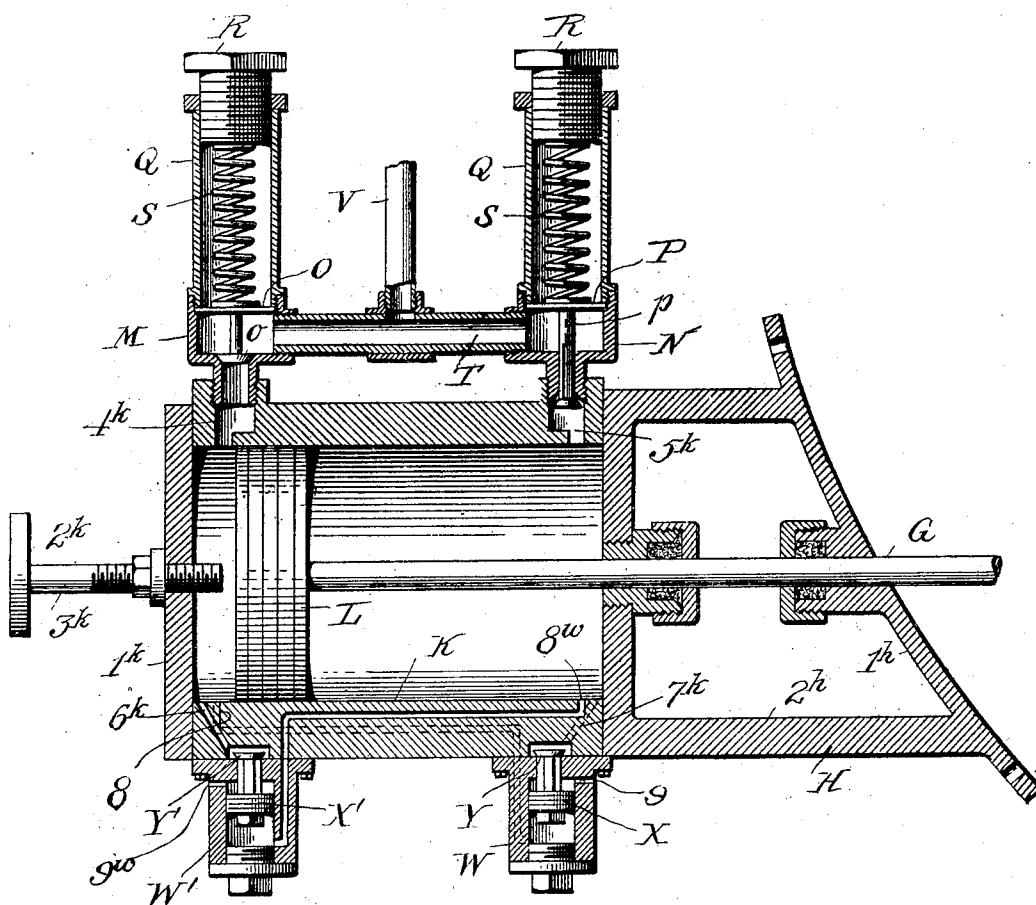


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C. L. PAGENHART.
VARIABLE PRESSURE ENGINE.
APPLICATION FILED DEC. 19, 1904.



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VARIABLE-PRESSURE ENGINE.

SPECIFICATION forming part of Letters Patent No. 794,882, dated July 18, 1905.

Original application filed October 12, 1904, Serial No. 228,213. Divided and this application filed December 19, 1904. Serial No. 237,556.

To all whom it may concern:

Be it known that I, CHARLES L. PAGENHART, a citizen of the United States, residing at Tennille, in the county of Washington and State of Georgia, have invented certain new and useful Improvements in Variable-Pressure Engines; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawing, wherein I have shown in vertical central section one form of an engine embodying my invention, the movable and adjustable parts being shown in elevation.

Like symbols refer to like parts wherever they occur.

My invention relates to the construction of that class of devices designed to be operated by variations in fluid-pressure to actuate any mechanism which it may be desirable to control by such means, and is especially applicable in governing and regulating the flow of steam, air, smoke, water, oil, or other fluids or substances through vents or passages.

In my application, Serial No. 228,213, filed October 12, 1904, of which this is a division, I have shown and described the device as operative by steam-pressure to control a variable-exhaust mechanism for a locomotive; but it is evident that the device is of broader and more general application and as such is the subject of this application.

My invention, generally stated, consists of a cylinder operated by high or low pressure, having inlet and exhaust ports, the former being controlled by valves independently actuated by variations in the pressure of the motive fluid.

A further feature of my invention consists of a cylinder operated by high or low pressure, having inlet and exhaust ports, the former being controlled by valves independently actuated by variations in the pressure of the motive fluid and the latter being controlled by independent valves actuated by the motive fluid.

There are other minor features of invention residing in certain elemental constructions

and particular combinations, all as will hereinafter more fully appear.

I will now proceed to describe my invention more fully, so that others skilled in the art to which it appertains may apply the same.

In the drawing chosen for the purpose of illustrating my invention, the scope whereof is pointed out in the claims, K is a cylinder, the head 1^k whereof is provided with a hand-wheel 2^k and attached threaded rod 3^k, having threaded engagement with the said cylinder-head 1^k, by which means the length of stroke of the piston or other movable member L within the cylinder K is limited and controlled; but, if desired, such hand-wheel or equivalent means may be omitted. The cylinder K is also provided with suitable means by which it may be secured in proper relation with respect to the devices which it controls, said means preferably consisting of a bracket H of the particular form which circumstances may require, said bracket being secured to the cylinder K by bolts passing through an annular flange thereof or in other suitable manner.

In the drawing the bracket H illustrated is designed to be applied to the exterior of the smoke-box of a locomotive and comprises a base-plate 1^h and an open yoke 2^h, the said base-plate and yoke being each provided with a stuffing-box of any usual or suitable construction, either made integral therewith or detachable therefrom. In other forms of the bracket for other purposes a greater or less number of stuffing-boxes may be required.

Within the cylinder K is a piston L of any well-known or suitable construction, the piston-rod G whereof passes through and is guided by the stuffing-boxes of the bracket H, to be connected with any mechanism which it is adapted to actuate and control.

At opposite ends of the cylinder K, so located as to admit pressure upon opposite sides of the piston L, are the motive-fluid-inlet ports 4^k 5^k, one of which, 4^k, is a high-pressure port and the other of which, 5^k, is a low-pressure port, the said cylinder being also provided

with corresponding leakage-grooves or equivalent high and low pressure exhaust-ports 6^k 7^k, respectively, for the proper escape of the motive fluid. As a means of automatically governing the opening and closing of the exhaust-ports 6^k 7^k I prefer to secure upon the exterior of the cylinder K, at points adjacent to the said exhaust-ports, exhaust-valve cases or supplemental cylinders W W', each of which is formed with an interior chamber, the outer end whereof is closed by a threaded cap or nut or in other suitable manner. The low-pressure exhaust-valve case or supplemental cylinder W is provided with a piston or diaphragm X, to which is attached a low-pressure exhaust-valve Y, interposed between the low-pressure exhaust-port 7^k of the cylinder K and the exhaust-port 9 of the valve-case W, the piston-chamber of the said valve-case at a point on the opposite side of the piston X from the exhaust-port 9 being connected by a pressure passage or port 8 with the high-pressure end of the said cylinder K. Similarly the high-pressure exhaust-valve case or supplemental cylinder W' is provided with a piston or diaphragm X', to which is attached a high-pressure exhaust-valve Y', interposed between a high-pressure exhaust-port 6^k of the cylinder K and an exhaust-port 9^w of the valve-case W', the said valve-case W' being connected to the low-pressure end of the cylinder K by a pressure port or passage 8^w.

At opposite ends of the cylinder K and either made integral therewith or mounted thereon in any suitable manner are the diaphragm-bodies M and N, each of which is provided with a valved passage or chamber communicating with its respective cylinder inlet-port 4^k or 5^k and each of which is provided with an aperture to receive a pipe T or other means for transmitting the motive-fluid pressure to their respective diaphragms O and P, as will hereinafter more fully appear. In lieu of connecting the diaphragm-bodies by the pipe T, as shown, any other form of connection may be employed—as, for example, a hollow casting integrally uniting the said diaphragm-bodies.

Upon each of the diaphragm-bodies M and N is mounted a spring-case Q, the diaphragms O and P within their respective diaphragm-bodies M and N being preferably secured in position by being clamped between a shoulder upon the diaphragm-body and the lower end of the spring-case, which is preferably threaded to engage a correspondingly-threaded portion of the said diaphragm-body; but, if desired, other means for securing the diaphragms in position may be employed, and the spring-cases may be united to the diaphragm-bodies in any suitable manner.

Within each of the spring-cases Q is a spring S, which at one end bears upon an adjusting-nut R, having threaded engagement with the spring-case, and which at the other

end bears upon one of the diaphragms O P, the latter having attached to them, respectively, the high-pressure valve *o* and the low-pressure valve *p*, which control the corresponding high-pressure inlet-port 4^k and low-pressure inlet-port 5^k.

The flexible diaphragms O P, to which the valves *o* and *p* are attached, are preferably formed of copper or brass; but in lieu of controlling the said valves by diaphragms I may control them by pistons in a manner similar to that in which the exhaust-valves Y Y' are governed by the movement of their pistons X X'. By the use of diaphragms, however, the opening of the attached valves is limited in a very simple manner, and a tight steam-joint is readily secured.

The interior chambers of the diaphragm-bodies M and N, which communicate with the cylinder K through the respective ports 4^k 5^k, are connected to a common source of motive-fluid pressure through the pipe T, which connects the diaphragm-bodies, and the pipe V, which is connected with the said pipe T; but other means may be adopted for this purpose, if desired—as, for example, each diaphragm-body may be independently connected with the source of pressure.

It will be observed that by means of the adjusting-nuts R R the tension of the springs S may be so graduated that the respective valves upon which they bear, through the interposed diaphragms, may be arranged to operate independently at any desired difference of pressure and that therefore the device may be so adjusted as to permit any desired fluctuation in the motive-fluid pressure without actuating the piston L.

The construction being substantially such as hereinbefore pointed out, the device will operate as follows: The desired length of stroke of the piston L having been fixed by properly adjusting the screw-rod 3^k by means of the hand-wheel 2^k and the adjusting-nuts R R having been manipulated to produce pressure upon the respective diaphragms and valves corresponding to the pressures at which it is desired they shall open to admit the motive fluid to the cylinder K, the motive fluid will pass to the interior chambers of the diaphragm-bodies M and N through the pipes V and T. If at this time the motive-fluid pressure is within the normal limits of variation it is desired to allow, such variation being measured by the difference between the spring-pressure upon the high-pressure valve *o*, which is designed to open when the motive-fluid pressure rises above the desired upper limit, and the spring-pressure upon the low-pressure valve *p*, which opens when the motive-fluid pressure falls below the desired lower limit, then both high-pressure valve *o* and low-pressure valve *p* will remain closed, since the pressure of the motive fluid is insufficient to overcome either.

spring, and the piston L will not be actuated. If from any cause the motive-fluid pressure should rise above that at which the high-pressure valve *o* is adjusted to operate, such motive-fluid pressure acting upon the high-pressure diaphragm O will overcome the spring S bearing thereon and cause the high-pressure valve *o* to rise, thus permitting the motive fluid to pass through the high-pressure inlet-port 4^k to the high-pressure end of the cylinder K, thereby actuating the piston L and the devices attached to or controlled by its piston-rod G. During this time the pressure of the motive fluid upon the low-pressure diaphragm P is greater than the pressure of the spring S thereon, and consequently the low-pressure valve *p* maintains the low-pressure inlet-port 5^k closed, thereby preventing the ingress of the motive fluid to the low-pressure end of the cylinder K. Immediately upon the entrance of the motive fluid to the high-pressure end of the cylinder K in the manner described a portion thereof passes to the interior chamber of the valve-case or supplemental cylinder W, actuating the piston X or diaphragm therein, and thereby operating the attached low-pressure exhaust-valve Y to permit the exhaust of the low-pressure end of the cylinder K through the low-pressure exhaust-port 7^k and the exhaust-port 9 of the supplemental cylinder W. When, by reason of the operation of the devices controlled or regulated by means of the movement of the piston L or from any other cause, the pressure of the motive fluid falls below the pressure at which the high-pressure valve *o* is set to operate, such valve is closed by means of the spring acting thereon. If now the motive-fluid pressure transmitted to the diaphragm-bodies M and N through the pipes V and T should fall below the pressure with which the spring bears upon the low-pressure diaphragm P and attached low-pressure valve *p*, such spring-pressure acting upon the said diaphragm will overcome the motive-fluid pressure thereon and the low-pressure valve *p* will be forced from its seat to admit the motive fluid to the low-pressure end of the cylinder K through the low-pressure inlet-port 5^k, the piston L being again actuated, but in an opposite direction. During this time the motive-fluid pressure upon the high-pressure diaphragm O is insufficient to overcome the spring-pressure thereon, and the high-pressure valve *o* therefore remains seated. At this time the piston X' or diaphragm and attached high-pressure exhaust-valve Y' are automatically actuated by the entrance of the motive fluid into the interior chamber of the valve-case W' through the pressure port or passage 8^w, thereby permitting the high-pressure end of the cylinder K to exhaust through the high-pressure exhaust-port 6^k and exhaust-port 9^w in a manner similar to that heretofore described. When the pres-

sure of the motive fluid rises above the pressure at which the low-pressure valve *p* is set to operate, the spring S, bearing upon the low-pressure diaphragm P, seats such low-pressure valve *p*, thus preventing further admission of the motive fluid to the cylinder K.

By the use of a device of the character described either a wide or narrow range of fluctuation may be permitted in the pressure of the motive fluid and the pressure maintained upon the piston L until the normal pressure of the motive fluid is restored supports such piston against possible movement due to condensation in the cylinder K when steam is employed.

It will be noted that in lieu of the springs S S for maintaining the constant pressure of predetermined amount upon the high-pressure and low-pressure inlet-valves other means may be employed for this purpose or the high and low pressure diaphragms may be made of the desired difference in stiffness. It will also be observed that the automatic exhaust devices are applicable to engines generally, as well as to variable-pressure engines, as here described.

Obviously my invention is susceptible of many modifications and changes in construction and form of parts without departing from the spirit and scope thereof.

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

1. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, said valves being independently movable, and means for connecting said valves to a source of pressure, substantially as and for the purposes specified.

2. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, diaphragms for the said valves, and means for connecting said valves and diaphragms to a source of pressure, substantially as and for the purposes specified.

3. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, diaphragms for the said valves, springs acting upon the said diaphragms, and means for connecting said diaphragms to a source of pressure, substantially as and for the purposes specified.

4. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pres-

sure valve controlling a cylinder inlet-port, diaphragms for the said valves, springs acting upon said diaphragms, means for adjusting the pressure of the said springs upon their respective diaphragms, and means for connecting said valves to a source of pressure, substantially as and for the purposes specified.

5. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, diaphragms for the said valves, springs acting upon said diaphragms, means for adjusting the pressure of the said springs upon their respective diaphragms, exhaust-ports for said cylinder, and means for connecting said valves to a source of pressure, substantially as and for the purposes specified.

6. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, and exhaust-valves for the cylinder automatically controlled by the admission of the motive fluid to the said cylinder, substantially as and for the purposes specified.

7. In an engine, the combination with a cylinder, of a movable member within said cylinder, cylinder inlet and exhaust ports, suitable valves for the said ports the valves of the exhaust-ports being independent of each other, piston-controlled pressure ports or passages which connect each of the said exhaust-valves with the cylinder, and means whereby the admission of the motive fluid to the said cylinder actuates the exhaust-valves, substantially as and for the purposes specified.

8. In an engine, the combination with a main cylinder, said cylinder having inlet and exhaust ports, of a movable member within said cylinder, suitable valves for the several ports of the main cylinder, the exhaust-valves thereof being independent of each other, supplemental cylinders or valve-casings, pistons in the supplemental cylinders which control the independent exhaust-valves, and suitable piston-controlled pressure ports or passages leading from the opposite sides of the movable member of the main cylinder and communicating with the respective supplemental cylinders or valve-casings, substantially as and for the purposes specified.

9. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, high and low pressure cylinder inlet and exhaust ports, and suitable valves for said inlet-ports independently actuated by variations in the pressure of the motive fluid, substantially as and for the purposes specified.

10. In a variable-pressure engine, the combination with a cylinder, of a movable mem-

ber within said cylinder, high and low pressure cylinder inlet and exhaust ports, suitable valves for said inlet-ports independently actuated by variations in the pressure of the motive fluid, and suitable valves for the said exhaust-ports independently actuated by the motive fluid, substantially as and for the purposes specified.

11. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, exhaust-ports for the said cylinder, and means for limiting the length of stroke of said piston, substantially as and for the purposes specified.

12. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, exhaust-ports for the said cylinder, and means whereby the said valves may be adjusted to operate at independent pressures, substantially as and for the purposes specified.

13. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure inlet-valve controlling a cylinder-port, a low-pressure inlet-valve controlling a cylinder-port, exhaust-ports for the said cylinder, suitable valves for the said exhaust-ports, means whereby the said inlet-valves may be adjusted to operate at independent pressures, and means whereby the said exhaust-valves are automatically actuated by the admission of the motive fluid to the cylinder, substantially as and for the purposes specified.

14. In a variable-pressure engine, the combination with a cylinder, of a movable member within said cylinder, a high-pressure valve controlling a cylinder inlet-port, a low-pressure valve controlling a cylinder inlet-port, exhaust-ports for the said cylinder, suitable valves for the said exhaust-ports, diaphragms attached to the said valves controlling the inlet-ports, pistons attached to the said valves controlling the said exhaust-ports, springs acting upon said diaphragms, means for graduating the pressure of said springs upon their respective diaphragms, and means for actuating said exhaust-valves by the admission of motive fluid to the cylinder, substantially as and for the purposes specified.

In testimony whereof I affix my signature, in presence of two witnesses, this 16th day of December, 1904.

CHARLES L. PAGENHART.

Witnesses:

W. B. KENDRICK,
OTIS ELLISON.