W. E. LAIRD.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAY 27, 1919.

1,418,875. Patented June 6, 1922.

3 SHEETS—SHEET 1.

Fig. 1.

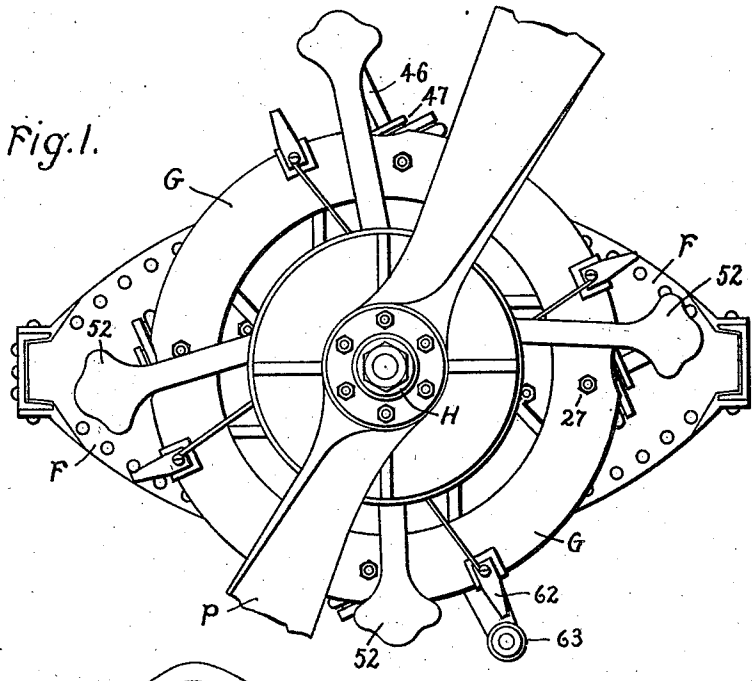
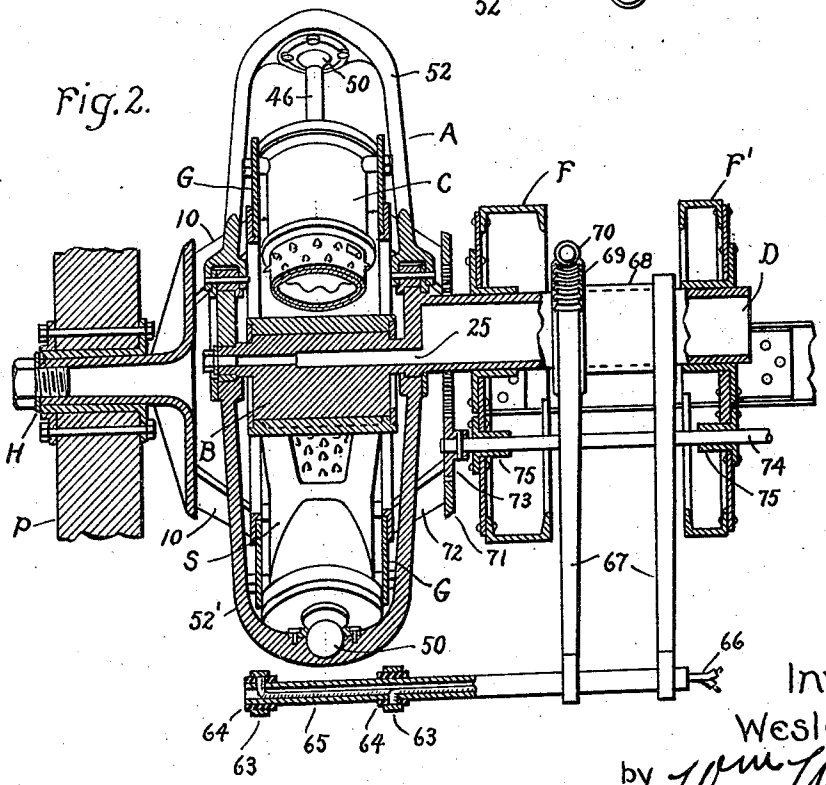


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

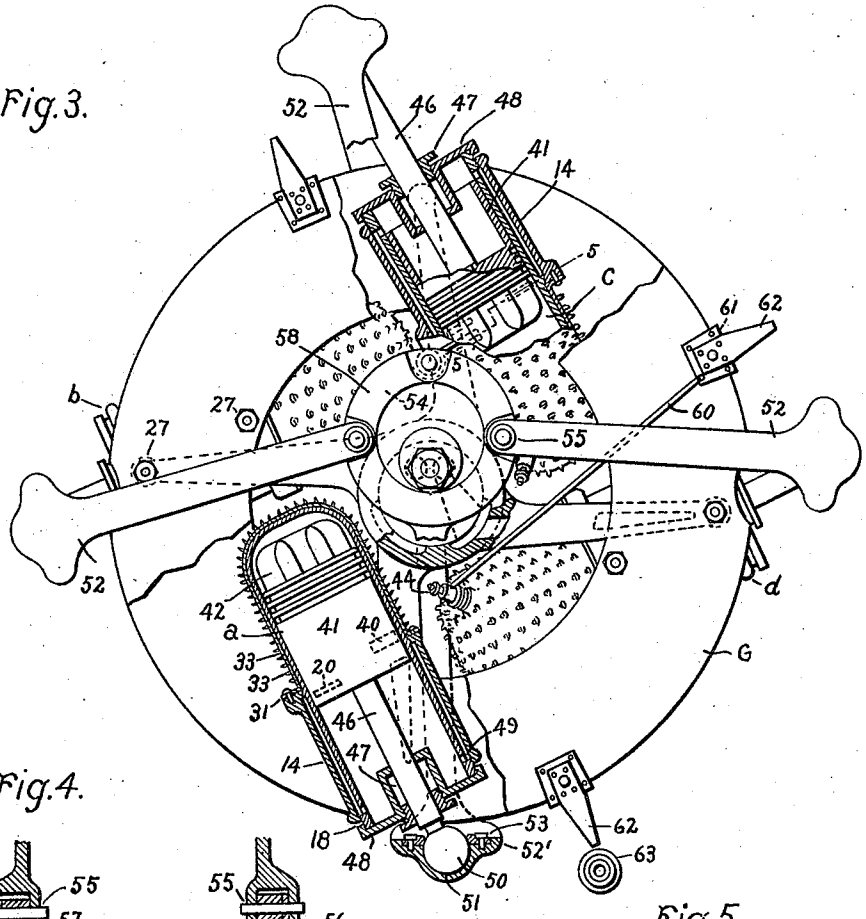


Fig. 4.

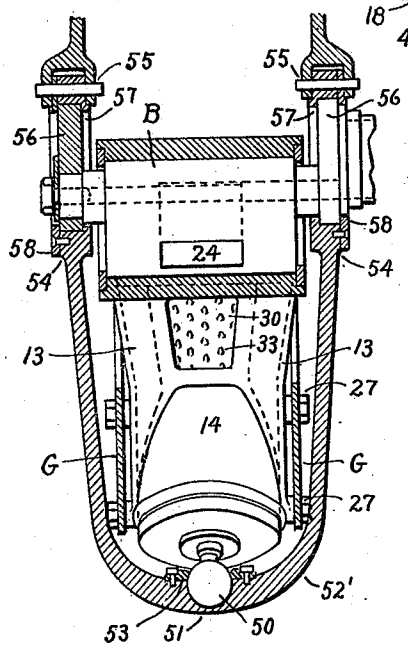
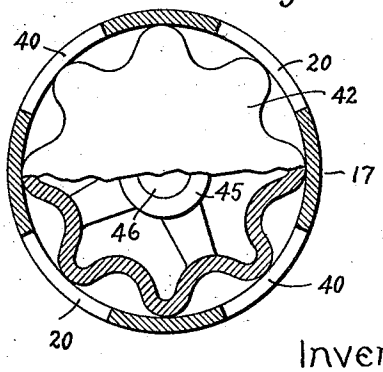


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

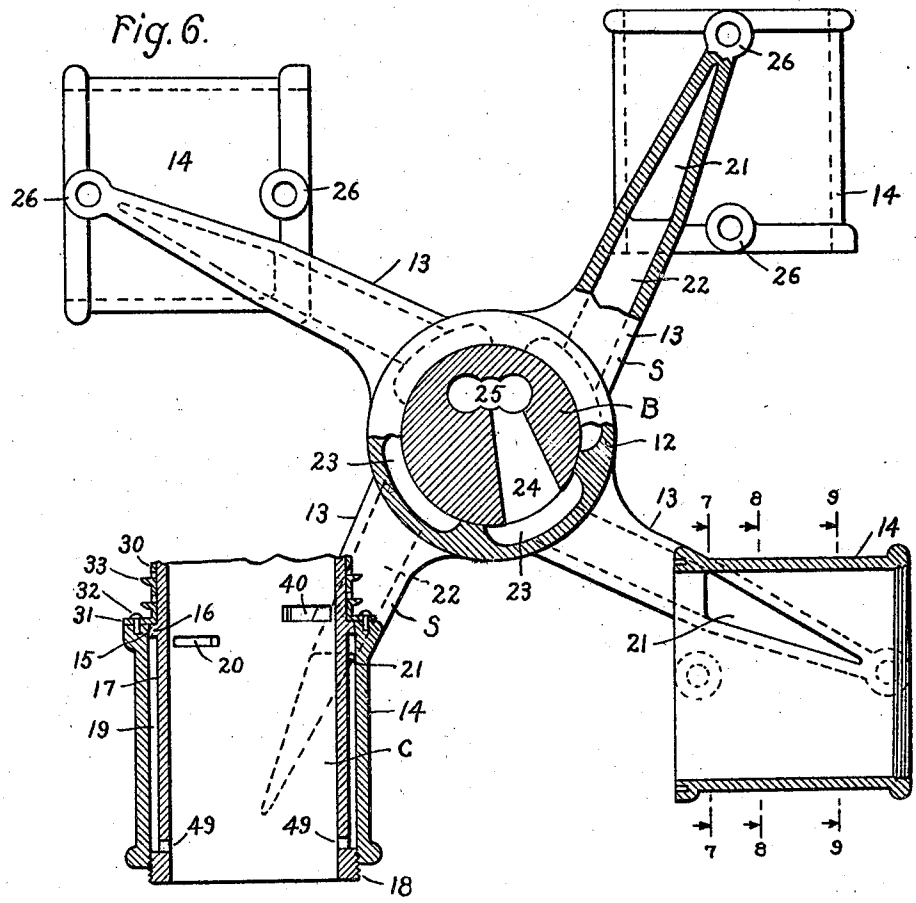


Fig. 7.

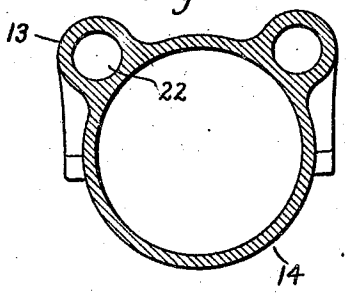


Fig. 8.

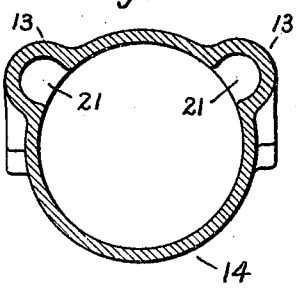
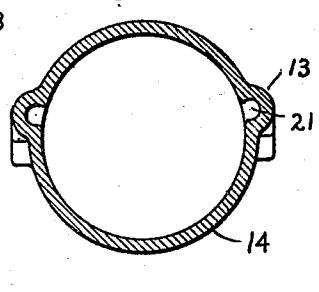


Fig. 9.



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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,418,875. Specification of Letters Patent. **Patented June 6, 1922.**

Application filed May 27, 1919. Serial No. 300,045.

To all whom it may concern:

Be it known that I, WESLEY E. LAIRD, a citizen of the United States of America, residing at Pittsfield, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to internal combustion engines and has for its object an improved arrangement and disposition of parts resulting in a simple, rugged and economically manufactured engine.

More specifically my invention relates to internal combustion engines of the rotary type and has for its object an arrangement which is not only rugged and economical but which is adapted for engines developing large power at high speeds as well as engines of lower ratings.

In rotary internal combustion engines, or those in which the cylinder-structure revolves, it has been found that there are critical values of the speed and the radial length which it is permissible to swing. These values the designer must not exceed in producing engines of large power, because they introduce into the engine structure unsafe mechanical strains.

In the practice of my invention I have overcome these limitations by an arrangement in which the main centrifugal strains are removed from the periphery of the revolving parts. This I accomplish by mounting the cylinders near the center of the revolving structure arranged in a manner having the pistons so positioned as to transmit their thrust outwardly in the first instance.

In the further carrying into effect of my invention, I have constructed the cylinder, its mounting and accessories in a novel manner which lends itself very expeditiously to manufacturing.

Further objects and advantages of my invention will be ascertained from the following detailed description when taken in connection with the accompanying drawing in which:

Fig. 1 shows a front elevation of one embodiment of my invention as applied to the propelling of aircraft. Fig. 2 shows a view partly in section and partly in elevation taken in a generally vertical plane perpendicular to that of Fig. 1. Fig. 3 is an enlarged detail view similar to Fig. 1 but having parts broken away while others are shown in section in order to more clearly disclose the structure involved. Fig. 4 is a somewhat enlarged cross-sectional view in a plane passing through the axis of rotation of my engine. Fig. 5 is a cross-section taken through a mid-portion of a cylinder on line 5—5 in Fig. 3. Fig. 6 is a cross-section of the rotating spider employed in my invention for carrying the cylinders; and Figs. 7, 8 and 9 are sections respectively taken on the lines 7—7, 8—8 and 9—9 respectively in Fig. 6.

Referring now to the drawings, and to Figs. 1 and 2 in particular, A denotes generally the engine, which comprises cylinders C mounted in a spider S arranged to turn about the main journal B. The main journal B is secured to and preferably formed integrally with the hollow stud D which is rigidly supported in some convenient supporting frame shown at F and F′; which frame may be as here represented a portion of the body of a vehicle to be propelled, for instance an aeroplane.

For reasons explained hereinafter more fully in detail I find it expedient to secure guard rings, such as shown at G to the cylinders both in front of and in the back thereof. These guard rings turn with the cylinders and constitute a convenient means to which may be attached the motion transmitting mechanism. As illustrated, when propelling an aeroplane this mechanism comprises the hub H carrying the propeller P; the hub being supported from the ring G by means of arms 10 and is coaxially arranged with respect to the journal B.

The spider S, for carrying the cylinders, as is clearly shown in Fig. 6 comprises a bearing portion 12 surrounding and turning upon the journal B, from which spider radiate the tubular arms or webs 13. These arms or webs merge into and terminate in the cylindrical jackets 14 formed to receive and support the cylinders C. The cylinders C, here shown as four in number although obviously any convenient number may be employed, are supported in these jackets 14 with their heads pointing inwardly and with their axes each respectively making angles with a radius of the spider.

These jackets 14 have one end formed internally with a slight conical bevel, shown at 15 to engage with and retain the collar 16 formed integrally on the exterior of the cylinder wall 17. The other end of each

jacket 14 is threaded to engage with a corresponding thread on the flanged end 18 of the cylinder wall 17. There is thus provided, as shown, a slight annular clearance space 19 between the interior wall of the jacket 14 and the exterior of the cylinder wall 17. This annular space 19 provides a convenient passage for the supply of explosive or charging mixture to the inlet ports 20, shown in Fig. 6 as opening just below the collar 16, since my engine is designed for two cycle operation.

In order that charging mixtures may be fed to the space 19, elongated openings 21 are formed in the wall of jacket 14 communicating with passages 22 in the tubular arms 13, which passages in turn communicate with the chambered recesses 23 formed in the interior bearing surface of the bearing 12. One of these recesses 23 corresponds to each jacket 14 and is adapted to successively communicate with the passage 24 somewhat radially disposed in the journal B. The passage 24 connects with the axial passage 25, which latter passage connects with the interior of the hollow stud D to which the explosive or charging mixture is fed from any convenient source, for instance a carburetor (not shown).

On the exterior of the jackets 14 are formed bosses 26 which serve as convenient supports for the guard rings G, which are shown in Fig. 3 as secured thereto by means of bolts 27.

Over the head of each cylinder C is drawn a jacket 30, formed in any convenient manner as by a die, of sheet metal having high thermal conductivity. The lower rim 31 of this jacket is secured to the jacket 14 by means of pins or screws 32. The jacket 30 is preferably formed with small upstanding fins 33 which assist in the cooling of the cylinder C.

The cylinder C, which has the inlet ports 20, is also provided with exhaust ports 40 in a different plane to the ports 20 so that they open to the atmosphere directly through the cylinder wall 17 just above the collar 16. The ports 20 and 40 are preferably placed in alternate quadrants as clearly indicated in Fig. 5. Ports 40 are hence oppositely disposed so that currents of air set in motion by movement of the cylinders in the atmosphere consequently assist in the scavenging. If the port on the rear sides of the cylinders is made larger than the front ones, it will assist rotation. In each cylinder reciprocates a piston 41 provided with a corrugated head 42 adapted to extend well into the firing chamber 43, as shown in Fig. 3, in which chamber the explosive or charging mixture is ignited by means of spark plugs 44; a pair of spark plugs preferably being provided for each chamber.

From a hub 45 (see Fig. 5) in the centre of the piston extends the piston rod 46 which snugly passes through a packing gland 47 formed in the closure 48 for the otherwise open end of the cylinder C; the closure 48 being also in threaded engagement with the flange 18 on the cylinder wall as shown.

In addition to the ports or openings 20 and 40 in the cylinder wall 17, there is also provided the openings 49 just above the flange 18 so that they communicate with the annular space 19. This permits the charge of explosive mixture to be drawn into the chamber under the piston through the openings 49 by the up-stroke of the piston, in the well known fashion of two cycle engines.

The piston rods 46 each terminate exteriorly of the cylinder C in a ball 50 formed to engage with a corresponding spherical recess 51 in each of the bail-shaped connecting rods 52. The ball is retained in this recess by means of a suitably secured ring, such as shown at 53. In this manner is formed what is in reality a universal joint between the piston rods 46 and the connecting rods 52, so that each piston is free to rotate about its axis if need be. The particular connecting rod, denoted 52′ in Figs. 3 and 4, differs from the others in that it is made integral with the crank rings 54. The other rods 52 are all pivoted thereto as shown at 55. Rod 52′ will be referred to as the "mother rod."

The crank rings 54 engage with and turn upon cranks or discs 56 eccentric to the journal B, and are held in place by shoulders 57 formed about one edge of each crank ring on one side and by the overhanging rings or keepers 58 on the other side. The rings or keepers 58 are shown as secured in place by screws but obviously any convenient means for securing them in place is sufficient.

The cylinders C are each arranged so that its axis makes an acute angle with a radius of the spider S. This angular disposition of the cylinders permits the cylinder-masses to be fitted closely in about the axis of rotation so that high centrifugal strains in the revolving parts are thereby avoided. The heads of the cylinders are preferably made to point in the direction of rotation since in this manner I get a diminishing angle between a piston rod 46 and a connecting rod 52 during the power stroke, which diminishing angle in large measure compensates for the offset arrangement of the cylinders.

Each spark plug 44 is connected by conveniently disposed wires 60 to insulating segments 61 on the guard rings G; there being four segments on each guard ring. These insulating segments 61 on rings G are each provided with a conducting blade 62, which serves as the commutator for supplying the ignition to the cylinders C in proper se-

quence. These conducting blades 62 act to draw an electric charge from one of the rings 63 as it rotates past such rings.

The rings 63 as shown in Fig. 2 are mounted on spaced insulating collars 64 carried by the tube 65. This tube has in it electrical conductors 66 leading from suitable sources of electromotive force (such as a magneto and battery) supplying the current for ignition. The tube 65 is held in position by means of two radius rods 67 projecting from and turning with the sleeve 68, which is journaled on the stud D. An upstanding rib 69 on the sleeve 68 is conveniently formed with teeth adapted to engage with the worm 70. By rotating worm 70, the tube 65 can be moved one way or the other through a limited arc of a circle. The point in the rotation of a cylinder where the spark for igniting the explosive mixture in a cylinder can in this manner be moved, so that the firing is thus advanced or retarded as may be desired.

Suspended from the rear guard ring G, is the annular plate 71, secured in concentric relation thereto by means of arms 72, precisely as is hub H on the front guard ring G by means of arms 10. This annular plate 71 has internal gear teeth adapted to engage with the spur gear 73 carried by shaft 74 journaled in suitable bearings 75 conveniently located on the frame F. The shaft 74 may be conveniently connected to a magneto or to a starting device.

The arms 10 and 72 are preferably somewhat web-shaped and are arranged to have a fan action when rotating in order to draw in air and supply it to the central openings in the guard rings G. The air fed into this inner central portion of the guard rings G by the rotation of the engine, is subsequently impelled by centrifugal force to move rapidly out over the cylinders C and cool them. It is thus seen that the arrangement of the hub H, and annular plate 71 on guard rings G cooperate to provide a forced air circulating means for cooling the engine.

The operation of my engine is as follows:

Let us assume that there is a charge of explosive mixture compressed under the piston 41 in the cylinder in the position marked *a* in Fig. 3. This cylinder is about to draw a spark from the rings 63 as it is rotated clockwise. When the spark is drawn the mixture in the cylinder explodes and the piston 41 begins its power stroke, the rotation continuing in the clockwise direction. When the cylinder has reached position *b* in Fig. 3, the power stroke is about half completed; the angle between the piston rod 46 and connecting rod 52 now being very small.

When the cylinder has reached position *c* in Fig. 3, the power stroke has been completed. The exhaust ports 40 have not only been uncovered so that products of combustion may escape but the inlet ports 20 have also been uncovered and communication established with ports 49 which are not covered by the piston in its limiting position here shown.

While the cylinder is rotating from position *c* to *d*, the newly admitted charge above the piston 41 is being compressed preparatory to being ignited for another power stroke. When position *d* is reached the annular space 19 is placed in communication with the supply passage 25, through tubular passages 13 by the uncovering of passage 24 as the bearing portion 12 rotates. (See Figs. 3 and 6.)

The now partially evacuated space under the piston 41 creates a strong suction quickly to draw another charge of explosive mixture from the source of supply (such as the carburetor previously mentioned) as the cylinder rotates from position *d* to *a*.

Any suitable lubricating system for the engine of my invention may be employed, but as the lubricating system is not a part of my present invention, its showing has been omitted from the drawings in the interest of clearness.

The provision of a pair of spark plugs 44, one on each side of a cylinder, and each supplied with current independently from a commutating segment on the guard ring G on its side of the engine provides a rugged, durable and very sure ignition mechanism.

The use of bail-shaped connecting rods also insures a balanced transmission of power to the cranks, which automatically insures the alignment of the connecting rods.

While I have here shown a preferred embodiment of my invention which is at present the best means known to me for carrying my invention into effect, I would have it understood that this is merely illustrative in compliance with the patent statutes and that I do not mean to be limited to the precise details here shown, nor restricted in the choice of recognized equivalents except as defined in my claims hereunto annexed.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an internal combustion engine, the combination with a stationary member having a journal and two crank portions, of a rotating member turning about said journal portion and provided with cylinders having their axes angularly inclined to the radii of said rotating member, the heads of said cylinders being disposed adjacent the central portion of said rotating member, the piston rods thereof projecting away from said central portion, and a U-shaped connecting rod astride each piston rod having a universal connection therewith arranged to transmit equal portions of the power generated in each cylinder stroke to each crank portion.

2. In an internal combustion engine, the combination with a stationary member having a journal and crank portions, of a rotating member turning about said journal portion and provided with cylinders having their axes angularly inclined to the radii of said rotating member, the heads of said cylinders being disposed adjacent the central portion of said rotating member and pointing in the direction of rotation, the piston rods thereof projecting away from said central portion and terminating in a ball, and bail-shaped connecting rods provided with sockets in their central portions to receive said balls, said last mentioned rods being connected to transmit power to said crank portions.

3. In an internal combustion engine, the combination with a stationary member having journal and crank portions, of a rotating member provided with supporting jackets and power generating cylinders disposed therein and arranged in offset position and having closed heads, their firing heads being disposed adjacent said journal portion; said rotating member turning about said journal portion and formed to cover and uncover the ports supplying explosive mixture to said closed cylinders in the course of its rotation, and means for transmitting power to said rotating member.

4. In an internal combustion engine, the combination with a stationary member having a journal and crank portions and provided with passages adapted to feed the supply of explosive mixture, of a rotating member provided with jackets having their axes angularly inclined to the radii of the rotating member, said jackets having passages arranged to communicate periodically with said supply passages in the course of a revolution of said rotating member, ported cylinders secured in said jackets, and means for transmitting the power generated in said cylinders to said crank portions.

5. A rotating member for internal combustion engines of the two-cycle type, comprising a central journal portion formed to serve as a valve controlling the supply of explosive mixture, web portions provided with passages to conduct away the charge of explosive mixture released by said valve action, and jackets arranged for supporting the cylinders, for receiving said charge, and for accommodating the transfer of the charge from one portion of the cylinder to another.

6. The combination with a rotating member for internal combustion engines provided with annular jackets, of cylinders provided with flanges to engage the walls of said jackets and support the cylinders in said jackets in spaced relation thereto, and thermally conducting jackets drawn over the projecting ends of each cylinder also supported by said first named jacket.

7. In an internal combustion engine, the combination with a ported cylinder designed for two-cycle operation, of a piston having a closed head provided with outside corrugations projecting into the combustion chamber, a piston rod rigidly secured in said piston and a power transmitting connection having a ball and socket connection with said piston rod, whereby said piston is free to rotate but will always provide a deflecting portion for the incoming charge adjacent an inlet port.

8. In an internal combustion engine, the combination with a stationary member, of a rotating member, power generating cylinders carried by said rotating member, a guard-ring secured to said cylinders on each side of the common axial plane, and accessory members suspended from said rings and arranged to cooperate therewith in producing a fan action when rotating to force cooling air over said cylinders.

9. In an internal combustion engine, the combination with a supporting member, of a cylinder provided with flanges to engage with said member, and a thermally conducting jacket drawn over the head of said cylinder and in intimate contact therewith and retained in place by said supporting member.

10. In an internal combustion engine, the combination with a supporting member, of a cylinder secured thereon, a piston having a piston rod rigidly connected thereto, and a U-shaped connecting rod arranged to straddle said piston rod and having a universal-joint connection to said piston rod.

11. In a two-cycle internal combustion engine, the combination with an annular supporting member, of a cylinder secured thereto and formed to have its inlet ports disposed in two opposite quadrants in one plane and its exhaust ports in the alternate opposite quadrants in another plane of the wall of the cylinder; said exhaust ports being arranged to exhaust directly to the atmosphere in the line of rotation, one of said ports leading, the other following, whereby relative movements of the cylinder and the air of the atmosphere assist in scavenging.

In testimony whereof I, hereunto affix my signature.

WESLEY E. LAIRD.