(No Model.)

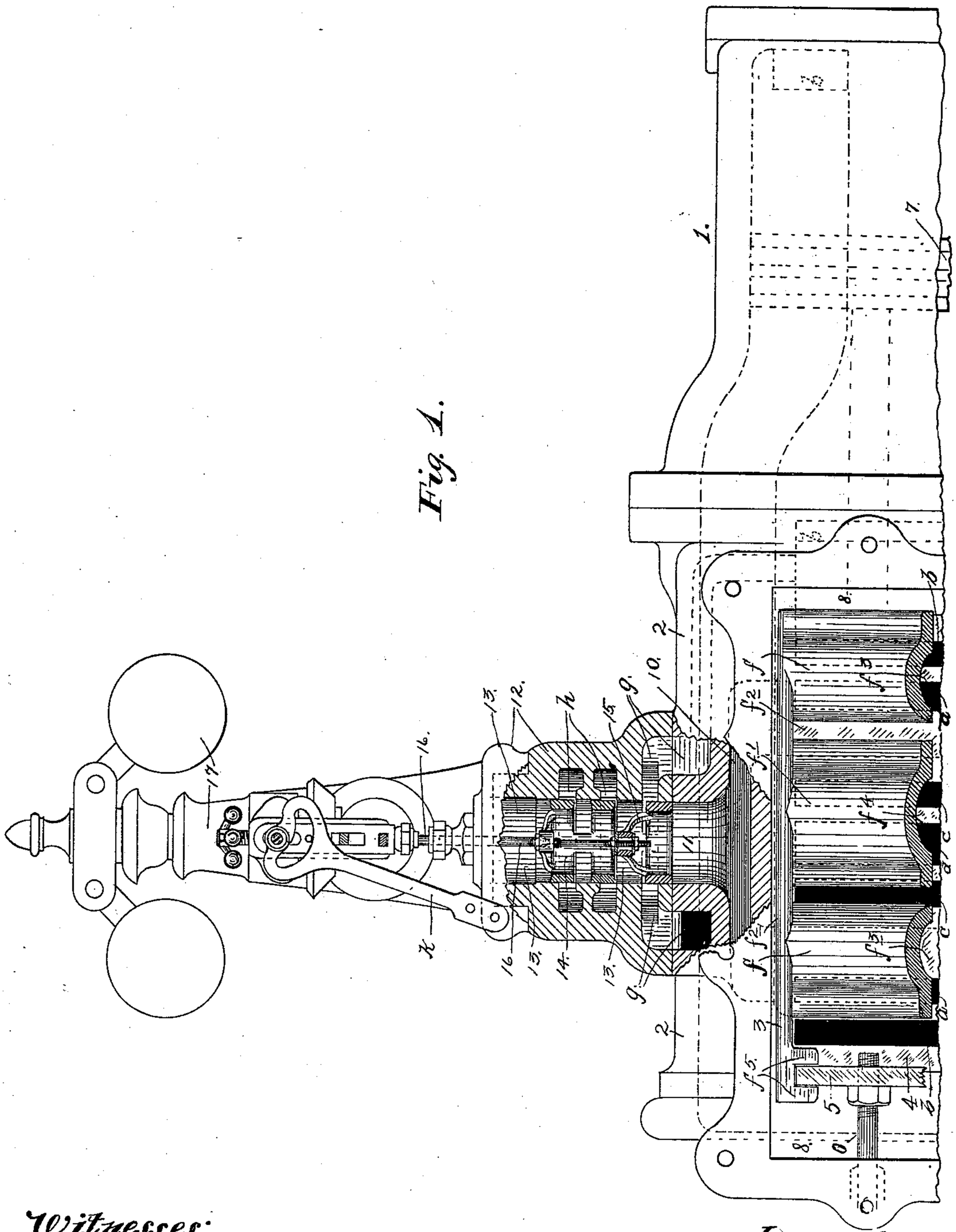
2 Sheets—Sheet 1.

E. J. WOOLF.

COMPOUND ENGINE.

No. 536,796. Patented Apr. 2, 1895.

Fig. 1.



Witnesses:
C. F. Kilgore
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By his Attorney.

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(No Model.)

2 Sheets—Sheet 2.

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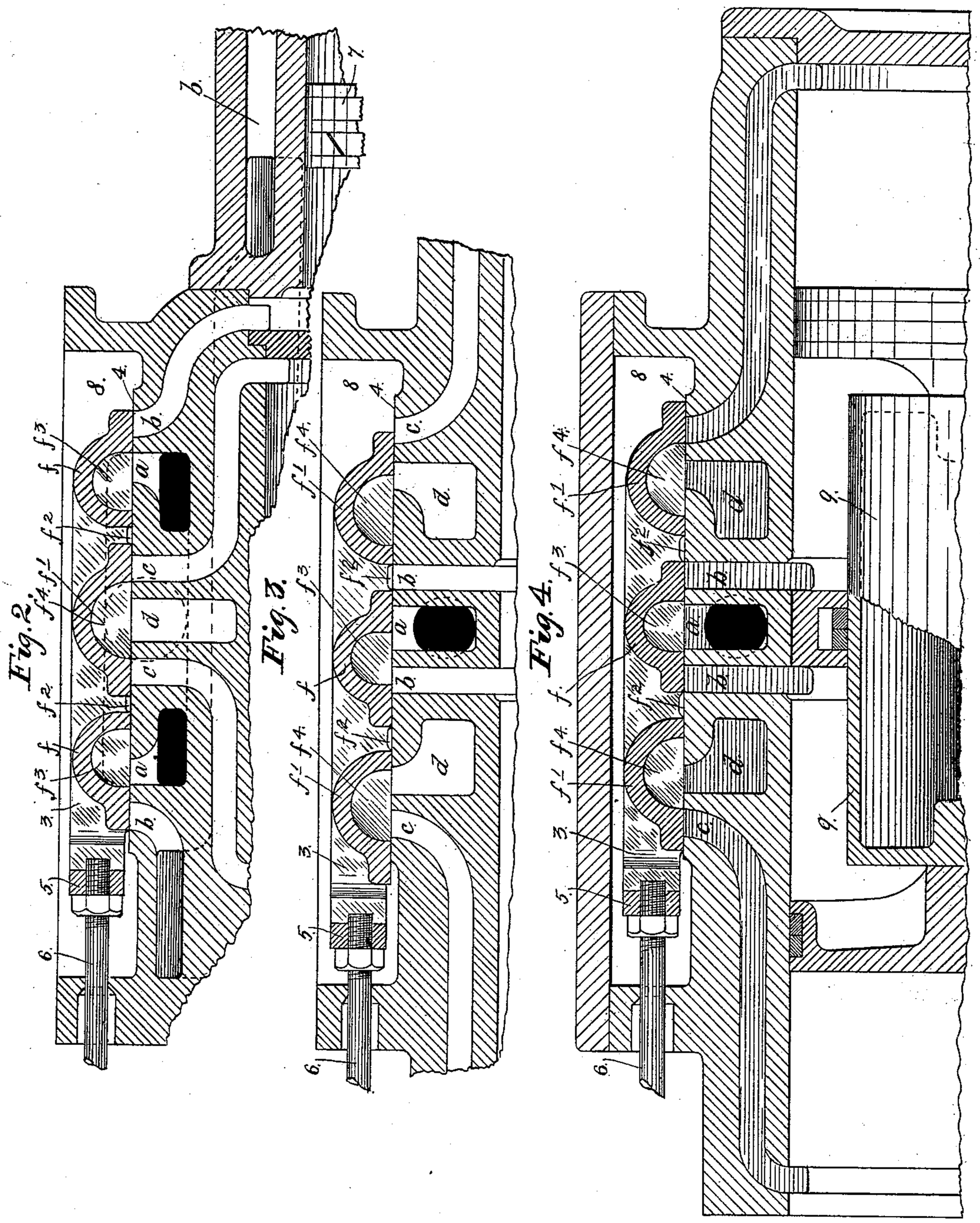

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Inventor:
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By his Attorney
Jas. F. Williamson

UNITED STATES PATENT OFFICE.

ELLIS J. WOOLF, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR TO THE WOOLF VALVE GEAR COMPANY, OF SAME PLACE.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 536,796, dated April 2, 1895.

Application filed January 12, 1895. Serial No. 534,624. (No model.)

To all whom it may concern:

Be it known that I, ELLIS J. 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 Compound Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to compound engines, and has for its object to provide an improved valve mechanism, especially adapted for double acting compounds, with a view of minimizing the drag on the valve actuating mechanism.

To this end, the invention consists in the novel features of construction hereinafter fully described and defined in the claims.

The invention is illustrated in the accompanying drawings, wherein like notations refer to like parts throughout the several views.

Figure 1 is a view, partly in side elevation and partly in vertical section, with some parts broken away, and with the distribution valve shown partly in angular section and shown as in its open position. In this view, the ordinary throttling valve and governor, together with a converting valve of my invention, is also shown for the purpose of illustrating a special combination in respect to this form of distribution valve. Fig. 2 is a sectional elevation, illustrating the same distribution valve and valve-seat, shown in Fig. 1, with the valve in its closed position, some parts being broken away and others removed. Fig. 3 is a sectional elevation, illustrating a modified construction of distribution valve and valve-seat, for accomplishing the same result, with the distribution valve shown in its open position, some parts being broken away and others removed. Fig. 4 is a sectional elevation, showing the same valve and valve-seat as in Fig. 3, together with a larger portion of the cylinders, pistons, &c., with the distribution valve shown in its closed position.

Having regard to Figs. 1 and 2, the high and low pressure cylinder castings 1 and 2, are arranged tandem, and the distribution valve 3 is mounted on a seat 4 located on the low pressure cylinder casting 2. In the said seat 4, *a a* represent a pair of supply ports in communication with a source of supply; *b b* are the high pressure ports; *c c* are the low pressure ports; and *d* is the final exhaust port.

The distribution valve 3, is constructed in three sections, *f f f'* which are either formed integral with each other, or are rigidly connected together. The said valve sections *f f'* are separated or provided with intervening passage-ways f^2 for the fluid. The valve sections *f* are provided with cup cavities f^3, which co-operate with the supply ports *a* and the high pressure ports *b;* and the valve section *f'* is provided with a cup cavity f^4, which co-operates with the low pressure ports *c* and the final exhaust port *d*.

As shown, the valve sections *f f f'* are formed integral with the side walls of the valve 3 and the fluid passages f^2 are formed between the body portions of the said sections and the said side walls of the valve; but it will be understood, of course, that the said valve sections might be rigidly connected in any other suitable way, and that the said fluid passages f^2, between the valve sections, might be otherwise formed. As shown, the side walls of the valve 3, are extended at one end, and provided with lugs f^5 which afford a means for detachably connecting the same to a block 5, which is rigidly connected to the valve stem 6. Supposing that high pressure fluid be available through the supply ports *a* in the valve-seat 4, the action of this valve 3 may be readily understood. If the valve be at the extreme of its travel, toward the right, as shown in Fig. 1, the high pressure fluid from the supply port *a* in the seat, can pass through the right hand valve cavity f^3 to the right hand high pressure port *b*. If now the valve 3 be moved toward the left to the extreme of its travel, then the fluid in the high pressure cylinder on the delivery side of the high pressure piston 7, will pass from the right hand high pressure port *b* into the valve chest 8, and thence through the right hand fluid passage f^2 between the valve sections *f* and *f'*, into the right hand low pressure port *c*. When the valve is then returned to the extreme of its right hand travel, or into the first assumed position, as shown in Fig. 1, then the fluid

from the delivery side of the low pressure piston will be finally exhausted from the low pressure port *c* through the valve cavity f^4 into the final exhaust port *d*. In tracing the action, as above, attention has been directed to the right hand co-operating ports. If attention had been given to the left hand set of co-operating ports, the actions would have been seen to be identical, but to have occurred in the reverse order.

From the foregoing statements, it will be obvious that the high pressure fluid is distributed from underneath the valve 3, and that the pressure from the high pressure fluid, operating on the valve 3, through the supply ports *a* from below or underneath, tends to unseat the valve; but to offset this tendency of the high pressure fluid on a limited portion of the said valve, it will be noted that low pressure fluid in the valve chest 8, will when the engine is working compound, be over the whole area of the top of the valve. Hence, by properly proportioning the valve and the cylinders, sufficient low pressure fluid will always be available on top of the valve, when the engine is working compound, under a normal load, to more than offset the tendency of the high pressure steam underneath the valve, and hold the valve down to its seat. In virtue of these facts, therefore, the valve is practically a balanced valve and the drag on the valve actuating mechanism is reduced to a minimum.

From the foregoing statement, it will also be clear that only low pressure or expanded fluid ever enters the valve chest 8, when the engine is working compound.

Having regard to Figs. 3 and 4, it may be first generally stated that the actions are substantially the same as in Figs. 1 and 2, but the construction differs in the use of a single supply port instead of the two supply ports, and in the use of two final exhaust ports instead of a single final exhaust port, as shown in Figs. 1 and 2, with corresponding changes in the valve, to accommodate said changes in the seat.

More specifically stated, in Figs. 3 and 4, *a* is the single supply port in the seat, *b b* are the high pressure ports, *c c* are the low pressure ports, and *d d* are the final exhaust ports. The single centrally located valve section *f*, co-operates with the centrally located single supply port *a* and the high pressure ports, *b b* in the seat; and the pair of valve sections *f' f'* co-operate, respectively, with their corresponding respective low pressure and final exhaust ports *c d* in the seat. As already stated, the actions of the valve or distribution of the fluid will be exactly the same as in the construction shown in Figs. 1 and 2, and it is not deemed necessary to trace the same. It should be noted, however, that the amount of valve surface exposed to the high pressure fluid, in the construction shown in Figs. 3 and 4, is less than in the construction shown in Figs. 1 and 2.

The construction of valve and valve-seat, as shown in Figs. 3 and 4, is better applicable to a trunk compound engine than the form shown in Figs. 1 and 2; but the form shown in Figs. 1 and 2 is better adapted to the tandem compound, when the trunk is not used. The trunk is shown at 9, in Fig. 4.

The form of construction shown in Figs. 3 and 4, in respect to the valve and valve-seat, may be regarded as the reverse of the construction shown in Figs. 1 and 2; but in regard to both, if the valve be made for co-operation with three sets of ports, then, it will be noted, first, that the three valve sections must be rigidly connected together, and, second, that the single valve section which co-operates with three ports, to distribute the fluid to and from cylinder ends receiving the fluid of one pressure, must be centrally located and the other two valve sections, which respectively control the distribution, one to each cylinder end receiving the fluid of the other or different pressure, must be located on opposite sides of the said central section, in order to hold the valve to its seat.

Referring now to another feature of my invention, attention is called to the fact, that when the engine is running with little or no load, or when, for other reasons, such as relatively larger area of the low pressure piston, the fluid after being used in the high pressure cylinder and exhausted therefrom through the valve chest 8 and over the valve into the low pressure cylinder, near atmospheric pressure, the pressure underneath the valve might overcome the pressure above the valve and unseat the same. To meet this contingency and insure the seating of the valve, under all conditions as to load, I provide a means of admitting a limited amount of high pressure fluid over the distribution valve, when so required. This means will be readily understood, by reference to Figs. 1 and 2, by inspection of which, it will be seen that the supply ports *a* communicate with the fluid passage or chest 10, which connects with the supply opening 11, in the cylinder casting. The said cylinder casting is also provided with sections *g* of supplemental high pressure supply ports, which communicate, respectively, one with each of the high pressure ports *b b*. A governor casting 12 is provided with the central passage 13 and corresponding sections of said supplemental high pressure ports *g*, which passage 13, in the governor casting 12, unites with the supply opening 11 in the cylinder casting and the sections of the supplemental ports *g* in the said two castings 2 and 12, also unite through the common flange joint, which connects the said castings. The governor casting 12 is provided with the ordinary supply ports *h*, which are under the control of the ordinary or any suitable throttle-valve 14. In the said passage 13 of the governor casting 12, below the throttle-valve 14, is located an additional valve 15, which controls the supplemental high press-

ure ports *g*; and for that reason may be termed the supplemental port valve. This supplemental valve 15 is shown as attached to the same rod 16, to which the throttle valve 14 is secured; and, the said supplemental valve 15 is attached to the said rod 16, in such a way as to be adjustable thereon, in respect to the throttle valve 14. As shown, the adjustment is effected by ordinary check and jam-nuts. With this construction, the said supplemental valve 15 may be set relative to the throttling valve 14, so that it will open the supplemental ports *g*, whenever the said valve travels to some predetermined point on either side of its central position. For example, if the said converting valve be located or set, in respect to the throttle-valve 14, as shown in the drawings, then the said converting valve will open the said supplemental ports *g* to a limited extent, at the upper end of the said valve, when the throttle-valve 14 is nearly closed, as shown in Fig. 1. This is the means provided, as above referred to, for admitting a limited amount of high pressure fluid over the distribution valve 3, when required for the purposes of holding the valve down to its seat, when the engine is operating under little or no load. It must be obvious, for example, that if the said supplemental valve 15 and throttle valve 14 be in the position shown in Fig. 1, then the high pressure fluid, to a limited amount, may pass through the supplemental ports *g* to both ends of the high pressure cylinder; and that with the distribution valve 3, in the position shown in Fig. 1, such of said high pressure fluid as enters the delivery side of the high pressure piston, through the left hand member of said supplemental ports *g* can pass through the left hand high pressure port *b* of the distribution valve seat, directly into the valve-chest 8; and if the distribution valve 3 be at the opposite extreme of its travel, then the said high pressure fluid will reach the valve-chest 8 through the right hand member of said high pressure ports *b* in the seat. Hence, there can never be a condition of load, when the distribution valve 3 will not be held down to its seat, assuming, of course, that the said valve and the cylinders have been properly proportioned. The said supplemental port valve 15 will also open the supplemental ports *g*, at its lower end, whenever, on account of excessive load, the throttle valve 14 moves to some predetermined point in its opening movement. This enables the engine to be converted from a compound into a simple acting engine, whenever so required by the load. The rod 16, to which the throttle valve 14 and the supplemental valve 15 are both attached, is connected, as shown with an ordinary centrifugal governor 17, which is also provided with a hand device *k*, which renders it possible to operate the said valves 14 and 15 independent of the centrifugal weights of the governor. Of course, it will be understood, that the said supplemental ports *g* and the said supplemental valve 15, controlling the same, might be somewhat differently located, in respect to the cylinder and governor castings, without altering the action.

As shown in the drawings, the distribution valve 3 is constructed in three sections, with the three sections thereof arranged end to end, and with fluid passages f^2 between the sections. The said fluid passages f^2 between the said sections is incidental to the said end to end arrangement of the sections.

The construction of the valve in three sections and the three sets of ports in the seat, for co-operation with said valve sections, is for the purpose of rendering the unseating tendency of the high pressure fluid on the valve, in lines which will not tend to tilt the valve. Otherwise stated, the forces from the high pressure fluid on the under side of the valve operate at right angles to the valve and with equal force on all sides of the center of the valve, or in proportion to the counterpoising effect of the low pressure fluid over the top of the valve.

It has already been noted, and it is obvious from an inspection of the drawings, that the valve-chest 8 is a receiver for the low pressure fluid, and, inasmuch as the high pressure fluid is distributed solely from underneath the valve, it is obvious that the low pressure fluid is always available over the top of the valve, under the ordinary distributing action, for holding the valve to its seat and substantially balancing the same. Otherwise stated, the valve and valve-seat are located in the receiver.

Any construction wherein the complete distribution is effected from a valve and valve-seat located in the low pressure receiver and by which construction the high pressure fluid is distributed from a limited area underneath the valve, and the low pressure fluid is distributed through the receiver and is available over the top of the valve, for holding the valve to its seat and substantially balancing the same, is within the principle of my invention.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. In a compound engine, the combination with a receiver for the low pressure fluid, of a valve and valve-seat located in said receiver, having supply, high and low pressure and final exhaust ports, arranged to effect the complete distribution and with the high pressure fluid distributed from a relatively small area underneath the valve, and the low pressure distributed through the receiver and available over the top of the valve, for holding the same to its seat and substantially balancing the valve, substantially as described.

2. In a compound engine, the combination with a receiver for low pressure fluid, of a valve-seat located in said receiver and having supply, high and low pressure and final exhaust ports, and a valve on said seat having high and low pressure sections rigidly

connected together and co-operating with said ports in the seat, whereby the high pressure fluid is distributed from a relatively small area underneath the valve and the low pressure fluid is available over the whole of the top of the valve, for holding the valve to its seat and substantially balancing the same, substantially as described.

3. In a compound engine, the combination with a receiver for low pressure fluid, of a valve-seat located in said receiver, having three sets of ports, the central set of which are used to distribute the fluid of one pressure, and the outside sets of which are used for distributing fluid of the other pressure, and a three section valve with the sections rigidly connected together for cooperation with said ports, whereby, under the ordinary distributing action, the high pressure fluid will be distributed from a limited area underneath the valve and the low pressure fluid will be available over the whole of the top of the valve, substantially as and for the purposes set forth.

4. In a compound engine, the combination with a receiver for low pressure fluid, of a valve-seat located in said receiver and having supply, high and low pressure and final exhaust ports, a valve on said seat having high and low pressure sections rigidly connected together and cooperating with said ports in the seat, a throttle valve, one or more supplemental high pressure ports, a valve controlling said supplemental ports, and a common device for actuating said throttle and supplemental valves, with the supplemental valve so related to the throttling valve as to afford a limited opening of said supplemental port or ports, when the throttling valve is nearly closed, substantially as and for the purposes set forth.

In testimony whereof I affix my signature in presence of two witnesses.

ELLIS J. WOOLF.

Witnesses:
JAS. F. WILLIAMSON,
E. F. ELMORE.