G. A. ILER & T. M. NALON.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 9, 1913.

1,153,432.

Patented Sept. 14, 1915.

4 SHEETS—SHEET 1.

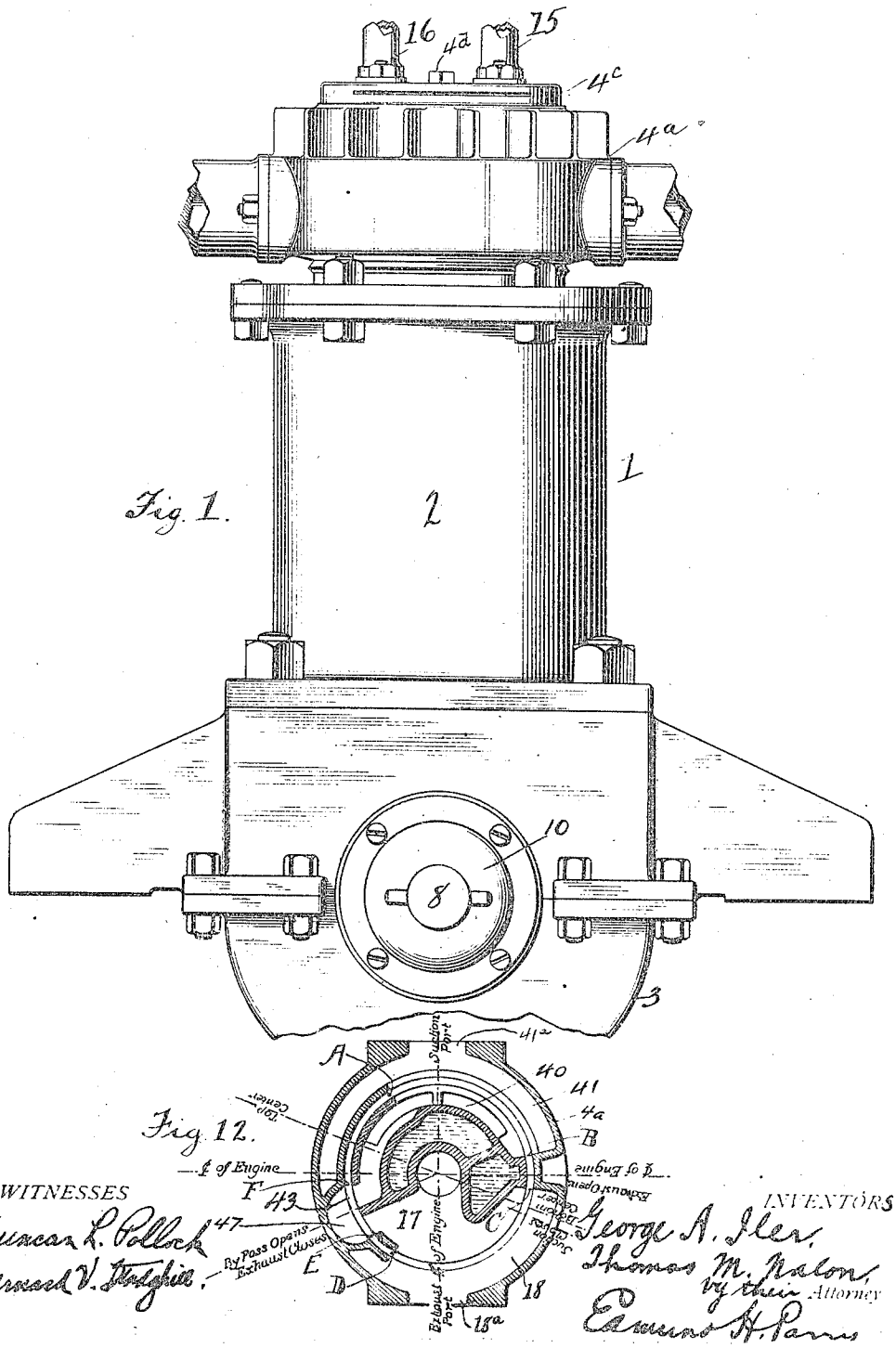


Fig. 1.

Fig. 12.

WITNESSES

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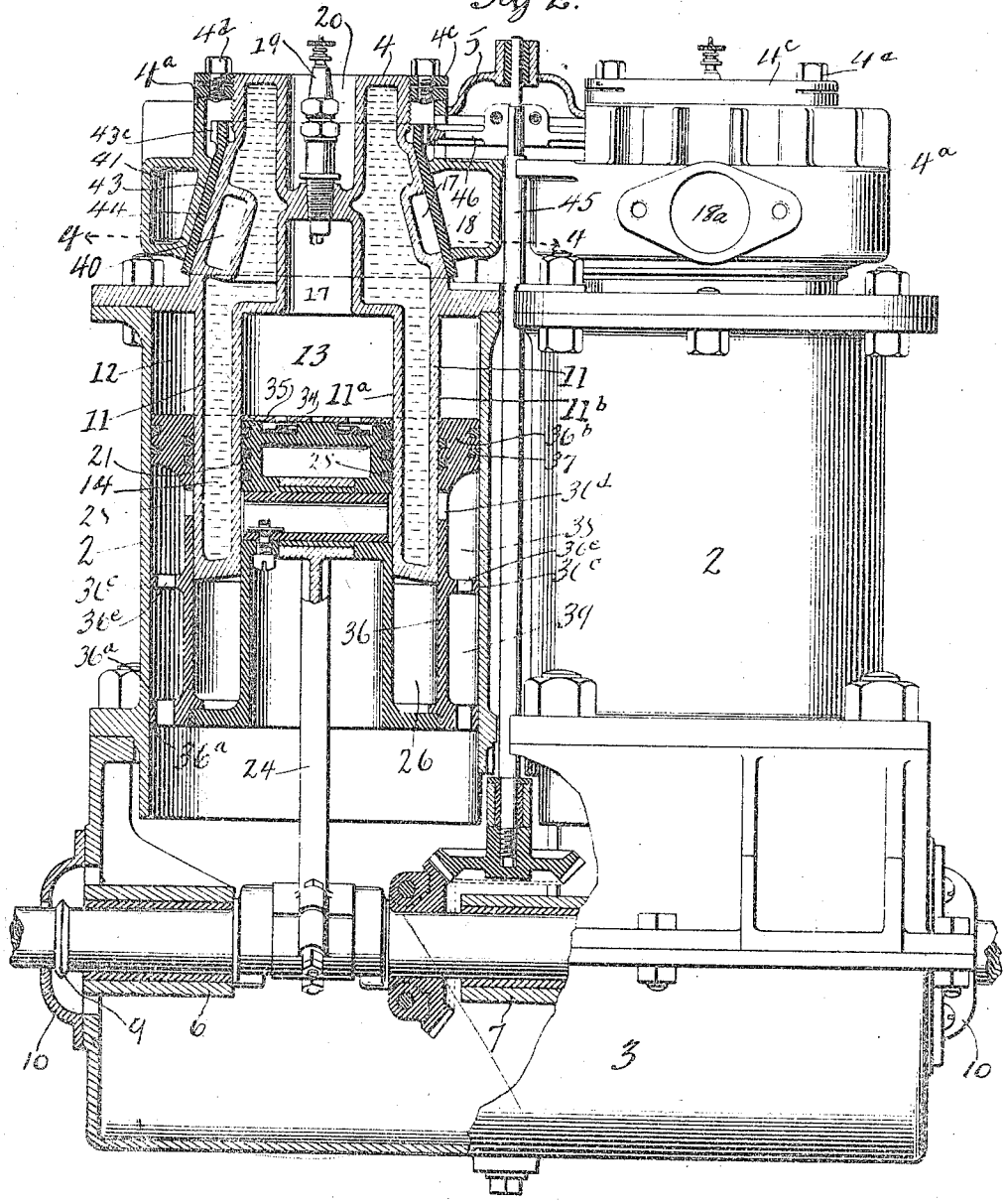
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4 SHEETS—SHEET 2.

Fig 2.



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4 SHEETS—SHEET 3.

Fig. 3.

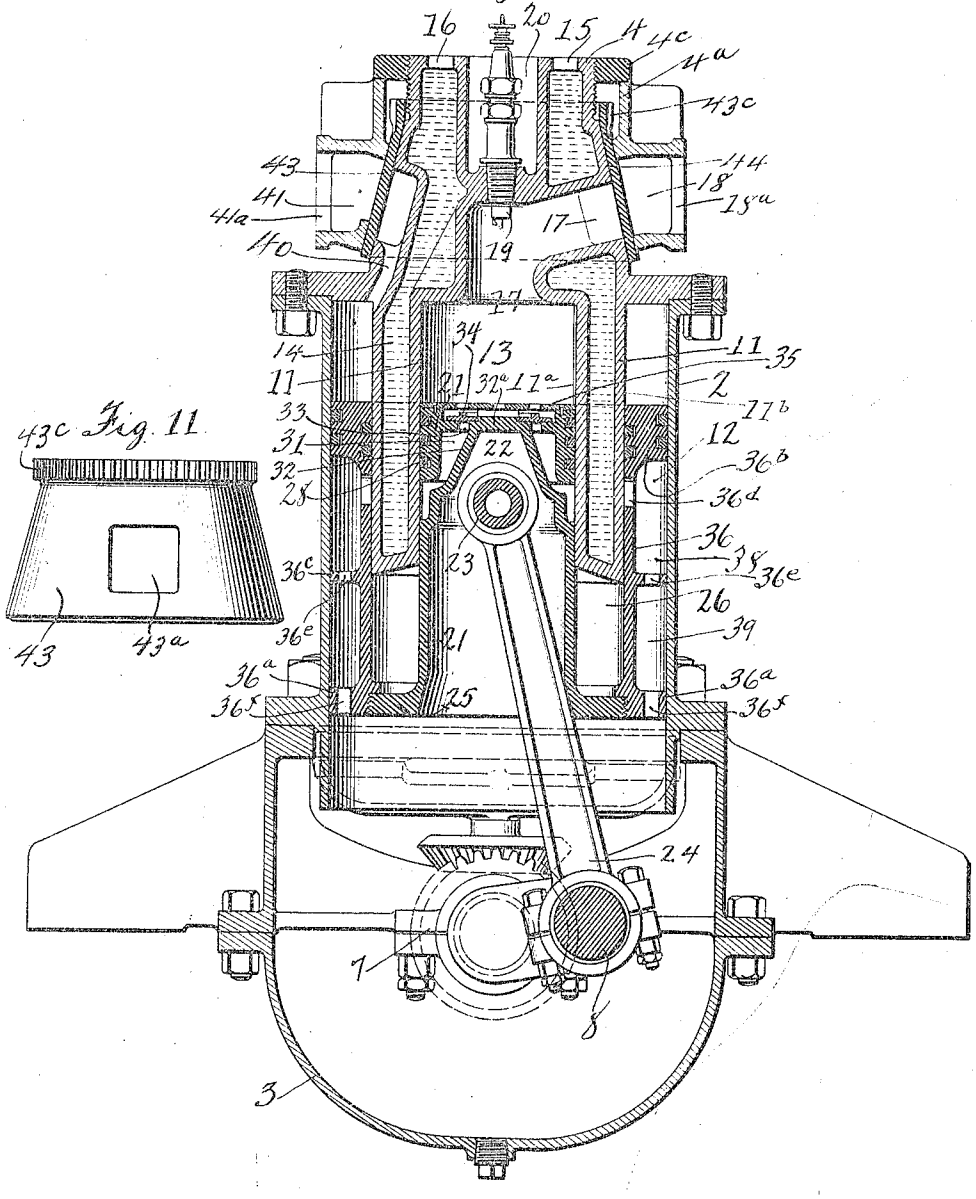


Fig. 11.

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4 SHEETS—SHEET 4.

Fig. 4.

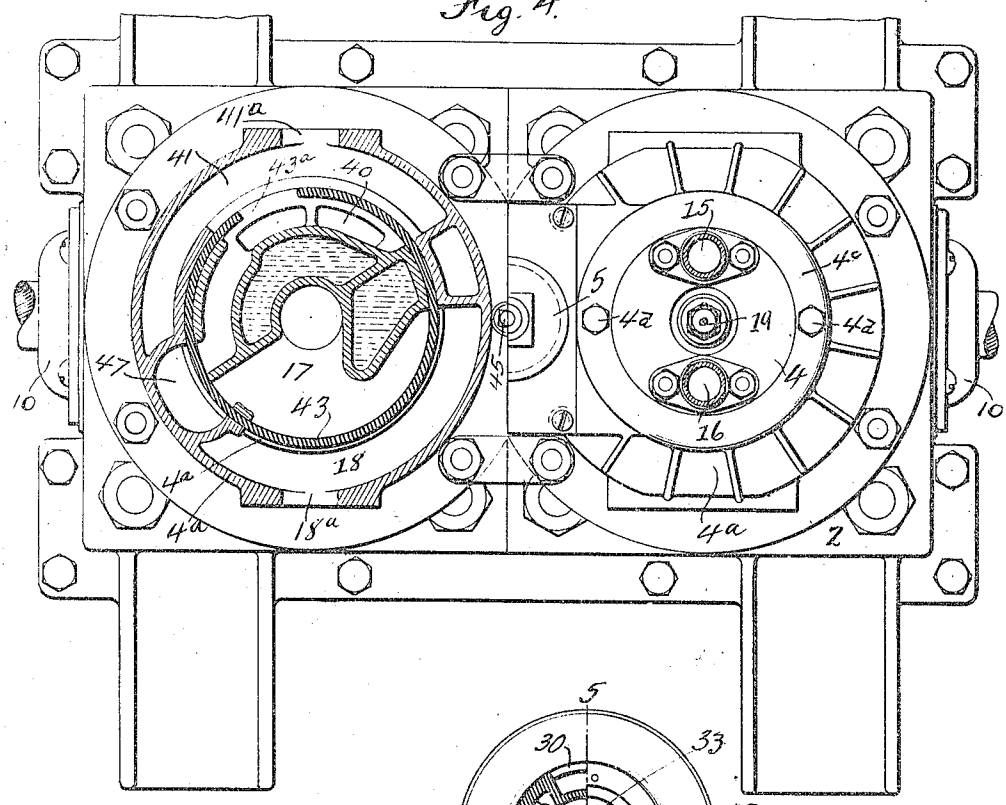


Fig. 7.

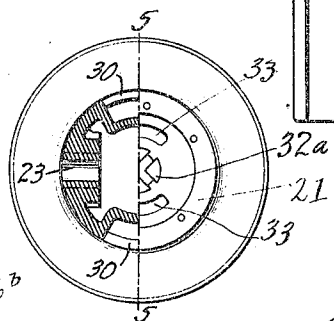


Fig. 5.

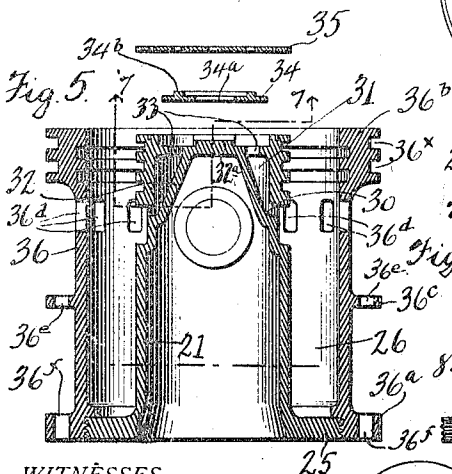


Fig. 6.

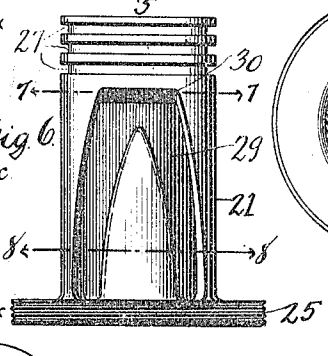
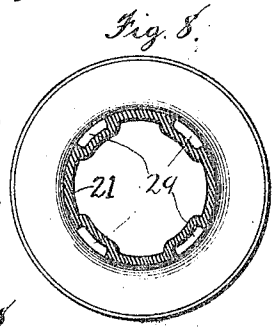


Fig. 8.



WITNESSES

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Fig. 9.

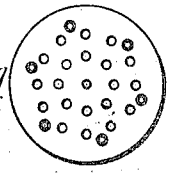


Fig. 10.



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INTERNAL-COMBUSTION ENGINE.

1,153,432. Specification of Letters Patent. Patented Sept. 14, 1915.

Application filed January 9, 1913. Serial No. 740,905.

To all whom it may concern:

Be it known that we, GEORGE A. ILER and THOMAS M. NALON, citizens of the United States, residing at Kirkwood and Edgewood, Atlanta, respectively, in the county of Dekalb and State of Georgia, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to internal combustion engines and, particularly, to the type thereof known as "two-cycle engines," in which the piston-elements receive an impulse at each alternate stroke.

The object of the invention is to increase the efficiency of the elements which coöperate to produce such impulse and, also, those which receive the effects of the same: This is accomplished, in part, by a simplification of the valve-mechanism forming an essential component of the engine, and, also, by the provision of a novel form of the valve employed; also, by the inclusion in the engine of a plurality of concentrically-arranged pistons (forming other components of the engine) which operate in properly-constituted cylinders, and which pistons operate as a unitary structure.

The object is, also, to provide a form of casing or housing which is peculiarly-well adapted for promoting the efficiency of operation of the components aforementioned, as well as of those hereinafter particularly described.

Another object is to provide an especially efficient water-cooling system whereby heating of the various components of the engine is prevented, or at least reduced to a minimum.

A further object of the invention is to provide for a reliable delivery of the charge to the firing-chamber and at such times as to insure its explosion in proper relation to the position of the pistons, whereby undesirable compression, etc., are obviated.

A further object of the invention is to provide an engine of the type aforementioned in which the use of cams, springs, etc., is dispensed with and, in lieu thereof, positively-operated devices are employed.

A further object of the invention is to reduce the number of parts and to provide but two reciprocating components as distinguished from engines employing actuatable valve-controlling rods, arms, etc.

With these and other important objects in view, the invention resides in novel parts, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, the same serving in connection with the description herein to explain the principles of the invention.

In these drawings: Figure 1 is an elevational view of an engine constructed in accordance with our invention; Fig. 2 is a view in sectional elevation—one part being shown in front elevation, while its companion part is illustrated in central vertical section; Fig. 3 is a view in vertical transverse section; Fig. 4 is a view in top plan, partly in horizontal section, the section being taken on the line 4—4, Fig. 2; Fig. 5 is a collective view in vertical section of the inner and outer pistons, the section being taken on the line 5—5, Fig. 7; Fig. 6 is an elevational view of the inner piston; Fig. 7 is a view in top plan, partly in section, the section being cut on the line 7—7, Fig. 5, and which is at the plane of the line 7—7, Fig. 6; Fig. 8 is a view in horizontal section taken on the line 8—8, Fig. 6; Fig. 9 is a detail view of perforate elements forming the top-plate of the inner piston; Fig. 10 is a similar view of a valve-disk underlying the top-plate; Fig. 11 is an elevational view of a rotary valve for controlling the intake of the charge and the escape of the exhaust; and Fig. 12 is a diagrammatic view, illustrating certain of the operations of the parts.

Referring to the drawings, it will be noted that the casing in which all of the operating components (hereinafter described in detail) are housed, is designated by the reference-numeral 1. It is a feature of our casing that it is so formed that, as shown, it has a smooth and finished appearance, and there are absent from it the usual exterior protrusions and irregular surfaces. This casing includes two cylinders 2, 2, properly of substantially identical construction; an elongated crank-case 3, which is common to both cylinders; head-elements 4, and cap-pieces or bonnets 4^a, one for each cylinder; and an intermediate gear-housing portion 5.

Journaled in end bearings 6 and an intermediate bearing 7, within the crank-case and extending longitudinally of the latter is a crank-shaft 8 provided with circumferential ribs 9, which are disposed just within pro-

tecting caps 10, suitably secured to the ends of the crank-case, as shown. In the sense that the crank-shaft is actuated by other instrumentalities (presently to be described) it is the driven-member of the engine. On the other hand, as it also acts to actuate the valve-device, it is a drive-member. It carries, outside of the casing as usual, a balance-wheel (not shown) and is adapted to be connected up, in any desirable way, to gearing, shafting, wheels, etc., (not shown) to be operated.

The cylinders.—Each of the cylinders 2, proper, is so constructed (in accordance with a preferred embodiment of our invention) as to include a plurality of cylinder-elements: To this end, each of the two head-elements 4 is constructed with an annular pendant portion 11 which divides the interior of the cylinder-elements into an outer cylinder 12 and an inner cylinder 13. The pendant portion 11 is preferably of a length considerably less than the height of the cylinder-element 2, and is desirably formed hollow to provide an annular water-space 14 whereby its two work-surfaces 11^a and 11^b as well as engaging and adjacent parts may be kept cool. This water-space extends upward toward the upper portion of the head-element, as shown, whereby the parts related to that portion of the engine are also kept cooled. This space is supplied with the contained water in any desirable way and which water may, itself, be cooled, as by passing through a radiator (not shown) or otherwise; the water passing into and out of said space through the apertures 15 and 16, respectively; as seen in Figs. 3 and 4. It will thus be seen that the inner cylinder is water-cooled; that the inner wall of the outer cylinder is likewise water-cooled; and that, as the outside wall of said outer cylinder is exposed to the atmosphere, it is air-cooled.

As seen in Figs. 2 and 3, the upper portion of the cylinder 13 is extended upward to provide (with that portion of the cylinder above the piston) an explosion-chamber 17 into which the charge is introduced. Communicating with said explosion-chamber 17 is a channel 18 having an exhaust-port 18^a that is controlled in a manner presently to be set forth.

Extending into the chamber 17 is a spark-plug 19 of any appropriate form and which is operated and controlled in the usual manner. The plug is, for a portion of its length, incased in a small depression 20, open at its top and the wall of which is kept cooled by the water which surrounds it, as clearly shown in Figs. 2 and 3.

The pistons.—Adapted to be reciprocated in the inner cylinder 13 is a piston 21 which is open at its lower end and, being hollow and of elongated form, provides a chamber 22 in which is formed a bearing 23 for a pitman 24 which connects at its lower end with the crank of the shaft 8. As shown, generally, in Figs. 2 and 3, and on a large scale in Figs. 5 to 8, this piston is of particular form and construction, and subserves important functions, wherefore we deem it desirable to describe it with considerable detail: In the first place, it will be observed that it is cylindrical in form and, at its lower end, is provided with an enlarged threaded portion 25. This portion 25 and the lower end of the pendant cylinder-dividing portion 11 provide two walls for forming an annular space or chamber 26, the function of which will be explained hereinafter. The upper portion of said piston is provided with a series of grooves 27, in which expansion piston-rings 28 are disposed. Between the piston-ring grooves and the threaded portion 25, the piston is, on its outer face, provided with a plurality (in this instance, four are shown) of inverted approximately U-shaped depressions 29, the upper ends of which communicate (through orifices 30) with a piston-chamber 31 formed between the ring-provided portion of the piston and a truncated cone-shaped wall 32 which extends upwardly to a point just below the plane of the top of the piston. The chamber 31 is provided with a pair of arcuate slots or ports 33, (Fig. 7) which are controlled by a pressure-operated disk 34 provided with a central opening 34^a adapted to be movably seated around a grooved boss 32^a of the wall 32, and with an upstanding annular flange 34^b which is adapted to control any flow through certain of the perforations in a distributor-plate 35 removably attached to the top of the piston.

The piston just described is designed to be reciprocated within the cylinder 13 and its exterior face is adapted to have a sliding engagement with the wall 11^a of the pendant portion 11. The packing-rings serve to make the engagement gas-tight.

Rigidly attached to the piston 21—by means of the threaded lower portion 25—and adapted to have a sliding engagement with the surface 11^b of the pendant portion 11, is an outer piston 36 which reciprocates in the cylinder 12. This piston 36, like the piston 21, is of peculiar design though it is unlike that of the piston 21. It is, however, operated in unison with and, for certain purposes, as a component part of said piston 21 by means of the connecting-rod or pitman 24. In other words, this pitman is common to and actuates both pistons simultaneously and in the same direction.

As seen generally in Figs. 2 and 3, and on a larger scale in Fig. 5, the piston 36 is formed with an annular flange 36^a at its lower end, with a grooved enlargement 36^b at its upper end, and with an intermediate flange 36^c, all of proper dimensions to have

a working-fit with the walls of the cylinder 12. In the grooves 36^x, in the enlargement 36^b, are expansion rings 37, as usual. Between the flanges 36^b and 36^c, the piston is provided with a series of ports or apertures 36^d which are in approximate alinement with certain of the ports 30 in piston 21. As the two pistons are separated by the pendant portion 11, it is seen that this portion is adapted (in the manner presently to be explained) to control the apertures 36^d and the ports 30. Referring to Fig. 3, it will be observed that the walls of the cylinder 12 and the piston 36 are spaced from each other and that the flange 36^c divides the space thus provided into two annular chambers 38 and 39. It is into the chamber 38 that the aperture or port 36^d opens, as shown in Figs. 2 and 3, and, through aperture 36^e in the flange 36^c, chamber 38 communicates with chamber 39. As the flange 36^a is similarly provided with apertures 36^f, the chamber 39 communicates with the crank-case.

Formed in the head-element 4 and communicating with the cylinder 12 is a gas-introducing channel 40, the same extending into a larger channel 41, provided with a port 41^a, and which connects with a suitable carbureter (not shown) or other charge-forming device.

Valve-mechanism.—The exhaust-port 18^a is arranged at the side of the casing opposite to the intake-port 41^a provided in the channel 41.

Manifestly, some means must be provided for controlling the inflow of the gas into the explosion-chamber and the outflow of the burnt gases into the exhaust, and it is desirable that such means shall be controlled, for certainty of operation and in proper cynchronism with the operation and position of the pistons, in a positive manner: We have, therefore, devised a form of valve and valve-operating mechanism which will accomplish these results: A preferred type thereof is disclosed in Figs. 2, 3 and 11, and comprises a rotary valve-member 43, of truncated cone form, and provided with a port 43^a, preferably of considerable size, and which is adapted alternately to register with the ports 18^a and 41^a. This valve-member is provided, at its upper end, with gear teeth 43^c whereby it may be rotated by mechanism presently to be described. Said member is adapted to be mounted upon a tapered bearing-surface 44 formed on the head-element so that it is adapted to cover and uncover the ports leading into and out of the charge-intake and exhaust channels. The member 43 is held in operative position by the cap-piece 4^a and which, in turn, is held in place by an internally-threaded ring 4^c that is screwed onto the threaded upper portion of the head-element 4. As shown in Fig. 2, the ring is split at its edge and is provided with screws 4^d adapted to effect a binding action between the ring and the head-element.

Mounted at the upper end of a vertical shaft 45 suitably journaled is a pinion 46 adapted to mesh with the gear-teeth formed on the valve member, already described. The lower end of said shaft carries a bevel-gear adapted to mesh with a corresponding gear fast on the crank-shaft 8. As will be seen, this valve and its actuating-mechanism are housed entirely within the casing 1 and receive positive movement (and continuously in one direction) from the crank-shaft and at crank-shaft speed and in such manner that the valve will perform its designed function of controlling the intake and exhaust ports aforementioned. By reason of the fact that the valve is positively rotated continuously (in one direction) from the crank-shaft—and consequently at exactly crank-shaft speed—the valve will open and close the respective ports at a speed corresponding with the speed of the engine. By reason of the fact that the valve-member is of tapering form and rotates on a correspondingly-tapered bearing-surface and is held in place by the cap-piece or "bonnet" which, in turn, is retained in position by the ring threaded onto said cap-piece, as already described, it is obvious that the degree of frictional engagement imposed on said valve-member may be varied to take up wear, etc., and this may be accomplished at all times, and even when the engine is in operation. Due to the fact that the valve rotates and on a tapering surface, it is self-grinding, so to speak, and will always be gas-tight. It will be observed that the valve-member is of a height sufficient to maintain a considerable portion of its inside surface in contact with the water-cooled wall of the head-element 4, in consequence of which said valve is water-cooled on its inside, and as it has a large part of its outside surface exposed to the outside air, it may be said to be air-cooled, also.

Operation.—It is to be understood that (assuming that the charge-intake port 41^a has been opened) the outer cylinder 12 and its piston 36 operate to draw in a fresh charge of gas from the carbureter (not shown), through the channel 40, on the down-stroke of the pistons, whereupon said charge is delivered into the inner cylinder during the last part of the upstroke of both pistons by means of a properly arranged by-pass, shown at 47, and at the proper compression to be exploded. The explosion occurs in the explosion-chamber, already described as being formed as a part of the inner cylinder. The impulse produced by such explosion forces the pistons down and

actuates the crank-shaft. Just before the inner piston reaches the end of its down or work-stroke, the exhaust-port will have been opened by the valve, and the burned gases are then permitted to escape therethrough, whereupon, as said piston rises, it will forcibly expel such of the gases as may not have escaped for approximately three-quarters of its full upward stroke.

As the pistons descend they (in conjunction with the pendant portion 11) constitute an efficient air-pump, with the result that air entering through vent-tubes (not shown) into the crank-case, will pass (through the ports 36^f) into the chamber 39, thence (through ports 36^e) into the chamber 38, and thence (through the ports 36^d in the wall of the outer piston) into the chamber 26, it being understood that the pistons have moved far enough down to open said port 36^d; that is to say, as the pistons approach the limit of their downward stroke, the ports 36^d begin to uncover, whereupon the partial vacuum which has been produced, fills the suction-chamber 26 with fresh air from the crank-case. Having reached the chamber 26, the air under the force imparted to it by reason of the impetus produced by the relative movement of the adjunctive parts will continue on in its course and pass into the U-shaped depressions 29 in the sides of the piston 21, thence through the orifices 30 into the piston-chamber 31 and, thence, (by raising the disk 34) through the apertures 33 and around said disk and through the perforations in the plate 35, into the combustion or explosion-chamber. Now, as the piston begins its upstroke, the ports 36^d are closed and the air in the pump-cylinder is then compressed until the pressure is sufficient to overcome that in the combustion-chamber which has now been opened to the exhaust and in which the pressure has been almost immediately reduced to atmospheric pressure.

When the pressure of the air back of the valve-disk 34 is greater than that in the combustion-chamber, said valve will rise, as aforementioned, and permit the air to pass through the distributor-plate 35 into said combustion-chamber; but when a new charge is introduced into the combustion-chamber, the conditions are reversed and the valve-disk 34 drops and closes the apertures 33 against passage of any of the fluid or gas which has been allowed to enter the combustion-chamber under a high compression.

In Fig. 12 we have illustrated, diagrammatically, a cycle of operations of certain of the parts and which, in the light of what has already been explained and what will now be explained, the operation of our improvement will be clear: Assuming that an explosion has been effected within the inner cylinder—the crank being at upper dead-center—the pistons will be forced downwardly by the explosive force and expansion of the gas in the firing-chamber, and into the outer cylinder will simultaneously be drawn a charge of new gas, from the carbureter, through the suction-ports. The valve-port being now between the points A and B, Fig. 12, there will be created, at the same time, a partial vacuum within the pump-cylinder. Just before the crank reaches lower dead-center, the exhaust-port is opened and the intake-ports of the pump-cylinder are uncovered, whereupon said cylinder will be filled with fresh cool air from the crank-case through the apertures in the outside piston-flanges, caused by the partial vacuum which will then have been produced. Immediately after the crank has passed lower dead-center and it and the pistons have started on the upstroke, the suction-port will close, and similarly the ports in the pump-cylinder, whereupon compression commences in both the outside and pump-cylinders. In the interim, the burnt gases are being forced out of the combustion-chamber. The valve-port will then have reached a position between the points C and D, Fig. 12. The exhausting of the burnt gases continues through approximately 145° of the upstroke of the crank. Immediately after the crank has passed lower dead-center, the pressure in the combustion-chamber becomes approximately equal to that of the atmosphere, or possibly somewhat less, and the increasing pressure within the pump-cylinder will now raise the ring-valve in the head of the inside piston and cause a flow of fresh cool air into the combustion-chamber, thereby forcing out all of the burnt gas that may not already have escaped, resulting in a cooling of the cylinder and also the extinguishing of any particles of incandescent carbon. Immediately after the exhaust-port has been closed, the port in the valve will reach a position between the points E and F, Fig. 12, and open the aforementioned by-pass to permit communication between the outer and inner cylinders. The pressure within the outer-cylinder, now being very high, and the pressure within the inner cylinder being equal to that of the atmosphere, approximately, the pressure in the two cylinders will instantly equalize. Then, the instant the by-pass is closed—or perhaps a little before, for very high speeds—the charge can be fired, whereupon will follow a repetition of the cycle just explained.

The form of piston-structure herein disclosed is for the purpose of introducing fresh cool air into the combustion-chamber during the period that the engine is exhausting, with the result that a complete scavenging of the ignition-chamber is effected. Immediately after the exhaust-port is closed, a charge of very rich mixture,

which has been introduced into and compressed in the compression-chamber, is transferred, by means of the by-pass aforementioned, into the ignition-chamber—too rich to be then utilized and exploded, wherefore, by reason of the fact that it will instantly mix with whatever air may be remaining in the ignition-chamber, there will form a mixture possessing the most desirable qualities that can be ignited just before the piston reaches its highest upstroke position.

The described arrangement of ports permits the utilization of an exceedingly rich mixture in the outer or compression-cylinder, and the possibility of a premature explosion from high compression is reduced to a minimum. Moreover, the provision of means (including the distributor-plate 35) for permitting a controlled passage of cool air into the ignition chamber prevents carbonaceous particles therein from becoming incandescent and causing back-fire, or forming a deposit on the piston-head. Moreover, the provision of double concentrically-arranged pistons, secured to each other, and operating in conjunction with other parts of the engine, enables us to compress a charge of fresh gas and a supply of fresh cool air, and, also, to exhaust the burnt gases from the ignition-chamber separately but simultaneously. The description thus given of the operation of one set of cylinders, pistons, etc., applies to the companion set. It is proper to mention, however, that one valve-operating gear-mechanism is so disposed as to be common to two sets, when more than two cylinders are used, the same as is the crank-shaft, etc.

From the foregoing, it will be understood that the various parts and devices, singly and in their coöperation, contribute to produce a high-powered motor, and that an engine has herein been exhibited which realizes the objects of the invention and the advantages inherent therein and as herein set forth, together with other objects and advantages.

The invention, in its broader aspects, is not limited to the particular construction, nor to any particular construction by which it has been or may be carried into effect, as many changes may be made in the construction without departing from the main principles of the invention and without sacrificing its chief advantages.

What we desire to claim as our invention and to secure by Letters-Patent is:

1. An internal combustion engine including in combination, a plurality of concentrically-arranged cylinders, one of said cylinders forming a charge-receiving chamber and the other an ignition-chamber communicating with the receiving-chamber, means for automatically controlling communication between the chambers, a plurality of tubular pistons connected to move as a unitary structure and concentrically disposed relatively, there being one in each cylinder, and valve-mechanism common to both cylinders and operative to control the introduction of a mixture into one chamber and the exhaust of gases from the other.

2. An internal combustion engine including in combination, a plurality of concentrically-arranged cylinders, one of said cylinders forming a charge-receiving chamber and the other an ignition-chamber communicating with the receiving-chamber, means for automatically controlling communication between the chambers, a plurality of tubular pistons connected to move as a unitary structure and concentrically disposed relatively, there being one in each cylinder, a crank-shaft connected to the pistons, and valve-mechanism common to both cylinders, directly connected to said crank-shaft and positively driven thereby in predetermined relation to the movement of the pistons, and operative to control the introduction of a mixture into one chamber and the exhaust of gases from the other.

3. An internal combustion engine including in combination, a plurality of concentrically-arranged cylinders, one of said cylinders forming a charge-receiving chamber and the other an ignition-chamber communicating with the receiving-chamber, means for automatically controlling communication between the chambers, a plurality of tubular pistons connected together adjacent their lower ends to move as a unitary structure and concentrically disposed relatively, there being one in each cylinder, a crank-shaft connected to the pistons, and valve-mechanism common to both cylinders, directly connected to said crank-shaft and positively driven thereby in predetermined relation to the movement of the pistons, and operative to control the introduction of a mixture into one chamber and the exhaust of gases from the other.

4. An internal combustion engine including in combination, a plurality of concentrically-arranged cylinders, one of said cylinders forming a charge-receiving chamber and the other an ignition chamber communicating with the receiving-chamber, means for automatically controlling communication between the chambers, a plurality of tubular pistons connected together in spaced relation to perform independent functions and adapted to move as a unitary structure and concentrically disposed relatively, there being one in each cylinder, and valve-mechanism common to both cylinders and operative to control the introduction of a mixture into one chamber and the exhaust of gases from the other.

5. An internal combustion engine includ-

ing in combination, a casing, a plurality of concentrically-arranged cylinders and forming, respectively, a charge-receiving chamber and an ignition-chamber communicating therewith, a plurality of tubular pistons connected together in spaced relation to perform independent functions in each of said cylinders and movable as a unitary structure, a pendant element extending between said pistons to space them and to divide the casing into independent cylinders, and valve-mechanism common to both cylinders for controlling the introduction of a mixture into said receiving chamber and the exhaust of gases from the other.

6. An internal combustion engine including in combination, a casing, a plurality of cylinders, a plurality of tubular pistons concentrically arranged relatively and connected together adjacent their lower ends to move as a unitary structure and spaced apart to perform independent functions, a pendant hollow and water-cooled element extending between said pistons to space them and to divide the casing into independent cylinders and a valve-member encompassing a portion of said casing and operating in relation to the movement of said pistons to permit introduction of a firing-mixture into one of the cylinders and exhaust therefrom of unused gases.

7. An internal combustion engine, including in combination, a series of cylinders, one arranged within the other, a plurality of cylindrical reciprocating pistons, one being concentrically arranged relatively to the other, a water-cooling spacing element disposed between said cylinders and with which said pistons have a sliding engagement and a valve-member encompassing a portion of said casing and operating in relation to the movement of said pistons to permit introduction of a firing-mixture into one of the cylinders and exhaust therefrom of unused gases.

8. An internal combustion engine, including in combination, a series of cylinders, one arranged within the other, a plurality of cylindrical reciprocating pistons, one being concentrically arranged relatively to the other, a water-cooling spacing element disposed between said cylinders and with which said pistons have a sliding engagement; the surface of one of said cylinders being exposed to the atmosphere whereby it may be air-cooled and, thus, effect a cooling of one of said pistons and a valve-member encompassing a portion of said casing and operating in relation to the movement of said pistons to permit introduction of a firing-mixture into one of the cylinders and exhaust therefrom of unused gases.

9. An internal combustion engine, including in combination, a pair of concentrically-arranged cylinders including ignition and compression-chambers, respectively, a pair of concentrically-arranged pistons arranged to reciprocate in said cylinders, and a single valve-mechanism including a valve-member having a single cycle of operation for each reciprocation of the pistons for controlling the introduction of a mixture into one of said cylinders and the exhaust therefrom of burned gases, said pistons operating to compress the charge of mixture and to effect exhaust of the burned gases simultaneously but separately.

10. An internal combustion engine, including in combination, a pair of concentrically-disposed cylinders including ignition and compression-chambers, respectively, a pair of concentrically-disposed pistons connected together and adapted to reciprocate, one in one of the cylinders to compress a charge of mixture in the compression-chamber, and the other in the other cylinder for actuation when the mixture in the ignition-chamber is exploded, a single valve-mechanism including a valve-member having a single cycle of operation for each reciprocation of the pistons for controlling the introduction of a charge of mixture into one of said cylinders and the exhaust therefrom of gases, and an auxiliary valve-device supported in one of said pistons for controlling the passage therethrough of fresh air.

11. An internal combustion engine, comprising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports, a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism arranged concentrically with said cylinders and pistons for controlling the ports formed in said cylinders and including a rotary valve, and means for rotating the same.

12. An internal compustion engine, comprising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports at one end, a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism for controlling the ports formed in said cylinders and including a rotary valve, arranged at the ported ends of said cylinders and in alinement therewith, and means for rotating the same, including a gear meshing with said valve, a shaft upon which said gear is fast, a gear at the opposite end of said shaft, and a gear fast on the crank-shaft.

13. An internal combustion engine, com-

prising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports, at one end a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism for controlling the ports formed in said cylinder and including a rotary conically-formed valve, arranged at the ported ends of said cylinders and in alinement therewith, and means for rotating the same, including a gear meshing with said valve, a shaft upon which said gear is fast, a gear at the opposite end of said shaft, and a gear fast on the crank-shaft.

14. An internal combustion engine, comprising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports, a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism for controlling the ports formed in said cylinders and including a rotary conically-formed valve, and means for rotating the same continuously in one direction.

15. An internal combustion engine, comprising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports, a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism for controlling the ports formed in said cylinders and including a rotary conically-formed valve, and means for rotating the same continuously in one direction, and means for adjusting said valve.

16. An internal combustion engine, comprising in combination, a pair of concentrically-disposed cylinders, one of which includes an ignition-chamber and another a compressing-chamber, and each provided with ports, a pair of concentrically-disposed pistons adapted to be reciprocated, one in each of said cylinders in spaced relation and one encircling the other, a crank-shaft connecting with one of said pistons and adapted to actuate both pistons, valve-mechanism for controlling the ports formed in said cylinders and including a rotary valve, and means for rotating the same, and a cooling-system adapted to cool said pistons and said valve.

17. An internal combustion engine, including a casing, a plurality of sets of concentrically-disposed cylinders housed therein, a plurality of sets of concentrically-disposed pistons operating in said cylinders, a crank-shaft common to all of said pistons, and valve-mechanism common to said sets of cylinders and directly connected to said crank-shaft whereby it is given positive movement and in predetermined relation to the movement of the pistons.

18. An internal combustion engine, including a casing, a plurality of sets of concentrically-disposed cylinders housed therein, a plurality of sets of concentrically-disposed pistons operating in said cylinders, a crank-shaft common to all of said pistons, and crank-shaft driven valve-mechanism common to said sets of cylinders and directly connected to said crank-shaft whereby it is given positive movement and in predetermined relation to the movement of the pistons.

19. An internal combustion engine, including in combination, a casing including cylinder-elements, a head-element communicating with said cylinder-elements and provided with channels and ports, and a crank-case common to said cylinder-elements, a crank-shaft operating in said crank-case; a pair of cylinders forming said cylinder-elements and one concentrically-disposed in relation to the other, a pair of concentrically-arranged pistons having a reciprocating movement in the respective cylinders and connected together for simultaneous movement, each of said pistons being formed tubular and provided with apertures, a piston-spacing element disposed between said pistons and serving as the active instrumentality for controlling the passage of fluid through said apertures, valve-mechanism in one of said pistons for controlling the passage therethrough of fluid, and shaft-actuated valve-mechanism for controlling the ports in said head-element.

20. An internal combustion engine, including in combination, a casing including cylinder-elements, a head-element communicating with said cylinder-elements and provided with channels and ports, and a crank-case common to said cylinder-elements, a crank-shaft operating in said crank-case; a pair of cylinders forming said cylinder-elements and one concentrically-disposed in relation to the other, a pair of concentrically-arranged pistons having a reciprocating movement in the respective cylinders and connected together for simultaneous movement, each of said pistons being formed tubular and provided with apertures, a hollow, water-cooled piston-spacing element disposed between said pistons and serving as the active instrumentality for controlling the passage of fluid through said apertures, valve-mechanism in one of said pistons for

controlling the passage therethrough of fluid, and shaft-actuated valve-mechanism for controlling the ports in said head-element.

21. An internal combustion engine, including in combination, a casing including cylinder-elements, a head-element communicating with said cylinder-elements and provided with channels and ports, and a crank-case common to said cylinder-elements, a crank-shaft operating in said crank-case; a pair of cylinders forming said cylinder-elements and one concentrically-disposed in relation to the other, a pair of concentrically-arranged pistons having a reciprocating movement in the respective cylinders and connected together for simultaneous movement, each of said pistons being formed tubular and provided with apertures, a hollow, water-cooled piston-spacing element disposed between said pistons and serving as the active instrumentality for controlling the passage of fluid through said apertures, valve-mechanism in one of said pistons for controlling the passage therethrough of fluid, and shaft-actuated valve-mechanism for controlling the ports in said head-element, including a rotary valve adapted alternately to cover and uncover said ports, and a gear and shaft connection between said valve and the crank-shaft.

22. An internal combustion engine including in combination a plurality of cylinders, one of which is formed with a firing-chamber, a plurality of tubular pistons concentrically arranged relatively and connected together to move as a unitary structure and each provided with ports, the outer piston carrying flanges provided with ports for the admission of fresh air and which passes through the ports in the outer ported piston, the ports in the inner piston permitting the passage of air to the firing-chamber.

23. An internal combustion engine including in combination, a casing, a plurality of concentrically arranged cylinders, the inner cylinder being formed with a firing-chamber, a plurality of tubular pistons concentrically arranged relatively and connected together to move as a unitary structure and provided with ports and spaced apart to perform independent functions, a pendent element extending between said pistons to space them and divide the casing into independent cylinders, and a crank-case below the pistons; the outer piston carrying flanges provided with ports for the admission of fresh air from said crank-case through the ports of said outer piston to the space formed below the lower end of said pendent element; and the ports in the inner piston permitting passage of air from said space below the pendent element to the firing-chamber.

24. An internal combustion engine including in combination, an engine-casing, a crank-case, a plurality of tubular pistons concentrically arranged relatively and connected together to move as a unitary structure and spaced apart to perform independent functions, a pendent element extending between said pistons to space them and divide the casing into independent inner and outer cylinders and providing an air-pumping space between the walls of said tubular pistons; the outer piston being provided with ports adapted to admit fresh air from the crank-case to said air-pumping space.

25. An internal combustion engine including in combination, an engine-casing, a crank-case, a plurality of tubular pistons concentrically arranged relatively and connected together to move as a unitary structure and spaced apart to perform independent functions, a pendent element extending between said pistons to space them and divide the casing into independent inner and outer cylinders and providing an air-pumping space between the walls of said tubular pistons; the outer piston being provided with ports adapted to admit fresh air from the crank-case to said air-pumping space; an ignition chamber formed in the inner cylinder; the inner piston carrying a ported head and a valve, whereby fresh air from said air-pumping space is introduced into the ignition-chamber to scavenge it of burned gases.

26. An internal combustion engine including in combination, a casing, a plurality of cylinders, a plurality of tubular pistons concentrically arranged relatively and connected together adjacent their lower ends to move as a unitary structure and spaced apart to perform independent functions, a pendent element extending between said pistons to space them and to divide the casing into independent cylinders, said element extending upward to form a cylinder-head, and valve-mechanism including a conical valve-member encompassing and rotatable around said head for controlling inflow of a mixture into the cylinders and the exhaust of gases therefrom.

In testimony whereof we affix our signatures in presence of two witnesses.

GEORGE A. ILER.
THOMAS M. NALON.

Witnesses:
DUNCAN L. POLLOCK,
BERNARD V. STODGHILL.