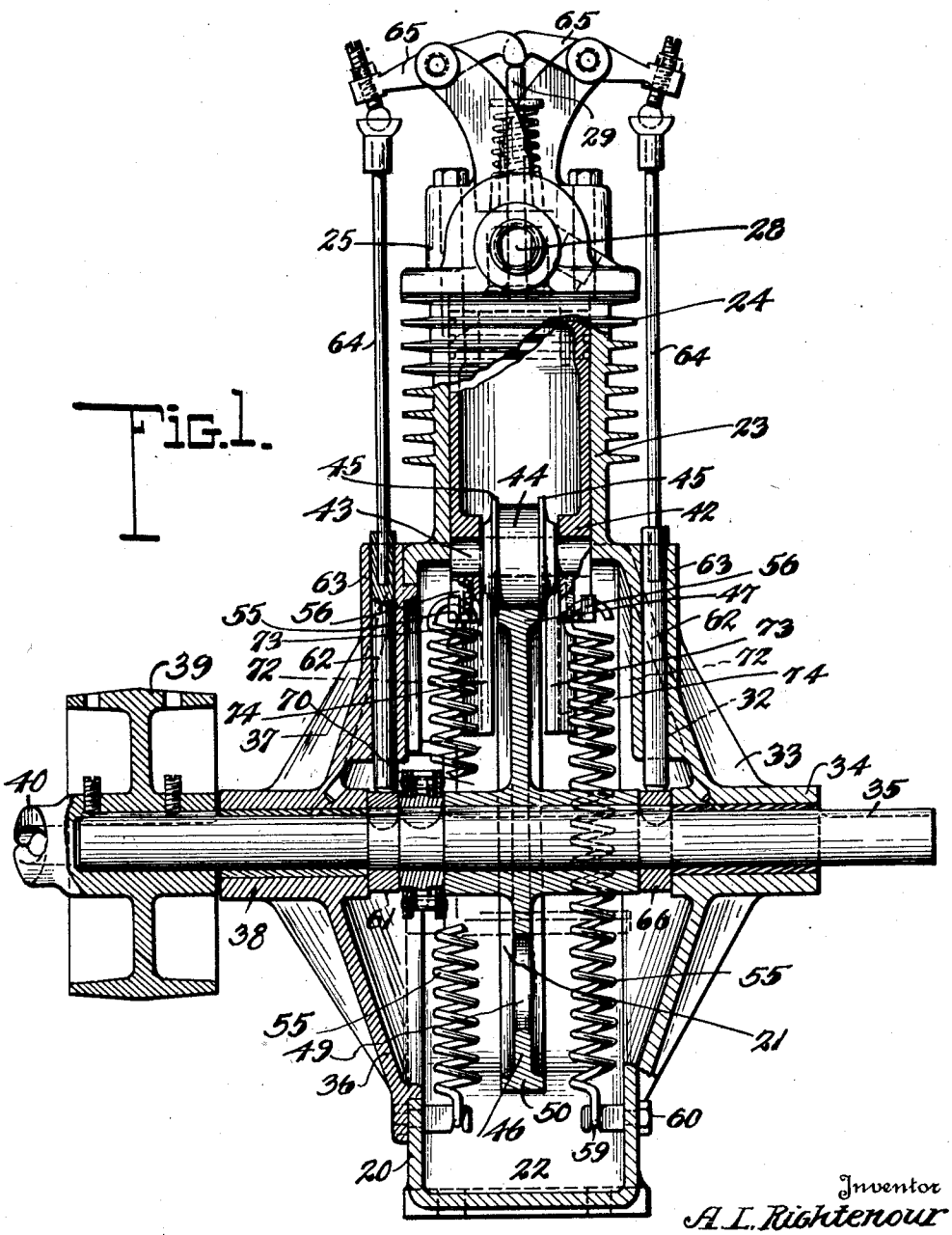
Sept. 17, 1929. A. L. RIGHTENOUR 1,728,363

VARIABLE STROKE COMBUSTION ENGINE

Filed May 26, 1927 4 Sheets-Sheet 1

Fig. 1.



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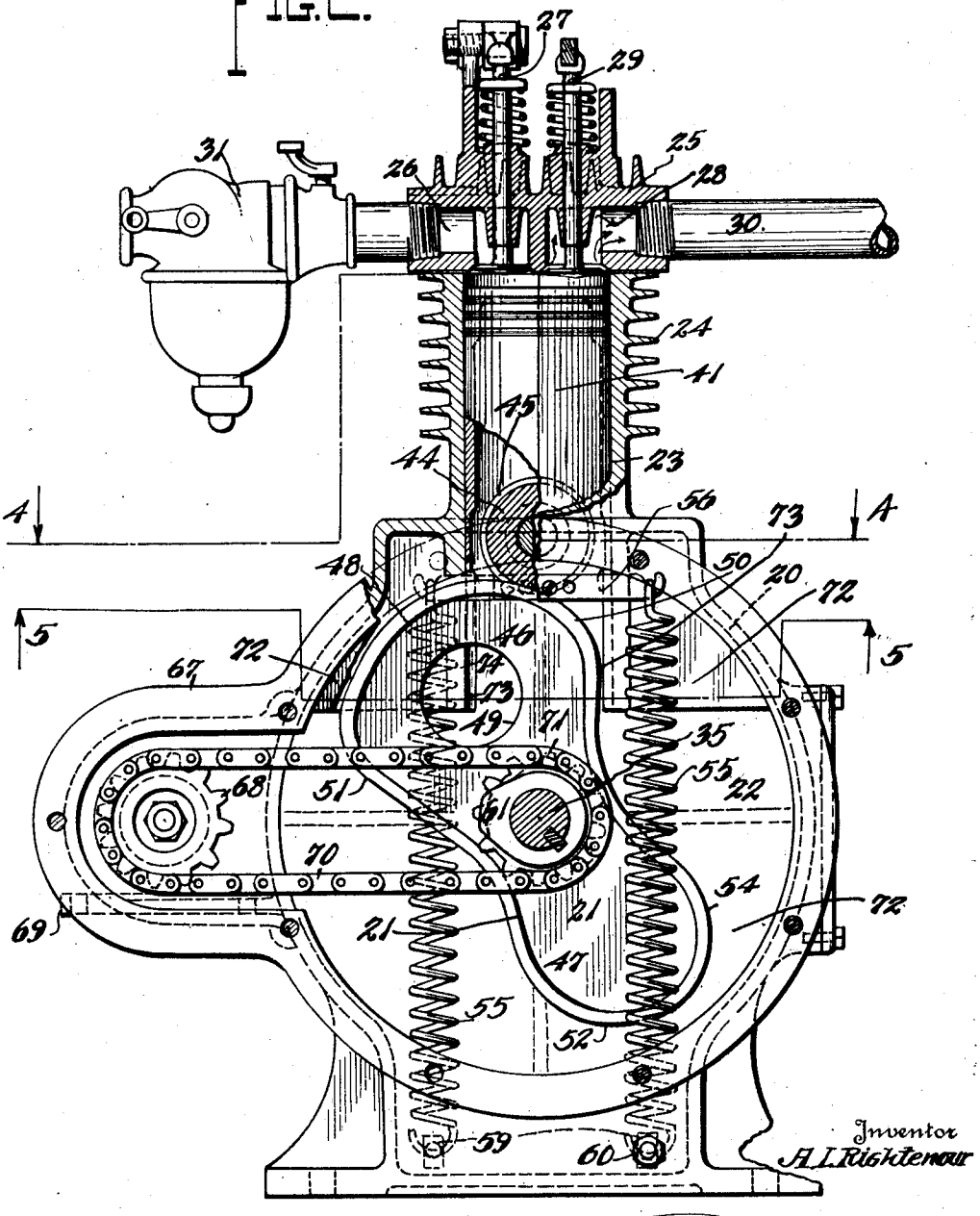
VARIABLE STROKE COMBUSTION ENGINE

Filed May 26, 1927 4 Sheets-Sheet 2

Fig. 2.



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VARIABLE STROKE COMBUSTION ENGINE

Filed May 26, 1927 4 Sheets-Sheet 3

Fig. 3.

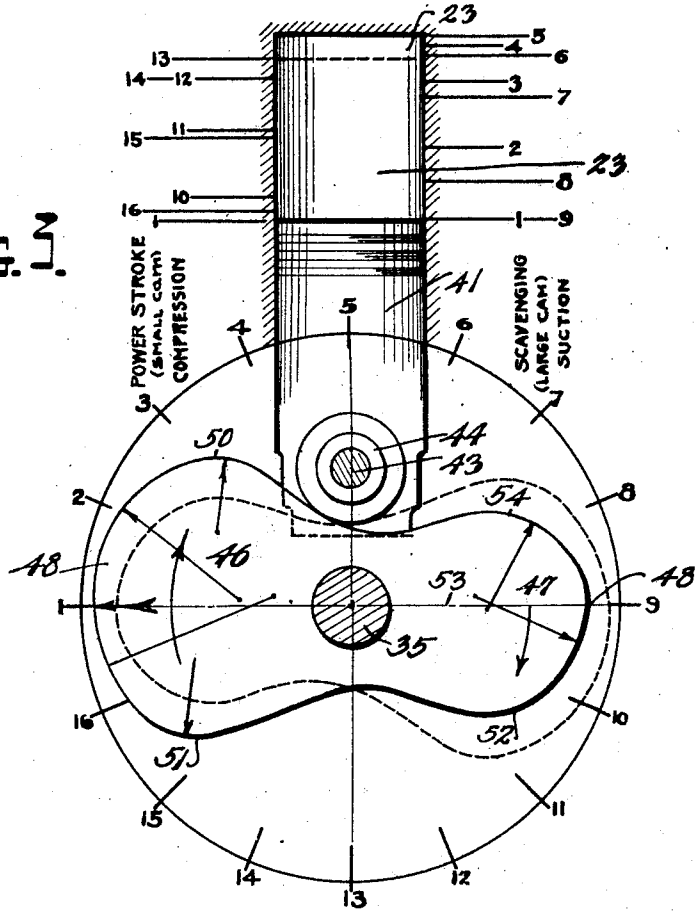
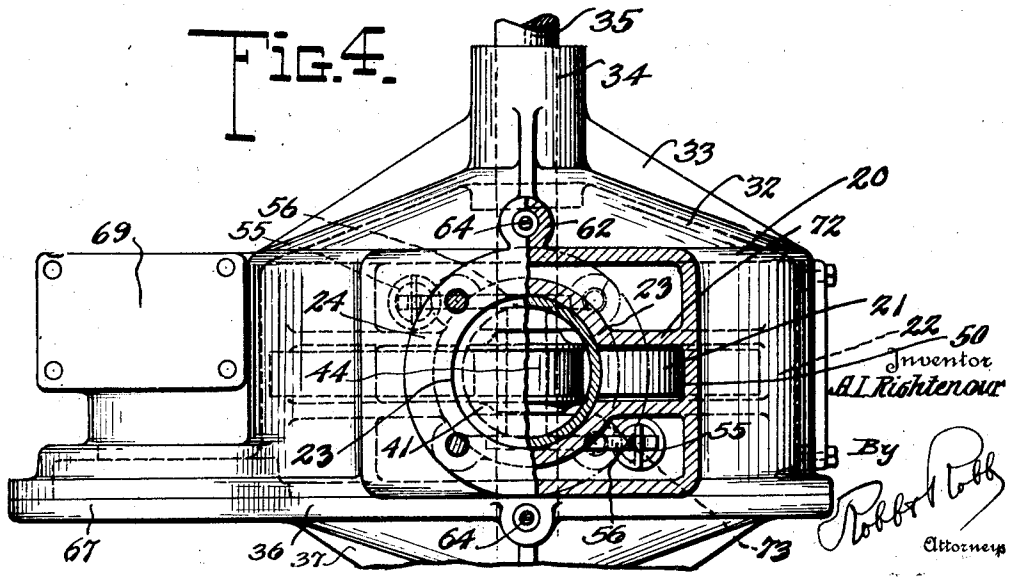


Fig. 4.



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VARIABLE STROKE COMBUSTION ENGINE

Filed May 26, 1927 4 Sheets-Sheet 4

Fig. 5.

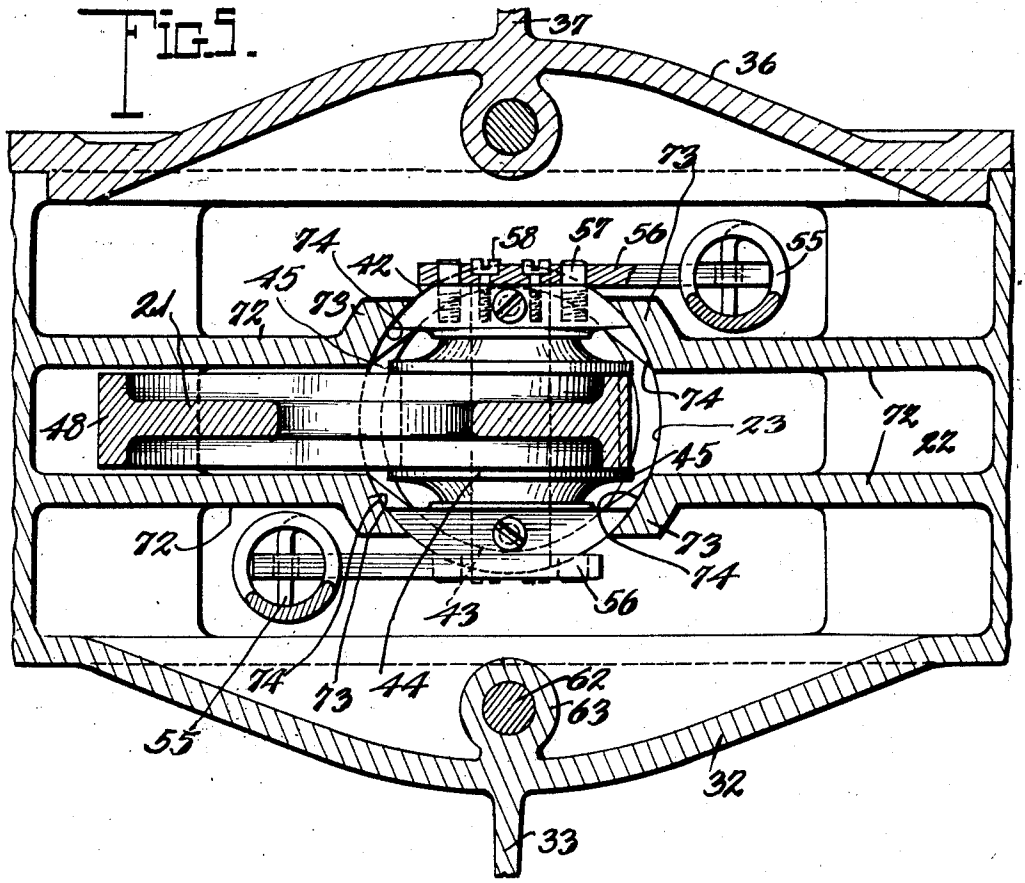
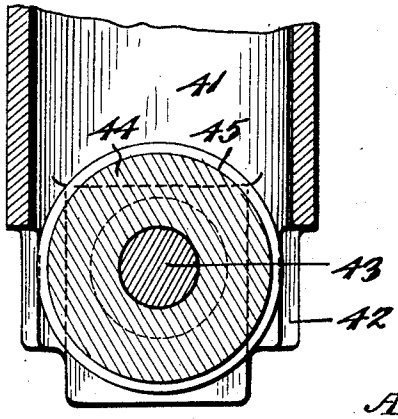


Fig. 6.



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UNITED STATES PATENT OFFICE

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VARIABLE-STROKE COMBUSTION ENGINE

Application filed May 26, 1927. Serial No. 194,455.

This invention relates to a variable stroke combustion engine, and particularly to a construction wherein the piston is directly associated with an actuating cam formed to vary the length of its stroke for the successive cycles of engine operation during a complete rotation of a driven shaft.

In this type of engine it is important to provide for the maximum length of piston stroke during the exhaust or scavenging movement and the opposite suction or intake travel which involve a one-half revolution of the cam while the minimum length of the piston stroke occurs during the compression and firing cycles when the piston is at its usual length of stroke. To effect such operation the piston is yieldingly held in contact with a figure 8 cam on the driven shaft and to secure the most efficient action of the piston during the successive cycles of engine operation the movements of the piston are differently timed so that I obtain a variation in the length of piston stroke and also vary the time of opposite movements comprising such strokes. This may be readily accomplished by forming the opposite cam heads of different transverse width and also by offsetting one of the side contact faces of the cam at a greater distance from the longitudinal center of the cam than its opposite face. The result is to provide actuating faces at opposite sides of each end of the cam having different arcs of curvature which control the movement of the piston relative to the travel of a given point of the cam.

Under this arrangement, when the piston is at its inward limit of movement after the firing cycle, the cam engaged therewith causes a rapid preliminary travel and a subsequent slower movement as the piston reaches its greatest length of stroke during the scavenging cycle. The return or suction stroke is slowly initiated and then accelerated greater than the exhaust travel during the remainder of its movement causing a rapid return of the piston resulting in intense suction action.

The short or compression stroke at the opposite head of the cam increases in speed during its first half and gradually diminishes when the stroke is completed, while the return movement of this stroke comprises the firing or power cycle and is more rapid than the compression travel which results in the greatest leverage at the beginning of the stroke and a reduction thereof until the piston is nearest the axis of the cam at the completion of the four cycles of operation.

The result of the side variations of the cam face or different arcs of curvature thereof, is that for a fixed distance of circular travel of a given point on the cam the piston has imparted thereto a different extent of movement during the successive cycles of operation resulting in a much more efficient action than would be produced were the side faces of the cam equal in curvature and the heads of the same transverse diameter.

In an engine of this character it is desirable to avoid extended connections such as piston rods between the piston and its controlling cam and I have provided for the direct engagement of the piston with the cam whereby a positive action is secured; the engine parts reduced in number and closely nested to effect a material reduction in weight and cost of construction; and providing a simplicity of construction which permits quick assemblage and reduces to a minimum the cost of repair. Toward this end of direct contact of the piston with the cam, the skirt of the piston is provided with a roller traversing the actuating face of the cam during its rotation and restoring springs are extended from the piston skirt to a point on the casing below the cam, which provides for a yielding contact between the piston and cam.

In order to guide the piston in its movement beyond the cylinder, flanges are provided at the open end thereof having curved faces conforming to the curvature of the cylinder which insures a full downward stroke of the piston in following the curvature of the cam without liability to side wobbling movement while the relation of these guides is such that the size and weight of the engine may be reduced by the closely nested relation of the piston and cam with their associated springs and guide.

In assembling an engine of the type before

described I have found it desirable to provide an improved form of casing for the nested arrangement of the parts and comprising a cam chamber with shaft bearings at opposite sides, a cylinder directly mounted at the upper portion of said chamber with inlet and exhaust valves, means on the shaft for actuating said valves, a piston within the cylinder, a cam disposed within said piston and springs within said chamber for retaining the piston and cam in yielding contact.

The invention has for an object to provide a novel and improved construction of variable stroke engine including a cylinder and piston therein, a cooperating shaft having a controlling cam thereon for the piston stroke and formed with heads at different distances from the shaft to vary the length of stroke and with means to vary the timing of the piston travel during the successive cycles incident to a complete revolution of said cam during the engine operation.

A further object of the invention is to provide an improved construction of controlling cam having its opposite heads extended at different distances from the axis of the cam, said heads being of different transverse diameters and having contact faces of variable arcs to effect a different timing motion of the piston during its travel upon opposite faces of either head of the cam.

Another object of the invention is to provide an improved construction wherein the piston directly engages a controlling cam and is yieldingly held in contact therewith so as to secure a direct action of one member upon the other and a closely nested assemblage of the parts.

A still further object of the invention is to provide an improved construction of engine casing having in its body a cam chamber and a cylinder at its upper portion communicating with said chamber together with inlet and exhaust ports at the head of said cylinder, a piston therein, and a cam within the chamber of the casing adapted to directly engage said piston.

Other and further objects and advantages of the invention will be hereinafter set forth and the novel features thereof defined by the appended claims.

In the accompanying drawings:

Figure 1 is a vertical section with parts in elevation;

Figure 2 is a similar view taken at a right angle to Figure 1;

Figure 3 is a diagram illustrating the relative cam and piston movements;

Figure 4 is a section on the line 4—4 of Figure 2;

Figure 5 is a similar enlarged view on the line 5—5 of Figure 2; and

Figure 6 is a detail section of the piston.

Like reference numerals designate corresponding parts throughout the several figures of the drawing.

The construction of engine herein disclosed may be of any desired size and the number of cylinders multiplied dependent upon the power to be developed, but for the purpose of illustration a single cylinder is shown. In this form of the engine the casing 20 may be of any preferred configuration and structure preferably circular and of substantially the size of the actuating cam 21 disposed therein so that it comprises a cam chamber 22.

Associated with the upper portion of the casing and communicating with the cam chamber is a cylinder 23 provided if desired with radiator ribs 24 while the head 25 of this cylinder is formed with the usual intake passage 26 and valve 27 controlling the same and with the exhaust passage 28 and valve 29 therefor. The exhaust passage communicates with a suitable discharge 30 while the inlet passage 26 may be in communication with a carbureter as shown at 31 in Figure 2.

One side or head 32 of the casing 20 is provided with outwardly radiating ribs 33 supporting a bearing 34 for the driven shaft 35. At the opposite side of the casing a removable head 36 is secured thereto in any preferred manner and formed with radiating ribs 37 supporting the bearing 38 for the shaft. Secured upon this shaft is the usual fly wheel 39 having means indicated at 40 for connection with a starting crank or lever.

Within the cylinder 23 a piston 41 is disposed and may be either solid or tubular as shown. The lower end of this piston is formed with a skirt portion 42 providing bearings for the journal 43 of a friction roller 44 which is flanged at 45 and rides upon the periphery or actuating face of the cam 21. This cam comprises opposite head portions forming a large cam 46 and a small cam 47, the former being provided with an apertured portion 49 in its web to properly balance the greater size of the portion 46. The actuating face 48 of the larger cam is disposed at a greater distance from the shaft 35 than the similar face of the smaller cam 47.

The opposite ends of this cam member are not only of greater length but also differ in their transverse width or diameter so as to provide side faces which may be located at different distances from a longitudinal central line extending through the axis of the cam which results in providing actuating faces at the sides of the cam differing in their arc of curvature.

Referring to Figures 2 and 3 it will be noted that on the larger cam head 46 the actuating face 50 at one side is at a different distance from the central line 53 of the cam and of a different curvature from the opposite actuating face 51 while the face 48 connecting these portions is of a curvature which effects the least movement of the piston. At

the opposite or smaller cam head 47 the face 52 is at the greater distance from the central line 53 while the face 54 is of less curvature and consequently nearer said line.

In order to insure a yielding contact between the piston roller and the cam I have provided spring members which, in order to secure a reduction in size and close nesting of the parts, are disposed at opposite sides of the cam and compress the coiled springs 55 extending from the connecting arms 56 at opposite sides of the piston skirt 42. These arms are projected in opposite directions to balance the spring tension on the piston and are secured to the skirt by means of pins 57 extending through apertures in the arms to prevent rocking movement thereof and the clamping screws 58 extending through the arms into the piston skirt 42. The lower ends of these springs may be secured in any desired manner, for instance by means of hooked lugs 59 bolted to the casing at 60. This novel form of casing is also adapted to cooperate with the valve actuating members and for that purpose an intake cam 61 is keyed to the shaft 35 and operates upon a pusher 62 disposed in a tubular portion 63 of the casing and carries the rod 64 extended to the valve operating lever 65.

The exhaust cam 66 at the opposite side of the casing is provided with a similar construction of parts for actuating the rocker lever for the exhaust valve 29. The casing is further provided with an extension 67 at one side adapted to receive the driving gear 68 for a generator or magneto disposed upon the platform 69 carried by the casing. This driving gear 68 is connected by the chain 70 with a sprocket gear 71 keyed to the shaft 35.

In the movement of the piston away from its head while traversing the curvature of the controlling cam, it is essential to provide suitable guide means to prevent side movement of the piston and this is effectually done by means of the parallel ribs 72 extended inward from opposite points on the casing, these ribs being formed with guide flanges 73 having suitable curved faces 74 which form a continuation of the cylinder walls at opposite points which permits a movement of the piston at all times in direct contact with the cam.

The general operation of the engine will be apparent from the foregoing description from which it will be seen that the larger cam imparts to the piston its greatest length of stroke during the scavenging and suction cycles while the smaller cam head reduces the length of such stroke for the compression and firing cycles.

As illustrating the variation of the timing in the piston movement, reference is made to the diagram of Figure 3 from which it will be seen that the cam in its full line position is at the end of the firing stroke and about to begin the scavenging cycle. In order to illustrate the movement of a given point on the cam such as the arrow at the left, the cam has been surrounded by a circle having a series of equal divisions indicated by the numerals 1 to 16 inclusive, and it will be seen that the movement of the arrow from the position 1 to 2 causes a rapid inward movement of the piston equivalent to the space between 1 and 2 indicated at the upper portion of the diagram on the wall of the cylinder. This continues until the arrow reaches the point 3 when the portion of the cam of less curvature is reached and the speed of the piston movement reduced so that it travels a less distance in the cylinder between the points 3 and 4 while when it reaches the point 5 of the circle it is at its greatest length of stroke and accomplishes a complete scavenging action of the cylinder.

The return or suction stroke begins in the travel of the arrow from the point 5 to the point 6, resulting in a relatively slow movement as indicated on the upper portion of the diagram and the wall 51 of the larger cam head being of less curvature causes a rapid increase in this movement between the points 6 and 7, and 7 and 8, while at the point 9 the piston has reached the inmost limit of its suction stroke, as indicated by dotted lines in Figure 3. The movement from this time occurs at the smaller head and the face 52 thereof effects a gradual rising movement of the piston in the travel of the arrow between the points 9 and 10 which is greatly accelerated during the compression action in the travel between the points 10, 11 and 12 while the limit of the short piston stroke is reached at the point 13.

The return or firing action now occurs and there is a slow starting movement in the travel between points 13 and 14 which is materially increased due to the curvature of the face 54 so as to secure a rapid movement during the firing stroke and the maximum leverage up to the point 16 after which the piston comes to its inmost point of travel at the point 1 and has completed the four cycles of the engine operation with proper provision in each cycle for a variation in the speed of the piston so as to secure the most efficiency incident to the difference in curvature between the opposite side faces of each of the cam heads.

It will be seen that this assemblage provides for a direct action of the piston upon the cam and the control of its movement thereby while the parts are so assembled as to greatly reduce the weight and simplify the construction of the engine so that it can be quickly assembled and reassembled and comprises an operating unit by which the corelated parts operate in unison to effect the intake and exhaust from the cylinder and the

action therefrom through the cam to the drive shaft.

While the detail construction of the several parts has been shown and described, the invention is not confined thereto as changes and alterations may be made without departing from the spirit of the invention as defined by the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a variable stroke engine including a cylinder and piston, a shaft, and a figure 8 cam disposed to actuate said piston and having heads of varied length to determine the stroke of the piston and its side faces at different curvature to control the timing of the opposite movements of said piston intermediate its limits of stroke.

2. In a variable stroke engine including a cylinder and piston, a shaft, a controlling cam upon said shaft operating in a path adjacent the open end of the cylinder, a piston disposed in said cylinder to directly engage said cam and having a skirt extending parallel to the cam, and oppositely disposed springs extending from the skirt of said piston to a fixed point.

3. In a variable stroke engine including a cylinder and piston, a shaft, a controlling cam upon said shaft, a piston disposed in said cylinder to directly engage said cam and having a skirt at opposite sides of the cam, and oppositely disposed springs extending from the skirt of said piston to a fixed point in planes parallel to that of the cam.

4. In a variable stroke engine including a cylinder and piston, a shaft, a piston within the cylinder provided with an anti-friction member, a controlling cam upon said shaft disposed adjacent the open end of the cylinder in direct traversing contact with said member, spring supporting arms carried by the skirt of said piston and extending in opposite directions, and resilient members extending from said arms to a fixed point beyond said shaft.

5. In a variable stroke engine, a casing provided with a cam chamber, a shaft extending therethrough, a variable stroke cam disposed within said chamber, a cylinder extended from said chamber, a piston within said cylinder having engaging contact with the actuating face of said cam at the open end of the cylinder, a head for said cylinder provided with inlet and exhaust valves, and actuating means upon said shaft for said valves.

6. In a variable stroke engine, a casing provided with a cam chamber, a shaft extending therethrough, a variable stroke cam disposed within said chamber, a cylinder extended from said chamber, a piston within said cylinder having engaging contact with the actuating face of said cam, a head for said cylinder provided with inlet and exhaust valves, actuating means upon said shaft for said valves, and tension means extending from the inner end of said cylinder to a point on the casing below said cam chamber and at opposite sides of the cam therein.

7. In a variable stroke engine, a casing provided with a cam chamber, a shaft extending therethrough, a variable stroke cam disposed within said chamber, a cylinder extended from said chamber, a piston within said cylinder having engaging contact with the actuating face of said cam, a head for said cylinder provided with inlet and exhaust valves, actuating means upon said shaft for said valves, tension means extending from the inner end of said cylinder to a point on the casing below said cam chamber and at opposite sides of the cam therein, an extension from said chamber provided with auxiliary driving means, means upon said shaft provided with a support, and means upon said shaft connected to actuate said auxiliary driving means.

8. In a variable stroke engine, a casing provided with a cam chamber, a shaft extending therethrough and carrying a variable stroke cam, a cylinder projected from said chamber, a piston therein disposed to directly engage said cam, and ribs projected inward from the casing within the cam chamber and having flanges forming a continuation of the walls of said cylinder for guiding said piston in its movement outward therefrom.

9. In a variable stroke engine, a casing provided with a cam chamber, and a cylinder projected therefrom, a shaft extending through said chamber and carrying a variable stroke cam, a piston within said cylinder having direct contact with said cam at the open end of the cylinder, a head for said cylinder provided with inlet and exhaust valves, opposite heads for said casing formed with shaft bearings and tubular passages, valve actuating cams disposed upon said shaft, and connections therefrom extending through said passages to the inlet and exhaust valves respectively.

In testimony whereof I affix my signature.

ASA LEE RIGHTENOUR.