May 10, 1927. 1,628,100

B. R. BACON

INTERNAL COMBUSTION ENGINE

Filed Jan. 31, 1924 4 Sheets-Sheet 1

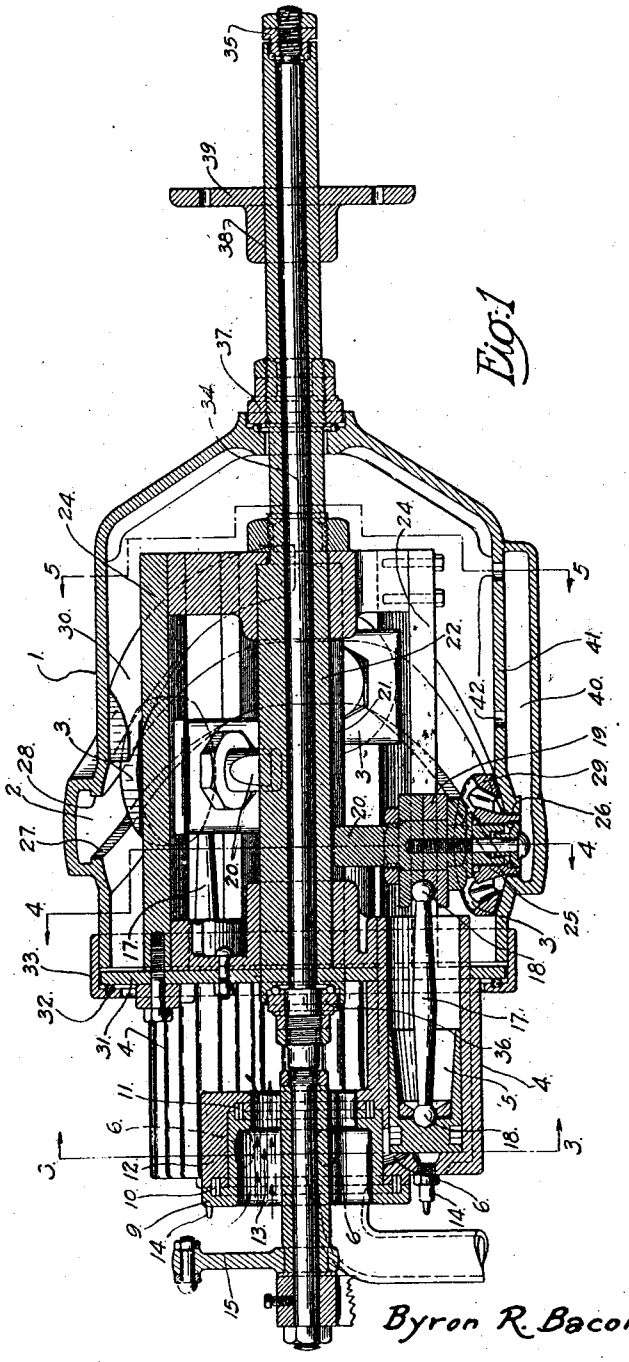

Fig. 1

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Filed Jan. 31, 1924 4 Sheets-Sheet 2

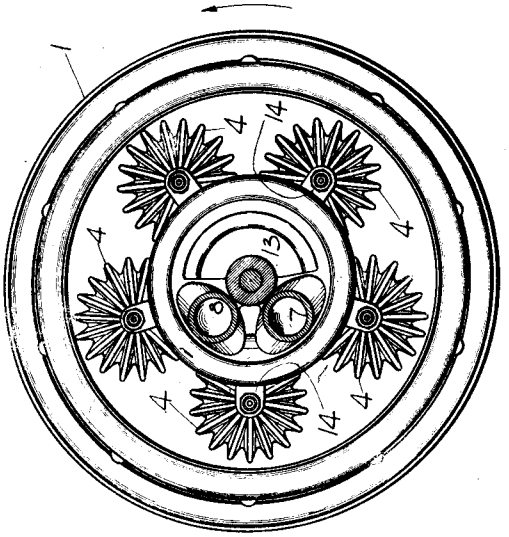

Fig. 2

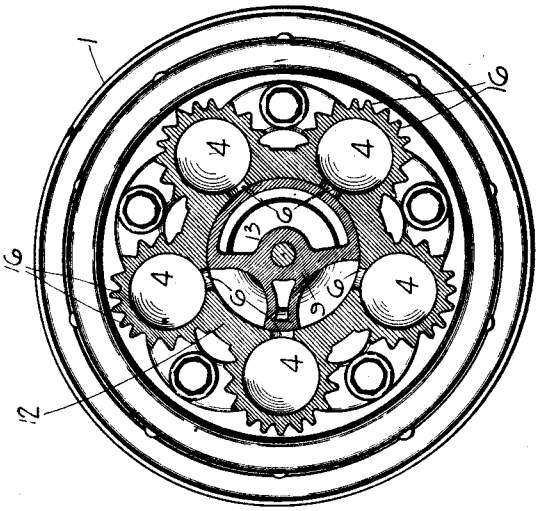

Fig. 3

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INTERNAL COMBUSTION ENGINE

Filed Jan. 31, 1924 4 Sheets-Sheet 3

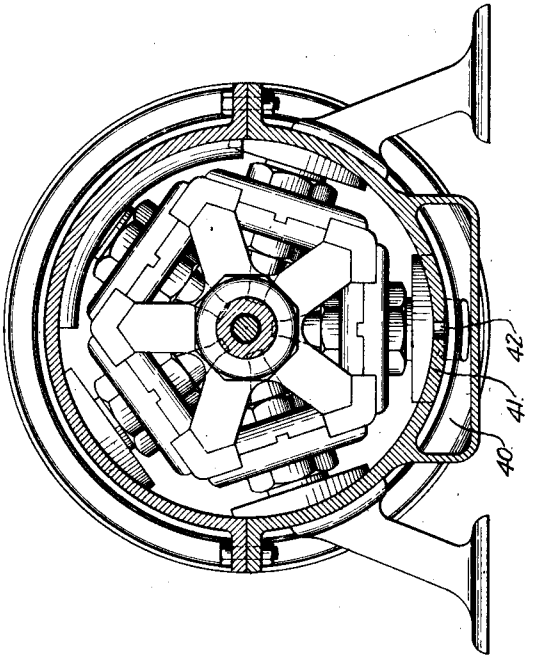

Fig. 5

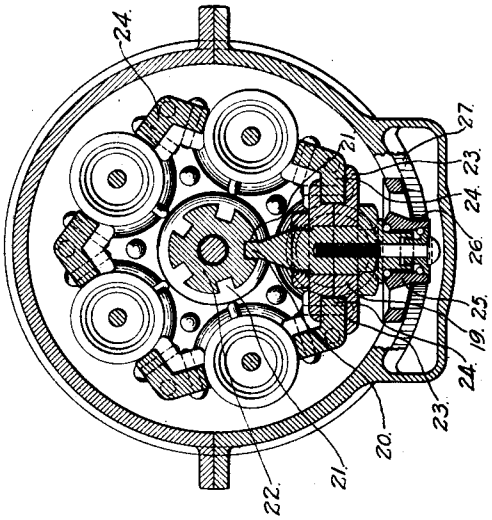

Fig. 4

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INTERNAL COMBUSTION ENGINE

Filed Jan. 31, 1924 4 Sheets-Sheet 4

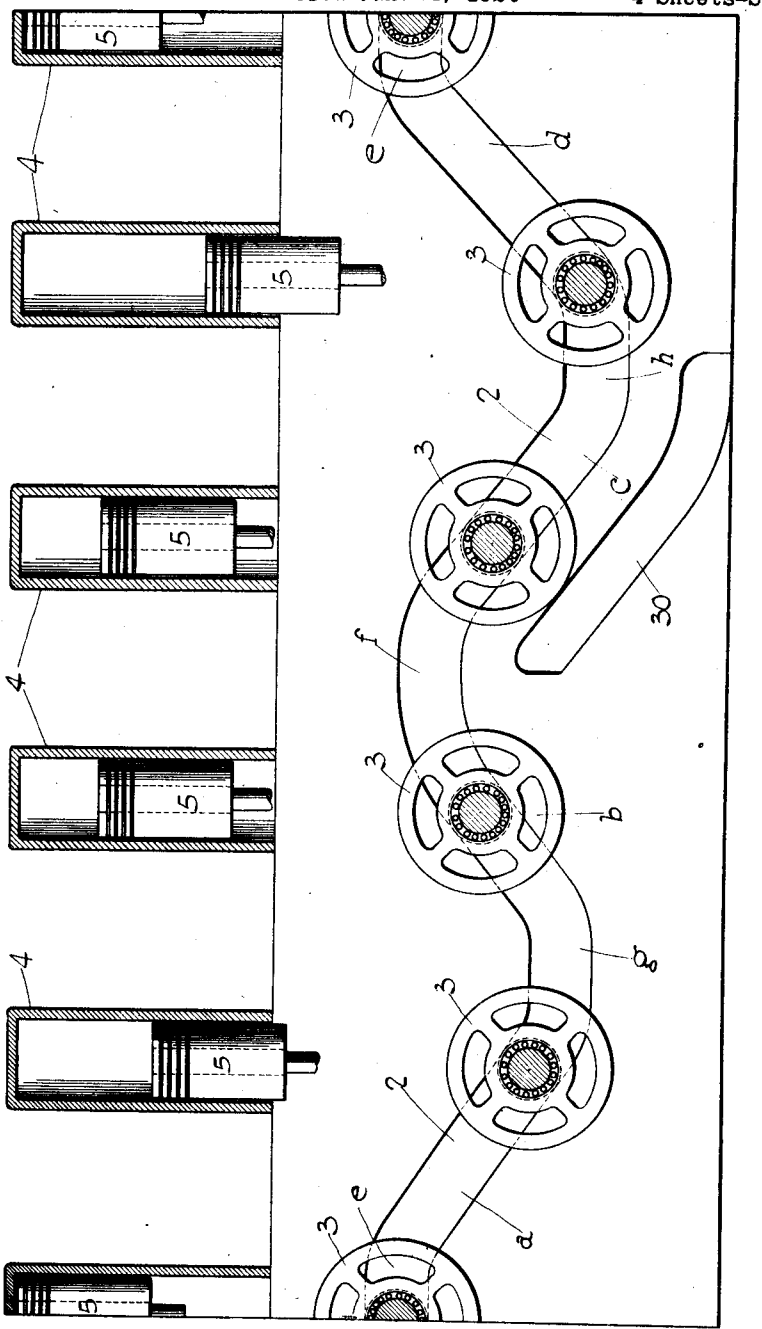

Fig. 6

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Patented May 10, 1927. 1,628,100

UNITED STATES PATENT OFFICE.

BYRON R. BACON, OF NEW YORK, N. Y., ASSIGNOR OF TWO-FIFTHS TO WILBER N. BACON, OF NEW YORK, N. Y.

INTERNAL-COMBUSTION ENGINE.

Application filed January 31, 1924. Serial No. 689,641.

My invention relates to devices of the class referred to, and more particularly to the type in which the change of the reciprocating motion of the piston to the desired rotary motion is effected not by means of the usual connecting rod and crank but by means of a cam, groove, or the equivalent, and a member reciprocating with the piston and engaging the cam or groove. The object of the present invention is to provide an improved apparatus of this type in which certain advantages are obtained which it is impossible to obtain in the connecting rod and crank type of engines at least without the introduction of undesirable complications; and which have not, as far as I am aware, been hitherto obtained even in the present type. The advantages will be more readily understood after the specification has been read, and they will be pointed out more fully hereinafter.

The invention is illustrated in the accompanying drawings, where Fig. 1 is a central longitudinal section of an illustrative form of an engine embodying my invention; Fig. 2 is an end elevation, as viewed from the left of Fig. 1; Figs. 3, 4, and 5 are sections on lines 3—3, 4—4 and 5—5 respectively of Fig. 1 looking in each case in the direction indicated by the arrows. Fig. 6 is a more or less diagrammatic development of the groove, the five cylinders, and the roller members engaging the groove, and will be referred to in explaining certain features of the invention.

In engines of this type it is of course entirely possible to keep either the portion bearing the cam, groove, or equivalent stationary and to have the rollers, or other engaging members, the pistons, and the cylinders rotate, or vice versa. I have chosen to illustrate my inventive idea in a form wherein the former arrangement is used, but it will be obvious from a perusal of the specification that the invention is not limited in this respect but is equally applicable to the other form.

In the form of my invention shown in the drawings and hereinafter described I show a series of five cylinders, but this again is merely illustrative and not by way of limitation, as some other number of cylinders may be used.

Referring to the drawings, the cylindrical housing 1 has formed in it the groove 2, about the precise form of which more will be said hereafter. This groove 2 is engaged by the roller members 3, of which there are five, one for each of the five cylinders. These cylinders, designated by reference numerals 4—4, are arranged symmetrically about the axis of the cylinder 1, and with their axes parallel to it. Within them reciprocate the pistons 5—5. The explosive charge is admitted to, and the exhaust is expelled from, the cylinders through ports 6—6. These ports 6 are connected to the intake and exhaust pipes 7 and 8 in proper sequence, and kept closed at other times, by stationary valve 9. Rings 10 and 11, extending into stationary valve 9 and into the rotating multiple-cylinder block 12 at opposite sides of ports 6, serve to prevent gas leakage from the cylinders. The opening 13 through valve 9 permits the circulation of air as indicated by the arrows in Fig. 1 to aid in cooling the cylinders. This air will be sucked in through 13 and be propelled outward over the cylinders by a centrifugal pump action.

14—14 are spark plugs, electrical contact with which is made at the proper moments by means of a contact carried by arm 15. As this portion of the arrangement forms no part of my present invention it will be unnecessary to describe it.

The fins 16—16 shown on the cylinders are for the purpose of increasing heat radiation from the cylinders.

The pistons 5 transmit their motion to the roller heads 3 or vice versa by means of the rods 17—17, whose ends engage the pistons and the rollers by ball-and-socket joints 18—18.

The roller heads 3 may be of any preferred construction. In the form shown each of them comprises a built up body portion 19 having a radially inwardly extending tongue 20 engaging and reciprocating in a groove 21 in the hollow shaft 22. Two lateral grooves 23—23 engage the guide bars 24—24. By means of the guide bars 24 and slots 21 the body portions of the roller heads are constrained to move in accurate alinement with their respective pistons. Opposite the tongue 20 each roller head carries the roller 25, on an adjustable ball-bearing.

The bearing surface 26 of roller 25 engages the bearing surfaces 27 and 28 of the goove 2. The roller 25 has an enlarged cir-

cular part 29 the outer surface of which at the proper time engages the left, (upper, in Fig. 6) surface of cam 30. This cam 30 is either integral with or at least firmly secured to the inner wall of the housing 1. Plate 31 is secured to and moves with the guide bars 24 and makes sliding contact with the packing ring 32 which is inserted in an annular groove in the L-shaped ring 33. By this means this end of the casing 1 is closed at this end for a purpose pointed out below.

Through hollow shaft 22 there extends the solid bar or shaft 34 equipped with the two ball-bearings 35 and 36, on which the hollow member 22 turns. 37 is an additional ball-bearing between the hollow rotating shaft 22 and the casing 1.

On the rotating hollow shaft 22 is mounted the hub 38 to the flange 39 of which is to be bolted the necessary mechanism for transmission of power to the point desired.

On the lower side of the casing 1 there is provided a chamber 40, separated from the remaining space in casing 1 by the partition 41, the partition being provided with holes 42—42. This space 40 is an oil reservoir, the oil filling it and standing to a level slightly above partition 41 so that the enlarged part 29 of the rollers 3 dip into it.

In the operation of the engine, the housing 1, valve 9, shaft 34 are stationary; and cylinder block 12, pistons 5, rods 17, roller heads 3, and the guide bars 24, plate 31, hollow shaft 22 and the parts connected to them, rotate.

Referring now to Fig. 6, there is illustrated here a development of the groove 2, the cylinders 4, pistons 5, and roller heads 3 being shown in the relative positions they occupy at one certain moment, which positions each of them will occupy successively.

At the left the piston is shown at the end of its exhaust stroke, ready to begin the suction stroke. This suction stroke occurs during the time the roller moves through the portion *a* of groove 2. The suction stroke is followed by the compression stroke which occurs while the roller is moving through portion *b* of the groove.

Then comes the combustion of the fuel and the power stroke of the piston, during which the roller moves through the portion *c* of the groove 2. This is followed by the exhaust stroke during which the roller traverses the portion *d* of groove 2.

The piston is then again in the position shown at the extreme left, having completed one entire revolution about the shaft, and is ready for a repetition of the cycle.

It will be noted that I have taken advantage of the fact that this type of engine permits of making the different strokes of the cycle of different lengths and in general of giving certain desirable characteristics to the strokes. The groove 2 is given such a shape that it brings the piston substantially to the very end of the cylinder at the end of the exhaust stroke, thus very effectively ridding the cylinder of the waste gases; while at the end of the compression stroke the piston is still at such a distance from the end of the cylinder as is required for a charge of carburetted gases at the proper pressure. The point *e* of the groove, in other words, is nearer the cylinder than point *f*. Similarly the points *g* and *h* need not be the same distance from the cylinder. *h* is put at such a distance that the full expansive effect of the burnt gases is realized, while *g* is chosen only with reference to the charge it is desired to take in, the two points not being tied to each other.

The different strokes are, moreover according to my invention, given certain characteristics by shaping the groove in a certain way. Thus the portion *b* of the stroke, during which compression occurs, is not of a uniform slope throughout but is steeper at the lower part and then at the upper part, as the force required for further compression increases progressively, is made with progressively smaller slope. Thus the work of compression can be distributed through the stroke just as desired. By contrast, in a connecting rod and crank engine the distribution of the work is fixed.

Similarly the power delivery during the power stroke may be distributed over the stroke as desired. I illustrate this by making the slope more gradual at first where the pressure is great and steeper farther on as the pressure diminishes. Others may prefer some other distribution of the power over the stroke but if they take advantage of the principle I have just stated and illustrated they are using my invention.

The intake and exhaust strokes may likewise, if desired, be shaped to take advantage of this inventive idea, although this will generally be of little moment in view of the relatively slight power expenditure involved.

Another possibility I take advantage of, which is present here, but absent in the connecting-rod and crank type of engine is the following. After the intake of the carburetted air or other explosive mixture is completed, it is of advantage to wait until the valve is thoroughly closed and the closing edge has advanced some little distance beyond the edge of the intake opening before compression is begun. Leakage is thereby minimized. I effect this by giving the groove the flat spot at *g*. Likewise I place a flat spot at *h*, the purpose in that case being to give the valve a chance to open wide before beginning the exhaust stroke so as to reduce the back-pressure and the work required to expel the gases.

I wish next to point out the object of the form given the roller, and of the cam 30. The former has two purposes. The first is that it is to coperate with cam 30 during the power stroke. The surface 26 being of comparatively small diameter the portion of it contacting with the surface of groove 2 is correspondingly small. While there is no danger of the metal crushing during any of the other three strokes there is some danger of this occurring during the power stroke. To prevent it the larger diametered portion 29 is used, which, engaging cam 30, presents an additional and larger contacting surface to take up the compressive stress.

The other function the larger portion 29 has is to act as a splasher and atomizer of the oil in the bottom of casing 1, throwing the oil in all directions thereby effecting thorough lubrication of cylinder walls and other surfaces requiring it. It is to prevent or minimize the leakage of this oil that packing ring 32, spoken of above, is inserted.

I have in the illustration and specification shown an arrangement whereby each piston performs two complete strokes while revolving once around the central axis. Obviously my inventive idea is not limited to this arrangement but has equal application in cases where the engineer chooses to form the groove so as to have more than one power stroke for each revolution of each cylinder. Such an arrangement will be a natural one where the number of cylinders selected is larger than the number I have chosen for illustrative purposes. It will likewise be obvious that the feature of my invention relating to the distribution of the load has application also in two-cycle engines.

What I claim is:—

1. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that at the end of the compression stroke the piston has not approached as close to the end of the cylinder as at the end of the exhaust stroke.

2. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that at the end of the exhaust stroke the piston has travelled substantially to the end of the cylinder, while at the end of the compression stroke it is still at a material distance from the end of the cylinder.

3. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that at the end of alternate inward strokes of the piston the piston is different distances from the end of the cylinder.

4. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that at the outward end of the intake stroke the piston is at a different distance from the end of the cylinder than at the end of the power stroke.

5. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that its slope over the part corresponding to the compression stroke varies to substantially equalize the load throughout the stroke.

6. In a four-cycle internal combustion engine of the class described the combination of a cylinder, a piston reciprocating in the cylinder, a housing provided with a continuous internal undulatory groove lying in a cylindrical surface, said engine cylinder being mounted to be rotatable about the axis of the cylindrical surface and relatively to it, a member engaging the groove, a rod operatively connecting the member and the piston, said groove being so shaped that its slope over the part corresponding to the power stroke varies to substantially equalize the load throughout the stroke.

7. In an internal combustion engine of the class described, the combination of a plurality of cylinders, a piston reciprocating in

each of them, a housing provided with a continuous undulatory internal groove lying in a cylindrical surface, said engine cylinders being mounted to be rotatable about the axis of said cylindrical surface and relatively to said surface, a plurality of members engaging the groove one for each piston, rods operatively connecting said members and the pistons, said groove being so shaped that each piston at the end of alternate inward strokes has approached its cylinder end by different distances.

8. In apparatus of the class described, the combination of a cylinder, a head closing it at one end, a piston reciprocating in it, a housing provided with a continuous undulatory groove lying in a cylindrical surface, said cylinder being mounted to revolve about the axis of the cylindrical surface, a member engaging the groove, a rod operatively connecting the member and the piston, said groove having a portion lying substantially wholly in a plane perpendicular to the axis of revolution.

9. In apparatus of the class described, the combination of a cylinder, a head closing it at one end, a piston reciprocating in it, a housing provided with a continuous undulatory groove lying in a cylindrical surface, said cylinder being mounted to revolve about the axis of the cylindrical surface, a member engaging the groove, a rod operatively connecting the member and the piston, said groove having a portion engaged by the member during the suction stroke of the piston followed by a portion that is substantially entirely in a plane perpendicular to the axis.

10. In apparatus of the class described, the combination of a cylinder, a head closing it at one end, a piston reciprocating in it, a housing provided with a continuous undulatory groove lying in a cylindrical surface, said cylinder being mounted to revolve about the axis of the cylindrical surface, a member engaging the groove, a rod operatively connecting the member and the piston, said groove having a portion engaged by the member during the power stroke of the piston followed by a portion that is substantially entirely in a plane perpendicular to the axis.

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