J. W. GEORGE.

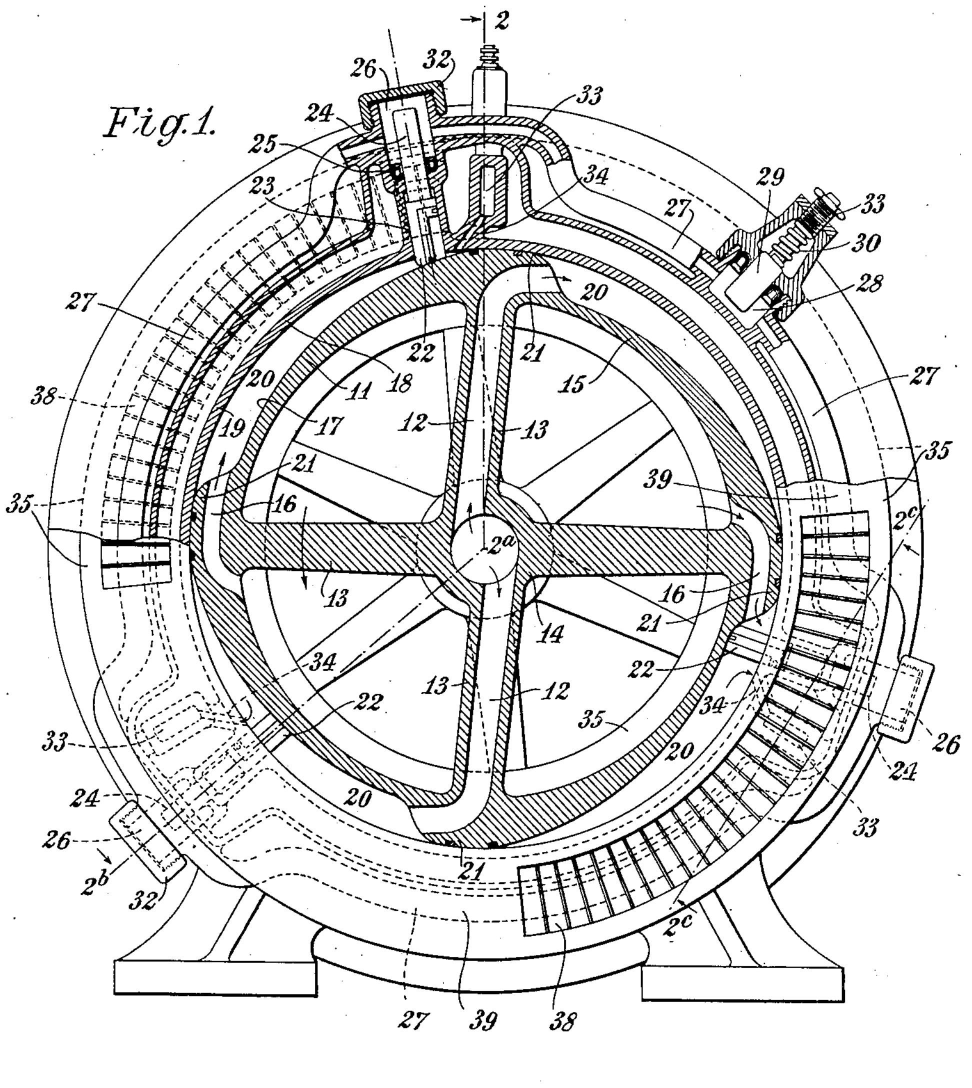
ROTARY INTERNAL COMBUSTION ENGINE.

APPLICATION FILED OCT. 16, 1918.

1,348,103. Patented July 27, 1920.

4 SHEETS—SHEET 1.

Fig. 1.



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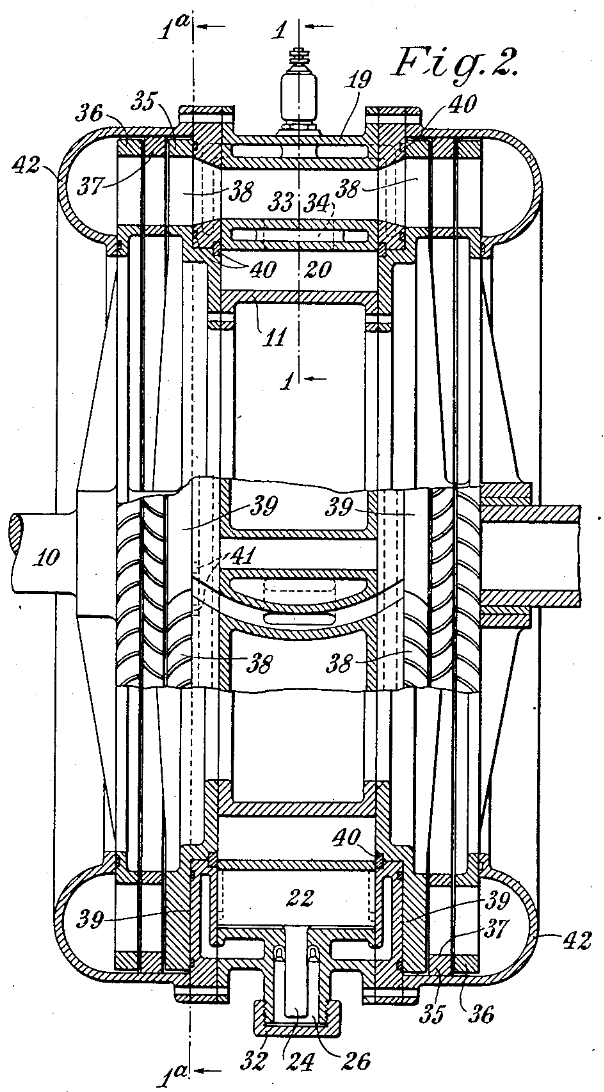
4 SHEETS—SHEET 2.

Fig. 2.



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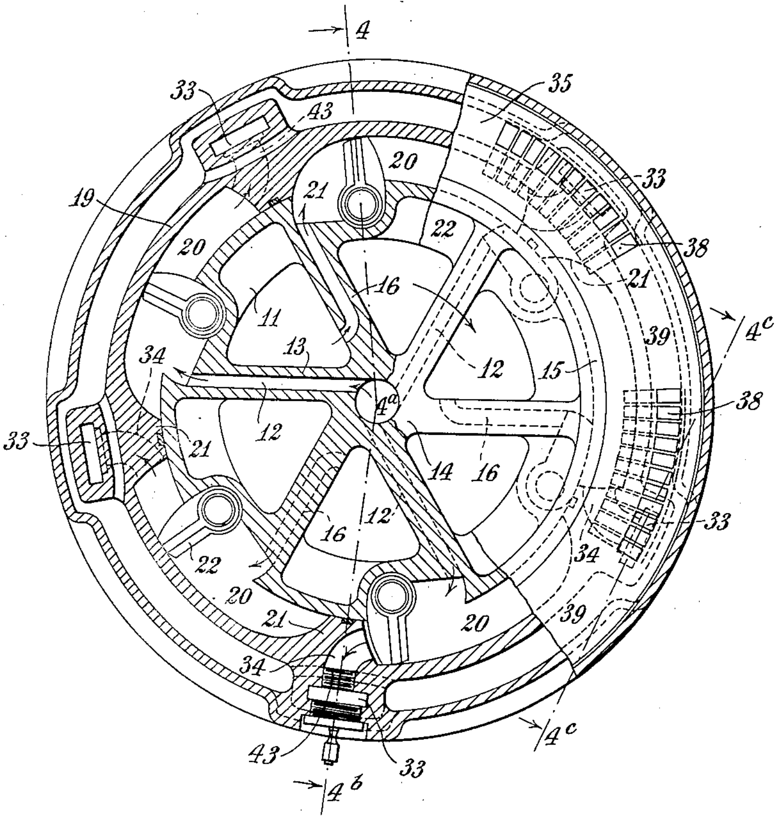
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

Fig. 4

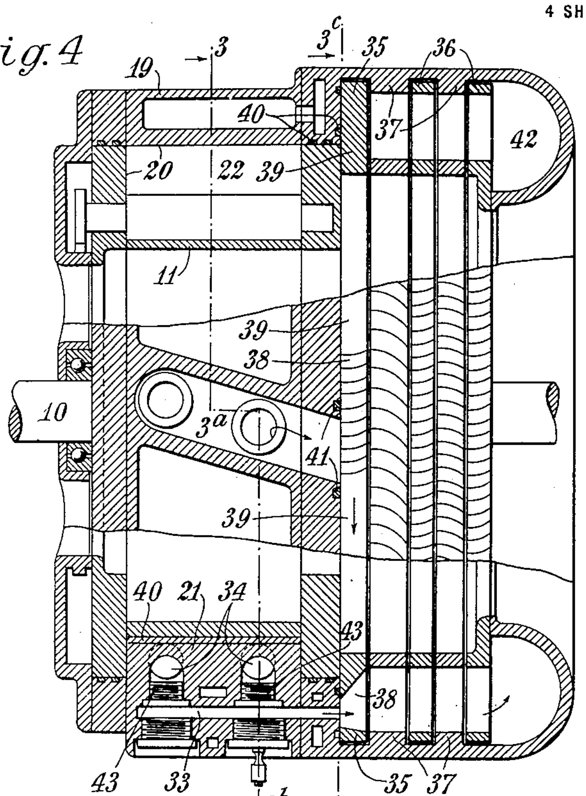
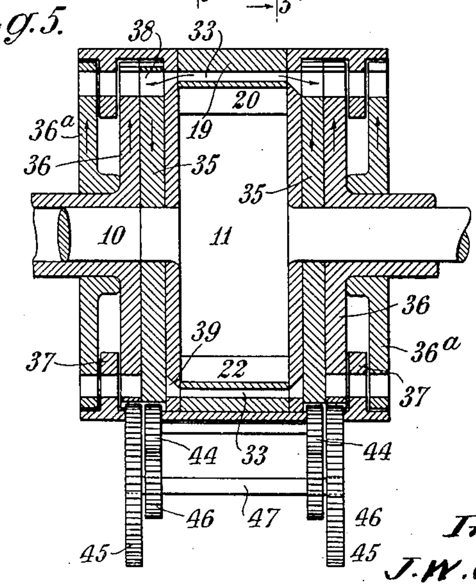


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN WILLIAM GEORGE, OF STROUD GREEN, ENGLAND.

ROTARY INTERNAL-COMBUSTION ENGINE.

1,348,103. Specification of Letters Patent. Patented July 27, 1920.

Application filed October 16, 1918. Serial No. 258,411.

To all whom it may concern:

Be it known that I, JOHN WILLIAM GEORGE, a subject of His Majesty the King of England, and resident of Stroud Green, in the county of Middlesex, Kingdom of England, have invented certain new and useful Improvements in or Connected with Rotary Internal-Combustion Engines, of which the following is a specification.

This invention relates to improvements in rotary internal combustion engines.

The invention has for its primary object to provide a rotary internal combustion engine which is highly efficient in construction and operation and of high power, and in which the working parts are few in number, friction is reduced to a minimum, the parts liable to overheating are adequately cooled and insulated from the other parts of the engine, lubrication is reduced to a minimum, leakage and loss of power at the most vital points are positively prevented, the explosive charges are highly compressed, the use of separate apparatus such as a pump coupled to the engine for compressing the charges is avoided, the firing of the compressed explosive charges takes place at the correct moment to obtain the maximum power from the engine, and the products of combustion are positively expelled from the combustion chambers and from turbine wheels, and said chambers and wheels are efficiently air scavenged and cooled.

Other objects of the invention are to provide a rotary internal combustion engine having fluid and air compressing vanes with improved means for operating said vanes, and to produce an improved engine in which end thrust on the rotary parts is balanced, the liability of tilting of the vanes under pressure is prevented, and the use of valves and valve springs can be entirely dispensed with.

The invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a staggered transverse sectional elevation, about the lines 1—1 and 1^a—1^a of Fig. 2, of an engine embodying the invention, and

Fig. 2 is a staggered longitudinal sectional elevation, about the lines 2—2^a—2^b and 2^c—2^c of Fig. 1, of said engine, the sectional portion on the line 2^c—2^c being shown as centrally disposed;

Fig. 3 is a staggered transverse sectional elevation, on the lines 3—3^a—3^b and 3^c—3^c of Fig. 4, of a modified construction of engine, and

Fig. 4 is a staggered longitudinal sectional elevation, about the lines 4—4^a—4^b and 4^c—4^c of Fig. 3, of said engine, the sectional portion on the line 4^c—4^c being shown as centrally disposed;

Fig. 5 is a partly sectional longitudinal elevation of a further modified form of engine.

In all of the various figures similar parts are designated by like reference numerals.

According to the preferred method of carrying out the invention, Figs. 1 and 2, the engine comprises a partly hollow rotary or stationary shaft 10 upon which is concentrically mounted to rotate therewith or thereon a rotor or inner drum 11 provided with a number, preferably two as shown, of radial or other fuel inlet passages 12 which communicate with the hollowed portion of said shaft and extend to the periphery of said rotor. The passages 12 are preferably formed within webs or conduits 13 which are positioned in the manner of the spokes of a wheel, so that the rotor 11 consists of a hub portion 14 surrounding and secured to the shaft 10 and a rim portion 15 connected to said hub portion by means of the webs or conduits. In this manner the open spaces intervening between the hub portion 14, the rim portion 15 and the webs or conduits 13 provide means whereby the rotor 11 can be internally cooled, and such cooling can be obtained by shaping the webs or conduits in the manner of fan blades and thus circulating air through the rotor by its rotation, by pumping or otherwise forcing water or other cooling fluid through the spaces. If desired, as an alternative or additional feature the rim may be water jacketed or air cooled. The rotor 11 is also formed with a number, say two, of air ducts 16 which communicate with two of the spaces within the rotor and with the periphery of the latter for a purpose hereinafter described. The periphery 17 of the rotor 11 is eccentrically shaped externally to form, in conjunction with the cylindrical inner surface 18 of a stationary annular outer casing or cylinder 19 surrounding said rotor and arranged concentrically therewith, a number, for instance four as shown, of induction and compression chambers 20 and intervening abutments 21, which abutments are in running but fluid-tight contact with said inner surface and have the outer ends of the fuel passages 12 and the air ducts 16 formed through them. Half of the number of chambers 20 serve for the induction and compression of the actuating medium and half for the induction and compression of air.

A plurality of vanes 22, preferably three in number, are carried by the outer casing or cylinder 19, which may be water or air jacketed, and slidably mounted with a close fit within deep radial guide slots or pockets 23 formed in the latter, and are each formed with one or more rearwardly extended plungers or pistons 24 which are packed by U-shaped packing washers 25 and are acted upon by suitable means serving to continuously press the vanes 22 inward with their inner ends in running contact with the shaped outer periphery 17 of the rotor 11. In the preferred arrangement the plungers or pistons 24 extend into pressure chambers 26 and are acted upon by hydraulic or pneumatic pressure within said chambers, and to continuously maintain and equalize the pressure in all of the chambers and insure that all of the plungers or pistons are constantly under pressure, and all of the vanes 22 press with equal force on the rotor surface 12, the chambers are preferably interconnected with one another by means of pipes or passages 27 and with one or more pressure maintaining and equalizing chambers 28 in which is or are movably mounted one or more pressure plungers or pistons 29 acted upon by a spring or springs 30 by means such as a screw plug or plugs 31 being provided, if desired, to enable the action of the spring or springs to be adjusted. The deep guide slots or pockets 23 and the long plungers and pistons 24 on the vanes 22 effectively prevent any tendency of the latter to tilt under pressure. The outer ends of the pressure chambers 26 behind the vanes 22 are preferably fitted with removable closure caps 32.

At or adjacent to its outer periphery the casing 19 is provided with a plurality, say three, of arcuate combustion or explosion chambers 33 which extend laterally from one side face or edge of the rotor 11 to the other as shown clearly in Fig. 2. Each combustion chamber 33 is fitted with one or more spark plugs or other ignition devices and communicates with one of the compression chambers 20 by means of a transfer passage or port 34 extending to the inner surface 18 of the outer cylinder or casing 19. The ends of the combustion chambers 33 open out onto two turbine wheels mounted one at each end of the engine to rotate with or upon the shaft 10, each of said wheels consisting of one or a number of separate rings or disks 35 and 36 having curved or angularly disposed radial or other blades or pockets fitted or formed on its or their periphery or peripheries, and when a plurality of such rings or disks are provided as illustrated, they alternate with interposed stationary rings or disks 37 fitted or formed with similar but oppositely directed fluid directing blades or pockets in known manner. The blades or pockets of the turbine wheels, or of the first rotary rings or disks 35 thereof, are preferably arranged in a plurality of sets, say two sets as indicated at 38, with plain or blank spaces 39 intervening between them on said wheels or disks. The provision of the two turbine wheels at both ends of the engine and both acted upon at the same time by the exploded gases insures the balancing of the engine and obviates end thrust upon the shaft 10.

The meeting faces or edges of the outer casing or cylinder 19 and the turbine wheels 35, and of the said casing or cylinder and the rotor 11, are packed and rendered gas tight by means of tightening or expansion rings 40 fitted between them, and said faces or edges may be lubricated by suitable means. The faces or edges of the casing 19 and rotor 11 may be packed on both sides of each end of each combustion chamber 33 by means of two or more radial tightening strips or bars 41. The shaft is preferably insulated to prevent its overheating, and the turbine wheels discharge into annular or other suitably shaped exhaust chambers or channels 42.

If desired, the vanes 22 may be operated by a suitable external cam or other mechanical actuating mechanism.

The operations of the engine above described are as follows:—

As the rotor 11 revolves, and the vanes 22 carried by the outer casing or cylinder 19 travel in the compression chambers 20, each of the vanes sucks behind it an explosive charge through the hollowed portion of the shaft 10 and the adjacent inlet passage 12 into the explosive mixture compression chamber through which it happens to be moving and compresses in front of it a similar charge already contained within said chamber, and this charge drawn in is compressed within said chamber by and in front of the next following vane when it travels through the chamber, and the compressed charge is forced by this second vane out of said chamber into the combustion chamber 33 communicating with it through the respective transfer passage 34. The compressed charge is then fired in the combustion chamber 33 and the gases of combustion act upon two of the sets of blades 38 of the two opposed turbine wheels 35, the firing being timed by suitable means to take place preferably at the moment when the first blades of the sets have just arrived opposite the ends of said chamber. During the compression and transfer stages of the explosive charges the plain or blank spaces 39 of the turbine wheels 35 travel in front of the combustion chambers 33. The combustion gases, after acting upon the turbine wheels 35 and 36 to rotate the same at high speed, escape through the exhaust chambers or channels 42.

Also, during the rotation of the rotor 11 each of the vanes 22 sucks behind it a charge of air through the adjacent air duct 16 into the air compression chamber through which it happens to be moving and presses in front of it a similar charge already contained within said chamber, and the charge drawn in is compressed within said chamber by and in front of the next following vane when it travels through the chamber and forced by this second vane out of said chamber into the combustion chamber 33 communicating with it through the adjacent transfer passage 34 and scavenges the latter and the chamber, thus positively expelling all the hot gases from said passages and combustion chamber and cooling them in readiness to receive the next explosive charge. This scavenging air also passes direct through the set of turbine blades 38 which happens to be passing the combustion chamber 33, thus scavenging said blade set also, and escapes by the exhaust chambers or channels 42. The air is preferably not compressed with the aid of the plain or blank spaces 39 on the turbine wheels 35 as in the case of the explosive charges, but is directly forced through the combustion chambers 33 and the turbine wheels, thus reducing back pressure.

Thus, during the operation of the engine, each vane 22 sucks in and compresses explosive charges and draws in and expels charges of scavenging and cooling air in turn, and the firing acts on sets of blades at intervals.

In a modified construction of the engine the inner drum 11 may be stationary and the outer casing or cylinder 19, carrying the vanes 22, rotary, said vanes being operated by a stationary cam surface or groove surrounding said casing or cylinder.

In a further modified construction of the engine, Figs. 3 and 4, said engine may comprise a rotor 11 provided with three radial explosive mixture inlet passages 12 and three radial air ducts 16 and fitted with six vanes 22 which are hinged or may be slidably mounted in pockets formed in the rotor and pressed outward by centrifugal force or by springs disposed behind them within said pockets. The rotor vanes 22 can be positively operated, in addition to or in place of the centrifugal or spring actions upon the same, by cam mechanism including a cam surface or groove provided on or in a ring or end plate secured to or formed integrally with a stationary annular casing or cylinder 19 spaced from and surrounding the rotor and arranged concentrically therewith, or by other suitable means.

The casing or cylinder 19 is formed or fitted with abutments 21 which extend from the inner periphery of the casing to the outer periphery of the rotor 11 to divide the space between said casing and rotor into five induction and compression chambers 20. Each chamber 20 may curve gradually at one or both ends toward the rotor 11 to prevent the formation, in conjunction with the vanes 22, of pockets and consequently avoid knocking. At or adjacent to its outer periphery the casing 19 is provided with five combustion or explosion chambers 33 the longitudinal axes of which are disposed diagonally, or at an angle other than a right angle, to the planes of the end faces or edges of the casing as shown in Fig. 4. Each combustion chamber 33 is fitted with one or more spark plugs or other ignition devices and with one or more inlet valves at 43, which valve or valves puts or put said chamber into communication with one of the compression chambers 20 by means of a transfer passage 34 formed in the adjacent abutment, and which valve, or each of which valves, may be spring returned or positively operated by cam mechanism or other means independent of or in conjunction with the mechanism positively operating the vanes 22 when such latter mechanism is provided, that is, one mechanism or two separate mechanisms may be adapted to operate the valves and vanes.

The combustion chambers 33 open out into a turbine wheel consisting of one or more blade rings or disks 35 and 36 and, when a plurality of such rings or disks are provided as shown, alternating with interposed stationary re-directing blade rings or disks 37. The blades of the turbine wheel, or of the first rotary ring or disk 35 thereof, are arranged in a plurality of sets 38 with intervening plain or blank spaces 39. The turbine wheel discharges into an annular or other exhaust chamber or channel 42.

The operations of the engine last described are as follows:—

As the rotor 11 revolves, and the vanes 22 carried thereby travel in the compression chambers 20, each of three alternate vanes sucks behind it an explosive charge through the hollowed portion of the shaft 10 and the adjacent inlet passage 12 into the chamber through which it happens to be moving and this charge is compressed within said chamber by and in front of the next following vane, one of the other three, when it travels through the chamber, and the compressed charge is forced by this second vane out of said chamber into the combustion chamber 33 communicating with it through the respective transfer passage 34, and the valve or valves in the latter. The compressed charge is then fired in the combustion chamber 33 and the gases of combustion act upon one of the sets of blades 38 of the turbine wheel, the firing being timed by suitable means to take place preferably at the moment when the first blade of the set has just arrived opposite the said chamber. During the compression and transfer stages the plain or blank spaces 39 of the turbine wheel travel in front of the combustion chambers 33. The combustion gases, after acting upon the turbine to rotate the same at high speed, escape through the exhaust chamber or channel 42.

At the same time, each of the three other alternate vanes sucks behind it a charge of air through the adjacent air duct 16 into the compression chamber 20 through which it happens to be moving, and this air is compressed within said chamber by and in front of the next following vane, one of the first three, when it travels through the chamber, and the compressed air is forced by this second vane out of said chamber into the combustion chamber 33 communicating with it and scavenges the latter, thus positively expelling all the hot gases from said combustion chamber and cooling it in readiness to receive the next explosive charge. This scavenging air also passes through the set of blades 38 which happens to be passing the combustion chamber 33, thus scavenging said blade set also, and escape by the exhaust chamber or channel 42.

Thus, during the operation of the engine, alternate vanes suck in explosive charges and compress charges of scavenging and cooling air, and draw in air and compress explosive charges, and the firing acts on sets of blades at intervals.

Means may be provided for causing one or more of the rotary turbine wheels or disks to be rotated at a different speed and, if desired, in opposite direction to the rotor of the rotary compressor and, if required, in relation to one another. In a convenient manner of carrying this out, Fig. 5, and when two or more rotary wheels or disks are to be so acted upon, the peripheries of the wheels 35 and 26 are formed or fitted with gear teeth which mesh with separate gear wheels preferably arranged under the engine. The or each gear wheel 44 meshing with the or each inner or first turbine wheel or disk 35 is of comparatively small diameter and also meshes with a second gear wheel 46 secured on a shaft 47, and said shaft carries one or more gear wheels 45 of much larger diameter to drive the or each outer turbine wheel or disk 36 at a greater speed than, and in a direction opposite to, that at which the inner turbine wheel or wheels 35 is or are driven. When a plurality of outer turbine wheels or disks are provided as shown two or more of them 36 and 36^a, may be keyed or otherwise secured to one another to rotate in unison. Thus in the arrangement illustrated in Fig. 5 each inner or first turbine wheel or disk 35 is shown as being formed with separate sets of turbine blades or pockets 38 alternating with blank spaces 39, and the other or outer turbine wheels 36 and 36^a as being geared to rotate at a different speed in relation to the rotor and to said inner or first wheels and in opposite direction.

In any of the forms of the engine the inner turbine disk or disks 35 may be formed with uninterrupted blades all around its or their surface or surfaces as with the other or outer disks 36, 36^a and 37, in which case a rotary or stationary ring or rings provided with transverse slots disposed at intervals around its, or their surface or surfaces can be mounted between the rotor 11 and said inner disk or disks. The turbine wheel or wheels would be geared to rotate at a greater speed than the rotor and in opposite direction if desired. The slotted ring or rings may be rotated in any suitable manner such as by the gearing above described, and it or they thus perform the functions of the turbine disk or disks having separate sets of blades and blank spaces. In this manner the opening of the ends of the combustion chambers to the turbine disk or disks is governed by the slotted ring or rings, and the latter may be adjustable by any convenient means so that the time of such opening can be advanced or retarded to vary the period of compression of the fuel and (or) scavenging air.

What I claim is:—

1. A rotary internal combustion engine comprising, an outer casing provided with transverse combustion chambers, said casing having substantially radial openings extending inwardly through its periphery and ports disposed near and forwardly of said openings and leading into the combustion chambers, substantially radial vanes mounted to reciprocate in said openings and projecting into the interior of the casing, and a rotor mounted within the casing and having a plurality of abutments to co-act with the vanes for forming compression chambers within the casing, said compression chambers having communication with the combustion chambers through the medium of the said ports, alternate abutments having gas supply openings extending through the rear ends thereof and alternate abutments having air supply openings extending through the rear ends thereof.

2. A rotary internal combustion engine comprising, an outer casing provided with transverse combustion chambers, said casing having substantially radial openings extending inwardly through its periphery

and ports disposed near and forwardly of said openings and leading into the combustion chambers, substantially radial vanes mounted to reciprocate in the said openings and projecting into the interior of the casing, a rotor mounted within the casing and including a rim, spokes, and a tubular hub, said rotor being provided upon its rim with a plurality of abutments to co-act with the vanes for forming compression chambers within the casing, said compression chambers having communication with the combustion chambers through the medium of said ports, alternate abutments having gas supply ports extending through the rear ends thereof and longitudinally of certain spokes and leading into the tubular hub and alternate abutments having air supply ports passing through the rear ends thereof and through the inner face of the rim, and turbine elements actuated by the explosion of the charge in the combustion chambers.

3. A rotary internal combustion engine comprising, an outer casing provided with combustion chambers, said casing having substantially radial openings extending inwardly through its periphery and ports disposed near and forwardly of said openings and leading into the combustion chambers, substantially radial vanes mounted to reciprocate in said openings and projecting into the interior of the casing, plungers connected with the outer ends of the vanes, pressure chambers receiving the plungers, means for maintaining the same degree of fluid pressure within all of the pressure chambers, a rotor mounted within the casing and having a plurality of abutments to coact with the vanes for forming compression chambers within the casing, said compression chambers having communication with the combustion chambers through the medium of said ports, the alternate abutments having gas supply ports extending through the rear ends thereof and the other abutments having air supply ports extending through the rear ends thereof, and turbine elements actuated by the explosion of the charge within the combustion chambers.

4. A rotary internal combustion engine comprising, an outer casing, substantially radial reciprocatory vanes carried thereby, plungers carried by the outer ends of the vanes, pressure chambers receiving the plungers, conduits connecting the pressure chambers in series, a compression chamber connected in one conduit, a compression plunger in the compression chamber, means to adjust the compression plunger, a rotor mounted to turn within the casing and having abutments to co-act with the vanes for forming therewith compression chambers, and means whereby fluid fuel is fed into the last named compression chambers.

In testimony whereof I have hereunto signed my name.

JOHN WILLIAM GEORGE.