Oct. 13, 1931. C. S. McCANN 1,827,094

RADIAL INTERNAL COMBUSTION ENGINE

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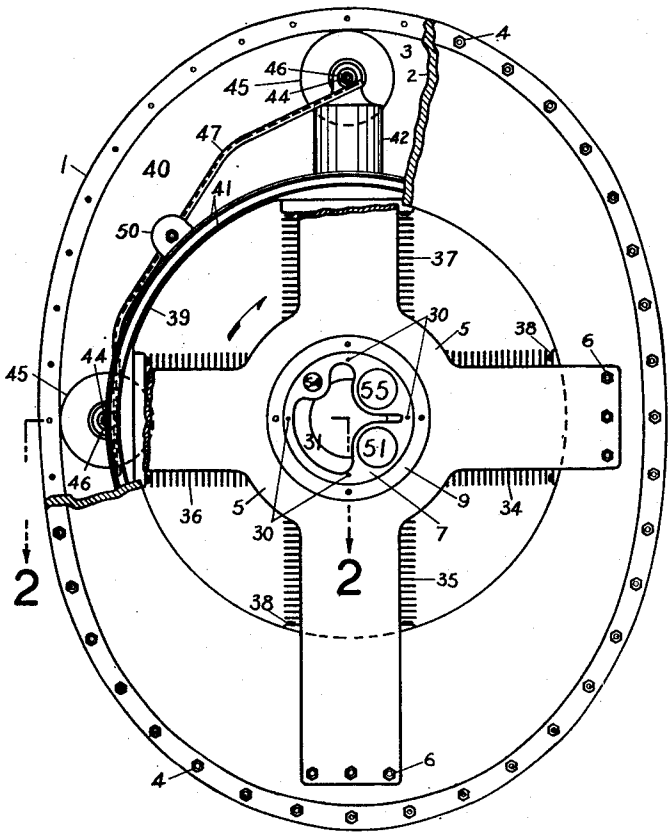


Fig. 1

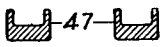


Fig. 11



Fig. 12

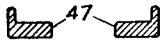


Fig. 9

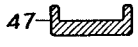


Fig. 10

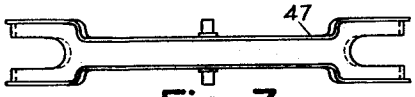


Fig. 7

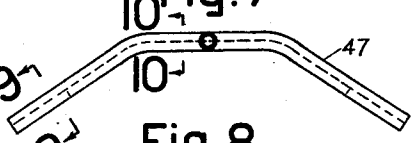


Fig. 8

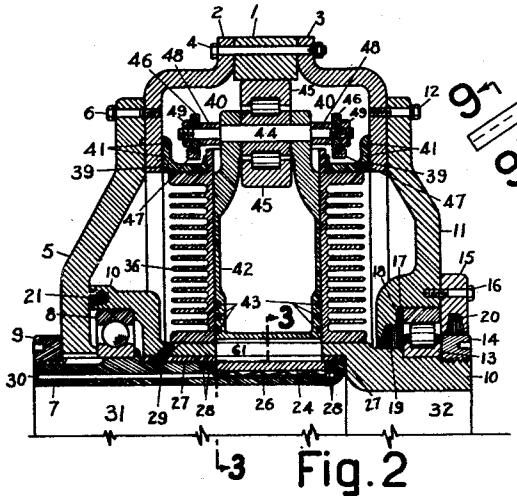


Fig. 2

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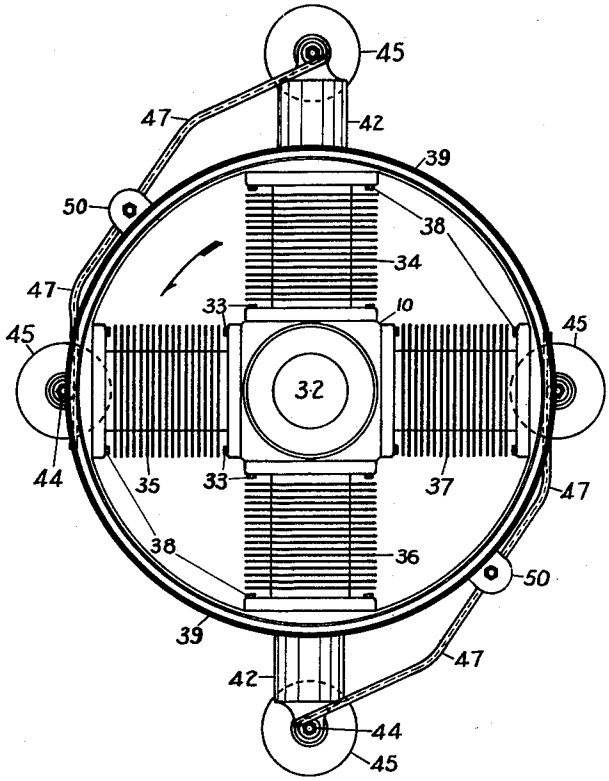


Fig.6

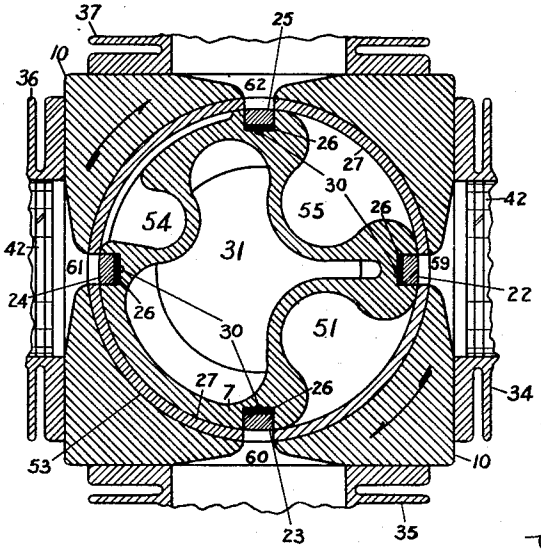


Fig.3

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Oct. 13, 1931. C. S. McCANN 1,827,094

RADIAL INTERNAL COMBUSTION ENGINE

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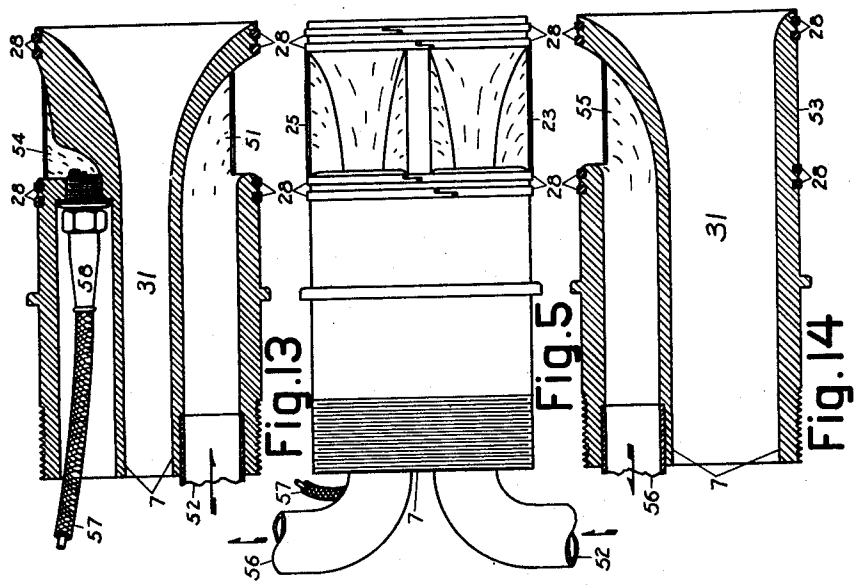


Fig. 13 Fig. 5 Fig. 14

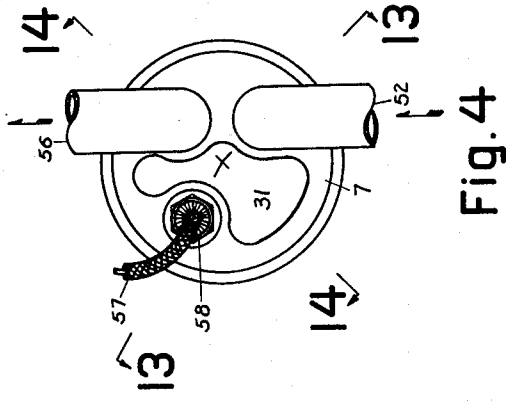


Fig. 4

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Patented Oct. 13, 1931

1,827,094

UNITED STATES PATENT OFFICE

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RADIAL INTERNAL COMBUSTION ENGINE

Application filed February 13, 1928. Serial No. 254,006.

This invention relates to new and useful improvements in radial internal combustion engines.

It is one of the principal objects of the invention to provide an internal combustion engine of the radial type in which moving valves are eliminated and the number of cylinders and other parts are reduced to the minimum.

It is another object of the invention to provide an internal combustion engine of the radial type in which the crank shaft, cam shaft and gears are dispensed with, and its construction, including the ignition system, is simplified, and the intake manifold made less intricate.

My improved engine has a volumetric efficiency which is the same at high speeds as at low speeds, since in the common type of engine there is a sluggish valve action at high speeds and my engine has no moving valves.

My improved engine is simple and compact in construction, positive and economical in operation and effects a saving in weight, space and cost of manufacture as against other types of explosive motors.

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

The preferred forms of embodiment of the invention are illustrated in the accompanying drawings, of which Figure 1 is an end view of the assembled engine partly in section.

Figure 2 is a sectional view taken on the line 2—2 of Figure 1, showing most of the details of the inner construction of the engine.

Figure 3 is a sectional view taken on the line 3—3 of Figure 2.

Figure 4 shows an end view of the central stationary valve member.

Figure 5 shows a side elevation of this central stationary valve member.

Figure 6 is an end view of the rotating assembly, looking from the opposite end to that shown in Figure 1.

Figure 7 is a top or plan view of the rocker arm shown in Figures 1 and 6.

Figure 8 is a side elevation of this rocker arm.

Figure 9 is a sectional view of the same taken on the line 9—9 of Figure 8.

Figure 10 is a sectional view thereof taken on the line 10—10 of Figure 8.

Figure 11 is a sectional view taken on the same line as 9—9 of Figure 8, showing an alternate design of the rocker arm from that shown in Figure 9.

Figure 12 is a sectional view taken on the same line as 10—10 of Figure 8, showing an alternate design of the rocker arm from that shown in Figure 10. The design shown in Figures 9 and 10 is the one incorporated in Figures 2, 6 and 1.

Figure 13 is a sectional view taken through the spark plug chamber and intake port on the line 13—13 of Figure 4.

And Figure 14 is a sectional view taken through the exhaust port and compression quadrant on the line 14—14 of Figure 4.

Referring to the drawings for a detailed description of the forms of my invention illustrated therein, the numeral 1 in Figures 1 and 2 designates the main outer cam. This cam is shaped from the polar coordinate 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". A cam shaped according to this formula will satisfy the necessary conditions, since, when the cylinder assembly is rotated through any given angle in one of the quadrants such as that between the horizontal and vertical axes, one piston and its roller that are in constant contact with the inner periphery of this cam will move outwardly the identical distance that either one of the adjoining pistons and its roller which is also in contact with the inner periphery of the cam moves inwardly. If the first-mentioned piston happens to be moving inwardly, its adjoining piston shall be moving outwardly according to the above conditions.

To the sides of the cam 1, end plates 2 and 3 are secured by bolts 4. (See Figures 1 and 2.)

The supporting frame 5 is secured to the

end plate 2 by means of bolts 6. (See Figures 1 and 2.) This frame 5 supports a central stationary valve member 7, and a bearing 8, by means of a clamping ring nut 9. The bearing 8 supports and guides endways a rotating block 10. (See Figure 2.)

There is another supporting frame 11 which is secured to the end plate 3 by means of bolts 12. This frame 11 contains a bearing 13, which also supports the block 10. This bearing is clamped in place by means of a ring nut 14 and a ring plate 15. The latter is secured to the frame 11 by means of bolts 16. (See Figure 2.)

The bearing 13 together with the flat rings 17 and 18 holds the oil packing material 19 in place in the frame 11. Oil packing material 20 is contained in a groove in the plate 15. Oil packing material 21 is also contained in a groove in the end of the block 10. (See Figure 2.)

The central stationary valve member 7 contains in slots four sealing bars 22, 23, 24 and 25 that are pressed outwardly by means of sine springs 26, 26, 26, 26 into sealing contact with the inner periphery of the block 10 which is lined with a ring 27 that is composed of a graphite compounded metal. (See Figures 2 and 3.) The valve member 7 also contains in grooves four expanding sealing rings 28, 28, 28, and 28, the two center rings butting against the ends of the four sealing bars 22, 23, 24 and 25, as shown in Figures 2 and 5. The ring 27 is secured to the block 10 by means of set screws 29.

The grooves that contain the rings 28, 28, 28 and 28, and the slots containing the four sealing bars 22, 23, 24 and 25 communicate with an oil pressure pump and lines (not shown) through holes 30, 30, 30, 30 in the member 7. (See Figures 1, 2 and 3.)

The member 7 is formed with the air passage 31, and the rotating block 10 has an air passage 32. Through these air passages the air blows, either by natural or forced draft, for the purpose of cooling the valve member 7 and the block 10. (See Figure 2.)

Secured to the rotating block 10 by means of bolts 33 are four identical finned cylinders 34, 35, 36 and 37. (See Figure 6.) The outer ends of these cylinders pass through and are secured by bolts 38 to a rigid ring 39 approximately channel shaped in section. This rigid ring is for the purpose of adding extra support to the cylinders, and to seal the oil within the space 40 and to keep the dirt out of it. (See Figures 1 and 2.) This sealing is done by means of the sides of the ring running in very close proximity to the end plates 2 and 3, and by having ring grooves 41, 41, 41, 41, formed in the sides of the ring that are adjacent to the end plates as shown in Figure 2. The oil pump which forces oil to the holes 30, also will supply oil to the grooves 41, 41, 41, and 41, through holes drilled conveniently through the end plates 2 and 3, opposite these grooves.

Within the four cylinders 34, 35, 36 and 37 are four pistons 42, 42, 42, 42. (See Figures 1, 2 and 6.) At the inner end of each piston are several expanding sealing rings 43, three of which are shown in Figure 2. The outer end of each piston supports a roller pin 44, upon which is mounted the main piston roller 45. The pin 44 also has secured upon it rollers 46, 46, which are in rolling contact with the forked end of a rocker arm 47. (See Figures 1, 2 and 6.) These rollers 46, 46 are located on the pin 44 by means of the spacers 48, 48, and nuts 49, 49. There are two rocker arms 47, 47, each of which is journaled in bearings in a supporting bracket 50 that is secured to the rigid ring 39 midway between each two adjoining cylinders. (See Figures 1 and 6.)

In Figures 11 and 12 I have shown a modified rocker arm 47 terminating in forked ends, with the ends of each fork channeled.

The outer periphery of the valve member 7 between the two center rings 28, 28, is divided into four distinct parts or quadrants by the sealing bars 22, 23, 24 and 25. (See Figure 3.) The periphery of one of these quadrants is formed to define an intake port 51 that extends from the bar 22 to the bar 23 and out to the intake pipe 52, to which the carburetor (not shown) is attached. (See Figures 4 and 5.) The quadrant 53 contains no port and is solid metal from the bar 23 to the bar 24. The third quadrant in clockwise rotation which extends from the bar 24 to the bar 25 is formed as a firing chamber 54. A spark plug 58 is screwed back into its recess, with its firing end projecting into the firing chamber 54. (See Figures 3, 4, and 13.)

The fourth quadrant in clockwise rotation, which extends from the sealing bar 25 to the bar 22, is formed as an exhaust port 55 which communicates with an exhaust pipe 56. (See Figures 3, 4, 5 and 14.) A wire 57 connects the high tension side of a vibrating spark coil (not shown) to the center terminal of the spark plug 58, as shown in Figure 4.

Directly beneath each one of the cylinders 34, 35, 36 and 37 are formed communicating ports 59, 60, 61 and 62, each of which as the block 10 and its assembly revolve around the valve member 7, makes successive registry with the intake port 51, the compression quadrant 53, the firing chamber 54 and the exhaust port 55. (See Figure 3.)

The principle of operation of this engine is as follows:

Referring to Figures 1 and 6, it is seen that as the rotating assembly of Figure 6 revolves, the piston rollers 45 are kept in constant contact with the inner periphery of the main cam 1 by means of the pressure of the rocker arms 47 against the rollers 46. (See Figures 1 and 2.) Thus, in Figure 1, we see that every time

a cylinder revolves through the lower right quadrant, i. e., from the position of cylinder 34 to the position of cylinder 35, the piston and its roller are moved from their extreme inward position, to the extreme outward position. This is called the suction stroke of the piston, since a vacuum is created in the cylinder and its communicating port (the port 59, 60, 61 or 62) through which the explosive mixture is drawn from the intake port 51. (See Figures 1 and 3.) Thus, every time a cylinder revolves through this quadrant, it receives its charge of gas. Every time a cylinder revolves through the lower left quadrant, i. e., from the bar 23 to the bar 24 in Figure 3, a charge of gas is compressed in the cylinder and its communicating port between the piston head and the surface 53, because the piston roller is forced from its extreme outward position to its extreme inward position by its contact with the cam 1. (See Figure 1.) Every time a cylinder revolves through the upper left quadrant, i. e., from the bar 24 to the bar 25 in Figure 3, its piston receives its power impulse by the compressed gas entering the firing chamber 54 through the communicating port in the block 10; and when fired by the spark plug 58 in this firing chamber, it expands back against the piston head.

Between the electrodes of the spark plug 58 a spark is continuously formed while the engine is running, since this spark plug is connected to a vibrating type of spark coil (not shown). The gas expanding against the piston head creates a radially outward force against the cam 1 through the roller 45. (See Figure 1.) The direction of the reacting force of the cam 1 against the roller 45 is perpendicular to the curve of the cam, which line of force is always above and to the right of the engine center line. We thus have a positive driving moment arm which causes the rotating assembly illustrated in Figure 6 to revolve in the clockwise direction shown by the arrow in Figure 1. Every time a cylinder revolves through the upper right quadrant, i.e., from the bar 25 to the bar 22, the roller 45 and its piston are forced by the cam 1 from its extreme outward position to its extreme inward position. Thus the piston forces the burned gases out of the cylinder through its communicating port, and thence through the exhaust port 55 into the exhaust pipe 56. (See Figures, 3, 5 and 14.)

From the above description of the principle of operation, it is seen that during each revolution of each cylinder, its piston makes four strokes, i. e., intake, compression, expansion (firing), and exhaust. Thus, every time a cylinder revolves through the lower right quadrant in Figure 1, it receives a charge of gas, and each time a cylinder revolves through the lower left quadrant, it has its charge of gas compressed. Every time a cylinder revolves through the upper left quadrant, its charge is fired and each time a cylinder revolves through the upper right quadrant, the burned gas within the cylinder is exhausted. Hence, as this engine has four cylinders, it receives four power impulses per revolution, which is the same as the present eight cylinder four cycle engine. I do not desire to be limited to an engine employing four cylinders, since any number of equally spaced cylinders may be used, four being preferred.

This engine contains no moving valves and no distributor system is needed for the ignition system, although one can be used. It has no crank shaft and no cam shaft, and but one spark plug.

In Figure 1 the bottom portion of the space 40, which is that between the ring 39 and the cam 1 and end plates 2 and 3, is used as an oil reservoir, the oil level needed being of course determined by experiment. It is thus seen that as the pistons, rollers, and rocker arms pass through this oil reservoir, they are lubricated by the splashing of the oil. This lubricates everything but the central valve member 7, and the main bearings 8 and 13 (Figure 2) which are taken care of by means of an oil pump (not shown) that pumps the oil from the oil reservoir in space 40.

The rollers 45 which travel in contact with the fixed elliptical cam 1 impart to the block 10 a continuous rotary movement. This motion is uniform since when one set of pistons is forced outward to rotate the block 10, a corresponding set is moved inward by the cam to exhaust the burnt gases.

My internal combustion engine is so constructed that all of its necessary parts are perfectly balanced in any of their different positions. This eliminates the necessity of additional balancing means and promotes a smoothly running motor.

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, a fixed axial valve member formed with an irregularly curved periphery to provide four quadrants, one quadrant formed to provide an intake space, the next quadrant a compression surface, the next quadrant an explosion chamber and the next quadrant an exhaust recess, a hub block free to rotate around said fixed member, a lining ring in said block, and containing four equally spaced holes, radial cylinders arranged on said block over said holes and through which they are open to said quadrants, pistons reciprocable in said cylinders, contact means on the outer ends of said pistons, a fixed cam having a curved surface against which the

contact means bear, the periphery of said fixed member formed with grooves on the lines separating said quadrants, and sealing bars in said grooves for engagement with the lining ring in said block for the purpose specified.

2. In an engine of the type described, an axial valve member, a hub block rotatable around said valve member, radial cylinders arranged in said hub block and open through it to 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 said cam, one fourth of the periphery of said valve member being a continuous curve to provide a gas compression means, the next quadrant being formed with a recess to provide an explosion space, the next quadrant formed with a larger recess to provide an exhaust space, and the next quadrant formed with a deep, wide recess to provide a gas intake space.

3. A valve assembly comprising an axial stationary valve member, a hub block rotatable around said member, the latter formed with slots, sealing bars in said slots, a lining ring within said block, and sine springs for forcing said bars into sealing contact with the lined inner periphery of the block.

4. A valve assembly comprising an axial stationary valve member formed with an air passage, and a hub block formed with an air passage, rotatable around said valve member, said passages adapted to co-operate to receive air for cooling the valve member and the hub block.

In testimony whereof I have hereunto set my hand this 10th day of February, 1928.

CHARLES S. McCANN.