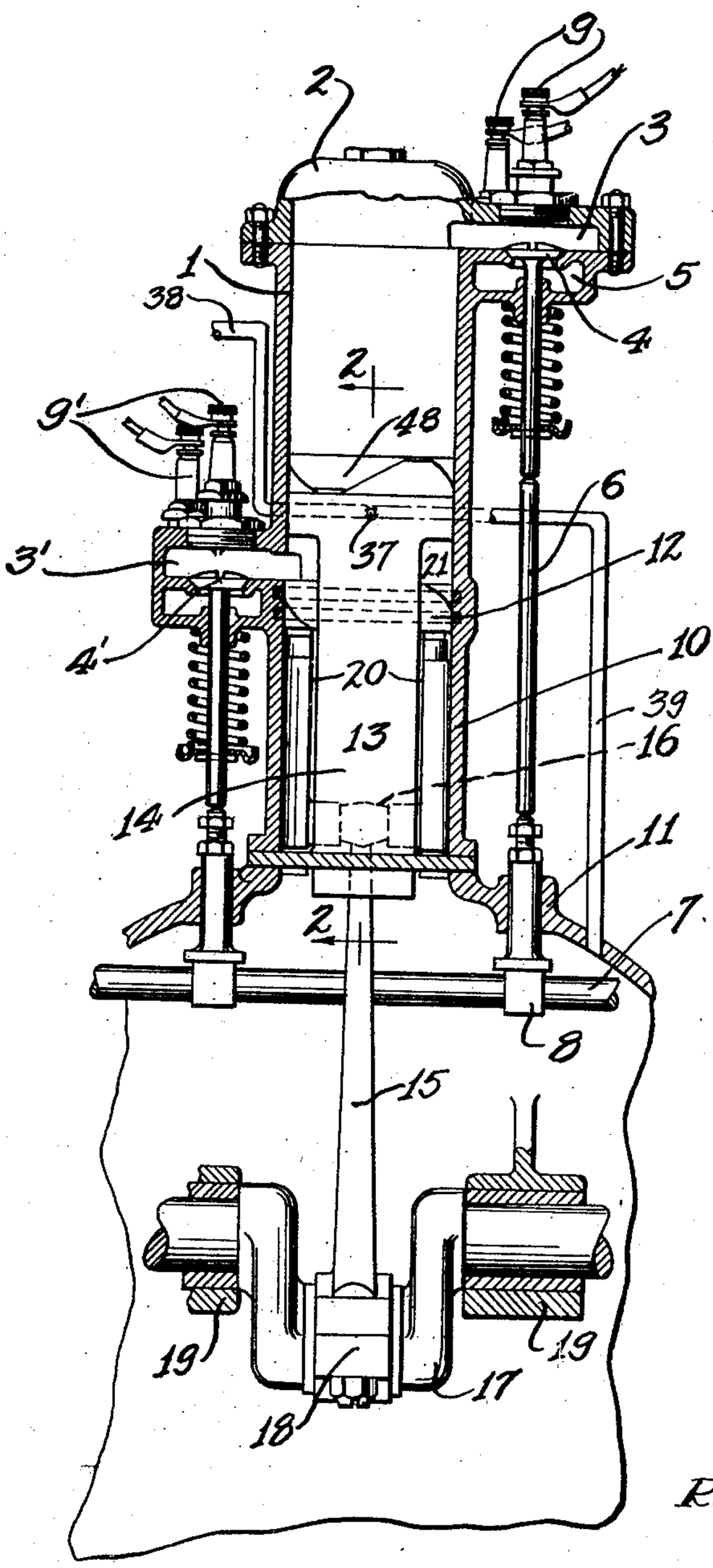
Oct. 7, 1930. R. E. DEEBLE 1,777,400

INTERNAL COMBUSTION ENGINE

Filed Sept. 29, 1928 4 Sheets-Sheet 1

Fig. 1.



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INTERNAL COMBUSTION ENGINE

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Fig. 2.

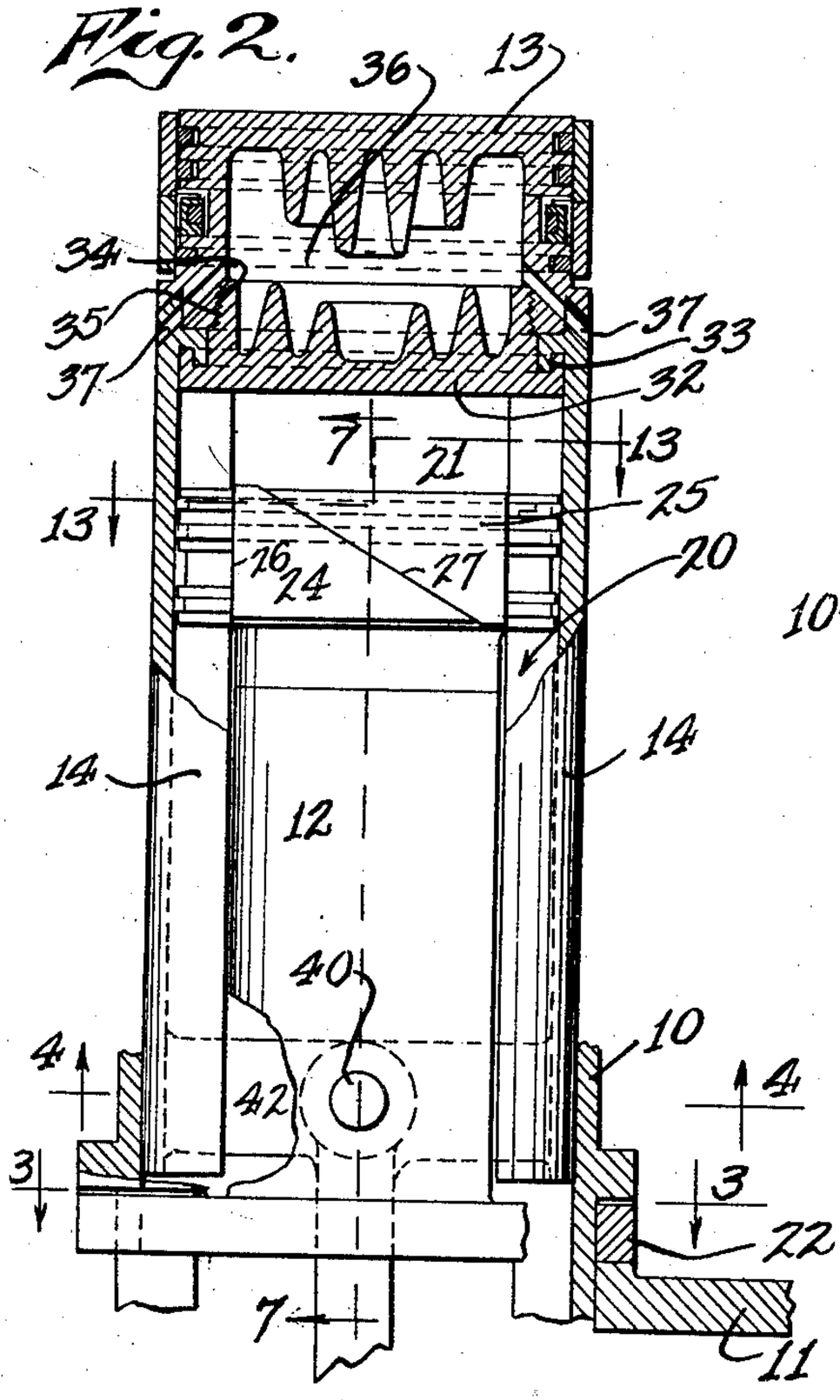


Fig. 3.

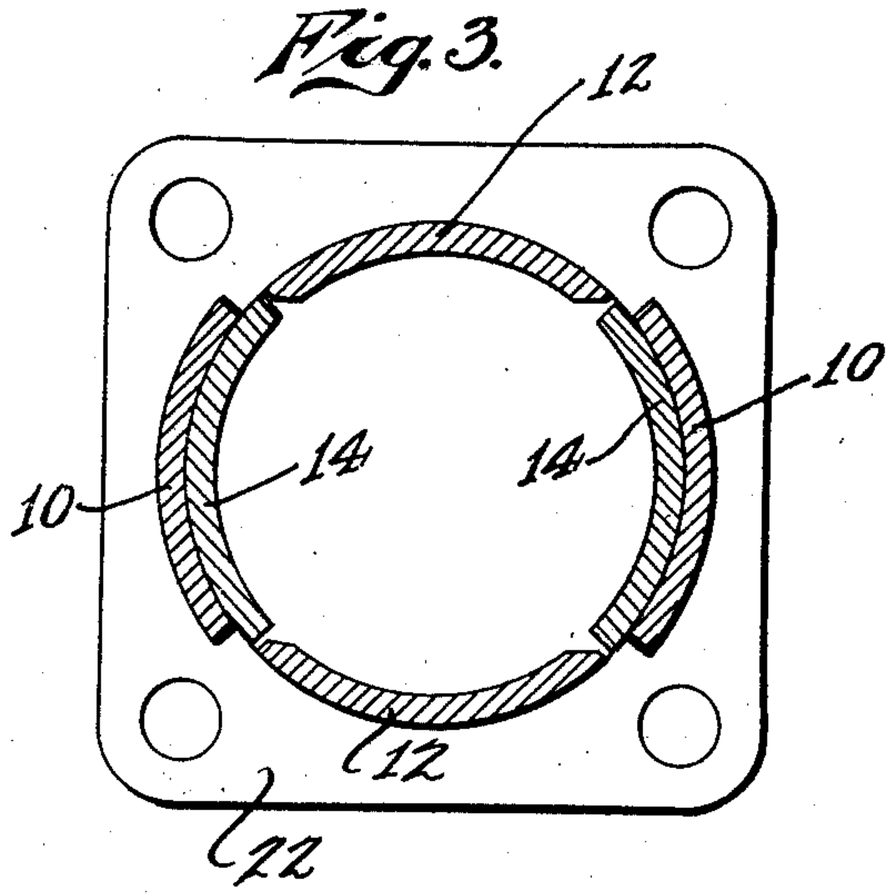


Fig. 4.

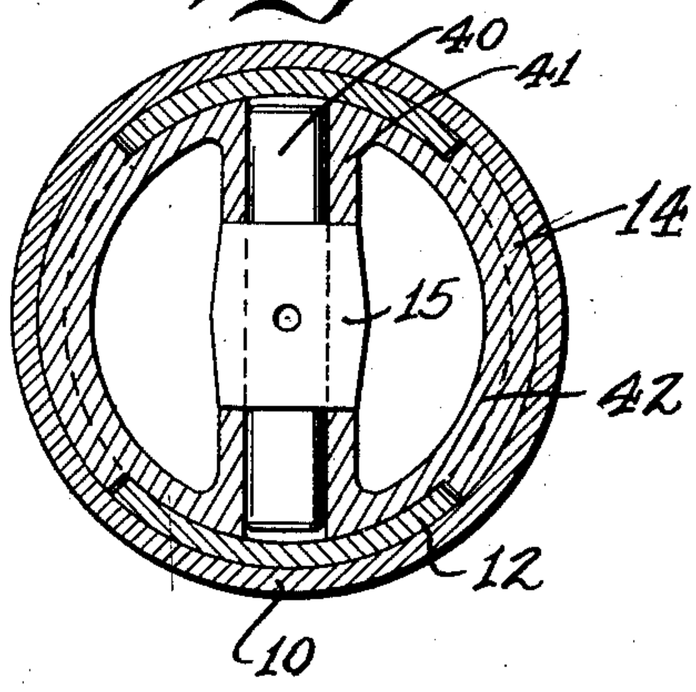
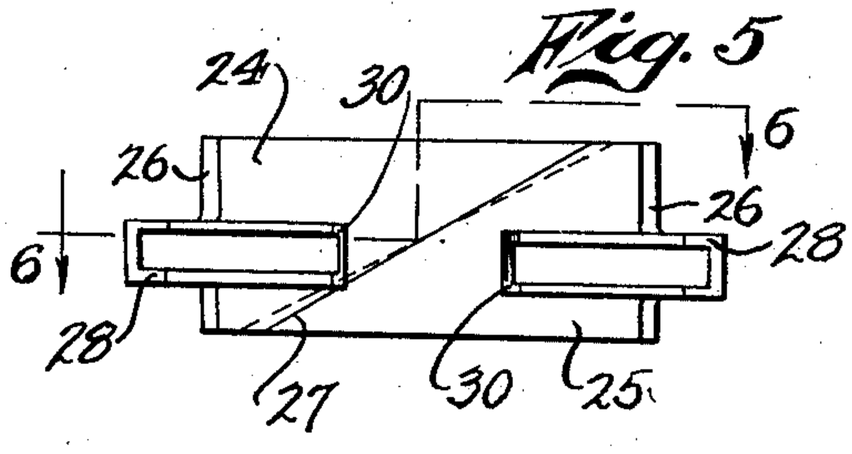


Fig. 5



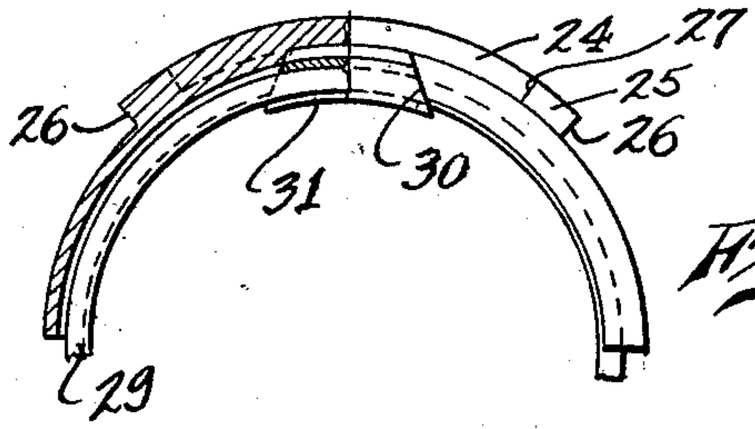


Fig. 6.

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INTERNAL COMBUSTION ENGINE

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Fig. 7.

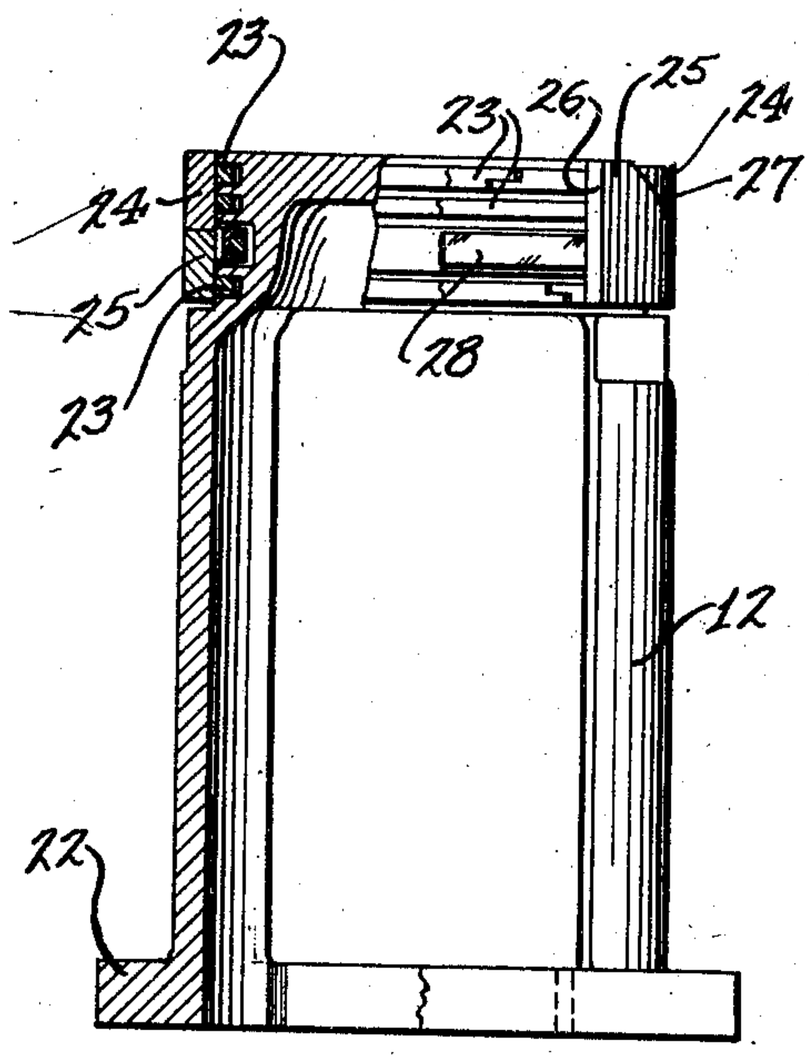
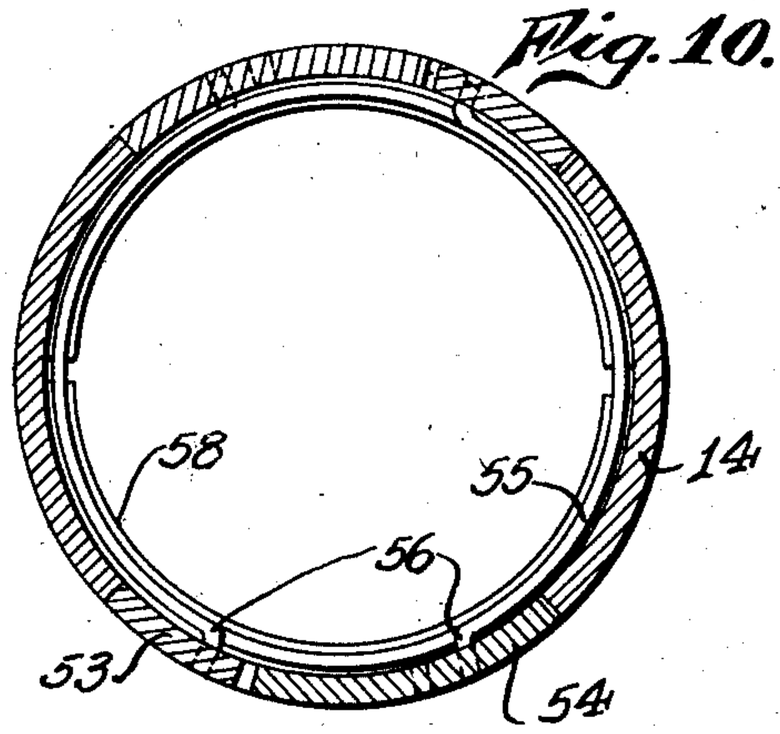


Fig. 10.



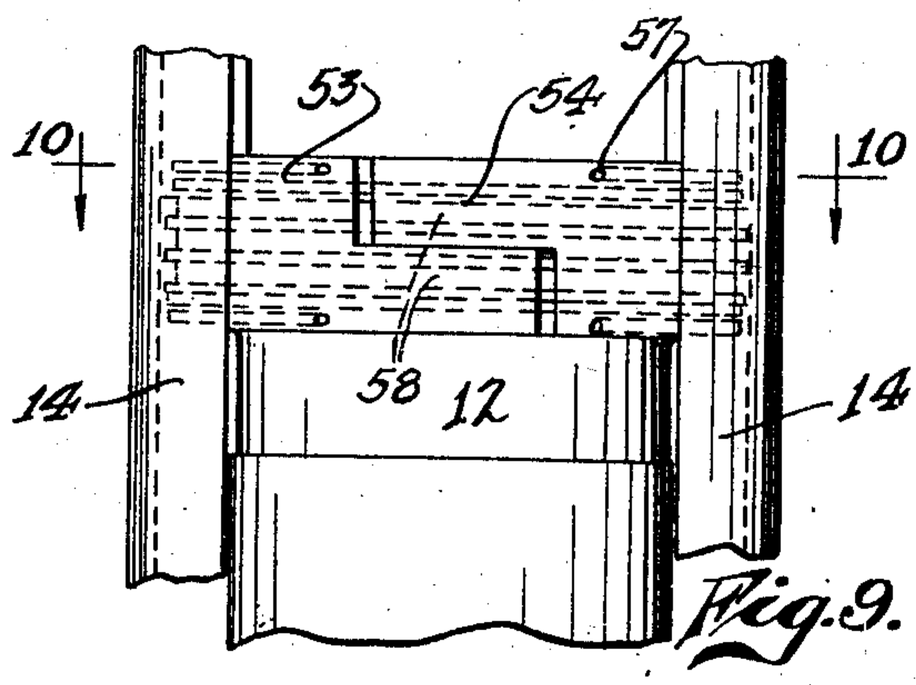


Fig. 9.

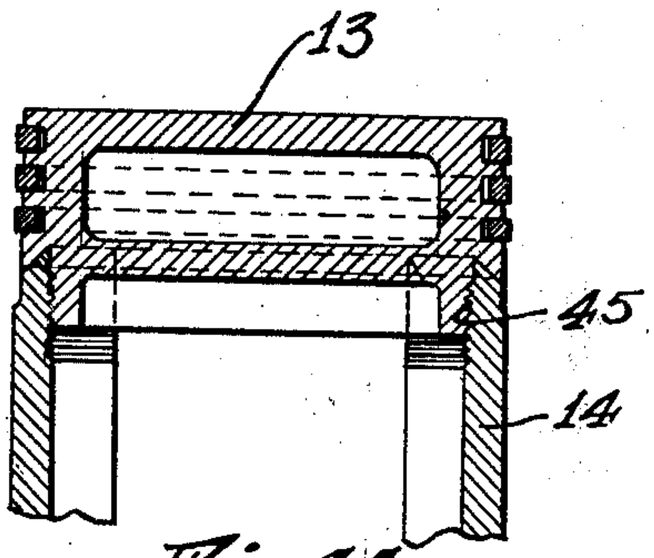


Fig. 11.

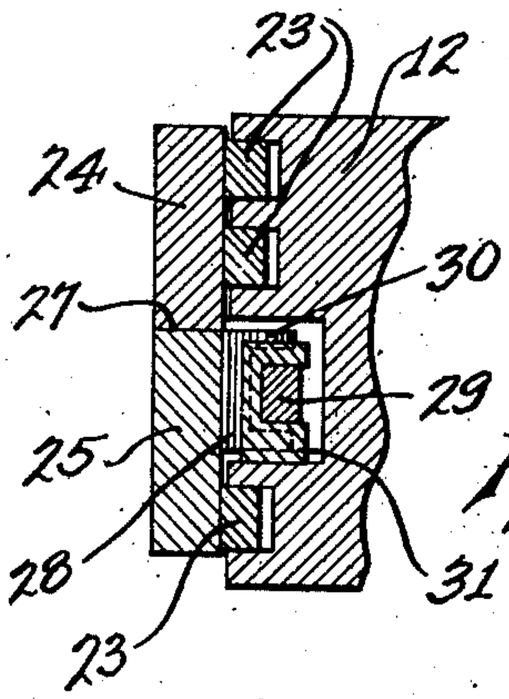


Fig. 8.

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INTERNAL COMBUSTION ENGINE

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Fig. 12.

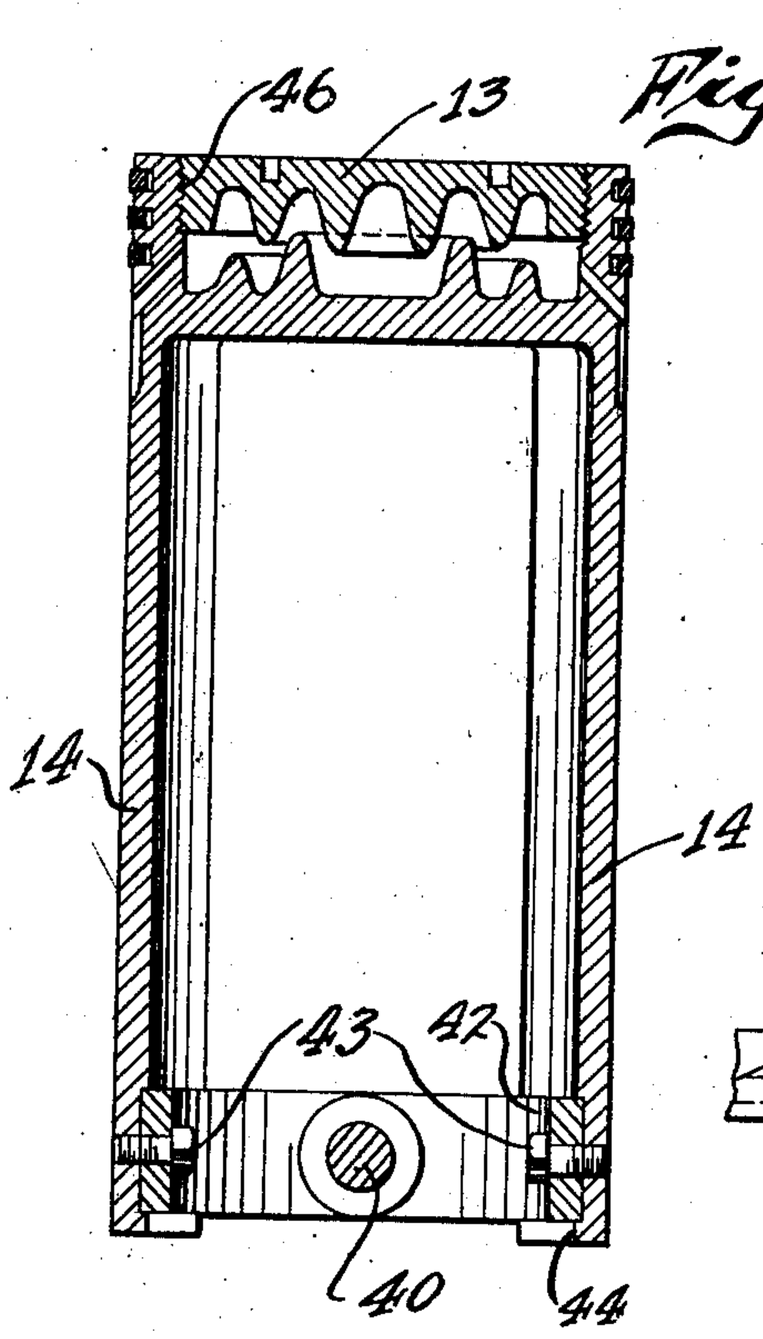
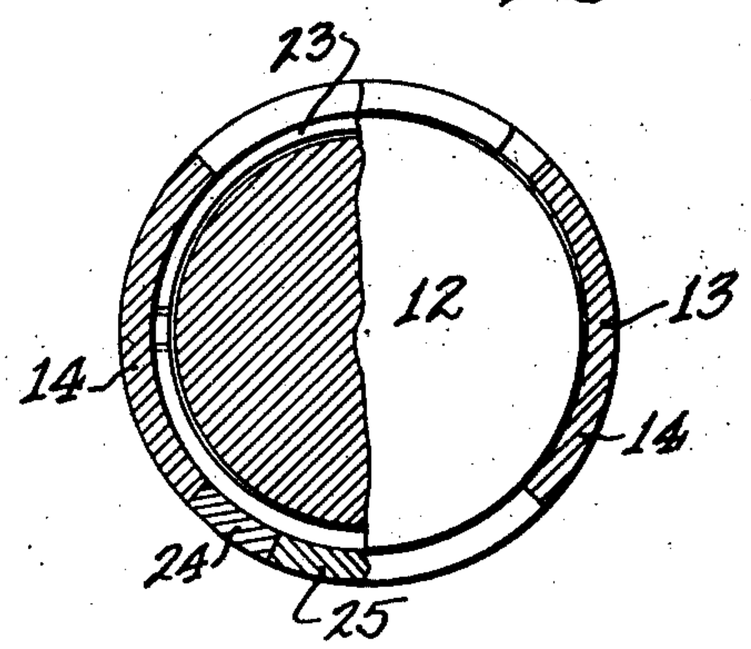


Fig. 13.



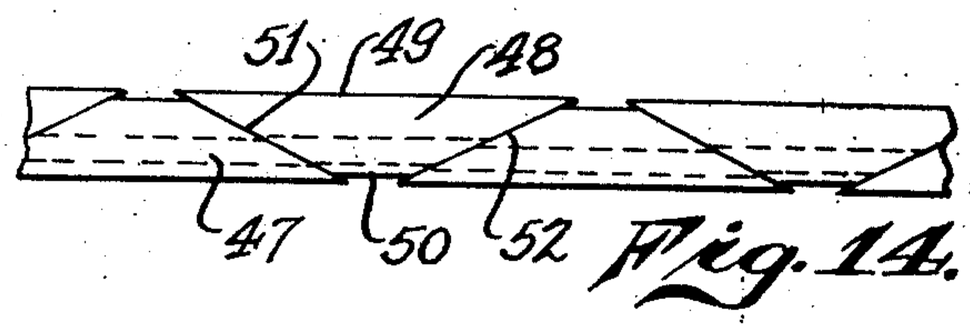


Fig. 14.

Fig. 15.

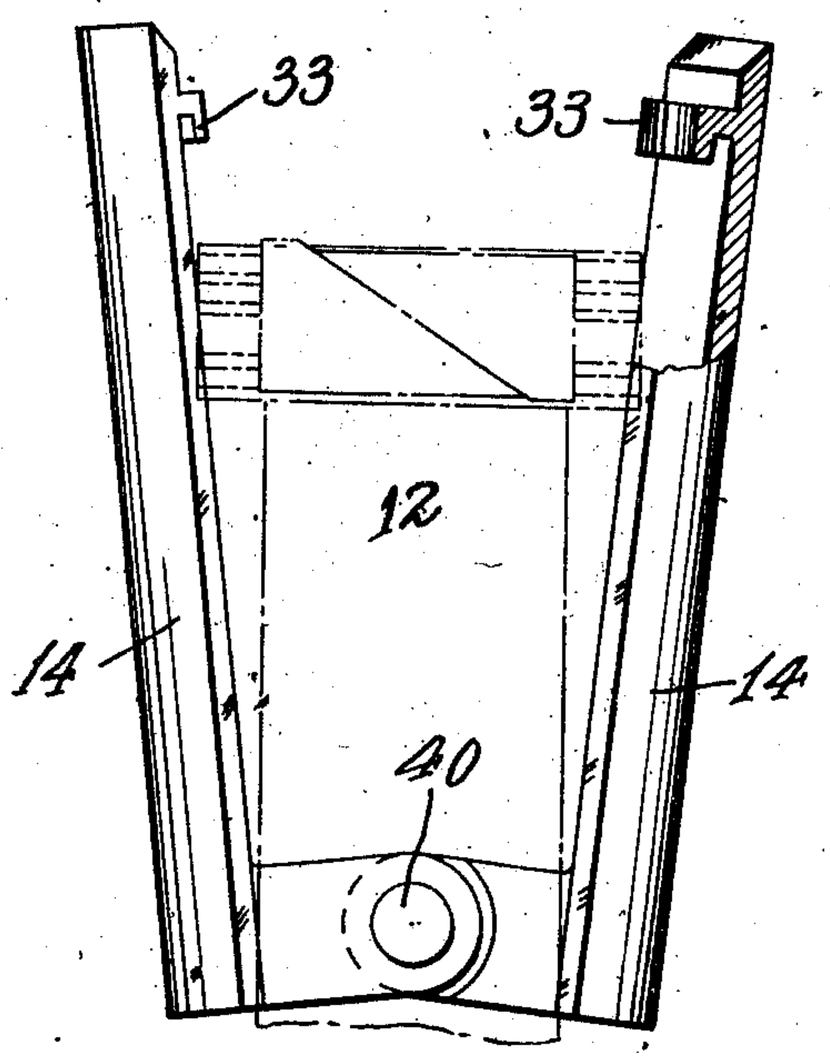
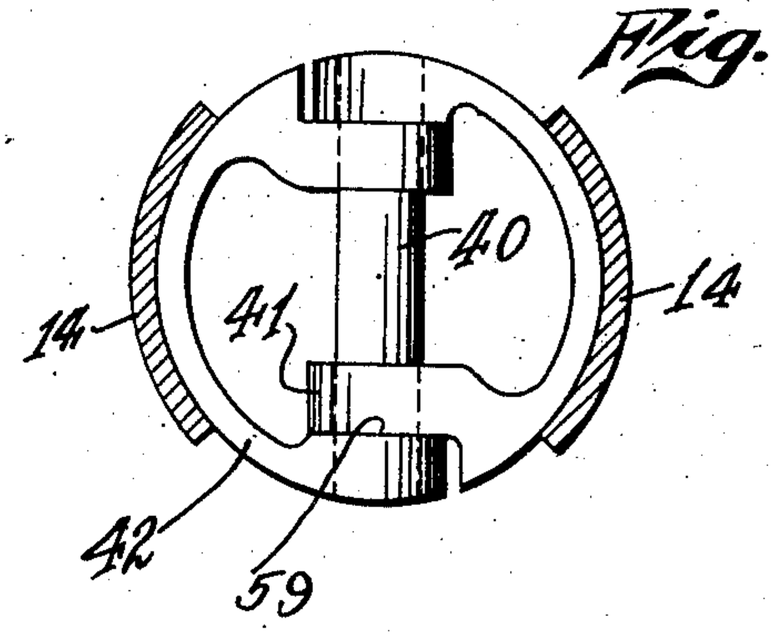


Fig. 16.



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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE

Application filed September 29, 1928. Serial No. 309,192.

This invention relates to an improved double acting engine capable of generating an increased quantity of power for a given weight of machinery and particularly to a construction of cylinders, pistons and packing rings which permits space heretofore wasted, to be utilized in the generation of power.

The construction hereafter to be described in detail refers to double acting engines in which gaseous or liquid fuel is to be used. The double acting principle, of course, can be utilized in both two-cycle and four-cycle internal combustion engines and for this reason, the invention hereafter described is also applicable to both two-cycle and four-cycle engines.

Generally described, my invention relates to an internal combustion engine comprising a cylinder, a stationary piston positioned in the cylinder and spaced from an open end thereof, a movable piston mounted above the stationary piston and provided with a split skirt passing through grooves formed in the stationary piston between said stationary piston and the cylinder wall, a connecting rod attached to the split skirt of the movable piston beyond said stationary piston, and means for admitting and discharging gases from opposed points, in that portion of the cylinder in which the movable piston is reciprocated. A new form of packing, expansible upon the compression of gas within a cylinder is also provided for use between the openings in the split skirt of the movable piston.

An object of this invention is to provide an internal combustion engine of the double acting type.

Another object of this invention is to disclose a double acting internal combustion engine in which means are provided for maintaining a movable piston in perfect alignment with the cylinder walls.

Another object is to disclose and provide a double acting internal combustion engine adapted to generate a maximum quantity of power for a given displacement.

A still further object is to provide new and improved means in a double acting internal combustion engine for sealing pistons against the passage of gases thereby.

Other objects and advantages of my invention will become apparent to those skilled in the art from the following detailed description of one form of my invention, reference being had to the appended drawings in which, for illustrative purposes, a double acting, four stroke cycle internal combustion engine is shown, together with a number of modifications. It will be understood that the invention is not limited, however, to adaptation and use on four stroke cycle internal combustion engines, but may also be applied to the two-cycle engines, such as for example, engines of the Diesel type.

In the drawings:

Figure 1 is an elevation partly in section of one cylinder of an internal combustion engine embodying my invention.

Figure 2 is a side elevation, partly in section of the stationary and movable pistons shown in Figure 1, the section being along line 2—2 of Figure 1.

Figure 3 is a horizontal section taken along line 3—3 of Figure 2.

Figure 4 is an inverted horizontal section taken along line 4—4 of Figure 2.

Figure 5 is a rear elevation of two packing rings.

Figure 6 is a plan view, partly in section, showing the two packing rings of Figure 5 along line 6—6 thereof, and other rings and wedges used therewith.

Figure 7 is a front elevation, partly in section of a form of stationary piston and expansion packing.

Figure 8 is an enlarged sectional view of the packing as used upon the piston of Figure 7.

Figure 9 is a side elevation of a modified form of expansible packing to be used on a stationary piston, showing the skirt of a movable piston in engagement therewith.

Figure 10 is a horizontal section taken along line 10—10 of Fig. 9.

Figure 11 is a vertical section through one form of movable piston.

Figure 12 is a vertical section through a modified form of a movable piston.

Figure 13 is a plan view taken along line 13—13 on Figure 2.

Figure 14 is a diagrammatic development of an expansible packing which may be used upon a movable piston.

Figure 15 illustrates a form of movable piston split skirt in position during placement upon a stationary piston.

Figure 16 is an inverted plan view of Figure 15.

Referring to Figure 1, the double acting four stroke cycle engine shown therein is of a type which may be used in motorcycles and the like. The engine comprises a cylinder 1 provided with a closure member or head 2 and with a combustion port 3 communicating with the head of the cylinder 1. A valve 4 is shown leading into an exhaust port 5 and activated by means of a valve rod 6 operated by a cam shaft 7 bearing a cam 8. A similar valve may also be provided for the intake of fuel into the cylinder or combustion chamber 3. Ignition means, such as the spark plugs 9, may be provided in the customary manner.

The cylinder 1 is preferably provided with an extension 10 and connected by suitable means to a crankcase or crank housing 11, that portion of the cylinder extension 10 connected to the crank case housing 11 being open thereto. A stationary piston 12 is mounted within the cylinder 1 and extension 10, said stationary piston 12 being connected rigidly to the cylinder extension 10 and to the housing or crankcase 11. A combustion port 3′ communicates with the cylinder 1 at a point adjacent to the stationary piston 12, ignition means 9′, valves 4′, etc. being provided in the combustion port 3′.

Within the cylinder 1 and between the combustion ports 3 and 3′, a movable piston 13 is provided, said piston 13 being provided with a split skirt 14 passing through segmental grooves or openings, preferably diametrically opposed, made in the stationary piston 12. A connecting rod 15 is pivotally connected to the split skirt 14 of the movable piston 13 by means of a connecting rod bearing 16. The connecting rod 15 is journaled upon a crankshaft 17 through a crankshaft bearing diagrammatically illustrated at 18. The crankshaft 17 is rotatably mounted in fixed bearings 19 and leads to a gear train, propeller shaft, or other means, whereby power may be taken off.

Details of construction of the movable and stationary pistons 12 and 13 are shown in Figures 2, 3, 4, 7, 8 and 12.

Referring to Figures 2 and 3, it will be seen that the stationary piston 12 is provided with a groove or slot 20 adapted to receive the split skirts 14 of the movable piston 13, so that the movable piston 13 may move upon the stationary piston 12. The opening 21 formed between the stationary piston head 12, the movable piston 13 and framed by the split skirts 14, permits fuel or gas to be introduced into the space between the movable and stationary piston during operation of the engine.

The stationary piston 12 may be connected to the crankcase 11 by means of lugs or a flange 22 adapted to extend into the space between the cylinder extension 10 and the crankcase 11.

As shown in Figure 7, the stationary piston 12 may be provided with a plurality of annular grooves in which expansible piston rings 23 may be positioned. Said piston rings 23 may contact with the split skirts 14 of the movable piston ring and between said split skirts, said rings 23 may contact expansible packing members 24 and 25 shown in greater detail in Figures 5, 6 and 8.

The expansible packing members 24 and 25 may be curved exteriorly to the diameter of the stationary piston 12 and be provided with vertical edges 26 adapted to contact with the vertical edges of the split skirt 14.

The complementary packing members 24 and 25 may also be provided with helical or inclined faces 27 upon which contact between said complementary members 24 and 25 is established. The packing members 24 and 25 are also provided with flanged groove members 28, extending away from the helical or inclined faces 27 beyond the vertical edges 26 so as to form ears as shown in Figures 5 and 6. A piston ring 29 may be provided adapted to be received in the groove formed by the flanged members 28 carried by the packing members 24 and 25, the ring 29 being of appreciable lesser width than the width of the groove made in said members 28, so as to allow motion of the members 24 and 25 relative to each other upon the inclined face 27 without bending upon the ring 29 placed within the groove formed by the members 28.

The flanged member 28 carried by the members 24 and 25 may terminate in inclined ends 30 adjoining the inclined or helical face 27. A wedge member 31 provided with inclined edges and with a groove adapted to slidably receive the expansion ring 29 may be placed between the inclined ends 30 of adjoining packing members 24 and 25, so that the expansion force of the ring 29 may be distributed by the wedge member 31 upon the inclined faces 30 of the flange member 28, thereby exerting a separating force upon the adjoining packing members 24 and 25. Such force will cause the packing members 24 and 25 to contact strongly upon the vertical edges of the split skirt 14 of the movable piston 13 with the edges 26, thereby resulting in a tight joint both between the cylinder extension 10 and the stationary piston 12 and between the stationary piston 12 and the split skirt 14 of the movable piston 13.

The movable piston 13 may be provided with a piston head of any suitable construction. As illustrated in Figure 2, the movable piston 13 may be provided with a removable hollow head, slidably received upon the upper portion of the split skirt 14. An inner member or plug 32 may be inserted within the split skirt member 14, said plug being provided with a plurality of recesses adapted to receive a plurality of flanges 33 carried by the upper portion of the split skirt 14. The plug 32 may also be provided with an exteriorly threaded flange 34 which is screwed into the head 13 of the piston, as indicated at 35. This construction prevents rotation of the head 13 with respect to the split skirt 14 by reason of the flanges 33 and longitudinal displacement of the head with respect to the split skirt 14, is prevented by the threaded connection 35.

In order to assist in cooling the movable piston 13, the chamber 36 formed between the piston head 13 and the plug 32 shown in Figure 2 may be periodically supplied with a cooling fluid. Means for accomplishing this may include perforations or ports 37 made in the sides of the movable piston and communicating with the inner chamber 36, said perforations or ports 37 being in alignment with ports in the walls of the cylinder 1. One of the ports in the walls of cylinder 1 may be connected by pipe means 38 with a source of cooling fluid under pressure, such cooling fluid being preferably, oil.

The opposite port in wall of cylinder 1 communicating with port 37 on the opposite side of the piston head may lead to a pipe means 39 through which the oil fed into cavity 36 in the piston may be discharged. As shown in Figure 1, the discharge line 39 leads into the crankcase. By these means, the interior cavity 36 of the movable piston 13 is supplied with an injection of cooled oil at timed intervals, said intervals being preferable at the completion of each stroke of the piston 13 within the cylinder.

The connecting rod 15 may be operably connected to the movable piston 13 by means of a wrist pin 40 retained in a sleeve 41 which may be formed integral with a ring 42 connected to the split skirt 14 of the movable piston at the lower end of said skirt. As shown in Figure 4, the ring 42 may be made integral with the split skirt 14, but in Figure 12 a modified construction is shown in which the ring 42 is retained in position within the split skirts 14 and at the lower end thereof by means of tap bolts 43. Furthermore, the lower end of the split skirts 14 may be provided with small flanges 44, the collar 42 being sprung into position within the split skirts 14 and then retained by the tap bolt 43, or similar means. It is desirable, however, to always have the wrist pin 40 lie in such a vertical plane that the thrust is absorbed by contact of the surface of the split skirts 14 upon the walls of the cylinder. In other words, the longitudinal axis of the wrist pin should preferably pass centrally through the opening between the split skirts.

The modified forms of movable cylinder head construction are shown in Figures 11 and 12. In Figure 11, the entire movable piston head 13 is threadedly retained upon the upper portion of the split skirts 14, as indicated at 45. In Figure 12, the movable piston head 13 is threadedly engaged as shown at 46, to a piston head formed integrally with the split skirts 14. In Figures 11 and 12 ordinary expansion rings are used on the movable piston, but in Figure 1, the use of an expansion packing similar to that used on the stationary piston and hereinabove described, is employed. The packing member used on the movable piston shown in Figure 1, comprises a plurality of packing members 47 and 48, a diagrammatic development of which is shown in part in Figure 14. The members 47 and 48 are curved exteriorly to the arc or diameter of the cylinder 1, and are provided with parallel upper and lower edges 49 and 50, the side edges 51 and 52 being helical so as to allow the portions 47 and 48 to slidably move and expand the total diameter made by the packing ring. Grooved flanged members may be provided on the interior side surface of the packing members 47 and 48, pressure being applied to the packing members within the groove formed in the flange members and exteriorly thereof by suitable expansion rings.

In Figures 9 and 10, a slightly modified form of stationary piston packing construction is illustrated.

The packing herein shown consists of slip rings 53 and 54 adapted to receive in the opening between the split skirts 14. The slip rings 53 and 54 are maintained in expanded position by means of springs 55 having their ends 56 embedded in apertures 57, made in the slip rings 54 and 53. Positive outward pressure may be applied to the slip rings 53 and 54 by means of expansion rings 58 positioned therebehind.

The operation of the apparatus described herein will be evident to those skilled in the art from the hereinabove description. With a movable piston 13 in the position shown in Figure 1, i. e., at the beginning of an upward stroke, fuel may be admitted into the combustion port 3′, or sucked thereinto and into the cylinder between the stationary piston 12 and the movable piston 13, through the opening 21 between the split skirts 14 of the movable piston 13. After the piston reaches its upward limit of travel, the fuel intake valve will close and during the return of the movable piston 13 to the position shown in Figure 2, the fuel will be compressed within the combustion chamber 3′ and the cylinder between

the movable and stationary piston. After the fuel has been compressed to the required extent, the mixture of fuel and air contained in the cylinder and combustion chamber 3′ may be ignited by means of the spark plugs or other ignition 9′.

The sudden expansion of the ignited gases will cause the piston 13 to move upwardly, such upward movement compressing suitable fuel which had been admitted into the combustion chamber 3, and upper portion of the cylinder 1. When the movable piston 13 reaches the upper limit of its stroke due to the explosion of gases between said piston and stationary piston 12, the compressed fuel in combustion chamber 3 may be ignited by means of the spark plugs 9 and the movable piston 13 will then be forced downwardly, the waste gases present in that portion of the cylinder between stationary and movable piston being then discharged through a properly timed and now open exhaust valve.

Details of intake and exhaust valve mechanism have not been shown in the drawings, as their construction and arrangement is well-known in the art. The type of packing rings to be used in the movable piston can be varied within wide limits, but the new form of packing adapted to be used between the split skirts of the movable piston and positioned on the stationary piston are preferred.

In order to facilitate placing the movable and stationary pistons in working engagement with each other, the modification shown in Figures 15 and 16 may be employed. The skirts 14 of the removable head piston shown in Figure 2 are provided with flanges 33, at their upper ends and connected together by the collar 42 in which the wrist pin 40 is fitted. The skirts 14 may be strained and sprung if it is endeavored to pass the flanges 33 over a stationary piston 12, so I form a joint 59 in the ring 42 at the bosses 41 of the wrist pin fitting, as shown in Figures 15 and 16. This construction enables the ring 42 to be made in two interfitting sections integrally with the split skirts 14 and permits the skirts to be pivoted upon the wrist pin 40 while the movable piston is placed upon the stationary piston. After the flanges 33 are above the head of the stationary piston 12, the plug 32 may be applied and the head threaded on.

Numerous changes and modifications may be made in the construction and arrangement of the various elements shown, such for example, details of construction of the movable head, cylinder walls (which may be air cooled or water cooled) and the like, without departing from the spirit of my invention which is of the scope of the following claims.

It will be readily seen that the apparatus described hereinabove discloses a simple, efficient manner in which a double acting two or four-cycle engine may be constructed, the arrangement and combination of elements making it possible to build a double acting engine in a much more compact manner than any of the double acting engines hereinbefore described. The use of elaborate and troublesome packing glands, piston rods, crossheads, and the like, is eliminated by my construction.

Furthermore, the particular construction and arrangement of elements claimed and described may be utilized not only in double acting engines, but may also be employed in compressors, steam engines and other equipment. For example, one chamber of the cylinder may be utilized for generating power, while the other chamber is utilized for compression purposes.

I claim:

1. An internal combustion engine comprising, a cylinder, a stationary piston within said cylinder spaced from one end thereof, longitudinal diametrically opposed grooves in said stationary piston and adjoining the cylinder walls, a movable piston positioned in the cylinder between said stationary piston and the other end thereof, said movable piston being provided with a split skirt extending through said grooves in the stationary piston, a combustion and valve chamber communicating with the cylinder between said stationary piston and movable piston and a separate combustion and valve chamber communicating with the end of the cylinder above the movable piston.

2. An internal combustion engine comprising, a cylinder provided with a closure at one end thereof, a stationary piston within said cylinder spaced from the open end thereof, diametrically opposed longitudinal grooves in said stationary piston, a movable piston positioned between the closed end of the cylinder and the stationary piston therein, said movable piston being provided with a split skirt extending through said grooves in the stationary piston, a connecting rod operably attached to said split skirt, a combustion and valve chamber communicating with the cylinder between said movable and stationary pistons and a valved port communicating with the closed end of the cylinder.

3. In an internal combustion engine, the combination of a stationary piston and a movable piston, said stationary piston being provided with diametrically opposed longitudinal grooves, said movable piston being provided with a split skirt, adapted to be slidably received in the grooves made in said stationary piston.

4. In an internal combustion engine, the combination of a stationary piston provided with diametrically opposed longitudinal grooves made in its outer surface, a movable piston of the same diameter as said stationary piston, said movable piston being provided with split skirt adapted to be slidably received in said longitudinal grooves

made in said stationary piston and means positioned between longitudinal edges of said split skirt and carried by said stationary piston whereby the space between said split skirt is sealed substantially gas-tight.

5. In an internal combustion engine, the combination of a cylinder provided with a closure at one end thereof, a hollow stationary piston within said cylinder spaced from the open end thereof, diametrically opposed longitudinal grooves on the surfaces of said stationary piston, a movable piston positioned between the closed end of the cylinder and the stationary piston therein, said movable piston being provided with a split skirt adapted to be slidably received in the longitudinal grooves of said stationary piston, a connecting rod operably attached to said split skirt of said movable piston within the hollow stationary piston and a segmental shoe packing portion carried by said stationary piston between said split skirts and provided with flanges extending into said stationary piston cooperating with expansible piston rings carried by said stationary piston.

6. An internal combustion engine comprising, a cylinder provided with a closure at one end thereof, a stationary piston within said cylinder spaced from the open end thereof, a diametrically opposed longitudinal groove in said stationary piston, a movable piston positioned between the closed end of the cylinder and the stationary piston therein, said movable piston being provided with a removable hollow head and split skirt extending through said grooves in the stationary piston, a combustion and valve chamber communicating with the cylinder between said stationary piston and movable piston, a separate combustion and valve chamber communicating with the closed end of the cylinder, and means for passing a cooling fluid through said movable piston.

7. In an internal combustion engine, a stationary piston comprising, a head and a hollow skirt, said head being of smaller diameter than said skirt, diametrically opposed longitudinal grooves made in said skirt, annular piston ring grooves made in said head, a plurality of segmental packing portions provided with contacting faces at angles to the longitudinal axis of the piston and with grooved flanges extending thereinto mounted upon the piston between said longitudinal grooves, said segmental packing portions and grooved flanges carried thereby cooperating with expansible piston rings carried by said piston.

8. In an internal combustion engine, a stationary piston comprising a head and a skirt, said head being of smaller diameter than said skirt, annular grooves cut in said head, longitudinal grooves adapted to receive a split skirt of a movable piston cut in the skirt of said stationary piston, an expansible packing carried by said stationary head between said longitudinal grooves, said expansible packing extending to the surface of the stationary piston head and being provided with edges adapted to form extensions of longitudinal grooves in said skirt, said expansible packing cooperating with expansion rings carried by said piston in annular grooves therein and adapted to expand by action of high pressure gases acting upon exposed edges of said packing.

9. An internal combustion engine comprising, a cylinder provided with a closure at one end thereof, a stationary piston within said cylinder spaced from the open end thereof, said stationary piston comprising a head and a skirt, said head being of smaller diameter than said cylinder and skirt, diametrically opposed longitudinal grooves in said stationary piston skirt, a movable piston positioned between the closed end of the cylinder and the stationary piston therein, said movable piston being provided with a split skirt adapted to be slidably received in the longitudinal grooves in said stationary piston, a connecting rod operably attached to said split skirt, expansible packing means carried by said stationary piston head between said longitudinal grooves and adapted to expand by action of high pressure gases acting upon exposed edges of said packing means, a hollow head carried by said movable piston, openings through the walls of said piston leading to the interior of said hollow head, said perforations being made in longitudinal alignment with the split skirts carried by said piston, ports in the walls of the cylinder in alignment with the ports made in said movable piston, means for supplying cooling fluid under pressure to one of said ports in the cylinder wall and means for discharging fluid from one of said ports in the cylinder wall, a combustion and valve chamber communicating with the cylinder between said stationary piston and movable piston and a combustion and valve chamber communicating with the closed end of the cylinder.

10. In a reciprocating engine, the combination of a stationary piston and a movable piston, said stationary piston being provided with diametrically opposed longitudinal grooves, said movable piston being provided with a removable head and a split skirt adapted to be slidably received in the grooves made in said stationary piston, a hinged ring connected to said split skirts and a wrist pin journaled therein, said ring being adapted to hinge on said wrist pin.

11. In a reciprocating engine, the combination of a movable piston provided with a skirt, longitudinal openings in said skirt, a stationary piston within said skirt, and an expansible shoe packing of segmental form

carried by said stationary piston within the longitudinal openings in said skirt.

12. In a reciprocating engine, the combination of a movable piston provided with a skirt, longitudinal openings in said skirt, a stationary piston within said skirt and having a smaller outside diameter than the outside diameter of said skirt, and an expansible shoe packing carried by said stationary piston within the longitudinal openings in said skirt, said shoe packing being adapted to increase the outside diameter of said stationary piston to substantially the outside diameter of said skirt.

13. In a reciprocating engine, the combination of a cylinder provided with a closed head, a movable piston provided with a skirt and a wrist pin assembly within said cylinder, a stationary bulkhead positioned in said cylinder and within the skirt, a longitudinal opening in said skirt, a valve chamber in operative relation to said opening and in constant communication therewith, and a second valve chamber in operative communication with the closed end of said cylinder whereby an expansion chamber is formed on each side of said movable piston.

Signed at Los Angeles, California, this 18 day of Sept., 1928.

ROY E. DEEBLE.