June 3, 1941. J. S. WILKERSON 2,244,438

ROTATING CYLINDER INTERNAL COMBUSTION ENGINE

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FIG. 1.

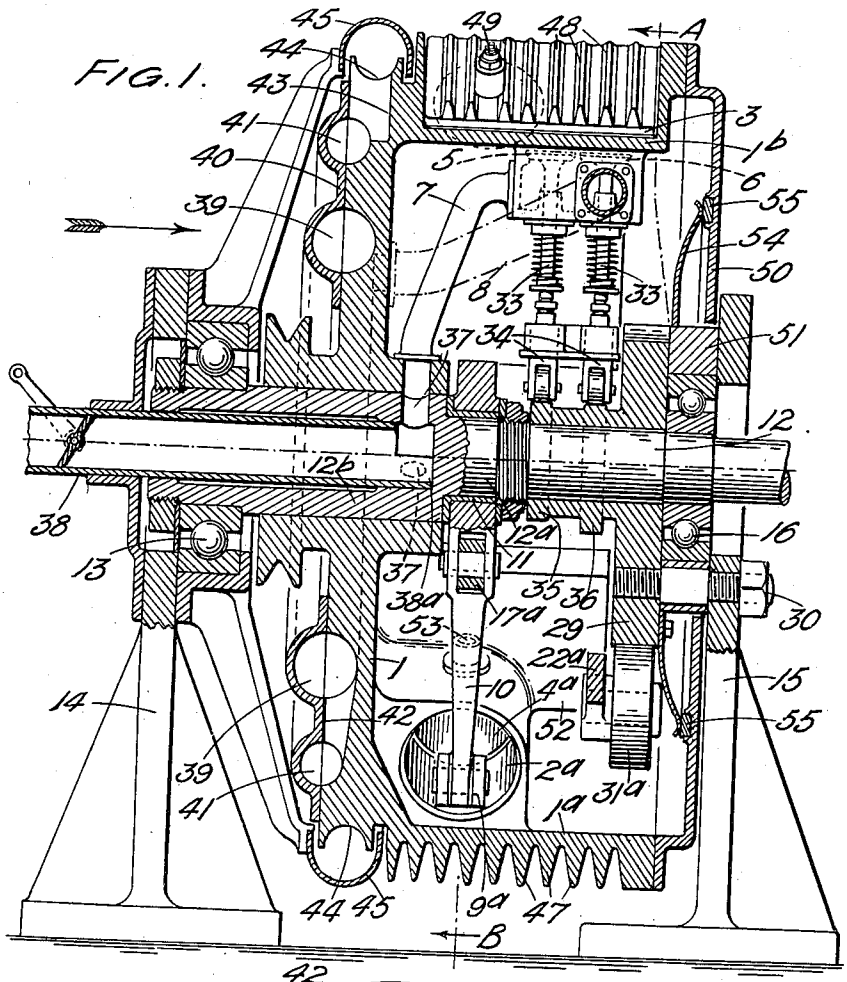
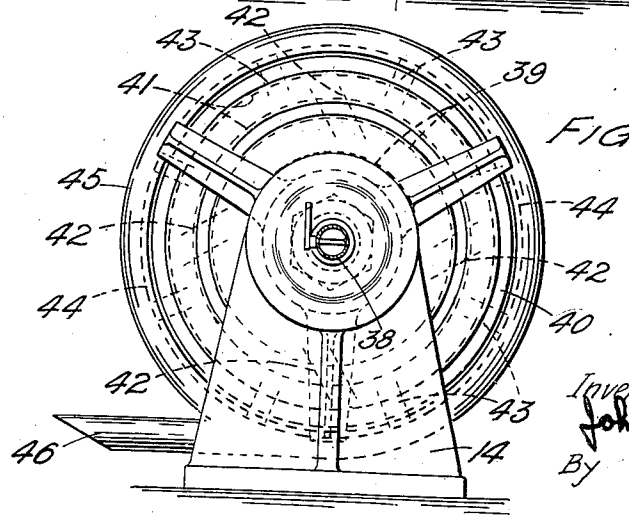


FIG. 2.



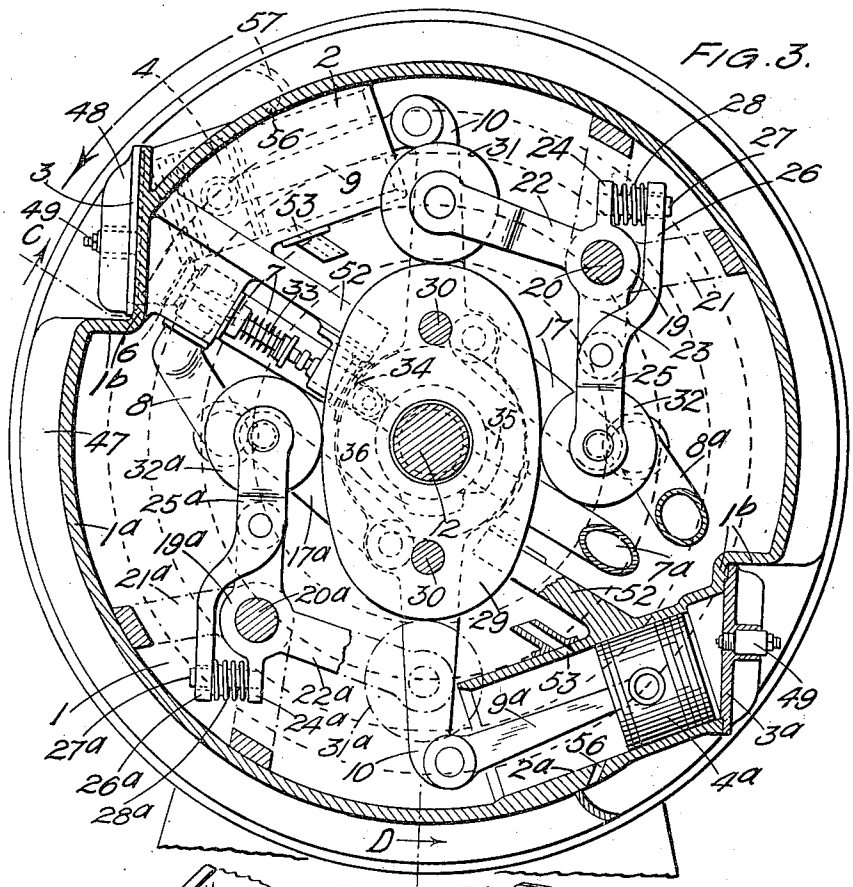
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ROTATING CYLINDER INTERNAL COMBUSTION ENGINE

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FIG. 3.



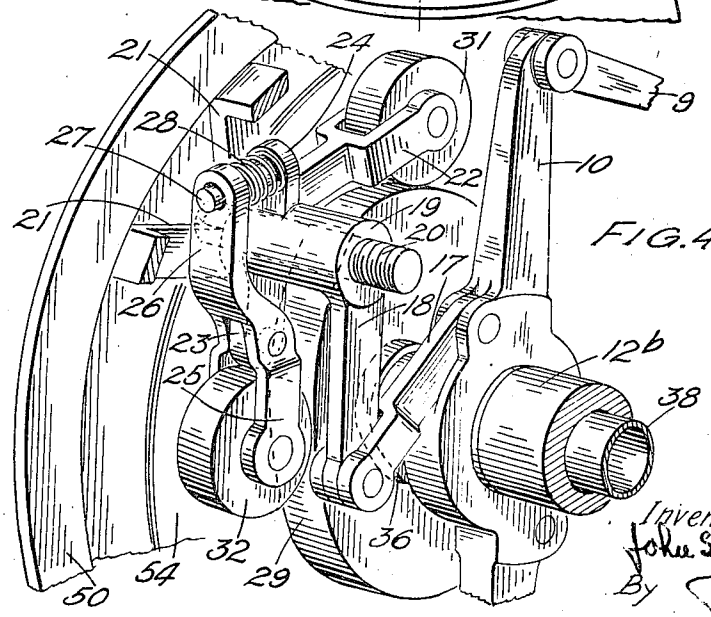


FIG. 4.

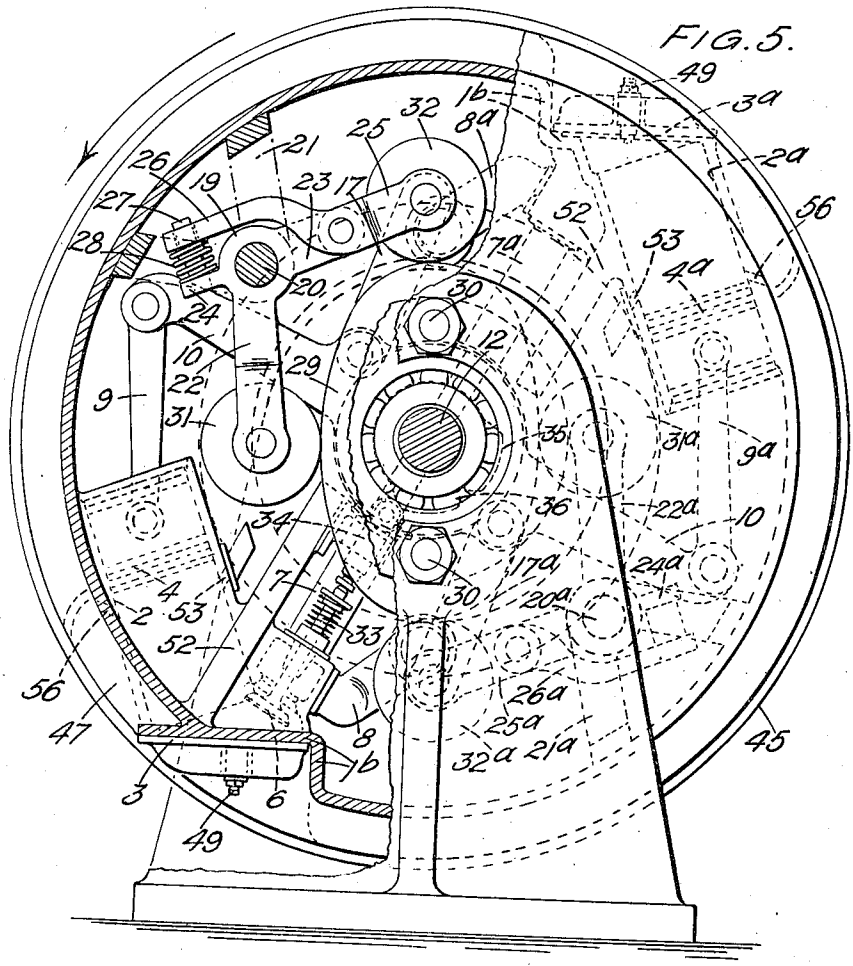
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ROTATING CYLINDER INTERNAL COMBUSTION ENGINE

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FIG. 5.



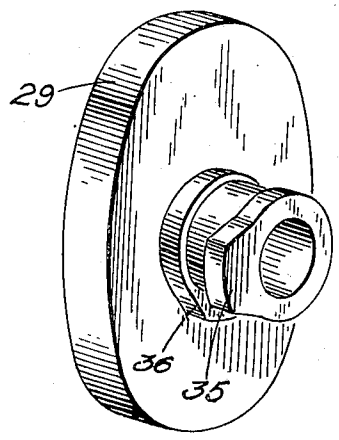


FIG. 6.

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ROTATING CYLINDER INTERNAL COMBUSTION ENGINE

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FIG. 7.

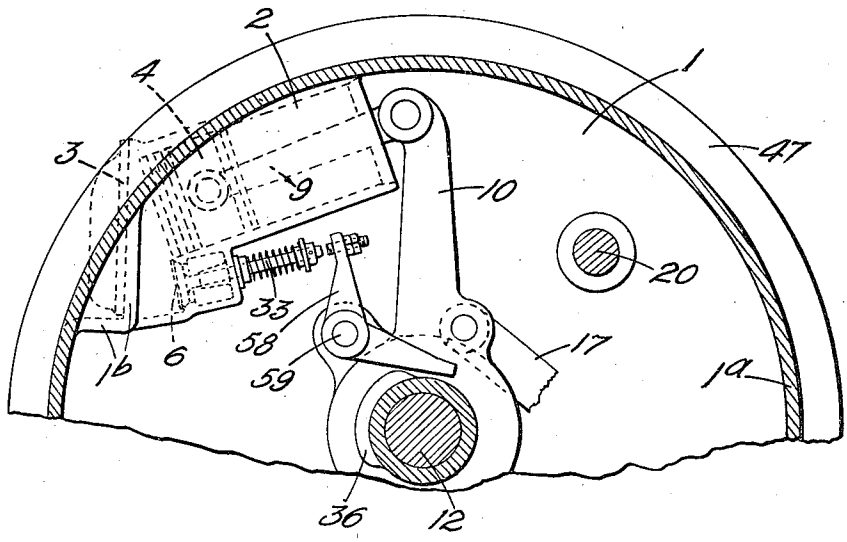
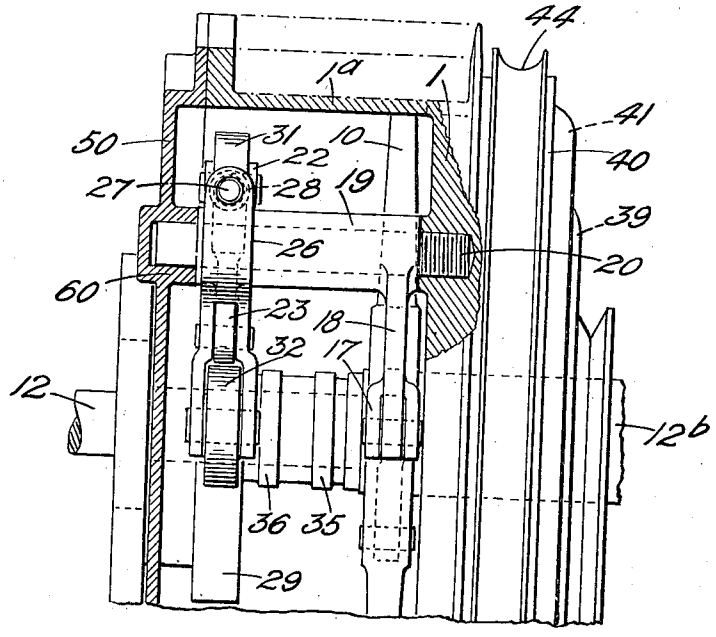


FIG. 8.



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Patented June 3, 1941 2,244,438

UNITED STATES PATENT OFFICE

2,244,438

ROTATING CYLINDER INTERNAL COMBUSTION ENGINE

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Application May 22, 1939, Serial No. 275,088
In Great Britain August 9, 1938

5 Claims. (Cl. 123—43)

This invention relates to rotating cylinder internal combustion engines and has for its object to provide an improved construction of engine which has few parts, is inexpensive to manufacture (requiring no crankshaft, cam-shafts or internal gearing), is adaptable for various fuels and possesses a low fuel-consumption.

According to the invention an internal combustion engine comprises a rotary body, a cylinder formed in or provided on said rotary body, a piston working in the cylinder, a lever pivoted on the rotary body, an operative connection between the lever and the piston, and a fixed part which constitutes means to govern the travel of the lever.

The said operative connection preferably comprises a second lever mounted for rotation about the axis of the rotary body and capable of oscillation relatively to the latter, a connection from the piston to the free end of the said lever and a second connection from the lever pivoted on the rotary body to the said second lever adjacent to its axis of rotation. The lever pivoted on the rotary body is preferably of bell-crank form and provided at each end with a roller or the like by which it is adapted to bear upon the fixed part. This latter is with advantage a symmetrical cam of substantially oval or elliptical form located with its centre point on the axis of the rotary body, the rollers or the like on the bell-crank lever engaging its edge at points angularly spaced apart through 90° about the said axis. The connection from the second lever to the said bell-crank lever is so arranged that the movement of the piston outwardly relative to its cylinder on the power stroke tends to urge one of the rollers on the bell-crank lever against the cam in a direction normal to the engaged surface thereof. Means is preferably provided for resiliently urging the ends of the bell-crank lever towards each other, thereby ensuring continuous contact between the rollers or the like carried on said ends and the cam or fixed part.

In the engine according to the invention, inlet and exhaust valves are conveniently actuated by means of non-rotatable cams relatively to which the valves and their actuating mechanisms revolve. These cams may be formed in one with or secured to the fixed part or cam for governing the travel of the lever mounted on the rotary body. The said fixed part or cam is devised firstly to exert a controlling effect during the working or power stroke of the piston so that an even driving impulse is transmitted and secondly to produce the necessary reciprocatory movement of the piston during the exhaust, induction and compression strokes (in the case of a four-stroke cycle engine).

Other features of the invention, such as the cooling arrangements and the exhaust system, will appear from the following description, given by way of example only, of a two-cylinder rotary engine operating on the four-stroke cycle. The engine is illustrated in the accompanying drawings, wherein:

Fig. 1 is an axial section thereof, taken on the line C—D of Fig. 3,

Fig. 2 is an end view taken in the direction of the arrow in Fig. 1, to a smaller scale,

Fig. 3 is a section taken on the line A—B of Fig. 1,

Fig. 4 is a fragmentary perspective view, taken from the rotor end of the engine, illustrating the operative connection between the piston and the lever pivoted on the rotary body,

Fig. 5 is a view similar to Fig. 3, partly in elevation however, showing the engine turned through 90°,

Fig. 6 is a perspective view of the fixed cams,

Fig. 7 is a fragmentary sectional end view showing an alternative valve-actuating gear, and

Fig. 8 is a fragmentary sectional side elevation illustrating a further modification.

In all the figures the same or corresponding parts are indicated by the same reference numerals.

In the example shown, a disc-shaped rotor 1 having a substantially cylindrical flange 1*a* on its inner face is formed to provide two cylinders 2, 2*a*. The cylinders are arranged with their axes located on equal and parallel opposite chords of the disc 1 and are disposed as near to the periphery of the latter as possible. The ends of the cylinders 2, 2*a* which are to lead in the direction of rotation of the rotor (indicated by an arrow in Figs. 3 and 5) open through the flange 1*a* which is stepped as shown at 1*b* (Figs. 3 and 5) to make it possible to fit a substantially planar detachable cylinder head 3 or 3*a* to each cylinder. A piston 4 or 4*a* is provided in each cylinder the combustion space of which is extended laterally beneath the cylinder head to have inlet and exhaust valves 5 or 5*a* and 6 or 6*a*, respectively, arranged therein. These valves respectively control inlet passages 7 or 7*a* and exhaust passages 8 or 8*a*.

Each piston 4 or 4*a* is pivotally connected by means of a connecting rod 9 or 9*a* to the one end of a common diametrically arranged lever 10 of a length slightly less than the internal diam-

eter of the flange 1a on the rotor 1. This lever is rotatably mounted at its centre of length by a bearing 11 (shown as a plain bushed bearing but usually constructed as an anti-friction bearing) on a stepped portion 12a of the driving shaft 12 of the engine. The shaft also has a larger diameter hollow portion 12b upon which the rotor 1 is keyed and which is mounted by means of an anti-friction bearing 13 in a standard 14, a second standard 15 serving to support the shaft 12 adjacent to its other end in a further anti-friction bearing 16 (see Fig. 1).

Adjacent to the central boss of the lever 10 each arm of the latter has pivotally attached thereto a short link 17 or 17a of which the other end is articulated to an arm 18 or 18a formed on the central boss of a composite lever pivoted on the inner face of the rotor 1. Each composite lever (see particularly Fig. 4) comprises a central boss 19 (or 19a) on which the arm 18 (or 18a) is formed and by which it is mounted on a pivot pin 20 (20a) screwed at one end into the rotor 1 and held at its other end by a V-shaped bracket 21 (or 21a) secured on the inner face of the flange 1a of the rotor. The boss 19 (or 19a) also has formed in one therewith an arm 22 (or 22a) set at approximately 90° to the arm 18 (or 18a), a shorter arm 23 (or 23a) having its axis substantially in the same plane as that of the arm 18 (or 18a) and a lug 24 (or 24a) substantially diametrically opposed to the arm 23 (or 23a). On the extremity of the arm 23 (or 23a) is pivotally mounted the central part of a forked lever 25 (or 25a) having a tail piece 26 (or 26a) extending substantially parallel with the lug 24 (or 24a) in which is secured a guide pin 27 (or 27a) that passes with some play through an aperture in the end of the tail piece 26 (or 26a). Around the pin 27 (or 27a) and between the lug 24 (or 24a) and the said tail piece is arranged a compression spring 28 (or 28a) that tends to urge the free ends of the arm 22 and lever 25 towards each other. These free ends each carry a roller co-operating with a common fixed cam 29 secured by bolts 30 to the standard 15 supporting one end of the engine so that the driving shaft 12 passes through it. The cam 29 is substantially of oval form and is disposed symmetrically relatively to the axis of the shaft, the roller 31 (or 31a) mounted on the bifurcated end of the arm 22 (or 22a), referred to herein as the operative roller, engaging the cam to determine the movements of the composite lever and the roller 32 (or 32a) engaging the cam at another location to restrain the operative roller against movement away from the cam under the action of centrifugal force.

The operative roller 31 (or 31a) engages the cam 29 at, or substantially at, one of the opposed points most remote from the axis of the driving shaft 12 when the associated piston 4 (or 4a) is in its innermost position (i. e. at the end of the compression or exhaust strokes) as shown in Fig. 3. The inoperative roller 32 (or 32a) engages the cam 29 at that one of the two opposed points nearest to the said axis which is behind the point engaged by the operative roller (considered in the direction of rotation of the rotor) when the piston is in the said position. Similarly, the operative roller 31 (or 31a) engages the cam 29 at one of the said two nearest points when the piston 4 (or 4a) is in its outermost position (i. e. at the end of the induction or explosion strokes) as shown in Fig. 5. Each revolution of the rotor 1 therefore results in each piston (4 or 4a) completing a full cycle or four strokes. The timing of the engine is preferably such that the explosion stroke in one cylinder (shown as 4 in the drawings) takes place at the same time as the induction stroke in the other cylinder (4a in the drawings).

The inlet and exhaust passages 7 and 8 (or 7a and 8a) leading to the respective cylinders 4 (or 4a) are controlled by the mushroom valves 5 and 6 (or 5a and 6a), respectively, arranged side by side in the direction of the thickness of the rotor 1 (see, for example, Fig. 1). Their stems 33 are arranged radially of the rotor 1 and are actuated by tappets 34 bearing on a common inlet cam 35 and a common exhaust cam 36, as the case may be, the cams 35, 36 being formed in one with or secured to the fixed cam 29. It will be seen that rotation of the rotor 1 will revolve the valves and their tappets relatively to the fixed cams 35, 36 and thus cause the actuation of the valves 5, 6 and 5a, 6a with the correct timing.

The fuel-air mixture is conducted from the carburetter (not shown) through the hollow end portion 12b of the shaft of the rotor 1 and through substantially radial ports 37 (Fig. 1) to the inlet passages 7 and 7a. The ports 37 open into the hollow shaft at diametrically opposite points and it is preferred that one of the ports be masked while the other is receiving the mixture and vice versa. This may conveniently be effected by providing a stationary sleeve 38 (Fig. 1) within the hollow shaft 12b, through which sleeve the mixture passes from the carburetter, and providing the sleeve with a half cylindrical extension 38a which covers the mouths of the ports 37 in succession as they rotate around the sleeve. The exhaust gases are discharged through the passages 8 and 8a which are directed towards the centre of the rotor 1 and open into an annular exhaust channel 39 (Figs. 1 and 2). This channel is formed in the outer face of the rotor 1 as for example by providing the latter with a semi-circular section annular groove and securing a cover 40 on the said face which is formed with the complementary portion of the exhaust channel. A further annular exhaust channel 41 of larger mean radius but smaller cross-section is similarly formed concentrically with the channel 39 which is in communication therewith through substantially radially directed passages 42 formed in the outer face of the rotor 1, as shown in Figs. 1 and 2. The exhaust gases are discharged from the exhaust channel 41 through radially directed passages 43 formed in the outer face of the rotor 1 and opening into a peripheral groove 44 formed in the latter. This groove is of semi-circular section and extends around the edge of the rotor 1 which is itself received within a stationary collecting channel 45 of U-section extending around and embracing the rim of the rotor 1 and formed with a tangential exhaust pipe 46. The exhaust passages 43 preferably open into the bottom of the groove 44 in the rim of the rotor so that the gases, due to their sudden lateral expansion upon leaving the ducts, may be deflected outwardly into the collecting channel 45.

The flange 1a on the rotor 1 may be provided with circumferentially extending cooling fins 47 and the cylinder heads 3, 3a may have cooling fins 48 disposed parallel with the fins 47. 49 indicates sparking plugs fitted in the cylinder heads. At the free edge of the flange 1a of the rotor is secured the outer edge of an annular

cover plate 50, the inner edge of which is spaced slightly from a fixed ring 51 carried by the standard 15. The space comprised between the inner faces of the cover 50, rotor 1 and flange 1a is partially filled with oil, for cooling and lubricating purposes, and two substantially radial webs 52 are provided between the rotor and flange, one in the neighbourhood of each cylinder, to ensure splashing of the oil on to the working parts. These webs 52 also serve as supports for the valve guides and as screening members for preventing the entry of oil into extra-air inlets 53 which may be provided for each cylinder.

The space containing the levers, links and cams is sealed against leakage of air therefrom into the outer atmosphere by means of a flexible metal annulus 54 secured on the outer face of the cam 29, by its inner edge, and bearing lightly by its outer edge upon a wearing strip 55 secured on the inner face of the cover plate 50 (see Fig. 1). Due to the outward movements of the pistons 4, 4a in their cylinders the pressure within the said space rises and, when the extra-air inlets 53 are uncovered by the pistons at the ends of their induction strokes, a small quantity of preheated air under pressure passes into each cylinder from the said space. "Make-up" air can pass into the said space from the outer atmosphere between the outer edge of the annulus 54 and the wearing strip, the annulus acting somewhat as a non-return valve. If desired, a further or alternative extra-air inlet 56 may be provided for each cylinder (see Fig. 3) to open through the flange 1a of the rotor between two of the cooling fins 47 thereon, the gap between the said fins being closed by a transverse scoop-like web 57 just behind the inlet 56 (considered in the direction of rotation of the rotor). With this arrangement air is deflected into the cylinder due to the rotation of the engine, the inlet 56 being uncovered by the piston at the end of its induction stroke. When the inlet 56 is provided additionally to the inlet 53 "make-up" air is continually being fed into the enclosed space through the inlet 56 while this is in free communication with the cylinder behind the piston.

In the operation of the engine described, the full four-stroke cycle is completed in each cylinder once for each rotation of the rotor 1. It is preferred that the power or explosion stroke in the one cylinder (shown as just commencing for cylinder 2 in Fig. 3 and just ending for the same cylinder in Fig. 5) correspond to the induction stroke for the other cylinder (2a), so that two power strokes are had for each revolution of the engine. When the explosion occurs in the cylinder 2 the pressure rise tends to force the piston 4 outwardly and thus to rock the lever 10 in the clockwise direction (as seen in Figs. 3 and 5). Such movement of the lever 10 is resisted, however, by reason of the link connection 17 to the arm 18 of the composite bellcrank lever 19, 22, 23, 25, since the said composite lever is thereby urged in the clockwise direction about its pivot 20 on the rotor 1 to cause the operative roller 31 to be pressed on to the cam 29 in a direction normal to the smaller radius part thereof. The composite lever and, consequently, the link 17, lever 10, connecting rod 9 and piston 4 are therefore held stationary and the pressure rise within the cylinder 2 acts to cause the rotor 1 to move in the anti-clockwise direction. As soon as this motion commences, the operative roller 31 begins to travel over the smaller radius part of the cam 29 but this is so designed that the piston 4 is held stationary in space until the cylinder head 3 has moved away from the piston 4 by an amount corresponding to a considerable part of the full stroke of the piston. Further movement of the rotor 1 brings the operative roller 31 on to the larger radius part of the cam 29 which is disposed nearer to the centre of the cam and thus permits the roller 31 to move towards the said centre. In consequence, the lever 10 is permitted to rock in the clockwise direction relatively to the fixed cam 29 and the piston 4 moves to the end of its stroke. It will be seen from Figs. 3 and 5 that the cylinder-head 3 moves through 90° while the piston 4 only moves through approximately 60°, about the axis of the rotor 1. Continued movement of the rotor in the anti-clockwise direction from the position shown in Fig. 5 causes the operative roller 31 to ride up the remaining portion of the larger radius part of the cam 29 on to the smaller radius part thereof. The piston 4 is therefore forced inwardly of the cylinder 2 on the exhaust stroke. Further rotation of the rotor then causes the induction and compression strokes in the manner already indicated since the cam 29 is symmetrical.

Instead of the valve-tappet mechanism shown there may be employed (see Fig. 7) rocker arms 58 of bellcrank form pivoted on the rotor 1 (at 59) and bearing at one end on the respective cam 35 or 36, the other ends of the rocker arms actuating the valve stems 33 which may then be arranged substantially parallel with the axis of the respective cylinder 2 or 2a, as shown. With this arrangement, the end of the rocker arm 58 contacting with the cam 35 or 36 is directed rearwardly with relation to the direction of rotation of the rotor 1 so that it is drawn or trailed over the rise of the cam and has a very smooth action. In addition, due to the modified dispositions of the valve stems 33, the combustion chamber may be made smaller than is possible with the arrangement first described.

Fig. 8 shows an alternative method of supporting the outer end of the pivot pin 20 (or 20a) which is screwed into the rotor 1 at its other end. The V-shaped brackets 21, 21a already mentioned are dispensed with and the outer ends of the pins are engaged in bores formed in bosses 60 on the inner face of the cover plate 50.

It will be understood that any desired number of cylinders may be employed and the respective pistons may be coupled to a common rocking lever or to a plurality of such rocking levers. These levers may each have one, two or more pistons associated therewith. Engines of the compression-ignition type may also be constructed in accordance with the invention and by suitable variation in the shapes of the cams the engines may be arranged to operate with a two-stroke cycle.

A very suitable arrangement, where increased power is required without increasing the bore of the cylinders and stroke of the pistons, is to dispose a plurality of units such as that described above on a common shaft in tandem fashion, the rotors all being keyed to the said shaft.

If desired, the cooling of the engine may be improved by forming air channels or passages through the masses of metal surrounding or forming parts of the cylinders, these channels or passages being directed substantially parallel

with the axis of the cylinder so that air will be forced therethrough due to the rotation of the rotor. Such passages may open, for example, into the outer faces of the cylinder heads. Alternatively, or in addition, air channels or tubes of this character may be utilised to cool the oil contained within the casing, the tubes or channels passing through the space normally occupied by the oil during the rotation of the rotor.

Variations may be made in non-essential details, such as the arrangement of the valve-actuating means, within the scope of the appended claims.

What I claim is:

1. An internal combustion engine comprising a rotary body, a cylinder mounted upon said rotary body, a piston working in the cylinder, a first lever mounted for rotation about the axis of the rotary body and capable of oscillation relatively to the latter, a second lever of bell-crank form pivoted on the rotary body, a connection from the piston to the free end of the first lever, a connection extending from the first lever at a point adjacent to its axis of rotation to the second lever, a fixed symmetrical cam of substantially oval or elliptical form located with its centre point on the axis of the rotary body and constituting means to govern the travel of the piston, and means at each end of the second lever by which it is adapted to bear upon the edge of the cam at points angularly spaced apart through 90° about the axis of the rotary body, the first and second levers and the connection between them being so arranged that the tendency of the piston to move outwardly relative to the cylinder on the power stroke causes one of the said means to be urged against the cam in a direction normal to the surface of one of the opposed parts thereof most remote from the axis of the rotary body.

2. An internal combustion engine comprising a rotary body, a cylinder rigidly mounted on said rotary body adjacent to the periphery thereof with its axis located on a chord of the body, a piston working in the cylinder, a substantially radially directed first lever mounted for rotation about the axis of the rotary body and capable of oscillation relatively to the latter, a second lever of bell-crank form pivoted on the rotary body, a connection from the piston to the free end of the first lever, a connection extending from the first lever at a point adjacent to its axis of rotation to the second lever, a fixed symmetrical cam of substantially oval or elliptical form located with its centre point on the axis of the rotary body and constituting means to govern the travel of the piston, and means at each end of the second lever by which it is adapted to bear upon the edge of the cam at points angularly spaced apart through 90° about the axis of the rotary body, the first and second levers and the connection between them being so arranged that the tendency of the piston to move outwardly relative to the cylinder on the power stroke causes one of the said means to be urged against the cam in a direction normal to the surface of one of the opposed parts thereof most remote from the axis of the rotary body.

3. An internal combustion engine comprising a rotary body, a cylinder mounted chordally on the said body adjacent to its periphery, a piston working in the cylinder, a first lever mounted for rotation about the axis of the rotary body and extending substantially radially therefrom, a second lever of bell-crank form pivoted on the rotary body, a connection from the piston to the free end of the first lever, a connection extending from the first lever at a point adjacent to its axis of rotation to the second lever, a fixed symmetrical cam of substantially oval form located with its centre point on the axis of the rotary body, and rollers rotatably mounted one at each end of the second lever and bearing upon the edge of the cam at points angularly spaced apart through 90° about the axis of the rotary body, the first and second levers and the connection between them being so arranged that the tendency of the piston to move outwardly relative to the cylinder causes one of the said rollers to be urged against the cam in a direction normal to the surface of one of the opposed parts thereof most remote from the axis of the rotary body.

4. An internal combustion engine comprising a rotary body, a cylinder mounted chordally on the said body, a piston working in the cylinder, a lever extending radially from and rotatable about the axis of the rotary body, a connection from the piston to the free end of the said radial lever, a substantially oval cam fixedly mounted with its centre on the axis of the rotary body and its major axis disposed substantially in line with the radial lever, a bell-crank lever pivoted on the rotary body near the periphery thereof with the free ends of its arms located close to the edge of the cam, a first roller mounted on the free end of one of the said arms to bear upon the edge of the cam, a connection from the free end of the other of the said arms to a point on the radial lever adjacent to its axis of rotation, a second roller displaceably mounted on the said other arm, and spring means for urging the said second roller into contact with the edge of the cam, the first and second rollers being located substantially on the major and minor axes, respectively, of the cam when the piston is on the point of moving outwardly relative to its cylinder.

5. An internal combustion engine comprising a disc-shaped rotary body, a pair of cylinders mounted on the said body with their axes located on equal and parallel opposite chords thereof, a piston working in each cylinder, a lever disposed diametrically of the rotary body to be rotatable about the axis thereof, a connection from each piston to one of the ends of the said lever, a substantially oval cam fixedly mounted with its centre on the axis of the rotary body and its major axis disposed substantially in line with that of the diametrical lever, a pair of bell-crank levers pivoted at diametrically opposite points on the rotary body with their free ends located close to the edge of the cam, a first roller mounted on the free end of one of the said arms of each bell-crank lever to bear upon the edge of the cam, a connection from the free end of the other arm of each bell-crank lever to one arm of the diametrical lever near the axis of rotation of the latter, and second rollers mounted one on the said other arm of each bell-crank lever to bear upon the edge of the cam, the first and second rollers of each bell-crank lever being located substantially on the major and minor axes, respectively, of the cam when the pistons are about to move outwardly relatively to their cylinders.

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