W. F. BROWN.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 13, 1912.

1,222,067.

Patented Apr. 10, 1917.

2 SHEETS—SHEET 1.

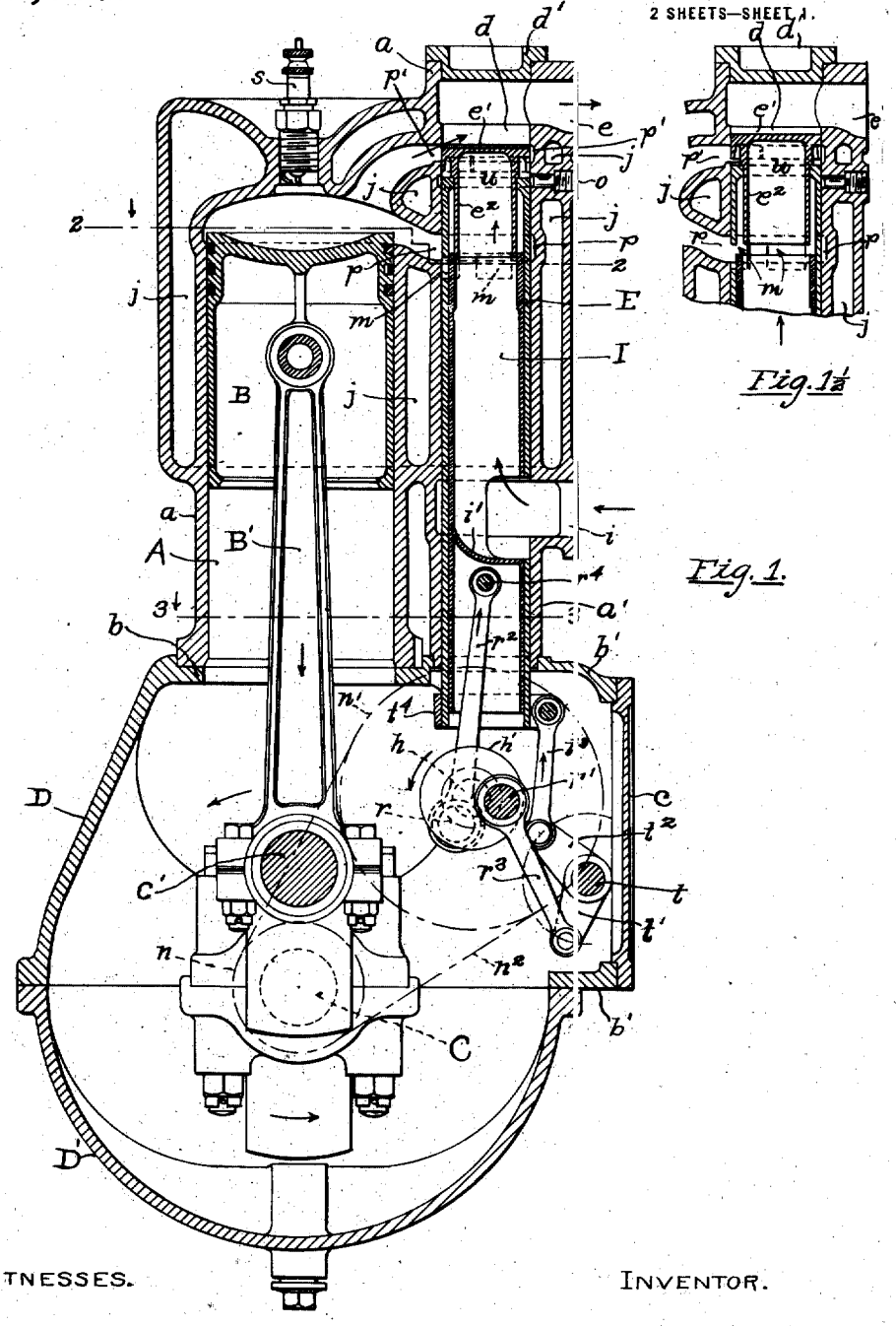

Fig. 1.

Fig. 1a.

WITNESSES.

H. Henderson

Calvin H. Brown

INVENTOR.

Walter F. Brown.

BY Geo. H. Remington.

ATTY.

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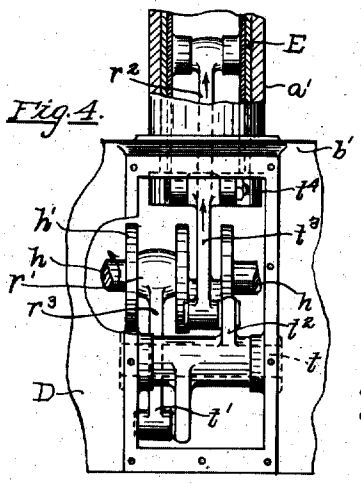
2 SHEETS—SHEET 2.

Fig. 4.



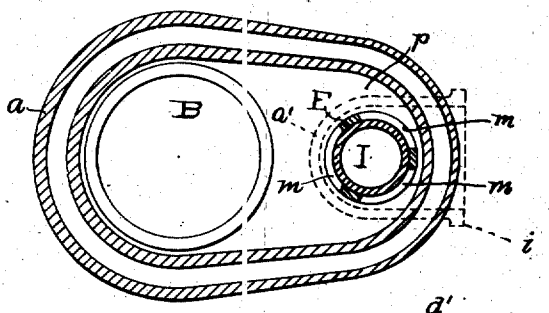


Fig. 2.

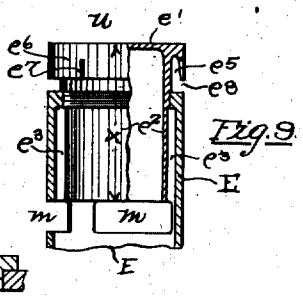


Fig. 9.

Fig. 5.

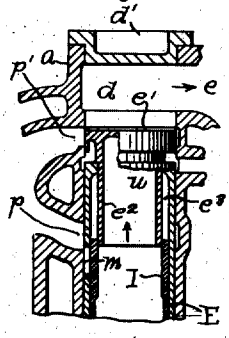
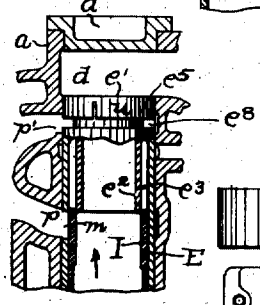
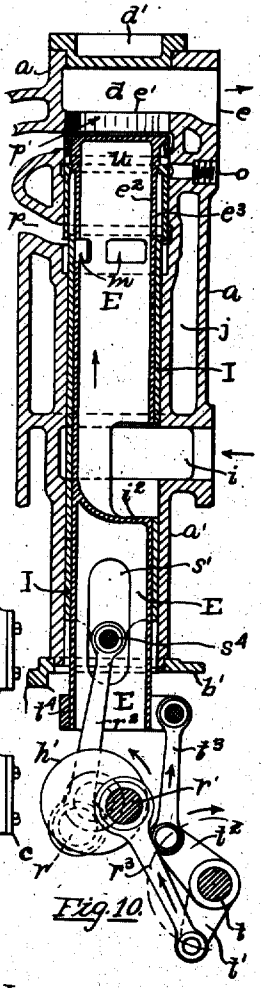


Fig. 6.





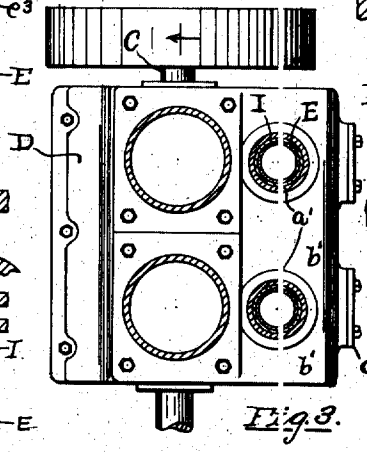


Fig. 3.

Fig. 10.

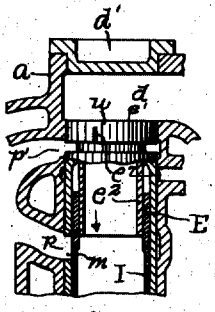


Fig. 7.

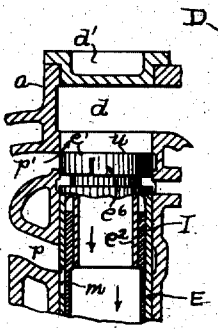


Fig. 8.

WITNESSES.

H. Hollander

Edward C. Brown

INVENTOR.

Walter F. Brown.

BY Geo. H. Remington,

ATTY.

UNITED STATES PATENT OFFICE.

WALTER F. BROWN, OF NEW LONDON, CONNECTICUT.

INTERNAL-COMBUSTION ENGINE.

1,222,067. Specification of Letters Patent. Patented Apr. 10, 1917.

Application filed February 13, 1912. Serial No. 677,317.

To all whom it may concern:

Be it known that I, WALTER F. BROWN, a citizen of the United States, residing at New London, in the county of New London and State of Connecticut, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

The invention forming the subject of this application for patent relates generally to internal combustion engines of the four-cycle type; and more particularly to engines of said type in which the inlet and exhaust valves thereof are tubular and mounted in a valve-chest integral with the main or working cylinder. The invention consists in the novel construction and combination of parts comprising the valve system, all as hereinafter set forth and claimed.

In valve arrangements of internal combustion engines as sometimes devised, having one or more sleeve valves, or a combination of piston and sleeve valve (one valve within the other), such engines have each a single main port communicating with the working cylinder and valve-chest; arranged whereby the waste gases are exhausted from the cylinder through such single port and through the annular exhaust-valve itself. An objection to this arrangement is that, owing to the very high temperature of said exhaust gases, the latter acts to practically destroy the normal function of the oil or other substance employed for lubricating the surfaces of the adjacent parts, the result being to materially increase the working friction of the corresponding elements, thereby, too, not only causing rapid wear of the parts, but also shortening the life and working efficiency of the engine, in that the joints cannot be maintained against leakage of gas.

The objects I have in view are to overcome or practically eliminate the said inherent defects in engines of the class referred to. To that end I provide the engine with two separated, independent main ports leading from the valve-chest to the cylinder, and having a water-circulating jacket or annular chamber formed between and around both the ports and encircling the valve-chest casing. I employ in my improved engine two coöperable valves (an intake valve and an exhaust valve) which may be termed piston-valves. That is to say, in sleeve or annular valves proper, as usually constructed, wherein one valve is adapted to reciprocate endwise within the other, such valves are unprovided with a closed end or a transverse partition. In my improved valve-gear the body part of the exhaust-valve is annular and has a closed top end. Said valves are concentric and slidably mounted in the valve-chest, one valve (the gas-inlet valve) fitting and endwise movable within the other. The fuel-charge of hydro-carbon, or other suitable gas, of relatively low temperature, passes freely from the source of supply to and through continuously open registering passages formed in the walls of an end portion of the said valves, so that when the opposite or discharge end of the inlet-valve is uncovered by the apertured encircling exhaust-valve, the main intake port is thereby uncovered to admit the charge of explosive mixture or inlet gases into the working cylinder for ignition. The resulting action causes the exploded gas to impinge against the working piston to rotate the crank and its shaft. Obviously, the exhaust port leading from the cylinder is maintained in a closed position until the exhaust valve arrives at the predetermined point to release the exhaust-gases. Obviously, too, the main intake port of the cylinder is temporarily closed against the entrance of inlet gases by the adjacent walls of the exhaust-valve while the main exhaust port is uncovered.

In my improved construction and arrangement of the tubular piston-valves, the end portions thereof contiguous to the main ports leading from the valve-chest into the cylinder may be telescoping; that is to say, the exhaust-valve in such case is provided with an annular space or chamber, closed at the outer end and open at the inner or bottom end to receive the corresponding open or discharge end of the fellow or intake valve. The portion of the outer wall of the exhaust valve lying immediately contiguous to the annular chamber is provided peripherally with a series of lateral ports or apertures disposed in a common plane. As thus devised, the conjoint endwise movements of the two valves causes the inner valve to be withdrawn from said chamber to permit the inflow direct into the cylinder of inlet gases outward through the open discharge end of the intake valve and laterally through the said apertures; the latter then registering with the main inlet port leading to the pis-

ton-carrying cylinder, thereby also at the same time completely closing the main exhaust port. A reversal of the valve's movements uncovers the exhaust port and closes the inlet port; or, in other words, the exhaust valve, in its movements, opens the exhaust port and permits the exhaust gases to flow over the valve's closed end and direct into the escape pipe, the coaction of the two valves at the same time closing the main inlet port and causing the inlet valve to reenter the annular chamber to the desired extent, substantially as before stated.

The outer or said closed end portion of the exhaust-valve is also adapted to be self-packing; that is, the side wall of this valve is provided with a second annular chamber disconnected from and disposed intermediate the first-named annular chamber and the valve's outer end. The said second chamber is in substantially continuous communication with the exhaust port, whereby the pressure of the gases in the cylinder and said second chamber are equalized. The thin outer wall of the chamber is adapted, owing to its resilience, to automatically press outward against the bore of the valve-chest to form a self-packing device.

In order to further increase the efficiency of the motor or engine, not only the cylinder and valve-chest are water-jacketed, but also the main inlet and exhaust ports, including the space between them. As thus constructed, the passages for the intake and exhaust gases are kept comparatively cool, thereby correspondingly eliminating the defects usually due to lack of proper lubrication of the valves, especially engines having tubular valves. Another advantageous result attained is the fact that since the high temperature exhaust gases do not pass through or around the valve or valves, but over the closed outer end of the exhaust valve, the walls thereof do not become injuriously heated, consequently the lubricating material is enabled to perform its normal functions.

In the accompanying two sheets of drawings, Figure 1 represents a vertical central sectional view of a four-cycle type of internal combustion engine embodying my improvement; Fig. 1½ is a sectional view, showing the intake port open; Fig. 2 is a horizontal sectional view, taken on the irregular line 2—2 of Fig. 1; Fig. 3 is a similar sectional view, in reduced scale, taken on line 3—3 of Fig. 1; Fig. 4 is a back side elevation showing portions of the engine base, &c., corresponding with Fig. 1; Fig. 5 is a partial central sectional view, showing the position of the upper portion of the valves at the commencement of the intake stroke; Fig. 6 is a similar sectional view of the parts at the commencement of compression; Fig. 7 is a similar sectional view, showing the parts at the beginning of the explosion and expansion stroke; Fig. 8 represents the parts at the commencement of the exhaust or scavenger stroke; Fig. 9 is a side elevation, in enlarged scale, partly in central section, showing the upper portion of the exhaust-valve; and Fig. 10 is a vertical central section, showing a modification of the valve arrangement.

The following is a more detailed description of my improved internal combustion engine, including the manner of its operation:

It may be stated in advance, however, that the general form, construction and arrangement of the main cylinder A (except as to the valve-chest), its piston B, its main or crank-shaft C, the base or housing D, D^1, and some of the minor members are well known, therefore a description of these elements is not deemed essential herewith.

The cylinder A is bored to receive a driving-piston B, connected to a pitman B^1, which in turn is jointed to the crank-pin C^1 of the main shaft C, substantially as usual. The shaft is adapted to be supported in suitable bearings disposed in the housing sections D, D^1, and having the top or table b of the upper section arranged to receive and support the cylinder and its valve-chest. This section has a chambered lateral extension b^1 disposed below the valve-chest, in which the valve-actuating mechanism is mounted for movement. The latter is rendered readily accessible upon removing the cover c.

The valve-chest chamber d is represented as bored longitudinally and disposed parallel with the axis of the cylinder; a removable bonnet d^1 closes the valve-chest's upper end. The valve-chest is also provided with lower and upper lateral hollow extensions or outer nozzles i and e, adapted to be connected, respectively, to pipes for supplying the inlet-gases to the cylinder and conveying the waste or exhaust-gases therefrom. The upper or head portion of the cylinder is provided with vertically separated, independent main inlet and exhaust ports, p and p^1, respectively, in open communication with the valve-chest's chamber, the exhaust port being the upper port. It is to be noted that not only the cylinder and valve-chest are jacketed, or adapted to be water-cooled, but that the said ports and the inclosed spaces between them are also jacketed. This latter serves to materially reduce the normally high temperature of the exhaust-gases at that point, thereby keeping the upper portion of the valves correspondingly cooled.

The following is descriptive of the endwise slidable main intake and exhaust valves I and E, respectively:—The valves are annular and cylindrical; I prefer to mount

the inner or intake valve in the bore of the other, or exhaust-valve E, which in turn is movably fitted to the bore or chamber of the valve-chest. The valves represented extend downwardly through the valve-chest and into the chamber below. The inlet valve I, open at the top, is materially shorter than the outer or exhaust valve E, and is provided with a large lateral opening through its lower wall in continuous open communication with said intake nozzle *i*; the inlet valve is also provided with a transverse, gas-tight partition i^1 located below said lateral opening for closing the lower end portion of the valve.

The other or exhaust-valve E, encircling valve I, has a lateral opening through its wall in continuous open communication both with the said opening of the valve I and that of the nozzle *i*. The lower end portion of valve E is open and provided exteriorly with a fast collar t^4 adapted to be jointed to a suitable driving-connection, as t^3. The opposite or upper portion of the valve is provided with a head or cap member *u* secured thereto and having its top or outer end closed, as indicated at e^1. The underside of the cap has an annular wall e^2 extending downward therefrom a suitable distance; that is to say, the external length of the member *u* is substantially the same as the combined thickness of the two ports *p*—p^1, plus the depth of the intervening metal between them. See Fig. 9, line *x*. The part e^2 forms, with the outer wall of the main part of the valve E, an annular space or chamber e^3, into which the upper open discharge end of the inlet-valve I is adapted to slide telescopically. At a point immediately below the lower edge of the cap's inner wall e^2 the outer wall of the valve is provided peripherally with a plurality of lateral apertures *m* arranged in a common plane, the depth of the openings being substantially the same as that of the contiguous main port *p*.

Again referring to Fig. 9, &c., the head part *u* of the exhaust-valve is self-packing, that is, an outer annular space or groove e^8 extends inward and upward to form an inverted shallow packing chamber e^5 whose outer, downwardly extending flange e^6 is quite thin and resilient and provided with vertical slits, e^7, at intervals, the construction being such that the pressure of the gases in the cylinder and packing-chamber e^5 are equalized at substantially all times, thereby adapting the flange e^6 to spring normally outward against the contiguous bore of the valve-chest to prevent leakage of the gases into the exhaust passage. Obviously, the said two annular chambers, e^3, e^5, are separate and distinct from each other, nor do the said slits ever open into the exhaust duct *e*.

The valve-gear driving mechanism represented in the drawings is substantially as follows, reference being had to Fig. 1:—To the main crank-shaft C is secured a suitable driving member adapted to transmit power therefrom to a wheel or member fixed to an eccentric shaft *h* revolubly mounted in a lateral extension b^1 of the housing section D. The said power-transmitting members employed may be sprocket-wheels connected by a noiseless sprocket-chain or belt, or by a train of toothed gearing, or other suitable means. In the drawings for primary driving member *n*, the receiving wheel or member n^1, secured to shaft *h*, and connecting means n^2, or chain, are indicated by broken lines; and since the engine is of the four-cycle type, wherein the main shaft makes two full revolutions (being four single reciprocations of the main piston) to one revolution of the said eccentric shaft *h*, it follows that the speed of rotation of the eccentric shaft is only one-half that of the crank-shaft.

The said eccentric shaft, so-called, is adapted to be suitably supported and provided with a plurality of disks h^1 having interposed, angularly separated pins or eccentric journals *r*, r^1, the latter pin, as drawn, being in advance of the other and circularly positioned about 90° from it. To the pin *r* is jointed a connecting rod r^2 extending upward into the lower portion of the inlet-valve I and is in turn jointed to a pin r^4 fixed to the valve, whereby the latter is positively reciprocated back and forth, the degree of movement obviously being equal to the circular "throw" of the pin *r*. The arrangement represented in Fig. 1 shows the intake-valve I mounted for movement within the exhaust-valve E, the latter or outer valve being interposed between the bore of the valve-chest and inlet-valve.

Reciprocatory movements are imparted to the exhaust-valve E through the medium of the revoluble shaft *h* carrying the eccentric pin r^1 jointed to a connection r^3, which latter is also jointed to an arm t^1 secured to a rock-shaft *t*; the angular movements of the latter vibrate a lever or arm t^2 fixed to the rock-shaft, which in turn reciprocates the valve E through the connecting link t^3 jointed thereto. This mechanism is somewhat analogous to the so-called "wrist-plate-motion." As thus constructed and arranged, the speed of rotation or "throw" of the two eccentric pins is the same; the pin *r*, however, when passing the lower "dead center" causes the valve I to remain practically stationary temporarily, while at the same time the forwardly located pin r^1, and its connections, causes the valve E to move upward quickly, thereby positioning its lateral openings *m* above the open end of the inlet-valve to substantially register with the main inlet-port *p*, then uncovered, to instantly re-

ceive the charge of intake-gases into the cylinder. Immediately succeeding the intake charge the inlet-valve moves upward past the inlet-passages m of the other valve into the annular chamber e^3 to its limit, the exhaust-port p^1 then being closed. The next succeeding action of the engine causes the intake charge in the cylinder to be compressed therein, followed by ignition from the igniter s and the consequent or resulting explosion and expansion pressure. Upon moving the exhaust valve E downward to uncover the exhaust port, the waste gases are then forced outward therethrough from the cylinder by the piston in its scavenger stroke direct over the top e^1 of the then depressed exhaust-valve into the continuously open escape nozzle e. The valves move conjointly and telescopically, but at varying speed ratios and distances, as before stated.

The upper portion a of the walls of the valve-chamber d is water-cooled; its corresponding end being capped by a bonnet d^1. The lower open end portion a^1 of the valve-chest may be turned and fitted to the table or top b of the corresponding housing section D. A normally closed opening o is formed in the wall of the valve-chest to facilitate the introduction of lubricating oils.

It is assumed that the function and action of valves in an internal combustion engine of the four-cycle type for motor cars are well-known. I have deemed it best to illustrate sectionally my improved valves, or rather the upper portion thereof, in various positions; these latter represent the said valve parts in connection or relation to that portion of the cylinder in which the main intake and exhaust ports are located. Fig. 5 indicates the position of said parts at the commencement of the intake stroke; Fig. 6 indicates the relation of the parts at the commencement of the compression stroke; Fig. 7 indicates the parts at substantially the commencement of the explosion and expansion stroke; Fig. 8 indicates the relation of parts at the commencement of the exhaust or scavenger stroke; and Fig. 1 indicates the relative position of the coacting valves at the commencement of endwise separation to uncover the main port p to quickly receive the charge of intake gases into the cylinder. It may be stated that the interior of the valves, or valve-chamber, are or may be in continuous open communication with the inlet nozzle i; the intake gases being unable to escape from said chambers except when the valves are separated endwise, as just stated, and substantially as indicated in Fig. 11. The arrows in said figure indicate the corresponding direction of the valve's movements.

In Fig. 1 of the drawings the opposed gas-tight partitions i^1 and e^1 of the valves I and E, respectively, in coöperation with the inclosed gases, serve to maintain the valves in a substantially normally balanced position.

I would state that the reciprocating action of the intake-valve itself is effected simply by means of a crank or eccentric secured to a secondary shaft h moving at one-half the speed ratio of the engine shaft; at the same time, too, the mechanism for imparting a wrist-plate motion effect to the exhaust-valve is also actuated by said secondary shaft, the arrangement of the device being such that while the intake-valve is positively and uniformly acted upon by a pitman connecting the valve and crank-pin r, as just stated, the character of the reciprocation of the exhaust valve E is very materially changed. That is to say, the wrist-plate mechanism operates to impart a more rapid opening and closing movement to the exhaust-valve. Or, in others words, the lap of the last-named valve after having closed the exhaust port p^1 causes the valve, in connection with the wrist-plate mechanism, to remain at rest in the closed position a much longer time; the corresponding or resulting dwell being equal to some 200° of the revolving main crank shaft. The construction and arrangement of the valve-controlling mechanism keep the exhaust port uncovered during 225° of crank movement, and by reason of the valve's inner lap or overthrow the port is kept wide open while the crank moves 85°, thereby giving the exhaust-valve an opening area greater than the port area. Obviously, the proper timing of the parts is assumed to have been made to correspond with the valve's lap.

In lieu of the exact arrangement of the valves I and E, represented in Fig. 1, they may be transposed and mounted substantially as indicated in Fig. 10; that is, the intake-valve I may be the outer one and the exhaust-valve E the inner one. In such case the latter valve may be closed at the top by partition e^1 and opposed by an inner partition i^2 contiguous to the inlet nozzle i; the valve's lower portion is tubular or sleeve-like and is adapted to be actuated in an endwise direction by the same mechanisms employed for moving the exhaust-valve shown in Fig. 1. Elongated vertical openings s^1 are formed in the valve's wall to allow free movements bodily up and down of the pin r^4 and its central connecting rod r^2. The outer or intake valve I, encircling the fellow valve E, is simply a sleeve, open at each end, and also being somewhat shorter than the inner or exhaust-valve E, its bottom end having the pin r^4 mounted therein. Obviously, the walls of both valves are cut away adjacent the nozzle i. In this modification the major part of the cap or head member u of the exhaust-valve may be integral with it, and the wall e^2, then the

outer one, screwed to the main wall, thereby producing the annular chamber e^3, adapted to receive the upper end portion of the valve or sleeve I, substantially as before stated. In this construction the outer annular member e^2 is adapted to enter an annular recess a^3 formed just below the port p in the wall surrounding the bored valve-chest. The means for actuating the valves is or may be the same as that represented in Fig. 1.

What I claim as my invention and desire to secure by U. S. Letters Patent, is:—

1. In a self-contained internal combustion engine, provided with a main or working cylinder having independent inlet and exhaust ports, a bored valve-chest having therein suitable main supply and outlet nozzles, arranged to communicate with ports registering with the cylinder's ports, and a main shaft, the combination therewith of a piston mounted in said cylinder, means connecting the piston and main shaft for driving the latter, a pair of suitably ported, tubular intake and exhaust piston-valves mounted one within the other in said valve-chest, means actuated by the main shaft to cause a double reciprocation of the intake valve during a plurality of revolutions of said shaft, and means, including a wrist-plate-motion-device for reciprocating the exhaust-valve and varying its speed at certain times with relation to the intake valve during each cycle of operations, constructed and arranged whereby the intake gases are adapted to flow through the ports of the said valves into the main inlet port of the cylinder when they are in juxtaposition, the arrangement also permitting the waste or exhaust gases to pass out freely from the cylinder through its main exhaust port, when the latter is uncovered, and past the outer closed end of the exhaust-valve, direct into the valve-chest and its outlet nozzle.

2. In an internal combustion engine, the combination with a main cylinder, a valve-chest having intake and exhaust nozzles, inlet and exhaust connection between the cylinder and valve-chest, a working piston in the cylinder and a driving shaft operatively connected with the piston, of a pair of tubular intake and exhaust valves arranged one within the other, and disposed in the valve-chest, there being an annular space formed in the outer valve and the inner valve telescoping said space at its discharge end, and means for operating the valve, substantially as described.

3. In an internal combustion engine, the combination with the main cylinder having independent intake and exhaust ports and a bored valve-chest integral with the cylinder, of annular intake and exhaust valves slidably fitting each other and said valve-chest arranged to receive and discharge the inlet and exhaust gases, means, including a wrist-plate motion device, for controlling and varying the character of the movements of said exhaust-valve at predetermined times at varying speed ratios, and means for actuating said wrist-plate device.

4. In an internal combustion engine, the combination of a water-jacketed main cylinder, a suitably driven main piston mounted therein, a water-jacketed valve-chest provided with spaced apart water-jacketed intake and exhaust ports communicating with the cylinder, said valve-chest having main inlet and exhaust passages for the supply and waste gases, respectively, vertically disposed tubular intake and exhaust piston-valves slidably mounted one within the other in said valve-chest, said valves being laterally apertured for the flow of gases therethrough, the intake valve being innermost and in continuous open communication with said main inlet passage of the valve-chest, means for actuating the intake-valve, and means, including a wrist-plate motion device, for actuating the exhaust-valve.

5. In an internal combustion engine, the combinaion of a main cylinder having a valve-chest integral therewith provided with outer intake and exhaust openings or nozzles, and also having independent main exhaust and inlet ports in direct communication with the cylinder and valve-chest, a pair of endwise movable tubular exhaust and intake piston-valves disposed in the valve-chest, one valve mounted within the other, the exhaust-valve being the outermost, the upper end of the last-named valve being continuously closed, means for imparting a double reciprocatory movement to the intake valve during two revolutions of the main shaft, and means in continuous connection with the exhaust-valve for actuating the latter to produce an accelerated opening and closing effect and at the same time imparting to it a comparatively long dwell in its open and closed positions.

6. In an internal combustion engine, the combination of a longitudinally bored main cylinder and a valve-chest integral therewith having independent inlet and exhaust ports connecting with the cylinder and valve-chest, a laterally apertured outer tubular exhaust piston-valve, closed at one end, slidably mounted in the valve-chest, a tubular inlet piston-valve slidably mounted in and fitting said exhaust-valve, adapted, when in use, to temporarily close said lateral openings of the outer valve, means for actuating the inlet-valve, and means coöperable with the last-named valve for actuating the exhaust-valve to cause its lateral openings to register with and uncover the main intake port for the passage of the inlet gases from the inlet valve into the working cylinder.

7. In an internal combustion engine, the combination with the main cylinder having

a valve-chest provided with main independent inlet and exhaust ports leading therefrom into the cylinder, of slidable tubular intake and exhaust piston-valves concentrically mounted in the valve chest, one within the other (the exhaust-valve being the outermost), and means adapted, when in use, for actuating the valves to uncover the main inlet port and permit the direct inflow therethrough of the inlet gases from the interior of the inlet valve and through the wall of the exhaust-valve into the main cylinder, said means also adapted to uncover the exhaust-port, whereby the waste or exhaust gases may pass direct from the exhaust port into the valve-chest and main exhaust-pipe without entering the exhaust-valve.

8. In an internal combustion engine, provided with a main or working cylinder having a valve-chest, a main driving-piston, a crank-shaft operatively connected to the piston and independent main inlet and exhaust ports in direct communication with said cylinder and valve-chest, the combination therewith of an endwise slidable, laterally apertured tubular exhaust-valve fitting the valve-chest, the walls of the upper portion of the valve being adapted to practically close both the said ports, an endwise movable tubular intake valve open at its outer or discharge end, mounted concentrically or telescopically within the exhaust-valve, and means, including a wrist-plate motion device actuated by the main shaft of the engine for controlling the movements of the said telescoped valves, whereby the exhaust-valve is caused to uncover the main exhaust port and permit a free escape of the waste gases direct from the cylinder and over the upper end of the exhaust-valve into the valve-chest and exhaust-pipe, said valve-controlling means being also adapted to uncover the main inlet-port for the introduction into the cylinder of the inlet-gases through the said valves.

9. In an internal combustion engine, the combination with a main cylinder having inlet and exhaust ports and a valve-chest communicating with said ports, of a laterally apertured tubular exhaust-valve closed at the outer or top end and endwise slidable in the valve-chest, said valve being self-packing and also arranged to both uncover and close said exhaust-port, a tubular intake-valve slidable within the exhaust valve in open communication with the inlet gas supply, having its outer or discharge end open, whereby the intake charge of gas is adapted to flow direct from the intake valve into the main inlet-port and cylinder when the said lateral apertures of the exhaust-valve register with the last-named port, and means for effecting the movements of both valves.

10. In an internal combustion engine, the combination with the main cylinder having independent main inlet and exhaust ports for the intake and exhaust gases, respectively, and a bored valve-chest communicating with the ports, of a pair of slidable tubular piston-valves mounted concentrically one within the other in the valve-chest, the exhaust-valve being laterally apertured and closed at the outer end, and a self-packing device integral with the exhaust-valve, comprising a narrow annular chamber having its outer wall somewhat resilient and provided with openings therethrough, whereby the presence of gases in the said chamber and cylinder are equalized, for the purpose set forth.

11. In an internal combustion engine, having a main cylinder and bored valve-chest provided with independent intervening main inlet and exhaust ports, a laterally apertured, tubular exhaust valve, mounted for sliding movement in the valve-chest, the end of said valve contiguous to said ports being closed at the top and having the adjacent side wall of the valve provided longitudinally with a comparatively short and narrow annular chamber whose outer lateral wall possesses a degree of resiliency, and means adapted for the continuous introduction into said annular chamber of a limited volume of the cylinder-gases, for the purposes set forth.

12. In an internal combustion engine, provided with a main piston-carrying cylinder and a ported valve-chest communicating with the cylinder, a pair of laterally ported tubular valves, one slidable within the other in said valve-chest and constituting, when in use, intake and exhaust-valves, means, including a normally revoluble crank for actuating the intake valve, and mechanism embodying a wrist-plate motion device operatively connected to the exhaust-valve for changing the character of the reciprocation relatively to that of the intake-valve, whereby, when in use, the exhaust-valve has imparted to it an accelerated opening and closing movement and a greatly increased amount of relatively stationary dwell when the exhaust valve is in the closed position.

13. In an internal combustion engine, the combination of a power-cylinder provided with independent main intake and exhaust ports, a pair of ported tubular valves arranged with respect to said main cylinder ports, said valves having one slidable within the other and constituting, when in use, an intake-valve and an exhaust-valve, means, including a revolubly driven member for actuating said intake-valve, mechanism provided with a rock-shaft and connections arranged both for actuating the exhaust-valve and varying the character of its reciprocatory movements, and a rotary main crank-shaft from which the said valve-operating mechanisms are driven.

14. The combination in an internal combustion engine provided with a main cylinder having a ported valve-chest connected therewith, a driving piston mounted for reciprocating movements in the cylinder, a main or crank-shaft, and a pitman connecting said piston and crank-shaft, of telescoping inner and outer tubular valves, mounted for reciprocation in said ported valve-chest, a suitably mounted eccentric shaft driven from said crank-shaft, valve operating mechanism consisting of a direct connection between said eccentric shaft and said inner valve, and wrist-plate motion means interposed between said eccentric shaft and said outer valve for controlling the intake and exhaust gases to and from the said main cylinder.

15. In an upright engine of the internal combustion type, having the main cylinder and valve-chest elements thereof in communication with each other through independent inlet and exhaust ports, the valve-chest itself having suitably disposed inlet and exhaust ducts adapted to connect with the main intake and exhaust pipes, respectively, the combination therewith of an elongated annular exhaust piston-valve mounted to reciprocate in and fitting the bore of said valve-chest; said valve having its top end closed and its side wall laterally apertured, an annular intake piston-valve slidably fitting the bore of said exhaust-valve having its upper end open, the lower end portion being closed, means for intermittently placing the said open end of the inlet valve, the lateral openings of the exhaust-valve and the independent inlet-port in juxtaposition so as to freely receive therethrough charges of inlet-gas into the cylinder for ignition, and means for moving the exhaust-valve to uncover the exhaust-port and also close the inlet-port, whereby the gases exhausted from the cylinder flow outward therefrom, over the closed end of the exhaust valve and direct into the valve-chest and exhaust-pipe.

16. In an internal combustion engine, the combination with a main cylinder, a valve-chest having outer intake and exhaust nozzles, main inlet and exhaust ports in direct communication with said cylinder and valve-chest, a working piston in the cylinder, and a driving-shaft operatively connected with the piston, of a pair of ported movable intake and exhaust valves disposed in the valve-chest, direct means for reciprocating one of the said valves of the pair, and independent means, including a wrist-plate motion device, for reciprocating the other valve to cause a change in the character of its reciprocation with respect to the action of the first mentioned valve, constructed and arranged whereby, when in use, the inlet gases are caused to pass through the corresponding intake ports into the cylinder and the exhaust gases to pass outward from the cylinder and discharge into the outer exhaust passage.

17. In an internal combustion engine, having a main cylinder and valve-chest provided with main intake and exhaust ports, inlet and discharge passages communicating with the valve-chest for live and waste gases, respectively, a main piston fitting the bore of the cylinder and a revolubly mounted crank-shaft connected to and actuated by the piston, the combination therewith of a pair of ported tubular valves, constituting intake and exhaust-valves slidable one within the other in said valve-chest, means, including a normally revoluble crank operatively connected to one of the valves, and mechanism, including a wrist-plate motion device, operatively connected to the other valve, whereby, when in use, the latter valve has imparted to it an accelerated opening and closing movement and a materially increased relatively stationary dwell when it is in the closed position.

18. In a self-contained internal combustion engine arranged to receive gaseous fuel and also to discharge the waste gases, the combination of a power cylinder provided with a ported valve-chest, a pair of ported slidable tubular valves mounted one within the other in the valve chest of the engine, said slidable members constituting intake and exhaust valves, means operated by the engine for actuating one of said valves, and mechanism, including a wrist-plate motion device, also operated by the engine, for actuating the other one of said valves, whereby, when the engine is in operation, the last-named valve has imparted to it accelerated opening and closing movements, the action of said device also imparting to the said valve a relatively increased degree of rest or dwell while the corresponding port of the valve-chest remains fully covered or closed by the said valve.

In testimony whereof, I have affixed my signature in presence of two witnesses.

WALTER F. BROWN.

Witnesses:
CALVIN H. BROWN,
GEO. H. REMINGTON.