially arranged in said hub block for communication therethrough with the valve member, pistons reciprocable in said cylinders, a fixed cam having a curved surface, means carried by the outer ends of said pistons for engagement with the curved surface of the cam, and an axial valve member of the Diesel type adapted to be substituted for the combustible gas valve member in the rotatable hub block to convert the engine from one of the combustible gas type to one operated on the Diesel principle.

2. In an engine of the type described, an axial valve member of the Diesel type, a hub block rotatable around said valve member, cylinders radially arranged in said hub block for communication therethrough with the valve member, pistons reciprocable in said cylinders, a fixed cam having a curved surface, means carried by the outer ends of said pistons for engagement with the curved surface of the cam, and an axial valve member of the two cycle combustible gas type adapted to be substituted for the Diesel type valve member in the rotatable hub block to convert the engine from one of the Diesel type to one operated on the two cycle principle.

3. In an engine of the type described, an axial valve member of the two cycle combustible gas type, a hub block rotatable around said valve member, cylinders radially arranged in said hub block for communication therethrough with the valve member, pistons reciprocable in said cylinders, a fixed cam having a curved surface, means carried by the outer ends of said pistons for engagement with the curved surface of the cam, and an axial valve member of the four cycle type adapted to be substituted for the two cycle valve member in the rotatable hub block to convert the engine from one of the two cycle type to one operated on the four cycle principle.

CHARLES S. McCANN.