J. F. WOOLF.

EXPLOSIVE ENGINE.

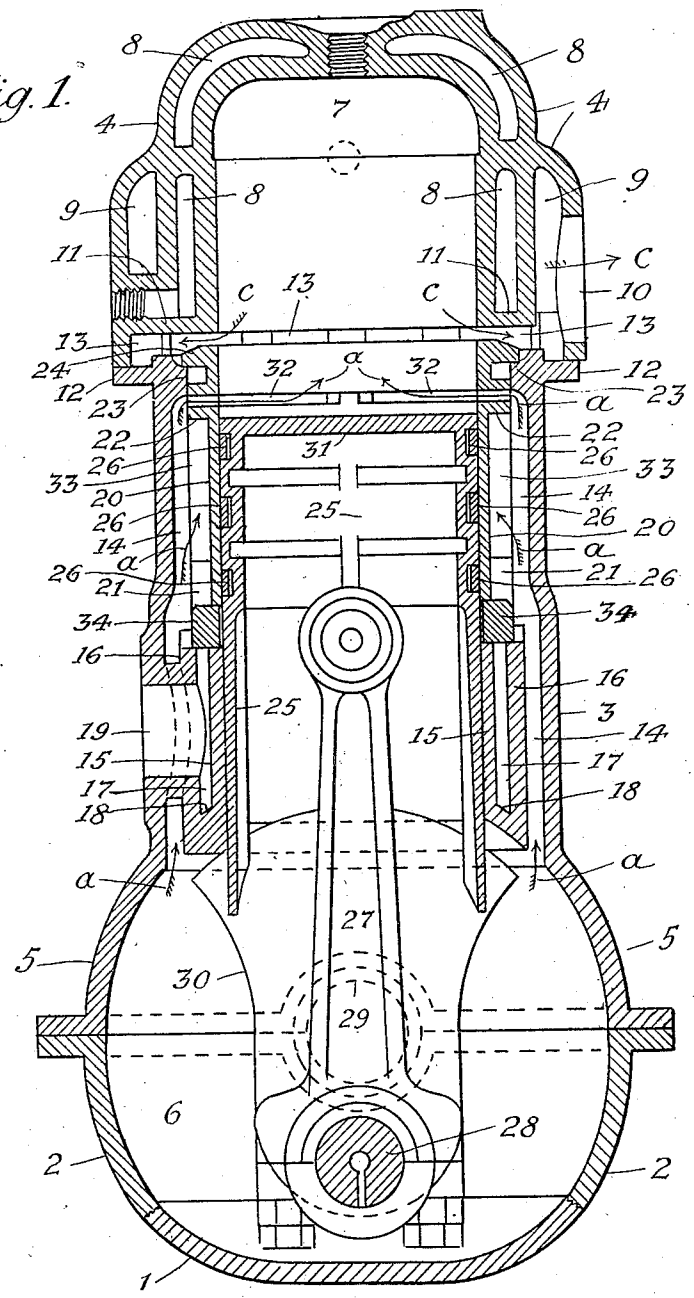
APPLICATION FILED JAN. 31, 1910.

968,725.

Patented Aug. 30, 1910.

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
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3 SHEETS—SHEET 2.

Fig. 4.

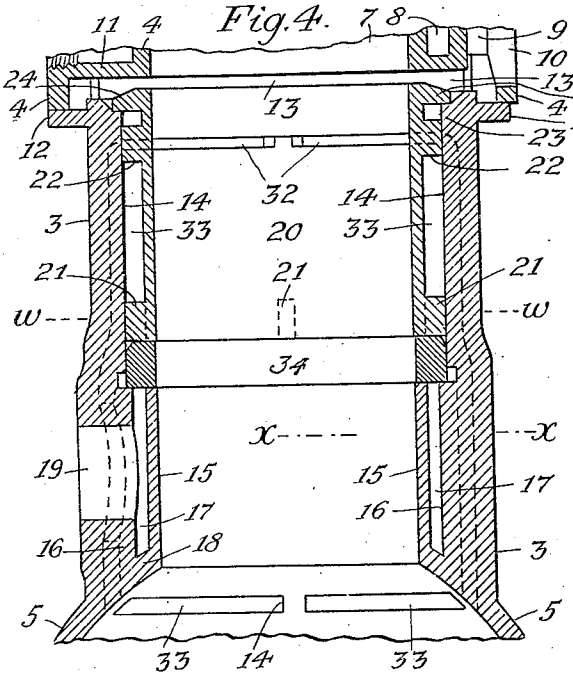


Fig 2

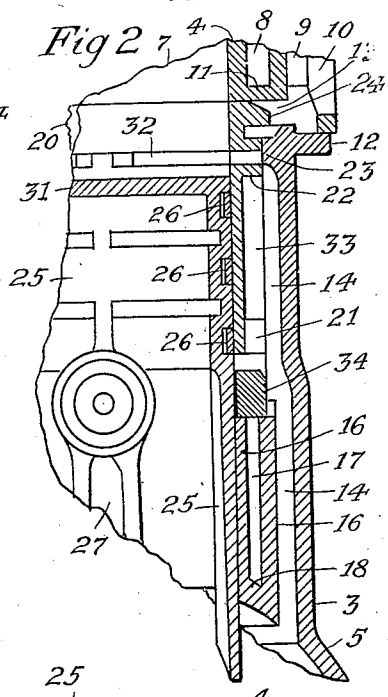
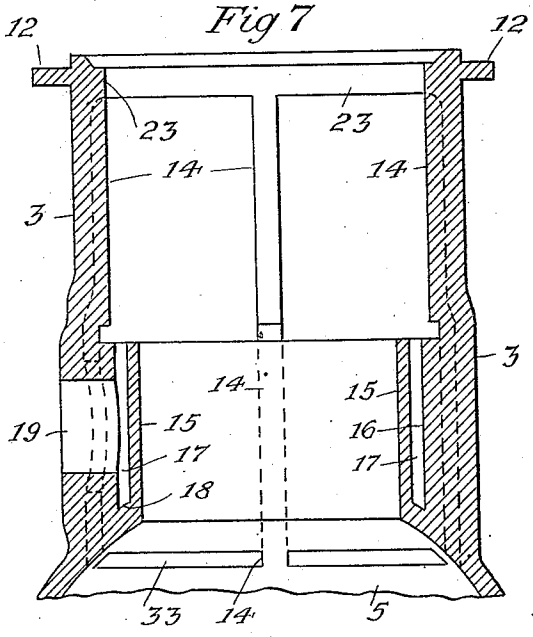


Fig 7



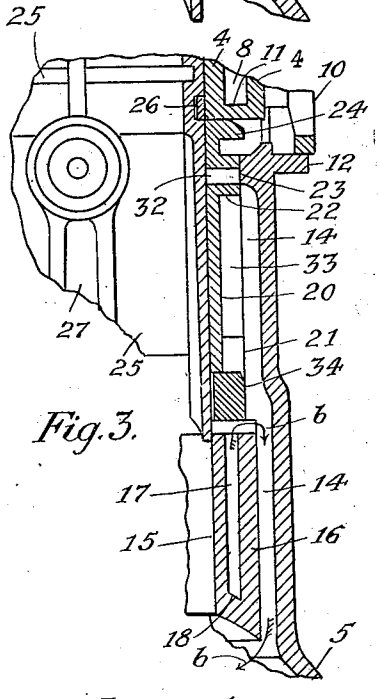


Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 5.

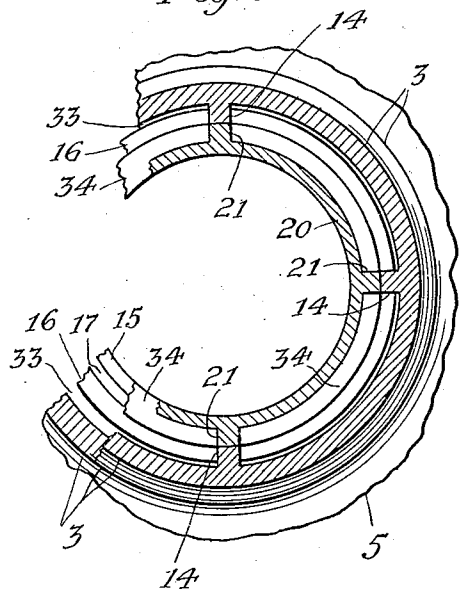


Fig. 6.

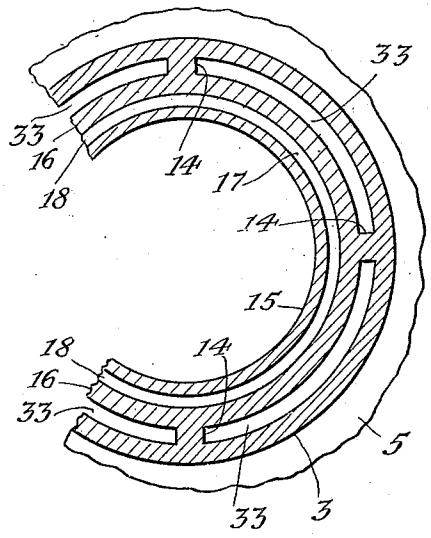


Fig. 8.

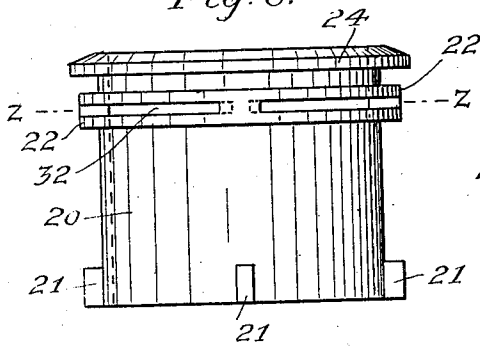
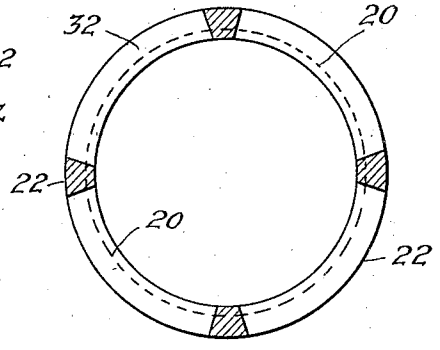


Fig. 9.



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UNITED STATES PATENT OFFICE.

JAY F. WOOLF, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR OF ONE-HALF TO ELLIS J. WOOLF, OF MINNEAPOLIS, MINNESOTA.

EXPLOSIVE-ENGINE.

968,725. Specification of Letters Patent. Patented Aug. 30, 1910.

Application filed January 31, 1910. Serial No. 540,959.

To all whom it may concern:

Be it known that I, JAY F. WOOLF, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

My invention relates to explosive engines, and its principal objects are to improve the means for introducing the charging mixture to the compression space and for conducting it therefrom to the explosion chamber. In furtherance of these objects I support in the interior of the lower portion of the cylinder circular partitions that provide an intermediate annular inlet port which is controlled by a ring suction-valve arranged to be lifted from its seat by the suction provided in the compression space by the outward movement of the piston. A sleeve slidable on and with the piston and provided with ports is reciprocated by the piston movements to alternately open and close an exhaust port and a passage-way leading from the compression chamber to the explosion chamber, and to and from contact with the suction-valve.

My improvements are illustrated in the accompanying drawings, in which—

Figure 1 is a central vertical section of an explosive engine embodying my improvements, showing the piston at the limit of its downward movement and showing both the charging and exhaust ports open and the inlet port to the compression chamber closed. Fig. 2 is a similar view of portions of the engine casing, piston, sleeve, and suction-valve, the latter two devices, which constitute the controlling valves, being shown in their closed positions; that is, in the positions they occupy when the piston has started on its upward stroke and has moved only far enough to lift the sleeve to position to close the sleeve ports and the exhaust outlet, but not far enough to produce the amount of suction required to lift the suction-valve from its seat on the inlet port. Fig. 3 is a similar view showing the piston at the limit of its outward stroke and the sleeve ports and exhaust port closed (as in Fig. 2), but showing the suction-valve lifted from its seat by the suction created in the compression chamber by the upward movement of the piston to permit the gas to flow through the inlet into the compression space. Fig. 4 shows a central vertical section of the cylinder, the sleeve and suction-valve in the positions shown in Fig. 1. Fig. 5 shows a horizontal section on the plane of the broken line w—w of Fig. 4. Fig. 6 is a similar section on the line x—x of Fig. 4, showing the construction of the inlet port. Fig. 7 is a vertical section of the cylinder intended to show particularly the ribs for guiding the sleeve and supporting the annular structure which provides the inlet port. Fig. 8 shows an elevation of the sleeve detached. And Fig. 9 is a horizontal section on the plane of the line z—z of Fig. 8 showing the construction of the portion of the sleeve in which the ports are provided.

In the drawings 1, 2, 3, and 4, respectively, designate the castings constituting a suitable engine casing. The members 1 and 2 are joined to the widened lower portion 5 of the cylindrical member 3 to form the crank case and main compression chamber 6; the upper member 4 provides the explosion chamber 7 and has the usual water-jacket 8 surrounding it and an annular space 9 constituting an exhaust passage-way outside the water-jacket and a discharge outlet 10 connected with the space 9. The outer wall of the member 4 extends a suitable distance below the inner or main base 11 of that member and seats upon and is secured to an outward flange 12 on the top of the cylinder 3, thus providing a circular space 13 between the top of the cylinder and the base 11 of the member 4 which serves as the exhaust port or primary outlet of the explosion chamber.

In the lower portion of the cylinder 3 and preferably cast therewith and supported by ribs 14 formed at intervals on the cylinder walls are upright concentric partition walls 15 and 16, which are separated by an intermediate annular space 17 that is open at the top but closed at the bottom by a base 18 uniting the lower ends of the two partition walls. This space 17 is in communication with an admission opening 19 formed in one side of the cylinder and constitutes the port through which the gas may pass on its way to the compression chamber.

Within the cylinder is a loose and slidable sleeve 20, the inner surface of which is in vertical alinement with the inner face of the partition wall 15. The reciprocatory movements of the sleeve are guided at its lower end by lugs 21 formed on its sides and which

contact with portions of the cylinder ribs 14, and are guided at its upper end by the contact of an outward rim 22 thereon with the face of an inward rim 23 formed around the upper end of the cylinder. The downward movement of the sleeve may be limited by the seating on the cylinder rim 23 of a flange 24 formed on the end of the sleeve; and its upward movement is limited by contact of its end with the base 11 of the casting 4.

The piston body 25 is provided with the usual packing-rings 26 on its upper portion and is arranged in frictional contact with the sleeve and the port wall 15 by which it is guided. The piston is connected by a rod 27 in the usual way to the crank-pin 28 of the crank-shaft 29 and the usual counterbalance 30 for the crank is provided. The piston consists of a cylindrical body open at the bottom and closed at the top by a head 31 and it serves, in conjunction with the other parts named, to separate the compression chamber from the explosion chamber.

The sleeve is provided with ports 32 extending through the rim 22 for the flow of gas to the explosion chamber from the compression chamber through the space intervening between the cylinder and the sleeve and partition wall 16, which space may for convenience be designated a passage-way 33 as distinguished from the main compression chamber 6. The ports 32 are so located as to be below the cylinder rim 23 and uncovered by the piston-head when both the piston and sleeve are in their lowermost positions (Fig. 1), and to be closed by contact with the face of the rim 23 when the sleeve is in its uppermost position (Figs. 2 and 3). In the former position the sleeve ports 32 permit the compressed gas in the compression chamber (which as a whole includes the chamber 6, the space within the piston and the passage-way 33) to flow through the passage-way 33 to the explosion chamber, its course being indicated by the arrows *a* in Fig. 1.

The inlet port 17 is controlled by a ring suction-valve or check-valve 34 that loosely encircles the piston and seats on the partition members 15 and 16 and is adapted to be lifted by the suction produced in the compression spaces by the upward movement of the piston to allow the gas to flow through the port 17 into the passage-way 33 and downward into the chamber 6, as illustrated in Fig. 3, the course being indicated by the arrow *b*. The valve 34 may be arranged to seat itself by gravity, but preferably it is forced to its seat by the sleeve 20 when the latter is moved downward by the down-stroke of the piston; that is, from the position shown in Fig. 3 to that shown in Fig. 1.

In operation, starting with the parts in the positions shown in Fig. 1, the first effect of the upward movement of the piston is to lift the sleeve from the position shown in Fig. 1 to that shown in Fig. 2, thereby closing the sleeve ports 32 and the exhaust port 13 and freeing the suction-valve 34 from contact with the sleeve. Then, during the further upward movement of the piston the suction created in the compression chamber and passage-way 33 lifts the suction-valve from its seat and draws a fresh supply of the charging mixture through the inlet 19 into the chamber or port 17 and thence through the passage-way 33 downward into the main compression chamber, as indicated in Fig. 3.

When the charge in the explosion chamber 7 has been exploded (which is done in the usual way) and the piston is started on its downward or working stroke, its frictional contact with the sleeve 20 moves that member along with it, from the position shown in Fig. 3 to that shown in Figs. 1 and 4, and thereby seats the suction-valve on the inlet port 17, and thereupon compression of the gas in the compression chamber begins and continues until the piston nears the lower limit of its stroke. The sleeve having been thus lowered below the plane of the exhaust port 13, as soon as the piston-head passes below that port the exhaust begins and continues (indicated by the arrows *c*) until the piston again starts on its return stroke. In the meantime, and before the exhaust is completed, the piston head will have passed below the sleeve ports 32 and the gas under pressure in the passage-way 33 will have begun to flow therefrom through the ports 32 inward and upward into the explosion chamber, as indicated by the arrows *a*. When the piston reaches the lower limit of its thrust, as shown in Fig. 1, the cycle of actions will have been completed.

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

1. In an explosive engine, the combination with casing members providing the compression and explosion chambers and an intermediate cylinder having an interior circular structure forming an annular inlet port in communication with the compression chamber, of a ring suction-valve adapted to be lifted from its seat on said port by the suction in said chamber, a piston within the cylinder in position to separate the compression chamber from the explosion chamber, and a sleeve on the piston arranged to be reciprocated by the down stroke of the piston to seat said valve and by the up stroke to release it, substantially as set forth.

2. In an explosive engine, the combination with casing members providing the compression and explosion chambers and an intermediate cylinder having an interior circular structure forming an annular inlet port in communication with the compression cham-

ber, of a ring suction-valve adapted to be lifted from its seat on said port by the suction in said chamber, a piston within the cylinder in position to separate the compression chamber from the explosion chamber, and a sleeve on the piston in proximity to the valve and slidable on and with the piston a limited distance and serving on its downward movement to seat the valve and at the limit of its upward movement to stop the upward movement of the valve, substantially as set forth.

3. In an explosive engine, the combination with casing members forming compression and explosion chambers, of a cylinder connecting them, concentric circular partitions supported within the cylinder and separated from each other by an annular space open at the top and closed at the bottom constituting an inlet port, the outer partition being separated from the cylinder by a space which connects the inlet port with the compression chamber, a ring suction-valve for the inlet port adapted to be lifted by suction, a piston within the cylinder in position to separate the compression chamber from the explosion chamber, and a sleeve thereon arranged to be reciprocated by the piston to alternately seat and release said valve, substantially as set forth.

4. In an explosive engine, the combination with casing members forming compression and explosion chambers of a cylinder connecting them, concentric circular partitions supported within the cylinder and separated from each other by an annular space open at the top and closed at the bottom constituting an inlet port, the outer partition being separated from the cylinder by a space which connects the inlet port with the compression chamber, a ring suction-valve for the inlet port adapted to be lifted by suction, a piston within the cylinder and casing in position to separate the compression chamber from the explosion chamber, a sleeve slidable on and with the piston a limited distance and serving on its downward movement to seat the valve and at the limit of its upward movement to stop the upward movement of the valve, substantially as set forth.

5. In an explosive engine, the combination with casing members forming compression and explosion chambers, and a cylinder connecting such members but separated from a portion of the base of the explosion chamber member by a circular space constituting an exhaust port, concentric circular partitions in the lower portion of the cylinder separated from each other by an annular space open at the top and closed at the bottom constituting an inlet port and separated from the cylinder by a space which connects said inlet port with the compression chamber; of a ring suction-valve for said inlet port adapted to be lifted by suction, a piston within the cylinder and casing in position to separate the compression chamber from the explosion chamber, a sleeve slidable on and with the piston for seating the ring check-valve and alternately opening and closing the exhaust port, the sleeve being separated from the cylinder by a space connected with the compression chamber and having ports past which the piston reciprocates to open and close the passage-way from the compression to the explosion chamber, substantially as set forth.

6. In an explosive engine, the combination with casing members forming compression and explosion chambers, and a cylinder connecting such members but separated from a portion of the base of the explosion chamber member by a circular space constituting an exhaust port, interior ribs extending along the cylinder walls and an interior structure supported by the ribs and forming an annular inlet port to the compression chamber, of a piston within the cylinder and casing in position to separate the compression chamber from the explosion chamber, a sleeve guided by said cylinder ribs and arranged on and slidable on and with the piston to positions to alternately open and close the exhaust port and having ports past which the piston head reciprocates, and which serve, when the piston is near the end of its inward stroke, as ports for connecting the compression chamber with the explosion chamber, and a ring suction-valve for said inlet port adapted to be lifted by the piston suction during its outward stroke and to be seated by the sleeve during the inward stroke of the piston, substantially as set forth.

7. In an explosive engine, the combination with casing members forming compression and explosion chambers, and a cylinder connecting such members but separated from a portion of the base of the explosion chamber member by a circular space constituting an exhaust port, a rim projecting inwardly from the top of the cylinder, interior ribs at intervals extending along the cylinder walls from the rim to the base and concentric circular partition walls united at the bottom and supported by the ribs in the lower portion of the cylinder, the annular space between said partition walls constituting an inlet port to the compression chamber, of a piston within the cylinder and casing in position to separate the compression chamber from the explosion chamber, a sleeve guided by said cylinder ribs and rim and arranged on and slidable on and with the piston and having ports past which the piston head reciprocates and having a projection for alternately contacting with the upper portion of the cylinder and the base of the explosion chamber casing, the sleeve ports serving when the piston is near the end of its in-

ward stroke to connect the compression chamber with the explosion chamber; and a ring suction valve held to its seat on said inlet port by the sleeve on the downward movement of the piston and lifted to contact with said sleeve by suction on the upward movement of the piston, whereby the piston movements control in proper sequence the inlet port to the compression chamber, the flow of gas from the latter through the sleeve ports to the explosion chamber, and the discharge at the exhaust outlet, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses this 20th day of January, 1910.

JAY F. WOOLF.

Witnesses:
CHAS. H. DIXON,
JNO. D. FARRAND.