M. A. TIPS.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED OCT. 11, 1917.

1,306,035.

Patented June 10, 1919.

5 SHEETS—SHEET 1.

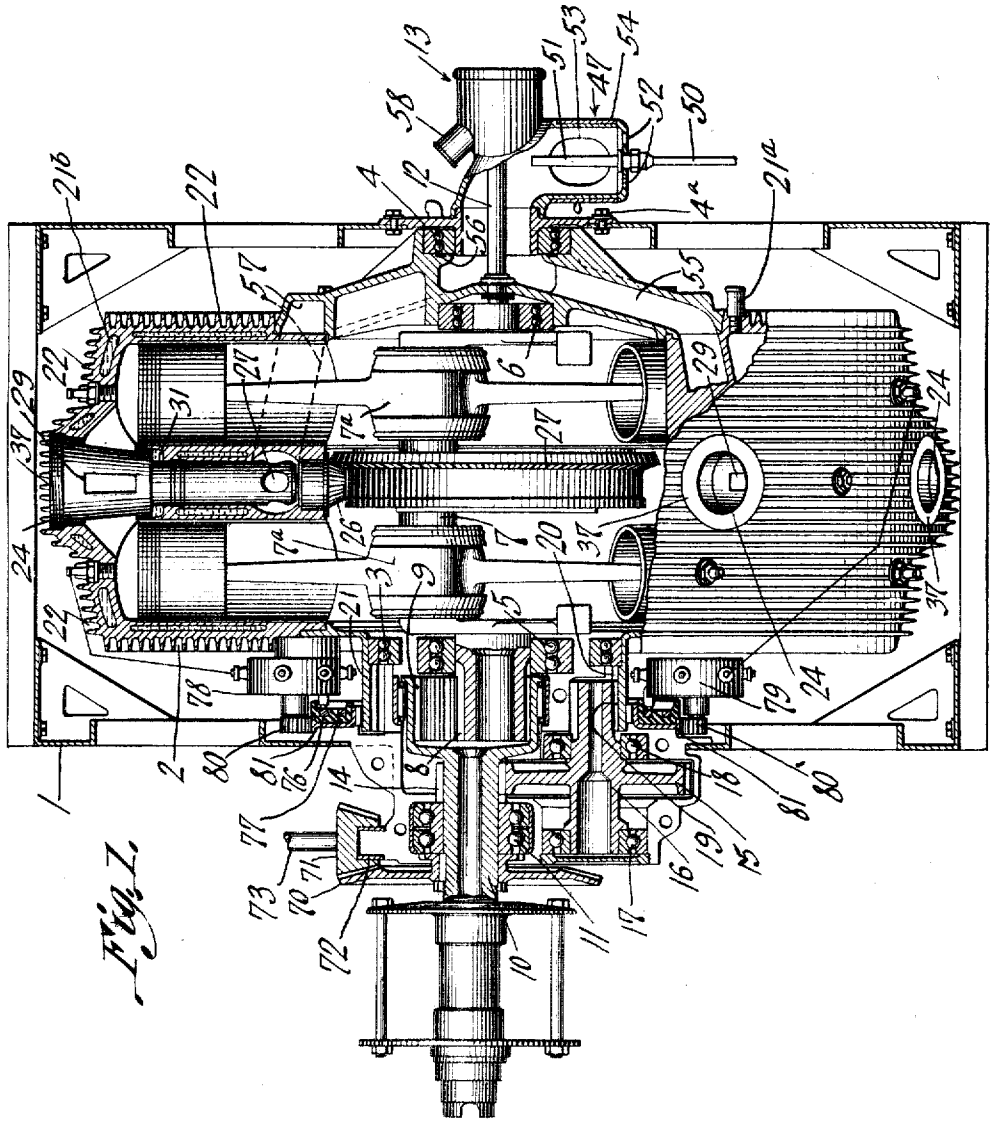

Fig. 1.

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5 SHEETS—SHEET 2.

Fig. 11.

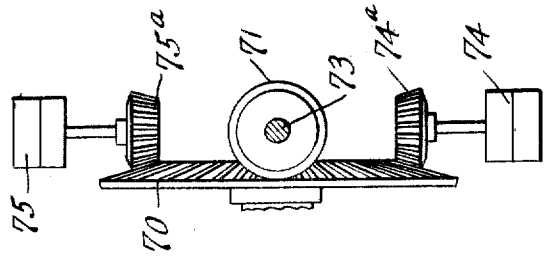
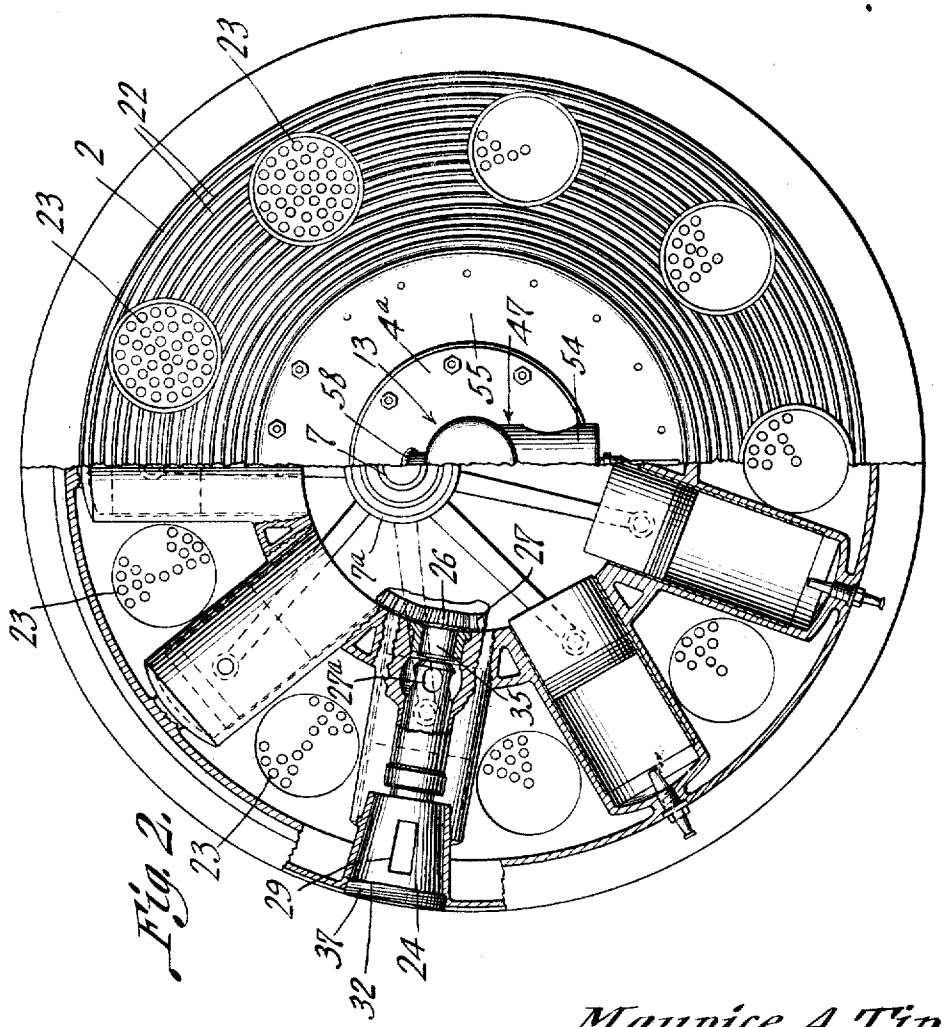


Fig. 2.



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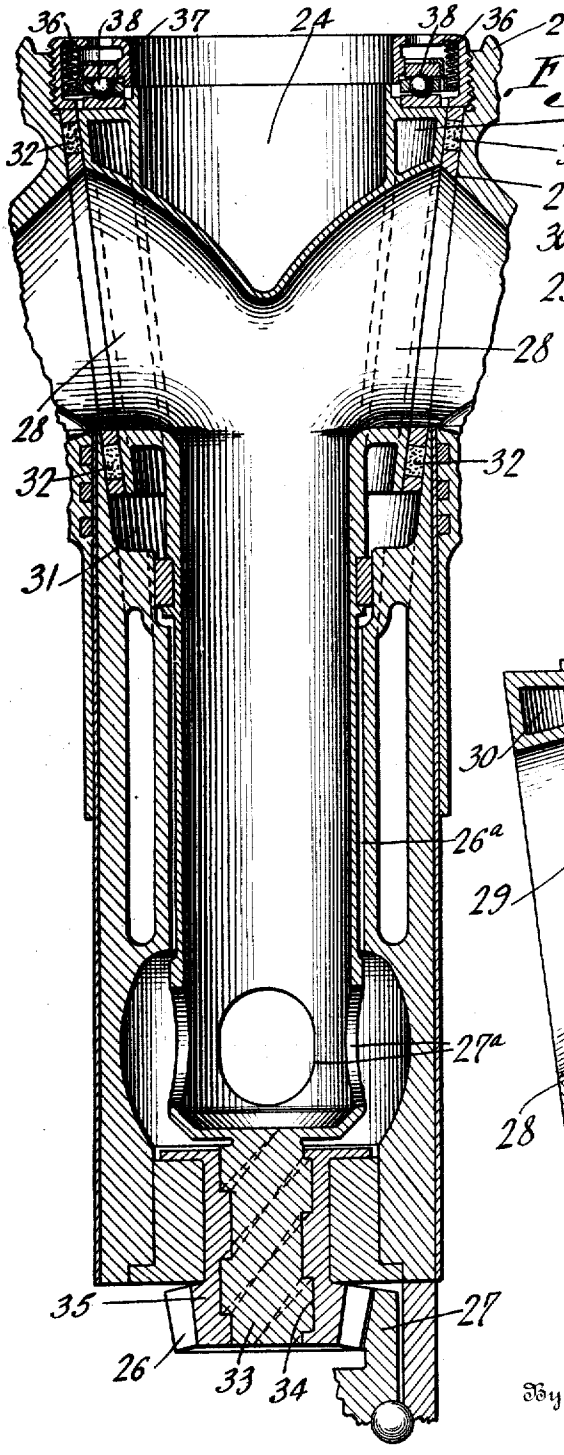

Fig. 3.

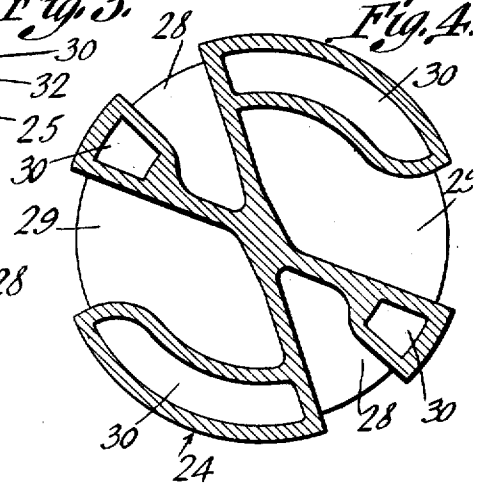

Fig. 4.

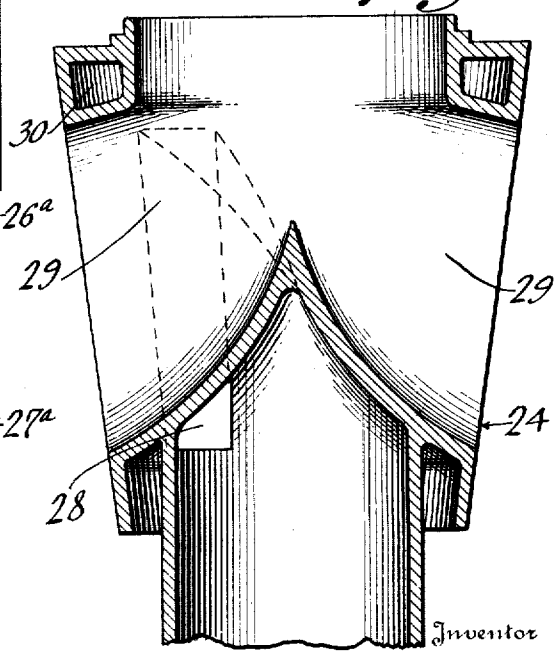

Fig. 5.

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5 SHEETS—SHEET 4.

Fig. 6.

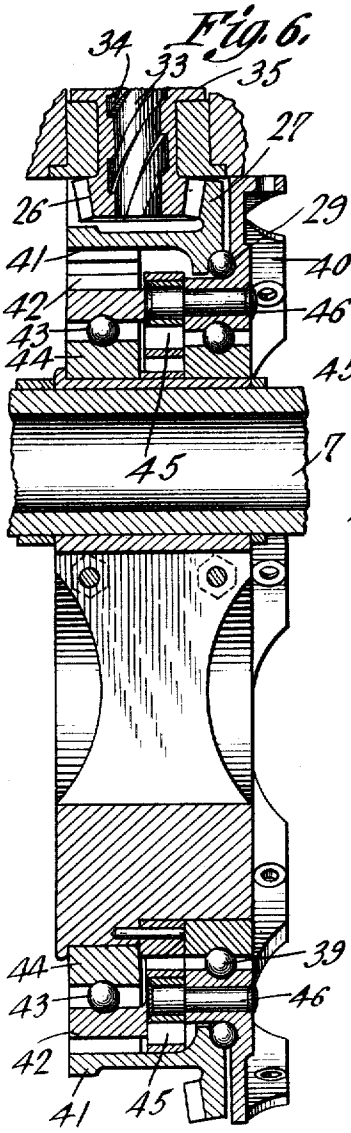


Fig. 7.

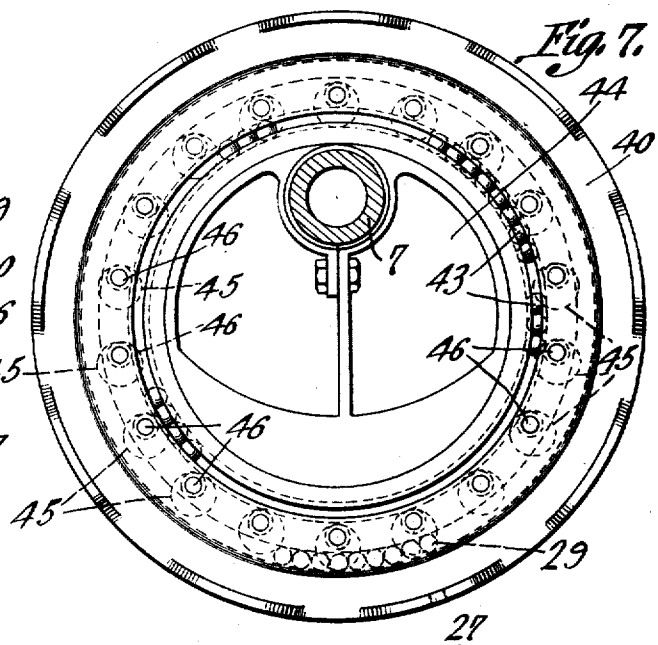
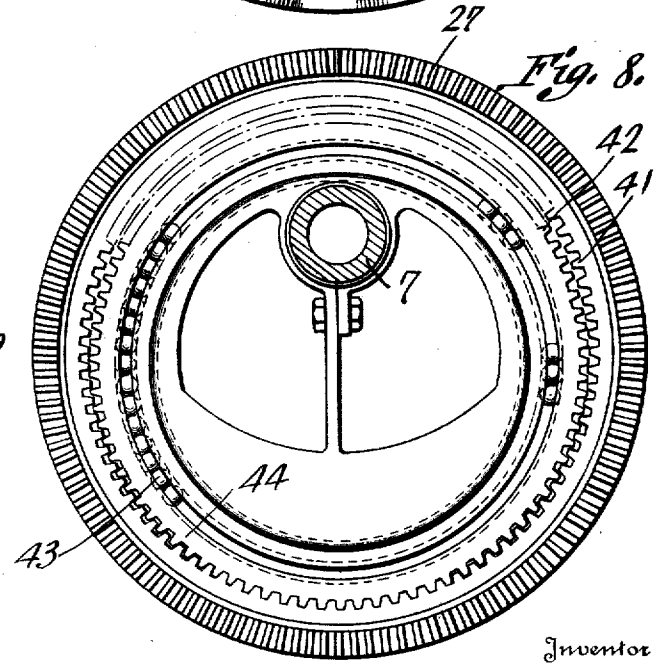


Fig. 8.



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5 SHEETS—SHEET 5.

Fig. 9.

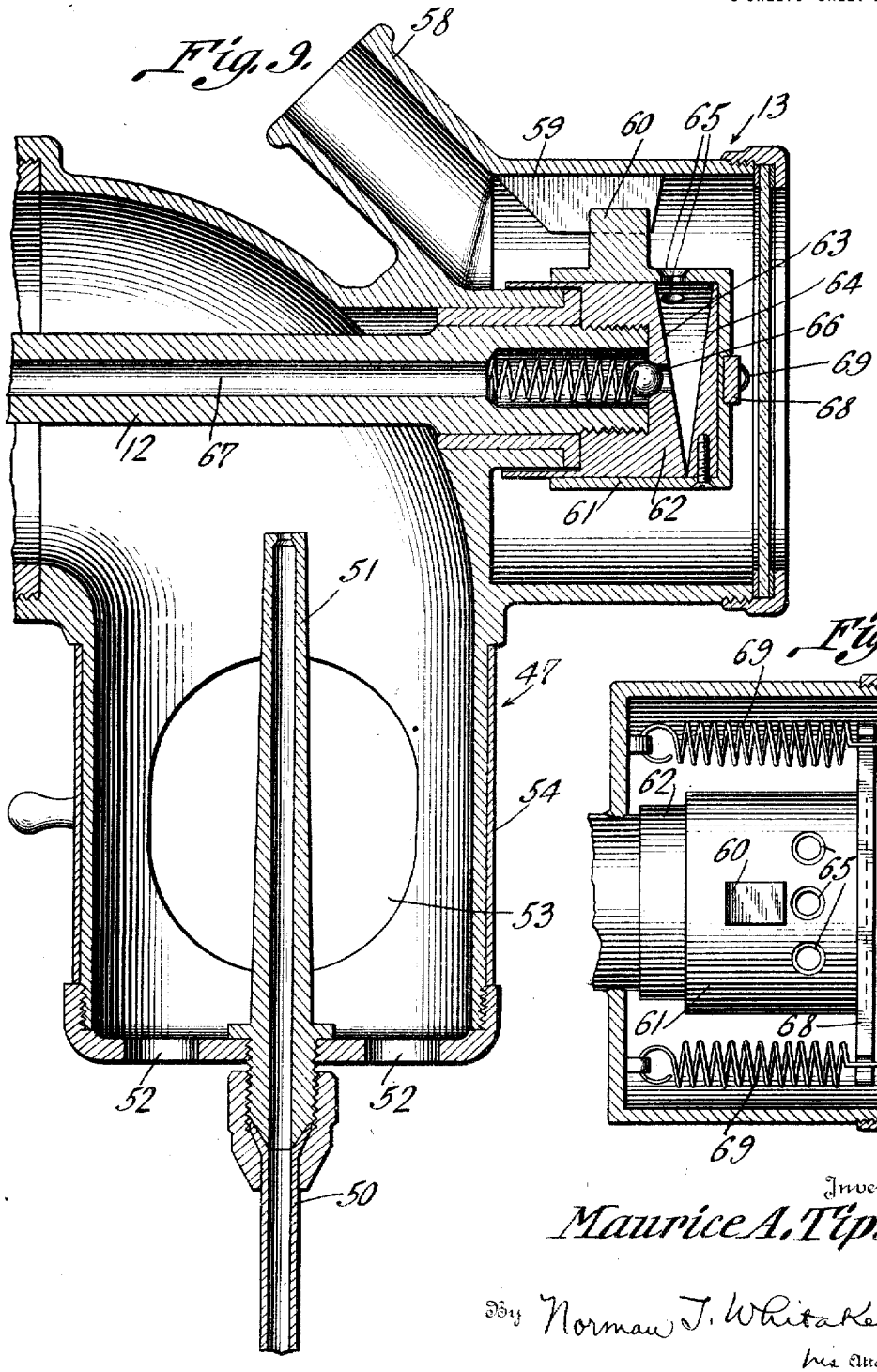

Fig. 10.

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,306,035. Specification of Letters Patent. Patented June 10, 1919.

Application filed October 11, 1917. Serial No. 195,898.

To all whom it may concern:

Be it known that I, MAURICE A. TIPS, a subject of the King of Belgium, and a resident of Woonsocket, county of Providence, and State of Rhode Island, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to internal combustion engines and has particular reference to the class of the rotating cylinder type employed particularly in connection with airplanes, although not restricted to such use.

An important object of the invention is to provide in a device of the above mentioned character a means affording a positive driving connection between the crank shaft and rotating cylinders whereby an opposed rotary movement of the rotating cylinders with respect to the crank shaft may be attained.

A further object is to provide in a device of the above mentioned character a means whereby the speed of rotation of the rotating cylinders will be greatly reduced with respect to that of the crank shaft, thereby relieving any excessive strain of rotation which would otherwise be set up within the various elements employed in transmitting movement from the crank shaft to the rotating cylinders.

A further object of the invention is to provide in a device of the above mentioned character a means whereby the reduction of speed between the crank and rotating cylinders may be effectuated with the least possible loss of energy.

A further object is to provide in a device of the above mentioned character a means whereby adequate and efficient cooling of the cylinders may be insured at all times without complication of parts.

A further object is to provide in a device of the above mentioned character a means whereby maximum intake and exhaust ports may be afforded, thereby permitting a free and unobstructed passage of the gaseous fuel to the cylinders, and relieving to a maximum degree any "back-pressure" set up within the cylinder as a result of the expulsion of exhaust gases under pressure.

A further object is to provide in a device of the above mentioned character a single means for opening and closing a plurality of intake and exhaust ports simultaneously.

A further object of the invention is to provide in a device of the above mentioned character a means whereby any tendency to impede the operation of the intake and exhaust port opening and closing means, may be counteracted.

A further object is to provide in a device of the above mentioned character a means whereby the side thrust upon the intake and exhaust opening and closing means, due to pressure exerted within the cylinder as a result of the gases exploded therein, may be counteracted.

A further object is to provide in a device of the above mentioned character a means whereby the several moving elements may be completely incased, and means whereby access may be readily gained to the several elements thereby facilitating an easy and quick disassembly of the device as a whole.

A further object of the invention is to provide in a device of the above mentioned character a means whereby the lubricant, employed in the oiling of the several moving elements, may be maintained at a relatively low temperature during its travel to the various elements designed to receive the same, whereby the maximum lubricating effect may be attained per unit of oil consumed.

A further object of the invention is to provide in a device of the above mentioned character a means whereby a perfect lubrication of the intake and exhaust opening and closing means may be maintained.

A further object is to provide a device of the above mentioned character which will be compact, strong, durable, and effective in its operation.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming

a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Figure 1 shows a side elevation of a motor partly in section;

Fig. 2 shows an end view and partial section of the same;

Figs. 3, 4 and 5 show details of the combined inlet and exhaust valve structure;

Figs. 6, 7 and 8 show details of the valve operating mechanisms;

Figs. 9 and 10 are detail views of the carbureter and lubricating pump; and

Fig. 11 shows the details of the ignition system.

In the drawings wherein for the purpose of illustration is shown a preferred embodiment of my invention the numeral 1 indicates a stationary frame member in which is rotatably mounted a cylinder block or casting 2, which in the present type of motor carries eighteen radial cylinders arranged in two sets of nine. The cylinder block is adapted to rotate in the frame member 1 by means of two sets of supporting ball bearings 3 and 4. Mounted within the cylinder block in bearings 5 and 6 is a built up counterbalanced crank shaft member 7 which crank shaft carries on one end a gear member 8, which in turn meshes with the teeth on the driving shaft 10 which rotates in a bearing 11 carried by the frame member 1. While any desired gear reduction may be used in the present instance the gear 8 has eighteen teeth and the internal gear 9 has thirty teeth which will provide for a reduction from eighteen hundred revolutions per minute, which is the normal speed of the crank shaft in the present embodiment of the invention, to a speed of a thousand eighty revolutions per minute of the propeller driving shaft which is found to be the most satisfactory speed of operation for this part. The fact that internal gears are used for this reduction provides for greatly decreased wear and strain upon the gears as both the crank shaft 7 and the driving shaft 11 rotate in the same direction, and the relative tooth velocity is only equivalent to the difference in speed between the crank shaft and driving shaft. The other end of the crank shaft 7, which has oil passages drilled therein is in connection with an extension 12 carried by and revolving with the cylinders through which lubricant is supplied to the crank shaft and interior of the motor by means of the oil pump 13, the detail structure of which will be later described. The usual type of pistons are employed in the cylinders, the nine connecting rods from each radial set of pistons being pivoted in a master bearing 7^a rotatably mounted upon the crank shaft.

Carried upon the driving shaft 11 is a gear 14 meshing with a pinion 15 which is formed integral upon a countershaft 16 carried in bearings 17 and 18, which countershaft also carries the gear which in turn meshes with an internal gear 20 carried upon a flange 21 bolted to the cylinder block casting 2, the counter-shaft 16 thereby providing means for causing the cylinder block to rotate. The gear 14 in the present instance having seventeen teeth, the gear 15 having fifty-one teeth, the gear 19 having eleven teeth, and the internal gear 20 having sixty-six teeth, the cylinder block is caused to rotate at a slow speed of sixty revolutions per minute in the opposite direction to that of the crank shaft thereby neutralizing the gyroscopic effect. Around each cylinder is cast a water space 21^b, the exterior of the cylinder casting being provided with air cooling fins 22 on both sides and rim of the cylinder casting, a safety valve 21^a being located near the inside rim of the cylinder block to relieve excess pressure in the jacket. As the cylinder block rotates, the water in this water jacket space will be caused to circulate, owing to the fact that the cooler water being denser will be forced to the exterior of the casting owing to centrifugal force thereby providing the greatest cooling for the heads of the cylinders. At the same time the air cooling fins 22 will provide means for cooling the circulating water, thereby doing away with the need of a radiator and its consequent air resistance, weight and complication of pump and so forth. In addition the casting contains a plurality of air passages 23 shown in Fig. 2 which pierce the cylinder casting between the cylinders, and which provide for the circulation of air therethrough. The rotative speed of the cylinder block is just great enough to obtain efficient circulation of the cooling water, but it is not sufficient to have a serious centrifugal effect on the oil in the crank case, a fault nearly always present in the ordinary type of rotating cylinder motor. A fly wheel effect is also obtained which does not produce an excessive gyroscopic effect.

Between each pair of adjacent cylinders is mounted a rotating valve member 24, which is shown in greater detail in Figs. 3, 4 and 5, each of these nine valves providing for the function of inlet and exhaust for each pair of cylinders, all the valves being driven by bevel gears 26 mounted on their lower ends and meshing with a master valve gear 27 which is operated in a manner to be described later. The valve member 24 which is shown in detail in Figs. 3, 4 and 5, consists of a tapered portion 25 integral with a hollow straight portion through which the combustible mixture is furnished. this mixture entering the valve through the openings 27^a in its lower end. The tapered portion of the valve is provided with four ports

or openings 28—28 and 29—29, these ports being located in pairs diametrically opposite each other, ports 28—28 providing for the inlet of combustible mixture to the cylinders, and ports 29—29 providing for the exhaust to atmosphere directly out of the end of the valve. It is to be noted that the tapered portion of the valve member is provided with water spaces 30 to which cooling water is supplied from the space 31 which is in connection with the water jackets of the cylinder. Self lubricant of the valve is provided by a plurality of graphite inserts 32—32 located in the seat of the valve and in addition an oil passage, which is not shown is provided for the passage of lubricant from the crank case of the motor to the valve seat, the oil being caused to travel out through these passages by the centrifugal effect of the rotating cylinder block.

The valve member 24 is provided at its lower end with an extension 33 which carries a male screw thread 34 upon which is mounted a female member 35 which carries the bevel gear 26 meshing with the master drive gear 27. The valve member 24 is normally pressed into its seat by means of a plurality of spiral springs 36 held in the valve retaining ring cap 37 and acting against the ball thrust bearing 38. It will be noted that as the valve member 24 rotates, the spring 36 acts to hold the same in good contact with the seat, but should the free rotation of the valve member be impeded in any way, as by the accumulation of carbon in the ports, the bevel gear 26 continuing to turn the screw thread 34 will act to raise the valve member 24 against the springs 36 thereby freeing the same and enabling the valve to overcome any tendency to stick, without throwing undue strain upon the same. It is to be further noted that the cylinders of each pair function simultaneously, the valve ports being located in the valve in diametrical opposite pairs for this purpose, which operation at all times produces a balanced action upon the valve. It is to be further noted that the valve ports rotate slightly above the plane of the cylinder heads, thereby providing for an inclined passage-way directly to the interior of the cylinders which allows the exhaust gases to pass to atmosphere along a line of least resistance through the maximum opening thus obtained.

The valve operating mechanism, and the driving of the master gear 27 will be next described, this being shown in detail in Figs. 6, 7 and 8. The master gear 27 is mounted to rotate on a large annular ball bearing 29 carried by a bearing plate 40 which is in turn fixed to the cylinder casting 2. Made integral with the master gear 27, is an internal gear 41, which internal gear possesses one hundred twenty-eight teeth, and into which meshes an external gear of slightly smaller pitch 42 which possesses one hundred and twenty-four teeth. This external gear is mounted upon an annular ball bearing 43 which is mounted upon an eccentric member 44 fixed upon the crank shaft 7. The eccentricity of this member being approximately equal to the pitch of the teeth of the external gear 42. This external gear has a series of circular holes 45—45 which fit loosely upon a series of pins 46—46, which pins are fixed in the bearing plate 40 carried by the cylinder casting, the external gear 42 thereby being forced to rotate in synchronism with the cylinder casting but at the same time being allowed to float upon the pins 46. It will now be seen that for each rotation of the eccentric 44 relative to the cylinder casting, the external gear 42 will be rolled once around the interior of the internal gear 41. As the internal gear possesses one hundred and twenty-four teeth and cannot rotate relative to the cylinder casting and the external gear possesses one hundred and twenty-eight teeth, such action will cause the master gear member 27 to advance four teeth, which action will rotate the valve member 24 through 90°, the bevel gear members 26 of each valve having sixteen teeth and the master bevel gear 27 having one hundred and twenty-eight teeth. It will therefore be seen that four relative revolutions between the crank shaft 7 and the cylinder casting will cause the valve member to make one complete rotation thereby causing the engine to function on the four stroke cycle, as each valve member possesses four ports.

The combustible mixture is supplied to the motor by means of a stationary carbureter or mixing device 47 shown in greater detail in Fig. 9, and which in the present instance consists of a gasolene supply pipe 50 communicating with an aspirating nozzle 51, the main air supply entering through ports 52—52 and an adjustable auxiliary air supply being provided through a port or ports 53 which may be controlled by a rotating sleeve member 54. The mixture passes into a nine armed integrally cast manifold structure 55 which is bolted to the cylinder casting 2 and which in addition forms a support for the outer race-way of the right-hand cylinder block supporting ball bearing 4, a packing member 56 being carried by the manifold structure to prevent leakage at this point, as well as supporting the outer race-way of the crank shaft ball bearing 6. This manifold structure communicates with corresponding inlet passage-ways 57 which are cast in the cylinder block and which provide for the conveyance of the combustible mixture from the manifold to the lower ends of the rotating valves. Owing to the fact that these passage-ways pass through the

water jacket space of the cylinder block, a mutual exchange of heat is provided between the combustible mixture and the circulating water, the mixture receiving heat to cause the ready and complete vaporization of the same the circulating water at the same time being cooled. By removing the combined carbureter and oil pump and taking off the bearing plate 4ª, the bearing 4 may be slipped out, and the manifold may then be unbolted and removed giving access to the whole interior of the motor crank case through which the piston and connecting rods may be removed.

Lubricant is supplied to the interior of the crank case of the motor through the hollow extension 12 of the crank case. Mounted upon the end of this extension 12 and integral with the carbureter is an oil pump 13 shown in greater detail in Figs. 9 and 10. This oil pump consists of a casing 13 to which is connected an oil supply pipe 58. The interior of the casing 13 is provided with a lug 59 against which bears a stop lug 60 which is carried by a cup shaped member 61 adapted both to slide and rotate upon a circular member 62 which is fixed upon the end of the crank case extension 12 and which rotates therewith. The end of the member 62 has a bevel surface 63 and the bottom of the cup 61 possesses a second bevel surface 64, the cup also containing a plurality of oil inlet orifices 65—65, an oil inlet with a spring operated ball check valve 66 being provided in cylindrical member 62 which communicates with the oil passage-way 67. The cup shaped member 61 which is prevented from rotation by the lugs 59 and 60 is normally urged toward the left by the cross piece 68 and the springs 69—69. It will therefore be noted that as the member 62 rotates with the crank case the inlet ports 65 are cut off by the bevel surface 63, the further revolution of the member 62 then permitting bevel surface 64 to move into complete contact with the bevel surface 63, thereby forcing the inclosed lubricant through the ball check valve 66 into the passage-way 67 and thence into the crank shaft. The fact that the passageway 67 passes through the carbureter vaporizing chamber provides for a refrigerating effect on the lubricant and thus enables cool oil to be supplied to the motor at all times.

A bevel gear 70 is mounted upon the propeller shaft 10 and provides for the magneto and starter drive, the two magnetos used, being mounted on diametrically opposite sides of the propeller shaft. As seen in Figs. 1 and 11, a full bevel gear 71 is mounted in a bearing 72 carried by the frame 1, the shaft 73 of this bevel being connected to any of the well known types of starting mechanisms.

Ignition is provided by two magnetos 74 and 75, which are driven by short bevel gears 74ª and 75ª meshing with gear 70 on opposite sides of the propeller shaft, the high tension windings of each of the magnetos being connected respectively to two concentric slip rings 76 and 77 carried on the frame 1.

Carried by the cylinder block 2, are two distributer elements 78 and 79, each one of which serves the spark plugs of one set of radiating cylinders. Each of the distributer elements receive energy from the slip rings by means of brushes contacting with the same, distributer 78 receiving its energy from slip ring 76 and distributer 79 receiving its energy from slip ring 77. The distributers are both driven by means of gears 80—80 which mesh with a fixed gear 81 mounted on frame 1. As both sets of radiating cylinders function simultaneously, a simultaneous electrical impulse is generated in the magnetos for each explosion, the resulting high tension current being transmitted simultaneously to both slip rings and through both distributers to the proper pair of cylinders.

It is to be understood that the form of my invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described my invention, what I claim as new and desire to secure and protect by Letters Patent of the United States, is:

1. An internal combustion engine comprising in combination a stationary frame, a cylinder block supported by, and adapted to rotate within said frame, a gear fixed to said cylinder block, a crank shaft adapted to rotate within said cylinder block, a drive shaft, gearing connecting said drive shaft with said crank shaft, and gearing connecting said drive shaft with the gear fixed to said cylinder block.

2. An internal combustion engine comprising in combination, a stationary frame, a cylinder block supported by and adapted to rotate within said frame, a gear fixed to said cylinder block, a crank shaft adapted to rotate within said cylinder block, a drive shaft carrying an internal gear, gearing connecting the crank shaft with the internal gear carried by the drive shaft, and gearing connecting said drive shaft with the gearing fixed to said cylinder block.

3. In an internal combustion engine the combination with a cylinder block of a crank shaft, a drive shaft having an internal gear, gearing connecting the crank shaft with said internal gear, said crank shaft having

its axis coincident with the axis of rotation of said cylinder block, and means for rotating said cylinder block with respect to said crank shaft.

4. In an internal combustion engine, the combination with a stationary frame, of a cylinder block supported by bearings in said frame and adapted to rotate, a crank shaft adapted to rotate in bearings within said cylinder block, and a combined end plate and manifold structure for said cylinder block comprising a casting containing a plurality of radiating gas passage-ways, said casting also having formed integral therewith an outer bearing support for one of said cylinder block bearings and an inner bearing support for one of said crank shaft bearings.

5. In an internal combustion engine, the combination with a crank shaft, of a rotating cylinder block containing a plurality of radiating cylinders, a water space surrounding said cylinders, and air cooling fins on the outside of said block.

6. In an internal combustion engine the combination with a crank shaft, of a rotating cylinder block containing a plurality of radiating cylinders, a water space surrounding said cylinders, and air cooling fins on the outside of said block, and air passages for the circulation of air located between the cylinders.

7. In an internal combustion engine, the combination with a crank shaft, of a rotating cylinder block in the form of an annulus containing a plurality of radiating cylinders, a water space surrounding said cylinders, and a safety valve in communication with said water space for relieving excess pressure, said safety valve being located on said rotating cylinder block near the inner edge of said annulus.

8. An internal combustion engine comprising in combination a stationary frame, a cylinder block supported by and adapted to rotate within said frame, a gear fixed to said cylinder block, a crank shaft adapted to rotate within said cylinder block and having its axis coincident with the axis of rotation of said cylinder block, a drive shaft, a gear connecting said drive shaft with said crank shaft, and a gearing connecting said drive shaft with the gear fixed to said cylinder block.

9. An internal combustion engine comprising in combination a stationary frame, a cylinder block supported by and adapted to rotate within said frame, a gear fixed to said cylinder block, a crank shaft adapted to rotate within said cylinder block, a drive shaft geared to said crank shaft and having its axis out of alinement with the axis of said cylinder block, a gearing connecting said drive shaft with the gear fixed to said cylinder block.

10. An internal combustion engine comprising in combination a stationary frame, a cylinder block supported by and adapted to rotate within said frame, an internal gear fixed to said cylinder block, a crank shaft adapted to rotate within said cylinder block and having its axis of rotation coincident with the axis of said cylinder block, a drive shaft carrying an internal gear, an external gear fixed on said crank shaft and meshing with the internal gear carried by said drive shaft, and gearing connecting said drive shaft with the internal gear fixed to said cylinder block.

11. A cylinder block for an internal combustion engine of the rotating cylinder type comprising an integral casting in the form of an annulus, said annulus containing a plurality of radial cylinders opening through the interior circumferential wall into the central opening of said annulus and extending radially into said annulus to a depth less than the radial thickness of the annulus.

12. A cylinder block for an internal combustion engine of the rotating cylinder type comprising an integral casting in the form of an annulus, said annulus containing a plurality of radial cylinders opening through the inner circumferential wall into the central opening of said annulus and extending radially into said annulus to a depth less than the radial thickness of the annulus, said annulus containing a water space surrounding each cylinder.

13. A cylinder block for an internal combustion engine of the rotating cylinder type comprising an integral casting in the form of an annulus, said annulus containing a plurality of radial cylinders opening through the inner circumferential wall into the central opening of said annulus and extending radially into said annulus to a depth less than the radial thickness of the annulus, said annulus containing gas passages therein to serve said cylinders, and a water space surrounding each cylinder.

14. A cylinder block for an internal combustion engine of the rotating cylinder type comprising an integral casting in the form of an annulus, said annulus containing a plurality of pairs of radiating cylinders which open through the inner circumferential wall into the central opening of said annulus and which extend radially into said annulus to a depth less than the radial thickness of the annulus, the axes of the cylinder of each pair lying in a plane which is parallel with the axis of said annular cylinder block.

15. A cylinder block for an internal combustion engine of the rotating cylinder type comprising an integral casting in the form of an annulus, said annulus containing a plurality of pairs of radiating cylinders opening through the inner circumferential

wall into the central opening of said annulus and extending radially into said annulus to a depth less than the radial thickness of the annulus and a cylindrical radial valve chamber located between each pair of cylinders of each pair and the axis of the valve chamber all lying in a plane which is parallel with the axis of said annulus cylinder block.

16. In an internal combustion engine the combination with a cylinder block of a crank shaft, a drive shaft, having an internal gear, gearing connecting the crank shaft with said internal gear, said crank shaft having its axis coincident with the axis of rotation of said cylinder block, and means for imparting opposed rotary movement to the cylinder block with respect to the crank shaft.

17. In an internal combustion engine the combination with a cylinder block of a crank shaft, a drive shaft having an internal gear, gearing connecting the crank shaft with said internal gear, said crank shaft having its axis coincident with the axis of rotation of said cylinder block, and means for imparting opposite rotary movement to the cylinder block with respect to the crank shaft and drive shaft.

18. In an internal combustion engine, the combination with a cylinder block, of a crank shaft, a drive shaft having a gear carried thereby, gearing connecting the crank shaft with the gear carried by the drive shaft, said crank shaft having its axis coincident with the axis of rotation of said cylinder block, and means for rotating said cylinder block with respect to said crank shaft.

19. In an internal combustion engine, the combination with a cylinder block, of a crank shaft, a drive shaft having a gear carried thereby, gearing connecting the crank shaft with the gear carried by the drive shaft, said crank shaft having its axis coincident with the axis of rotation of said cylinder block, and means for imparting opposite rotary movement to the cylinder block with respect to the crank shaft and said drive shaft.

20. In an internal combustion engine the combination with a cylinder block of a crank shaft, a drive shaft having an internal gear, gearing connecting the crank shaft with said internal gear, said crank shaft having its axis coincident with the axis of rotation of said cylinder block, and means for imparting opposite rotary movement to the cylinder block with respect to the drive shaft, said means comprising a gear carried by the cylinder block, a second gear carried by the drive shaft, and gearing connecting the gear carried by the cylinder block with the gear carried by the drive shaft.

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