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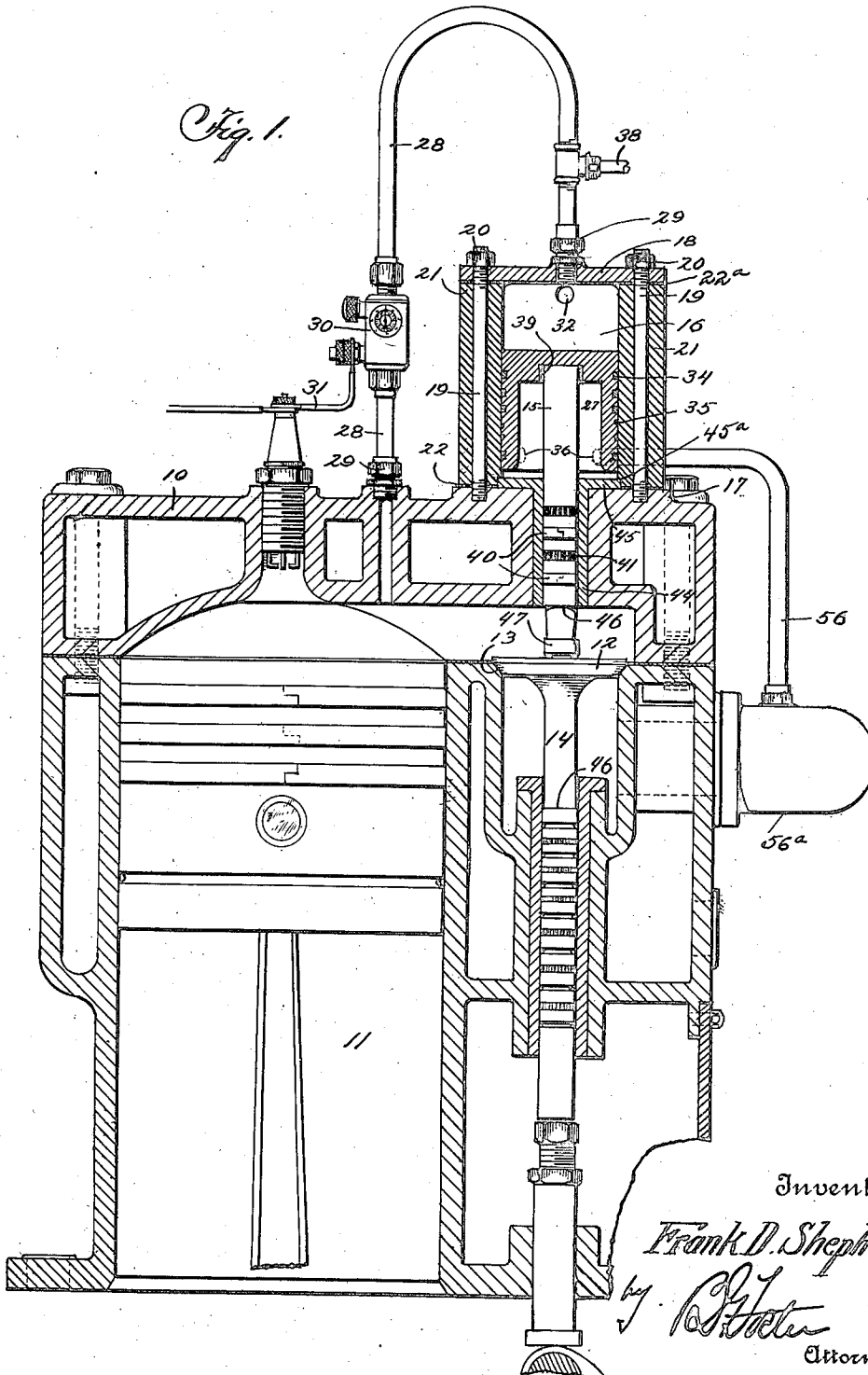
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F. D. SHEPHERD

INTERNAL COMBUSTION ENGINE

Filed Jan. 8, 1920

3 Sheets-Sheet 1



Nov. 20, 1923.

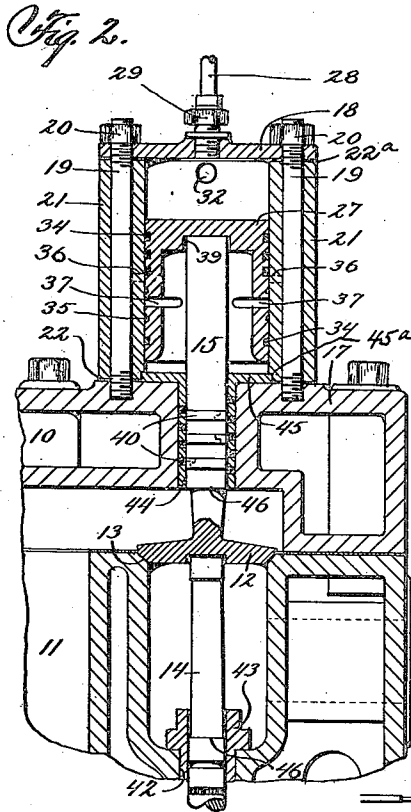
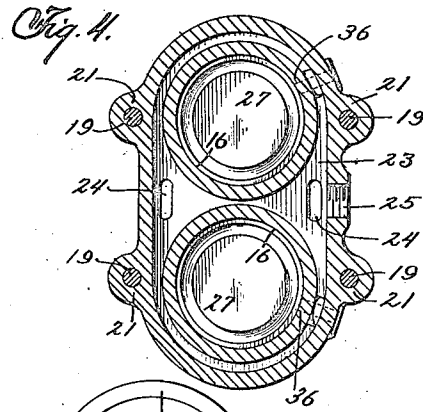
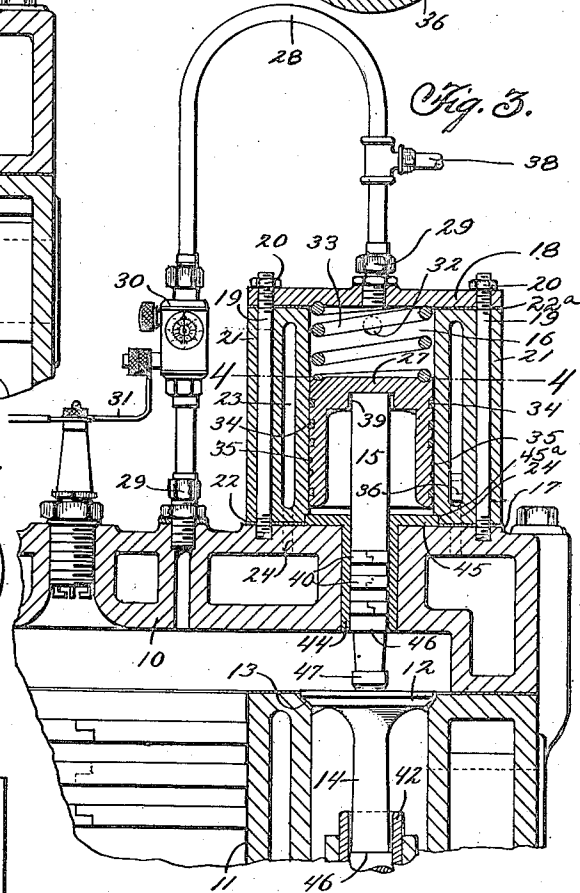
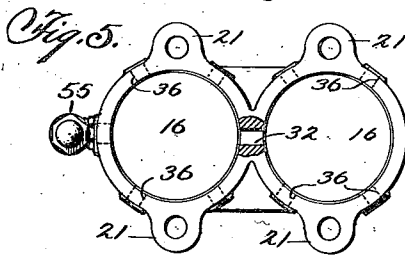
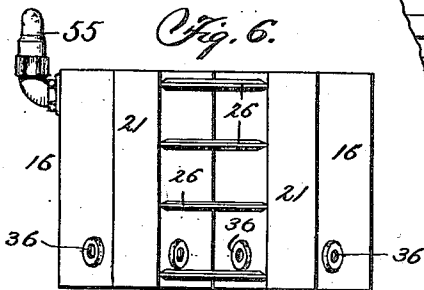
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3 Sheets-Sheet 2



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[Signature]

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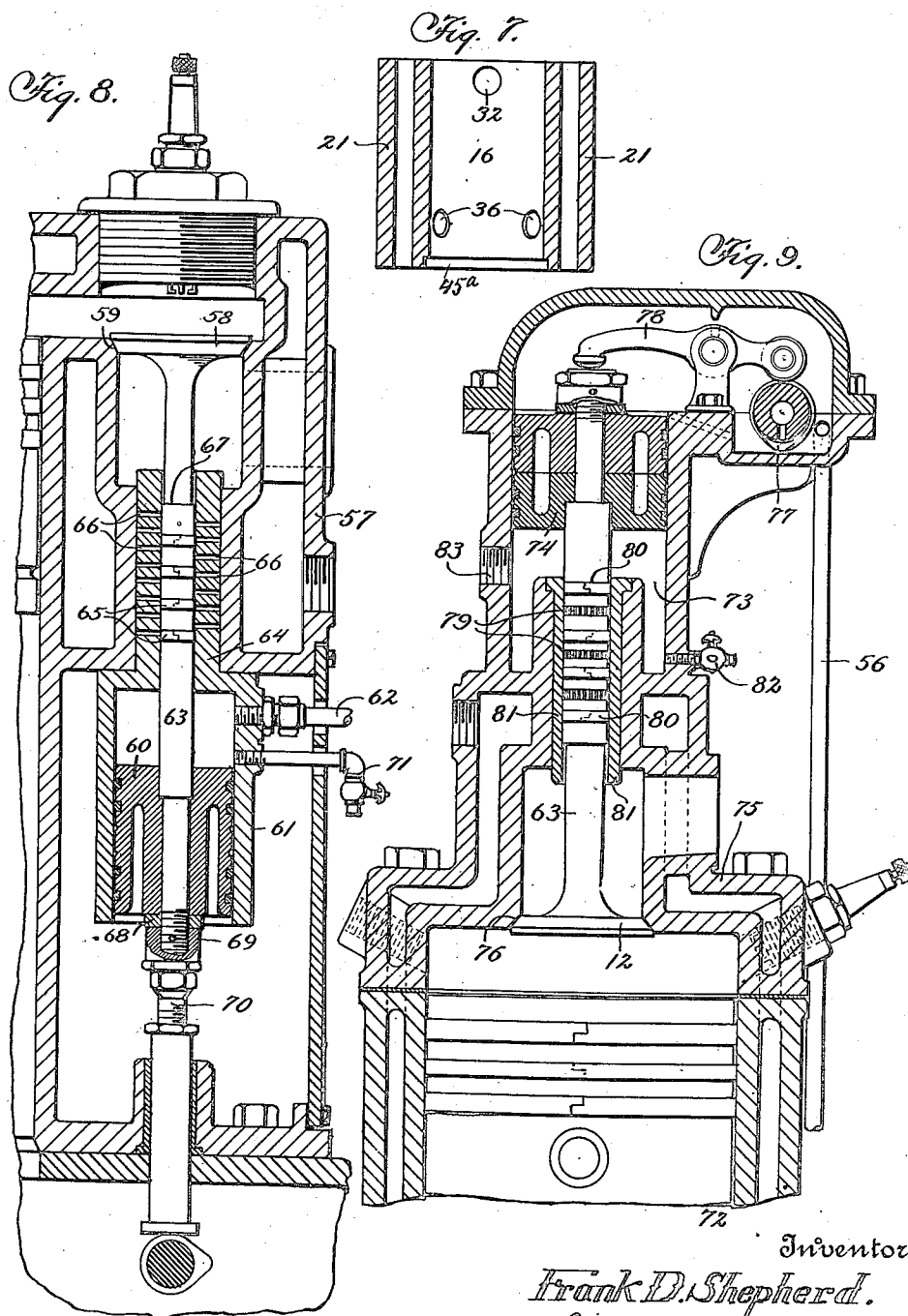
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F. D. SHEPHERD

INTERNAL COMBUSTION ENGINE

Filed Jan. 8, 1920

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

FRANK D. SHEPHERD, OF AURORA, ILLINOIS.

INTERNAL-COMBUSTION ENGINE.

Application filed January 8, 1920. Serial No. 350,116.

To all whom it may concern:

Be it known that I, FRANK D. SHEPHERD, a citizen of the United States, residing at Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention has to do with internal combustion engines, and my object, stated in general terms, is to so construct and organize elements or members thereof, that manufacture and assembly will be facilitated and hence original and maintenance costs lessened and the securing of maximum efficiency of the fuel promoted; that is to say, to so improve the engine that advantages to manufacturer, repair man, and user will be secured. I illustrate my invention as embodied in an engine using gasoline, but contemplate embodiments for using other fuel, alcohol, for example.

In the drawings:

Fig. 1 is a vertical section of enough of an internal combustion engine to illustrate one embodiment of my invention;

Figs. 2 and 3 are views like Fig. 1, showing, respectively, two other embodiments of my invention,

Fig. 4 is a section on line 4—4 of Fig. 3;

Fig. 5 is a top plan view of a pair of one-part or integral containers for the valve seating means;

Fig. 6 is a side elevation thereof;

Fig. 7 is a vertical section showing an air-cooled container;

Figs. 8 and 9 are vertical sections, respectively, of two other embodiments of my invention.

Before I proceed with a description in detail, of the various embodiments of my invention shown as examples, but not as limitations, it is proper to say that in some or all respects my invention is applicable to both L-head and T-head types and to both detachable and integral head engines and valve-in-head engines. In Figs. 1, 2 and 3 of the drawings 10 designates the detachable head of a multicylinder L-head engine in which the cylinders are cast en bloc, although my invention is not limited thereto. Each cylinder 11 has its own valve mechanism, consisting of intake and exhaust valves, and as all are alike for the different cylinders of

the same engine, it will be enough to describe one such mechanism.

The valve mechanism is of the type forming the subject of numerous of my patents, such for instance as No. 1,318,927, granted October 14, 1919, and includes a valve 12, its seat 13 controlling a port or passage leading to or from the cylinder 11, a cam-actuated lifter stem 14, a valve seating rod or stem 15, reaching from the valve through a guide hole in the head 10, which said stem slidingly fits, and a shell or container into which said stem 15 reaches, and which within the container is acted on to seat the valve and yieldingly hold it to its seat, by some elastic medium,—a spring or springs as in my prior patents or still pending applications, or, as in the present case an elastic gaseous or fluid medium, as is fully explained hereafter, or a combination of both.

In my said Patent 1,318,927, for example, my said container is formed either integral with the engine head, and has a removable top, or cover, or it is of the bonnet type construction, with an integral top or cover, each of which constructions has certain drawbacks, and which I overcome by my present invention as well as secure other important advantages.

Said container comprises a cylindrical body with an interior that is a simple cylindrical hole 16 running straight through it from end to end, as may best be seen by reference to Figs. 1, 2 and 3, whose bottom is closed by resting it upon the engine head top, or upon a raised circular boss or seat 17 thereon, and whose top is closed gastight by a removable cover which may be a simple cap plate 18, as shown in Figs. 1, 2 and 3. Each container may be a unit, or two may be cast in pairs, or all for the whole line of valves, may be cast en bloc. It will be seen that the operations involved in casting this container are very simple and inexpensive as the patterns are easy to make, and the molding operation is easy, the boring of the cylindrical interior is a simple, straight job, and as top and bottom are plain or flat throughout their extent, the machining operation is a simple and inexpensive job. The assembly operation is an easy job for one man, when the valve seating spring is used, for the workman can readily see that such a part as the push rod or stem head,

or disk is properly centered, or clears the interior of the container, and then drops the spring into the container and puts on the cap or cover plate, or applies the screw plug if that form of closure is used.

To secure the container to the engine head I use a pair of long bolts or studs 19 and nuts 20 that extend from top to bottom of the container, each through a hole in a rib 21 on the outside thereof, the lower ends of the bolts entering tapped holes in the engine head, and the bolt heads engaging the top of the cover plate, if that is used, so that the same bolts attach container to head and cover plate to container. A gasket 22 makes a gas-tight joint between head and container, and another gasket 22^a is interposed between the container and the cap plate 18.

Each container may have its own separately removable cap or cover which may be desirable so that access to any one requiring attention may be had without disturbing others, or, when the plate-form of cover is used, the one plate can be large enough to cover all or any number more than one, but less than all.

The containers can be air-cooled, or water-jacketed. I show in Figs. 3 and 4, the wall made hollow to provide a water space 23, which at the bottom has holes 24, that register with holes in the top of the engine head that lead to the water space thereof, and which at the side has a hole 25 for a pipe connection with the radiator, and thus I readily arrange for circulation of the cooling water for which the engine already has provision.

The pair of bolt holes for each container are placed diametrically opposite, and on the diametral line that is at right angles to the line of containers. This location of the holes economizes metal and reduces the number of bolts, compared with such a location of the bolt holes as that shown in my Patent No. 1,318,927.

When the containers are cast in groups of two or more, adjacent ones are joined by integral external horizontal ribs 26 at top and bottom, and between, (see Fig. 6) which give adequate strength with minimum material and least weight, and which increases the heat-radiating surface. Said ribs extend from the bolt-hole rib on one container to the like rib on the adjacent container.

In the embodiments of my invention shown in Figs. 1, 2 and 3, the container forms a cylinder for a piston 27 which at one end is connected with or acts upon the end of the valve seating stem that projects into the container, and on its other end is acted upon by fluid pressure to move it in the direction to seat the valve, and yieldingly hold it to its seat. Such fluid pressure may be compressed air, or steam suitably obtained, but in the engine shown in the drawings I take the

pressure from the engine cylinder or cylinders, connecting the top or outer end of the container by a pipe 28, preferably a small bore pipe, that at each end has a coupling 29 by which it is connected gas-tight, respectively, to the container and to the engine head at the upper end thereof, so that on the compression stroke of its piston, for example, some of the gas will be forced from the cylinder to the container. Suitable means are provided such as a pressure regulating valve 30 to prevent excess of pressure accumulating in the container, or back flow therefrom, as on the suction stroke, which would reduce the pressure. Said valve is adjustable so that any desired valve seating pressure will be maintained, and to enable the speed of the valve relative to cam speed to be easily and nicely regulated. I also provide means to close the valve 30 on explosion in the cylinder, so as to prevent sudden and violent transmission of pressure through the pipe to the container. This may be done in various ways. One good and convenient way and one which will assure absolute synchronism of close of valve with ignition and explosion is to use an electrical device connected in the same circuit with the spark plug, as by a wire 31 from the plug, so that on the flow of current to the plug, there will be flow of current to said device, which may be an electro-magnet that when energized, on the flow of the current to produce the ignition spark, acts to close the valve.

I prefer to place the adjacent containers in communication as by a port 32 so that pressure from one is transmitted to the other and equalized therein. An important difference between the action of fluid pressure and spring action is that in the former case, since the pressure on the container piston is not decreased, but is kept constant during the compression stroke of the engine piston or pistons, the valve seating pressure is not decreased which is as it should be in that it assures tight-seating of the valve during compression and the working stroke, as well; whereas, in the case of the spring, the pressure of the spring is least when the valve is on its seat, as it diminishes from the expansion of the spring. However, the use of a spring either alone or with the piston, is within the purview of my invention, and in Fig. 3 I show a coil spring 33 which, at one end bears on the the piston on the valve seating stem and at its other end bears against the container head.

The use of fluid pressure to close the valve peculiarly combines with a valve that is opened by a cam and the closing movement of which is controlled by such cam. If the valve was entirely free to close without resistance, the fluid pressure would effect such a sudden movement and with a force that would soon injure the valve or its seat or

both, but it will be obvious that the seating action is determined by the movement of the cam, so that there are no injurious results that would otherwise take place.

5 The container piston has at intervals along its length packing rings 34 and also oil receiving annular grooves 35, and to prevent accumulation of pressure on the inner side of the container piston, I provide a port
10 or ports 36 in the container wall that may open to the atmosphere, and which are situated so as to be uncovered by the bottom of the container piston only when the latter is fully lifted, as in Figs. 1 and 3 or as in Fig.
15 2, and which aligns with a port 37 in the piston when the latter is fully lifted by the action of the lifter cam in unseating the valve, but which is covered during compression and working stroke thus placing the container in a gas-tight condition during compression and working strokes. To conveniently supply lubricant to the container piston I attach an oil supply pipe 38 to the pressure supplying pipe 28 close to the container top.

The working connection or engagement of container piston and valve seating stem 15 is preferably a loose one so as to compensate for any inaccuracy of alignment and centering, and making unnecessary the fine and hence costly work that rigid construction would require.

Thus, the end of the stem and underside of the piston have a mere bearing one
35 against the other, preferably by seating the stem end in a shallow recess 39 in the underside of the piston, and, as shown in Figs. 1, 2, and 3, since the stem 15 and valve are separate and not rigidly connected, it will
40 be seen that the whole construction is a floating one that allows self-adjustment of the parts. However, as shown in Fig. 2, the stem 15 and valve may be integral, but in such case the lifter stem is free from the valve, and bearing contact of valve and lifter stem may be employed similar to that of stem 15 and container piston in Figs. 1 and 3. For several reasons it is of vital
50 importance that no gas leakage shall take place past either container piston or valve seating stem, especially when, as is the case in Figs. 1 and 3, the valve seating pressure is taken from the engine cylinder. Any leakage past the stem into the container
55 might result in an opposing or counterbalancing pressure being caused in the container that would work against the valve seating movement of the container piston. Again, as at certain times, the container is not gas-tight but is open through its relief
60 port or ports, gas finding its way to the container past either piston or stem, could escape from the container and be lost or wasted. Highly efficient packing for both

piston and stem is therefore most essential, 65 and as metal rings alone fill the requirement, I use them on both piston and stems. Those on the stem are shown as snap rings 40, see Figs. 1, 2 and 3, but of course any desired type may be used. If desired, as
70 shown in Fig. 1, the stem also may have grooves 41 filled with a lubricant such as graphite compound.

If desired, as shown in Fig. 2, the guide for the lifter stem can be a thimble 42 having a
75 flange 43 to overlap an adjacent part of the engine structure to prevent endwise movement of the thimble.

Preferably to make an easy repair or replacement job on account of wear on its
80 guide by the valve seating stem 15, said guide has a removable bushing 44 that surrounds the portion of the stem in the engine head. Said bushing has a head or out-turned flange 45 that is at the bottom of the
85 container, and it preferably enters an annular groove 45^a at the bottom of the container and is thereby held in place. The bushing can be easily removed when the container is removed. I make the bushing of thin metal
90 in order to diminish as much as possible the thickness of metal between the stem and the cooling water in the head.

That portion of the stems moving the valve, whether lifting or seating stems, 95 which is near the valve, and is exposed to high temperature is reduced in diameter, as shown, so that when such portion enters the stem guide a clearance will exist even when the stem is expanded in diameter, and thus
100 sticking of the stem in the guide is obviated, and at the same time a sharp shoulder 46 is provided that scrapes off or dislodges any carbon deposits on the guide. The reduced part is preferably tapered from the guide
105 outward so as to cause the quick freeing of any carbon caking thereon, and the valve-engaging end of the stem may have a head or enlargement 47, as in Figs. 1 and 3, to give a good bearing on the valve. 110

A spring can be placed in the container above the piston, so as to tend to press the latter downward and thus secure seating the valve under starting conditions, as shown
115 at 33 in Figure 3.

To prevent objectionable excess pressure in the container a safety valve 55 (see Figs. 5 and 6) is attached thereto that opens at a predetermined pressure in the container, and one such valve will serve for several intercommunicating containers. 120

The relief ports in the containers may be connected with a pipe 56 that is carried to the intake manifold 56^a, because the thereby released gas is combustible, or to some other convenient point so that there will be no
125 loss of gas and the discharge, if any, will be muffled or smothered and annoyances

therefrom avoided. All the ports may be connected by a manifold to a single discharge pipe.

In Fig. 8 my invention, wherein I use fluid pressure to seat the valve, is shown embodied in an integral head engine 57, the valve 58 being pulled to its seat 59 by a piston 60 in a container or cylinder 61 that receives the pressure from the desired source through a pipe 62. The valve stem 63 passes through a guide 64 which is a tubular extension of the container and has metal packing rings 65 at intervals along its length, to prevent gas leakage between stem and guide, and as a further protection against leakage, the wall of the guide has numerous pockets 66 in the form of radial holes or cavities into which leaking gas may expand and thus the pressure thereof be reduced. The portion of the valve stem next the valve is reduced to provide clearance between stem and guide to prevent sticking and to provide the shoulder 67 on the stem to scrape off any caked carbon.

In Fig. 8 the piston 60 and stem 63 are rigidly connected, the stem passing through the piston, and shouldered within the same, and the piston is held tight against the shoulder by adjacent nuts 68 and 69 screwed on the stem, the outer nut 69 being pinned to the stem, and engaged on its outer end by the cam-actuated lifter 70. The piston 60 is made hollow for lightness.

A pet or drain cock 71 is provided for the container to drain off any oil or condensation therein.

In Fig. 9 my invention is shown embodied in a valve-in-head engine 72. In this case, the container or cylinder 73 for the valve seating piston 74 is integral with the engine head 75 and as the valve seat 76 and valve lifting mechanism are on the head, the whole valve and valve operating mechanism may be removed and replaced intact with the head. The valve lifting mechanism is a cam 77 and a rocker arm 78 that transmits the cam motion to the valve. The piston 74 which is rigidly attached to the stem is made hollow for lightness, and in two similar parts so that it will be closed or solid not only at its pressure receiving end but at its opposite end, so that no pocket or chamber for accumulation of oil will exist. The valve stem 63 has lubricant grooves 79 and metal packing rings 80 to make a gas tight joint with its guide 81 which is a sleeve or bushing. It has a portion next the valve reduced to provide the clearance and scraping shoulder, and the cylinder has a drain or pet cock 82. The cylinder has a threaded hole 83 in one side for the pipe connection with a source of fluid under pressure.

It is to be understood that the various features of my invention shown in any one

of the illustrated embodiments thereof, need not be utilized in a single embodiment, for obviously some may be omitted, in a given case, and the features appearing in any one embodiment may be interchanged with those of another.

I claim:

1. An internal combustion engine having a head, a plurality of valves and pressure means to seat the valves, comprising for each valve a container, consisting of a cylindrical bore from end to end and opening through both ends, the inner end being in gas-tight contact with the head, and a gas-tight closure at the outer end, said containers being integrally joined, and having strengthening ribs connecting adjoining containers.

2. An internal combustion engine having a head, a plurality of valves and pressure means to seat the valves, comprising for each valve a container, consisting of a cylindrical bore from end to end in gas tight contact with the head, and a gas-tight closure at the other end, said containers being integrally joined, and having strengthening ribs connecting adjoining containers, the containers having diametrically opposite external projections perforated lengthwise of the containers, the diametral line on which said projections are situated being crosswise of the line of containers and attaching members in such perforations that enter tapped holes in the engine head.

3. An internal combustion engine having a valve, engine operated means for opening the valve and controlling the speed of its closing movement, and valve-seating means comprising a fluid pressure receiving member that acts on the valve, means for delivering fluid under pressure from the engine cylinder to said means, and means for maintaining the fluid delivered thereby and preventing its return to the cylinder.

4. An internal combustion engine having a valve, engine-operated means for opening the valve and controlling the speed of its closing movement, and valve seating means comprising a cylinder and a piston that acts on the valve and means to supply fluid under pressure to the cylinder and maintain the same therein on one side of the piston, and a vent port to prevent pressure on the other side of the piston.

5. An internal combustion engine having a valve, engine-operated means for opening the valve and controlling the speed of its closing movement, and valve seating means comprising a cylinder and a piston that acts on the valve, means to supply fluid under pressure to the cylinder on one side of the piston, comprising a passageway from the engine cylinder to the piston, and an automatic valve in the passageway for preventing the fluid so delivered from returning through said passageway.

6. An internal combustion engine having a valve, engine-operated means for opening the valve and controlling the speed of its closing movement, and valve seating means comprising a cylinder and a piston that acts on the valve and means to supply pressure to the piston comprising a valve-controlled passage from the engine cylinder to the piston and means to close said valve in synchronism with the explosion of a charge in the engine cylinder.

7. An internal combustion engine having a valve, and valve seating means comprising a cylinder and a piston that acts on the valve, means for supplying fluid under pressure from the engine to the cylinder on one side of the piston, and means in said supply means between the engine and the cylinder for automatically governing the supply comprising a pressure regulating device.

8. The combination in an internal combustion engine, of a valve seat and a valve movable into and out of coaction with the seat, means operated by the engine for opening the valve and controlling the speed of its closing movement, a cylinder on the engine, a valve-closing stem slidable in the engine wall and extending into the cylinder, a piston in the cylinder acting on the valve closing stem, means for maintaining fluid under pressure in the outer portion of the cylinder against the outer side of the piston,

and means for constantly relieving the inner portion of the cylinder and inner side of the piston from pressure due to leakage through the engine wall.

9. An internal combustion engine having a valve, a valve unseating stem engaged with the central portion of the valve, and a guide for the stem reaching part way to the valve, the portion of the stems towards the valve being reduced in size to provide a clearance space between stem and guide when said portion is within the guide, said reduced portion terminating in a sharp shoulder that enters the guide.

10. An internal combustion engine having a valve, means for effecting the closing movement of the valve, a cam operated stem engaging the central portion of the valve, and a guide for the stem, said stem between the valve and guide having a reduced clearance portion forming a sharp shoulder that enters the guide.

11. An internal combustion engine having a valve and a charge supplying manifold, fluid pressure means for actuating the valve, including a container and a piston operating in the container, and a relief passageway opening from the container and connected to the manifold.

In testimony whereof, I affix my signature.

FRANK D. SHEPHERD.