S. K. McLAIN & F. A. PIERCE.

LOCOMOTIVE ENGINE.

APPLICATION FILED DEC. 2, 1903.

912,272.

Patented Feb. 9, 1909.

6 SHEETS—SHEET 1.

Fig. 1.

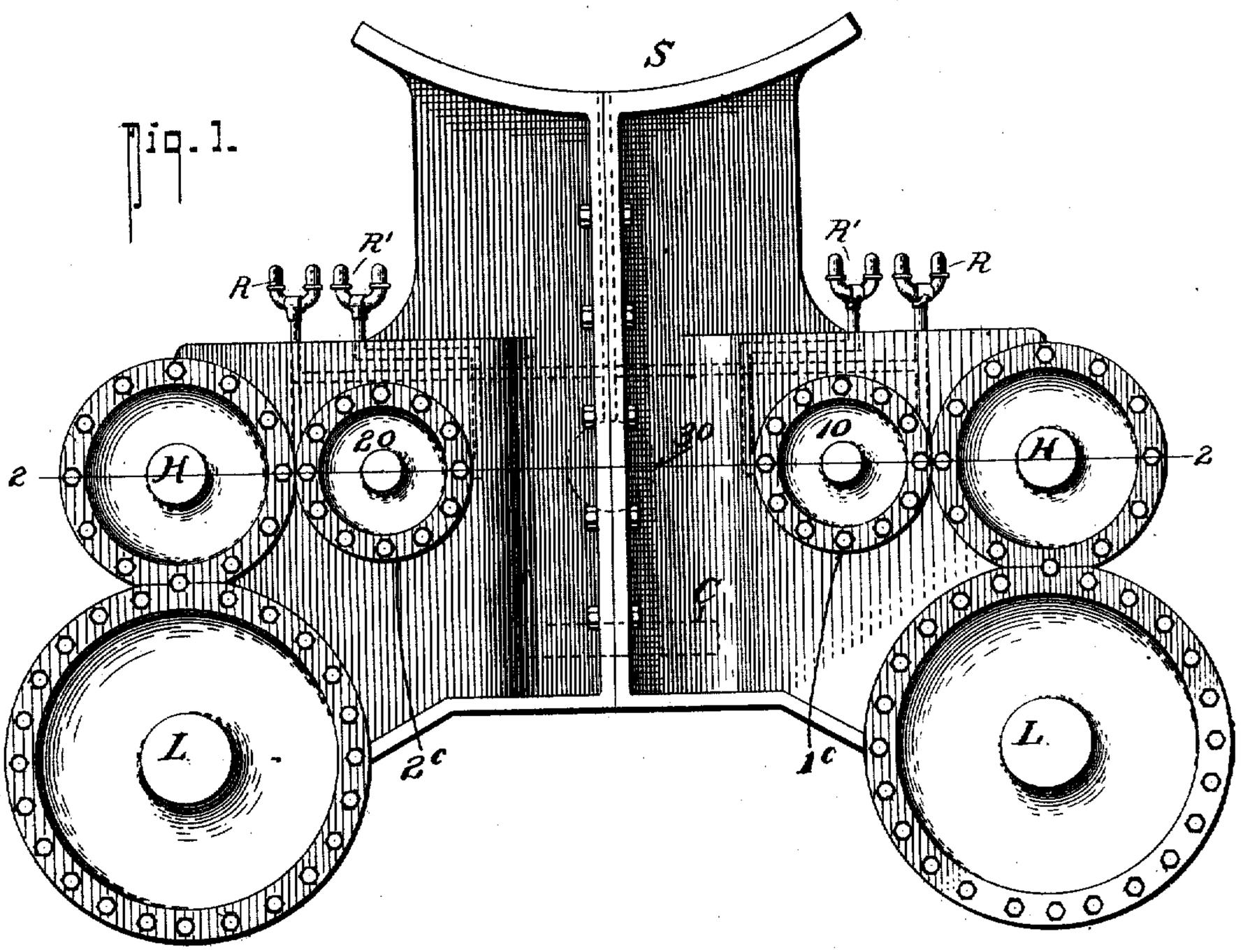

Fig. 8.

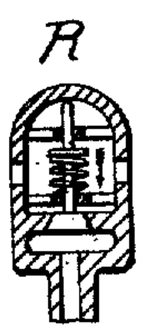

Fig. 9.

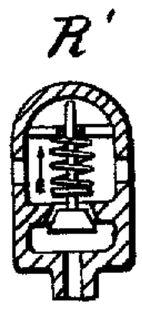

Fig. 7.

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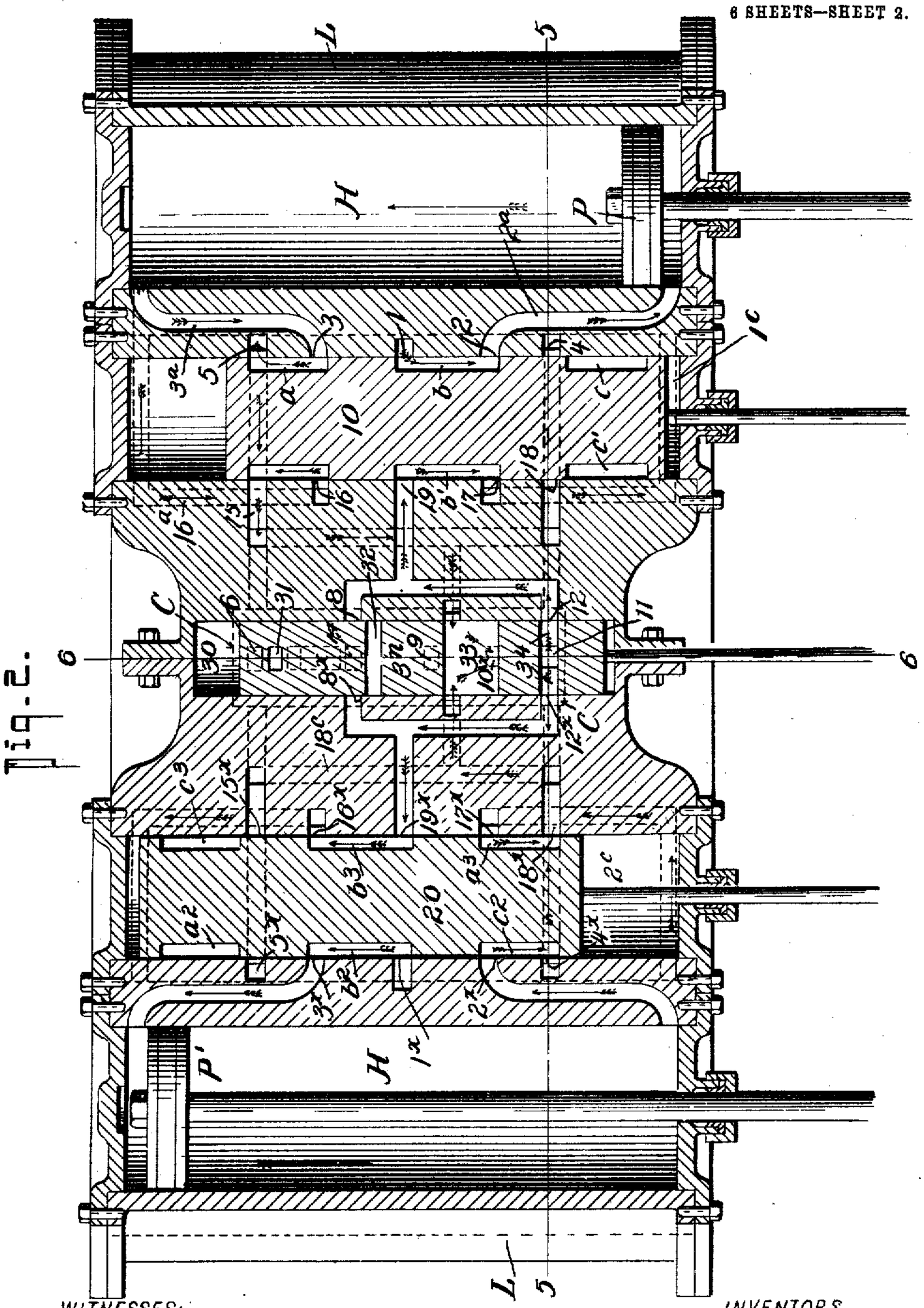

Fig. 2.

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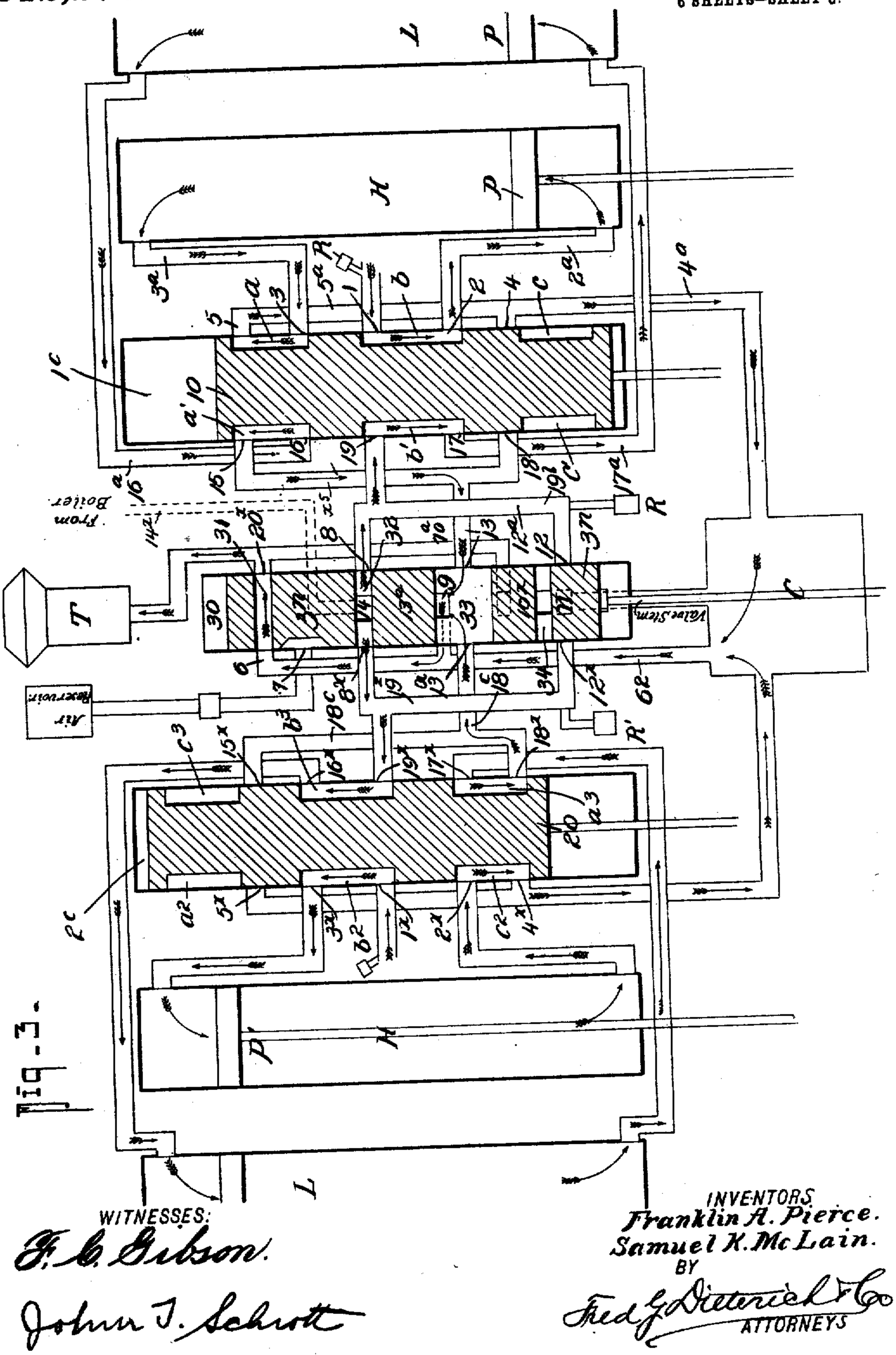

Fig. 3.

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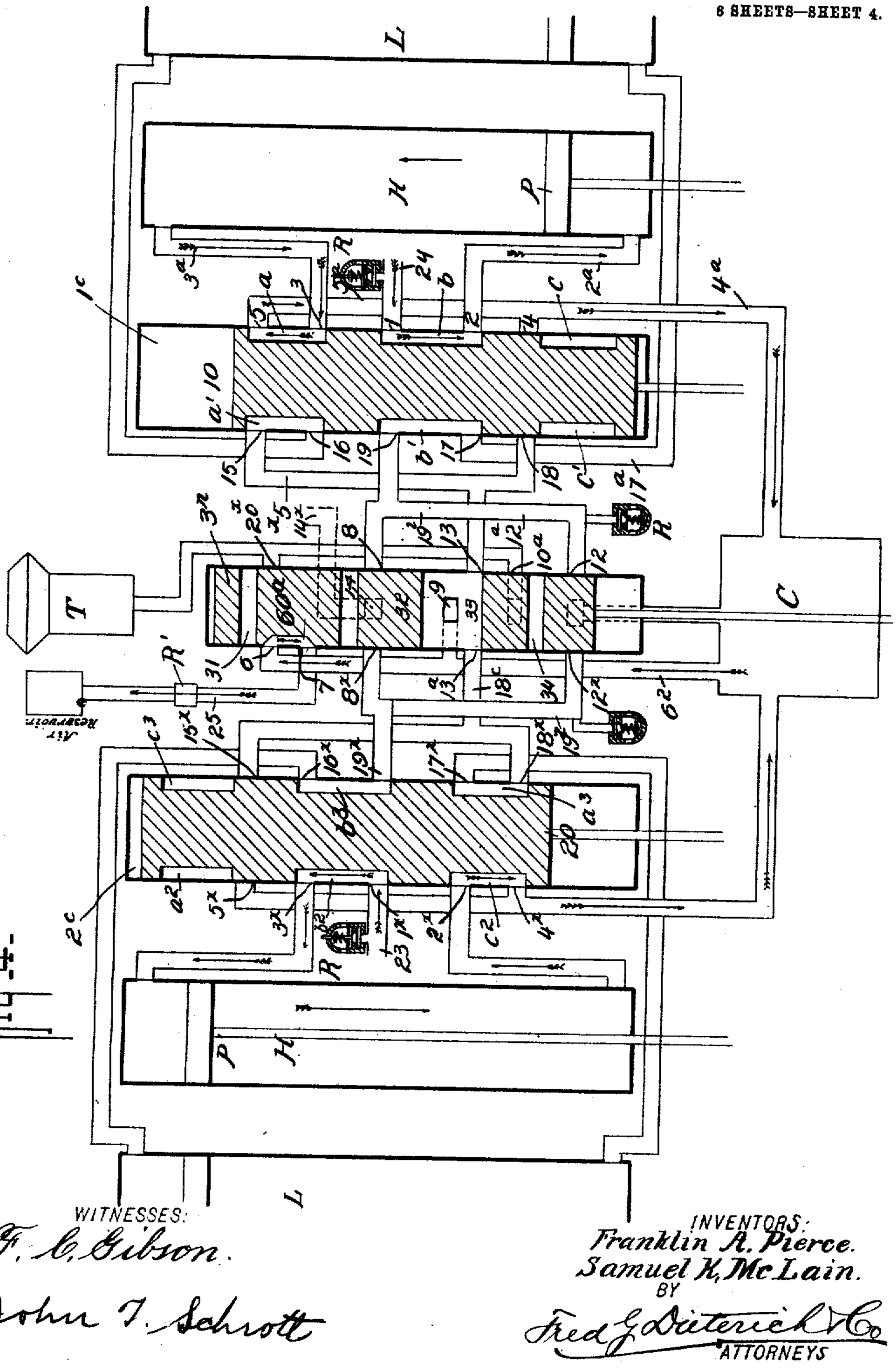

Fig. 4.

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6 SHEETS—SHEET 5.

Fig. 5.

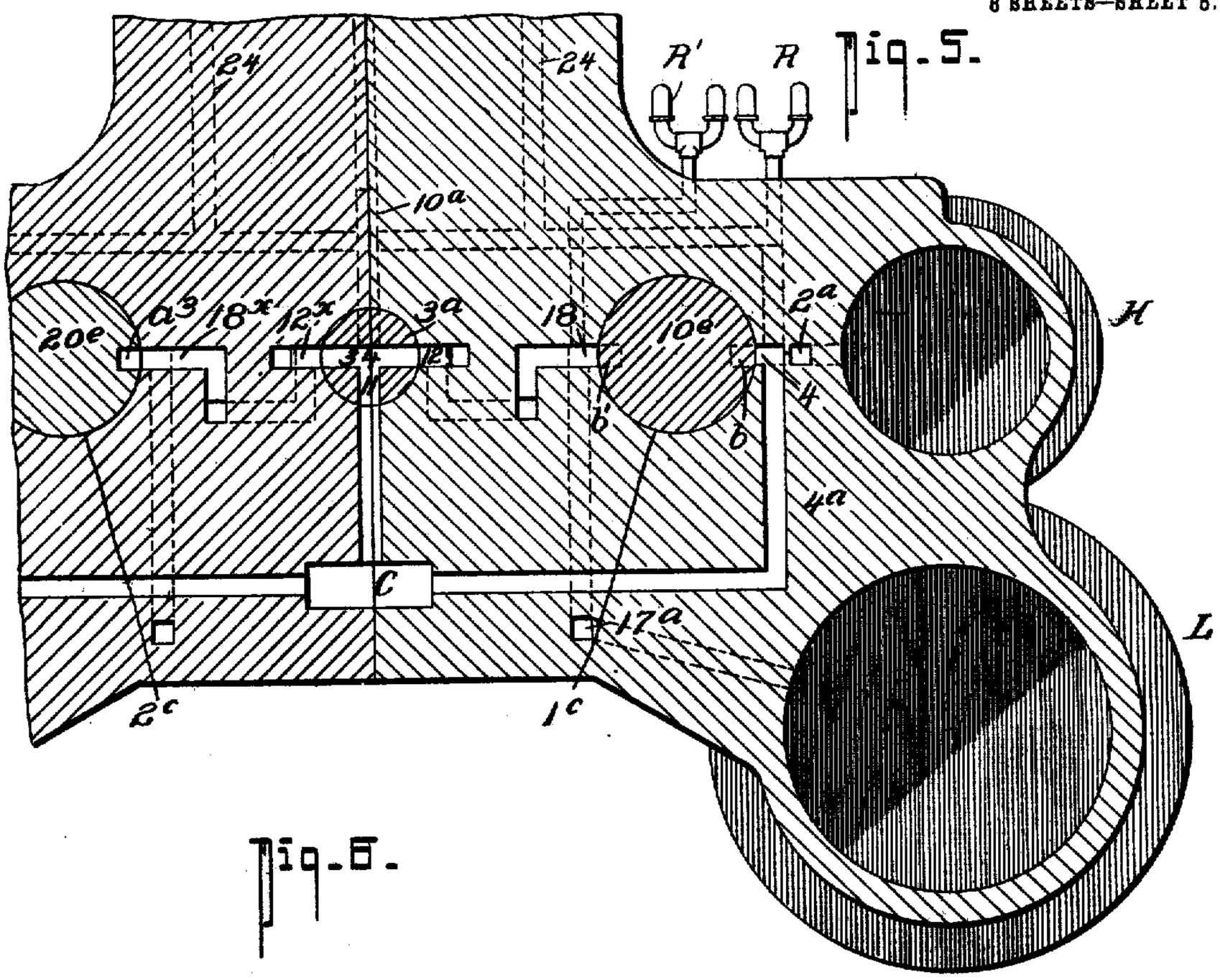
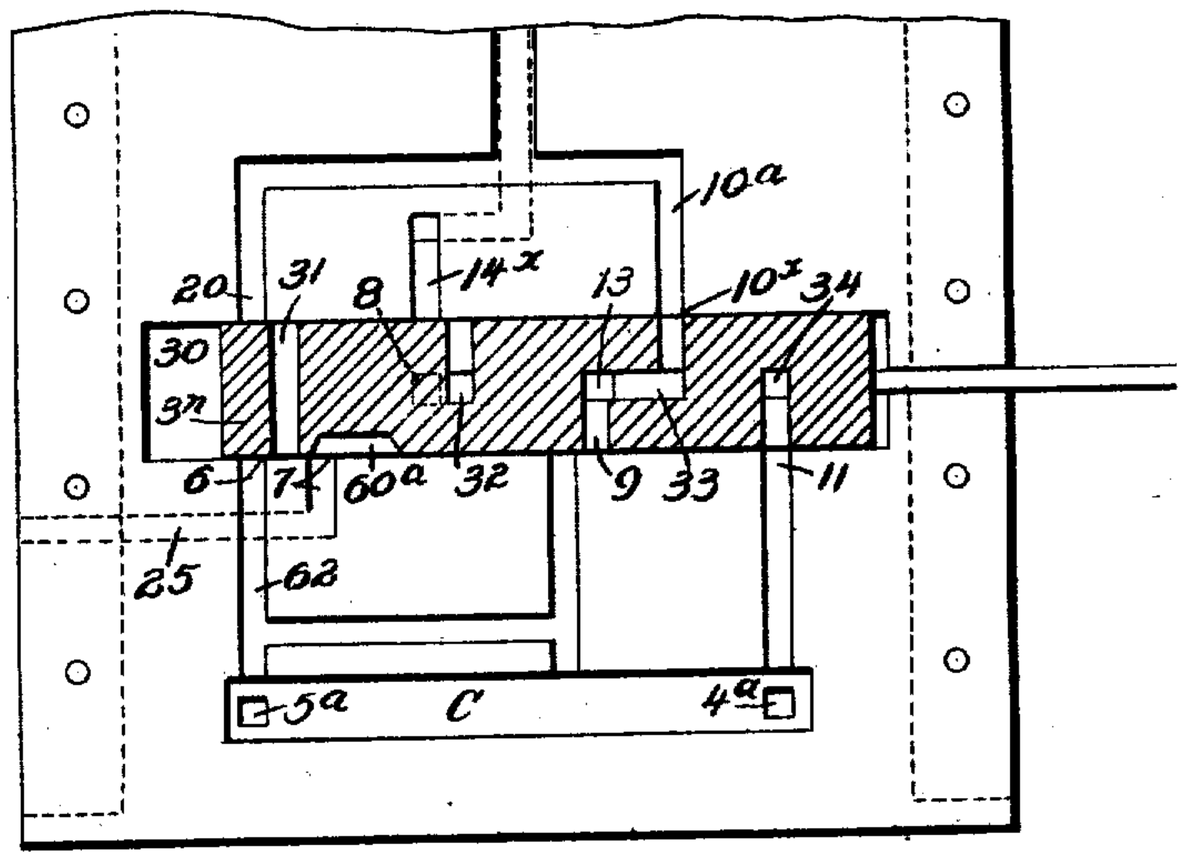


Fig. 6.



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6 SHEETS—SHEET 6.

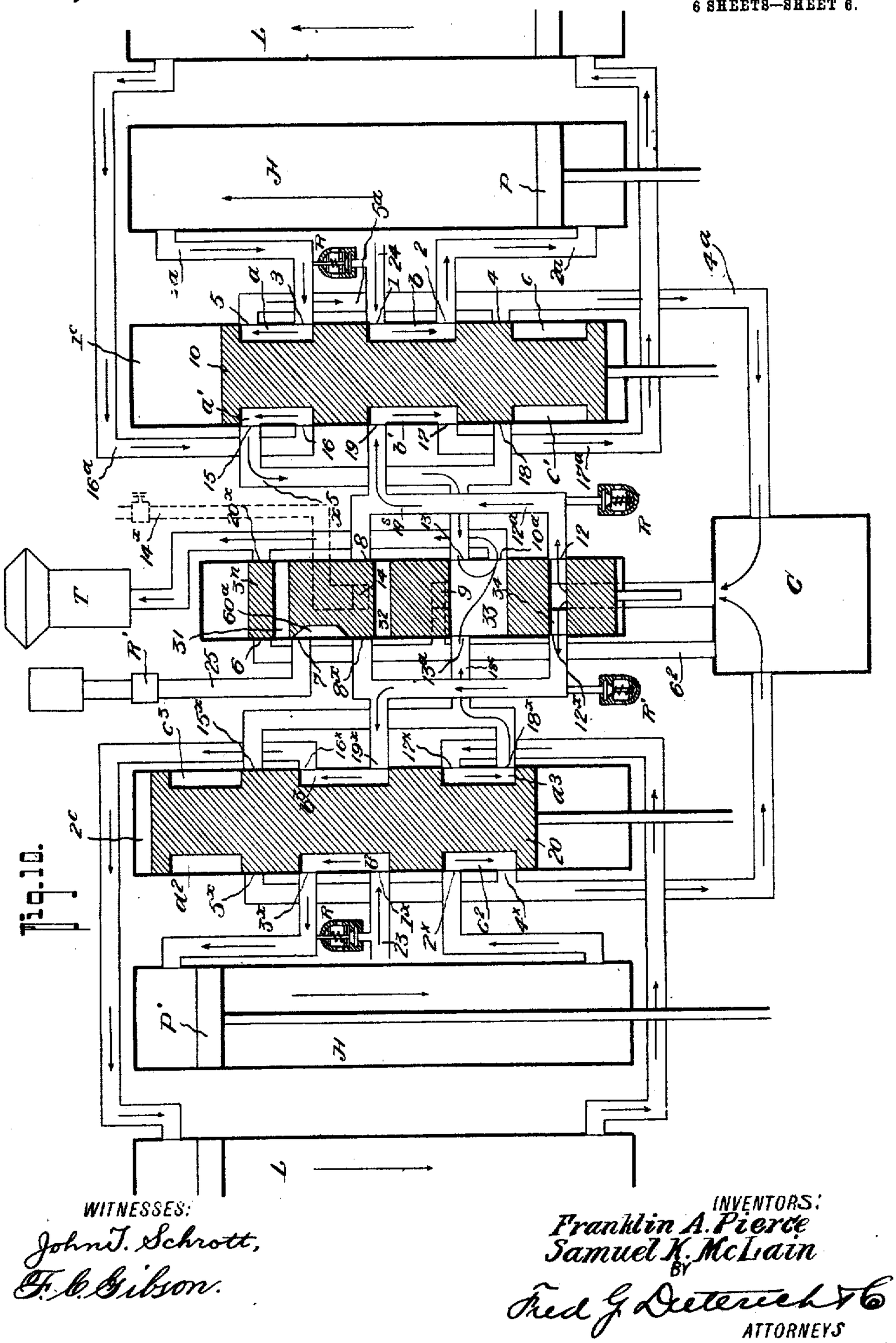

Fig. 10.

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UNITED STATES PATENT OFFICE.

SAMUEL K. McLAIN AND FRANKLIN A. PIERCE, OF WHEELING, WEST VIRGINIA.

LOCOMOTIVE-ENGINE.

No. 912,272. Specification of Letters Patent. Patented Feb. 9, 1909.

Application filed December 2, 1903. Serial No. 183,469.

To all whom it may concern:

Be it known that we, SAMUEL K. McLAIN and FRANKLIN A PIERCE, residing at Wheeling, in the county of Ohio and State of West Virginia, have invented a new and Improved Locomotive-Engine, of which the following is a specification.

Our invention relates to that class of steam engines more particularly locomotive engines, of the balanced type, and in which a high and low pressure cylinder are disposed at each side, and the said invention has special reference to that type of balanced engines in which the high and low pressure cylinders are disposed in vertical alinement with their valve casings in close proximity thereto and the several cylinders and casing mounted upon a single saddle or supporting means.

Primarily our invention seeks to provide an improved construction of engine of the character stated which involves a compact and economical arrangement of parts, in which the valve mechanism is designed for a maximum degree of efficiency for governing the feed of the high and low pressure working fluid and to control and regulate the fluid pressure exhausted from the high pressure cylinder in such a manner as to render the back pressure in the high and low pressure cylinders uniform.

Another and important object of our invention lies in providing an improved engine construction in which the parts can be quickly and conveniently shifted while the engine is in motion and whereby all the cylinders can be adjusted to work under high pressure.

Another object of our invention is to provide means whereby the engine can be set to choke itself down to a stop in the event that the throttle refuses to close while a heavy train is going down grade.

Again our invention contemplates a peculiar construction of engine of the character generally stated in which the operating mechanism can be quickly and operatively adjusted while the train is in motion to convert the several cylinders into air compressors for charging up the air reservoir of the usual brake and signaling mechanism.

With other objects in view which will hereinafter be apparent, our invention in its generic nature comprehends a pair of high and low pressure cylinders one set for each side, a pair of valve mechanisms of like construction for each set of cylinders with which they are coöperatively joined, a supplemental exhaust valve mechanism common to both sets of cylinder, valve devices and a means under control of the engineer for shifting the several valve mechanisms.

Our invention also embodies an improved construction of two sets of high and low pressure cylinders, a controlling valve for each set of cylinders, a supplemental valve mechanism coupled with the other valve mechanism, a single shifting means operable from the engine cab for setting the main and supplemental valve mechanisms, and a peculiar arrangement of coupling device for joining the several cylinders with the air reservoir, adapted under a proper manipulation, to instantly convert the several cylinders into air compressors, the said coupling devices including operating valves for controlling the fluid feed to the cylinders and into the air off-take from the said cylinders to the air storage receiver or reservoir, and in its more subordinate features our invention embodies sundry details of construction and peculiar combination of parts hereinafter fully described, specifically pointed out in the appended claims, and illustrated in the accompanying drawings, in which:—

Figure 1, is an end elevation of a compound locomotive engine constructed in accordance with our invention, Fig. 2, is a horizontal section of the same taken on the line indicated by 2—2 in Fig. 1, the parts being adjusted for compound pressure action, Fig. 3, is a diagrammatic sectional view illustrating the general coöperative connection of the several high and low pressure cylinders, the valve mechanism therefor and the supplemental exhausting valve, the parts being adjusted for high pressure action in all the cylinders, Fig. 4, is a diagrammatic horizontal section of our engine the supplemental exhaust valve being shown adjusted to convert the steam cylinders into air compressors, the said valve being set to lead the air from the cylinders into the air off-take to the air reservoir, Fig. 5, is a vertical section taken substantially on the line 5—5 of Fig. 2, Fig. 6, is a detail vertical section hereinafter referred to and taken substantially on the line 6—6 of Fig. 2, Fig. 7, is a detail perspective view of the shifting lever mechanism operable from the engine cab, Figs. 8 and 9, are detail views of the relief valves R and R′ hereinafter referred to, Fig.

10 is a diagrammatic sectional view illustrating the general coöperative connection of the several parts of our invention, the parts being adjusted for compound action.

In the practical application of our invention we provide a pair of high pressure cylinders, H---H each of which is cast integral or otherwise firmly joined with a low pressure cylinder L, and joined with a coöperating valve casing, the two casings which are designated 1^c and 2^c in the drawing, being disposed as closely to their respective high pressure cylinders as is practical, and preferably in the horizontal plane of the high pressure cylinder as shown in the drawing in which all of the cylinders and the valve casings, including a supplemental valve casing hereinafter referred to are suspended on the usual ordinary type of saddle S as shown.

While we prefer to arrange the high and low pressure cylinders and their respective valve casings in the manner stated and shown, said manner being the conventional way of mounting such parts, we desire it understood that our invention is not restricted to such special correlative position of the cylinder and the valve casings, as the said positions may be varied and the high and low pressure cylinders project side by side in horizontal plane, or in tandem if desired, so long as the special connection with their inlet and outlet ports with the several valves that coöperate therewith in the manner hereinafter described, are maintained.

The valve casing 1^c at one side, at a point midway thereof, has a live steam inlet 1 which feeds against the high pressure side of the valve 10 reciprocal within the casing 1^c, and the said casing in the same side also has ports 2 and 3 that connect through the leads 2^a and 3^a with the opposite ends of the high pressure cylinder H that is controlled by the valve 10 and furthermore it has in the said side, exhaust ports 4 and 5 that connect through the leads 4^a and 5^a, with the exhaust receiving chamber C which is common to both sets of cylinders and valve mechanisms, and the high pressure side of the valve casing, 2^c, has similar ports 1^x, 2^x, 3^x, 4^x and 5^x that coact with the high pressure side of the valve 20 which is operatable within the casing 2^c. Upon the other side the valve casing 1^c has ports 16 and 17 that communicate through the leads 16^a and 17^a with the opposite ends of the low pressure cylinder L that coöperates with the valve 10 and at such side the said casing 1^c is also provided with a port 19 which is diametrically opposite the main inlet 1 and said valve casing also has exhaust ports 15 and 18 that connect by a single lead 5^x with an inlet 13 in one side of a casing 30 in which operates a supplemental or extra exhausting valve 3^n. The port 19 joins with a port 8 in the valve casing 30 and through the lateral port 12^a with the port 12 in the said side of the casing 30, the reason for which will presently appear.

The valve casing 2^c is similarly provided with ports designated 16^x and 17^x, that join with the low pressure cylinder L controlled by valve 20 and also has ports 15^x and 18^x that join through the common lead 18^c with the port 13^x of the separate or supplemental exhausting valve 3^n at a point diametrically opposite the port 13 in communication with the valve casing 1^c. The valve casing 2^c is also provided with a port 19^x which is disposed diametrically opposite the feed port 1^x in the said casing and which, through the lead 19^z connects with the port 8^x in the valve casing 30 disposed diametrically opposite the port 8 that connects with the port 19 in the valve casing 1^c and the two ports 8 and 8^x are in annular alinement with another port 14 in the casing 30 which communicates through the lead 14^x with the boiler.

The lead from the port 19 in the valve casing 1^a to the valve casing 30 is provided with relief valves R and R′, as shown, and the lead 19^z that joins the ports 19^x and 8^x also has relief valves R and R′. The relief valves R and R′ may be of any well known type and one of said valves R (see Fig. 8) is normally held closed by spring pressure and opens inwardly by a vacuum in the cylinder with which it joins, while the other valve R′ (see Fig. 9), is normally held open by spring pressure, the valve opening inwardly, and arranged to close by steam or air pressure from the cylinder to which it joins. The valves R and R′ are arranged in pairs as shown in Fig. 7 and controlled by the three way valves U hereinafter again referred to so that when the lever 50 is manipulated either valve R or R′ can be brought into operative connection or both valves may be set to remain operative in a manner presently again fully explained. Relief valves are also provided in the leads 23 and 24, which leads are also coöperatively connected with the shifting mechanism shown in Fig. 7 to be operated in unison with the first mentioned sets of valves R and R′.

The valve 10 in the high pressure side has longitudinal pockets or grooves *a*, *b*, *c* one of which *a* coacts with the ports 5 and 3 in the casing 1^c, the one *b* coacts with the ports, 1, 2 and 3 and the other *c* coöperates with the ports 4 and 2 and the opposite or low pressure side of the said valve 10 has similar pockets or grooves *a*′, *b*′ and *c*′ which are disposed diametrically opposite the grooves *a*, *b* and *c* and are adapted to coact, the groove *a*′, with the ports 15 and 16 in the casing 1^c, the pocket or groove *b*′ which the ports 16, 19 and 17 and the pocket *c*′ with the ports 17 and 18 in a manner and for a purpose hereinafter described.

The valve 20 that operates in the casing

2^c has a similar arrangement of grooves or pockets a^2, b^2 and c^2 on the high pressure side which coöperate, the groove c^2 with the ports 2^x and 4^x in the casing 2^c, the pocket b^2 with the ports 1^x, 3^x, and 2^x and the pocket a^2 with the ports 3^x and 5^x and on the low pressure side it has pockets or grooves c^3, b^3 and a^3 that coact, the pocket a^3 with the ports 17^x and 18^x, the pocket b^3 with the ports 19^x 15^x and 16^x and the pocket c^3 with the ports 15^x and 16^x.

The supplemental exhaust valve 30 has a series of transverse ports 31, 32, 33 and 34, one of which, 32, under a proper shifting of the said valve 30 communicates with and connects the two ports 8 and 8^x in the valve casing 3^c and opens up communication between the two valves 10 and 20.

The port 31 under a proper shifting of the valve 3^n opens communication through the ports 6 and 20^x in the valve casing 30 between the stack T and receiving chamber C.

The cross port 33 is of sufficient width to connect under one adjustment with an exhaust 9 in communication with the lead 62 from the port 6 to the receiver C and with the port 13, and under another adjustment it is adapted to connect the said port 13 direct with the stack T through an outlet 10^x in the valve casing and the lead 10^a that joins with the stack as best shown in Fig. 6.

In operation, when working under high pressure steam our engine mechanism operates as follows:—Assuming the correlation of the valves 10 and 20, the supplemental exhaust valve 3^n and the pistons in the high pressure cylinders being in the position shown in Fig. 3 and the direction of movement of the two pistons P and P′ being indicated by the arrows. When thus arranged the valve 20 takes live steam from the boiler which enters the high pressure side of the valve 20 through the port 1^x from whence it enters the groove b^2 in the valve 20 and passes out through the port 3^x into the high pressure cylinder H in front of the piston P′. At the same time the high pressure cylinder H referred to is exhausting at the rear end through the port 2^x the valve pocket c^2 out through the port 4^x to the receiver C and from thence through the ports 6 and 20^x in the casing 30 and the cross port 31 in the valve 3^n to the stack. The valve 10 likewise receives high pressure steam through the inlet 1 which passes through the valve groove b out through the port 2 and to the rear of the piston P in the high pressure cylinder H that is joined with and controlled by the said valve 10 and the said cylinder H exhausts through the port 3 the valve groove a in the valve 10 out through the port 5 into the receiver C and from thence to the stack. High pressure steam is also admitted from the boiler into the port 14 of the exhaust valve casing 30 and from thence through the ports 8 and 8^x and the lead 19^z to the port 19 in the valve casing 1^c and to the port 19^x in the valve casing 2^c against the low pressure side of the valves 10 and 20 and from thence through the grooves b' and b^3 out through the ports 16—16^x to the low pressure cylinders, which cylinders exhaust through the ports 16 and 15 in the valve 10 and 17^x and 18^x in the valve 20 into the lead that connects with the ports 13 and 13^x in the valve casing 30 and through the cross port 33 in the said valve out through the outlet port 9 to the stack.

When working our improved engine mechanism under the high pressure in the four cylinders the lever 50 (see Fig. 7) is set to the notch m', both relief valves R and R′ being cut in, the valve 10 takes steam through the port 1 from the boiler and admits said fluid pressure through port 2 to the high pressure cylinder connected therewith and which is then exhausting at the other end through the ports 3 and 5 to the receiver C. The ports 11 and 12 in the supplemental exhaust valve at this time will close by proper shifting of the valve 3^n (see Fig. 3) and the ports 6 and 20 are open by reason of the cross port 31 in the valve 3 being in register therewith. The high pressure exhaust goes through the ports from the receiver C to the ports 6 and 20^x to the stack, and during this latter arrangement of the mechanism, the high pressure steam feed from the boiler also goes through the ports 14 and 19 to the low pressure side of the valves 10 and 20 while at the same time exhausting out of ports 16 and 15, 17^x and 18^x back to ports 13 and 9 and from thence joins with the high pressure exhaust to the stack.

When the engine is working compound the lever 50 is set to the notch m^2, the relief valve R′ being brought into operative position and the steam is admitted through the port 1 from the boiler to the high pressure side of valve 10 and transmitted from there through the port 2 to the high pressure cylinder and at the same time the exhaust passes from the other end of the cylinder through the ports 3 and 5 that lead to the receiver C and through the leads from the said receiver C back through the separate exhaust port 11 and out through port 12 to the low pressure side of valve 10 through the port 19, and then to the low pressure cylinder through the port 17 which cylinder exhausts at the same time at the other end through the ports 16 and 15 to the port 13 in the separate exhaust and through the port 10 to the stack (see diagrammatic illustration, Fig. 10). When the engine is needed for compressing air for brake services the lever 50 is set to the notch m, the relief valve R being brought into operative connection and the supplemental valve 3 is shifted to the limit

of its back motion to close the exhaust port 20^x and to connect the port 6 with the port 7 (see Fig. 4) that leads to the air reservoir.

The relief valves R and R′ in the leads 23, 24, and 19^r then come into play and air is taken in through the high pressure cylinder at one side and it is exhausted in the same manner as when working under high pressure steam, until it comes to the exhaust port 20^x and by reason of the latter being at this time closed and the ports 6 and 7 are coupled together the air flows from the port 6 through the pocket 60^a in the valve 3^n out through the port 7 to the air reservoir. Any suitable means may be utilized for shifting the exhaust valve 3^n and the valve 30, operated from the engine cab, for example, such as is illustrated in Fig. 7 by reference to which it will be noticed the hand lever 50 has a pawl 50^a that engages with the rack M having three notches m, m' and m^2 one of which m^2 designates the point of adjustment of the lever 50 for working the engine compound, the central one m' the point for adjusting the lever to work the engine under high pressure and the third or last, m, the point for adjusting the lever to adapt the mechanism for compressing the air for the air reservoir and the lever 50 is pivotally connected with the rod N that joins with the exhaust valve 3^n. The said rod has stop collars n—n for coöperating with the shifting arm O that controls the crank lever Q connected with the three-way valves that govern the action of the relief valves R and R′.

From the foregoing description taken in connection with the accompanying drawings, it is believed that the manner in which our improved engine operates, and its construction will be readily apparent to those skilled in the art to which it appertains.

Among the advantages of our invention it should be stated that the engineer can make any of the changes quickly and effectively, while the engine is in motion. Should the engine be pulling a heavy train up a grade and the strain is too much by moving the actuating lever to the second notch m' will shift the valves to work all cylinders under high pressure, and should anything happen to the usual automatic pump while going down grade, by throwing the lever to the notch m^2 the several cylinders and the valve mechanism will then be worked high pressure to cause the cylinders shifted beyond to actuate as air compressors. It is understood that in the line to the air drum suitable pressure regulating valves are provided.

By providing the relief valves R in the leads 1—1^r, it is obvious that when running down grade and no air storage is needed, by properly setting the valves R to remain open, no vacuum will be formed in the cylinder H as its piston reciprocates, and under such adjustment of the valves the cylinders H do not operate as air pumps.

Another important advantage of our invention is that should a heavy train be going down grade and the throttle, for any reason, refuse to close, by simply throwing the lever 50 to the central notch, the parts will be set so that the cylinders will work under a high pressure. When the parts are thus adjusted, by then moving the lever 50 from the central notch so as to gradually cause the valve 3^n to close off the ports 6 and 20^x, to the stack, the pressure in the air reservoir will soon exceed that of the steam at the throttle valve, and thereby choke off or prevent the steam from passing into the engine through the throttle valve. And as there are no open exhausts to the stack T at this time, the engine will be brought to a stop by the power stored up, due to its own momentum in going down grade.

While the arrangement of parts as shown in the drawing illustrates a preferred construction of our invention, yet we desire it understood that the details of construction may be readily varied, modified or amplified without departing from the spirit of the invention or the scope of the appended claims.

Having thus described our invention what we claim and desire to secure by Letters Patent, is:—

1. As an improvement in engines, the combination with a pair of cylinders, a distributing valve for each cylinder, and an exhaust lead that is common to both distributing valves, of an auxiliary valve having an exhaust port that communicates with the stack and is adapted under one adjustment to connect the exhaust lead from the two cylinders with the stack, an air reservoir having a lead that connects with the supplemental exhaust valve, the said exhaust valve having a port adapted under a predetermined adjustment to connect the cylinder exhaust with the reservoir, and relief valves 3 connected with the feed lead to the distributing valves for charging the cylinders with air when the exhaust through the supplemental valve to the stack is cut off and the exhaust from the said valve to the air reservoir is open, for the purposes specified.

2. In a locomotive engine, the combination with high and low pressure cylinders, of a distributing valve therefor on one side of the locomotive, and corresponding parts on the opposite side of the locomotive, of a receiver space common to both sets of cylinders and their distributing valves, and an air reservoir, of an auxiliary exhausting valve that communicates and coöperates with the two distributing valves at the opposite sides, and with the receiver space, said supplemental exhausting valve including a port adapted to be brought into communication with the

air reservoir, means operable from the engine cab for shifting said auxiliary valve with relation to the distributing valves, said valves having provisions in virtue of which the several cylinders may be operated under compound action or under high pressure in all the cylinders, or as air compressors, as set forth.

3. The combination with a pair of cylinders and a separate distributing valve cooperatively joined with each cylinder; of an exhaust receiver in communication with the distributing valves, and an auxiliary valve mechanism having inlet and exhaust ports that communicate with the receiver and adapted under one adjustment to control the feeds in the exhausts to feed a steam pressure into the cylinders and under another adjustment to convert the two cylinders into air compressors, and means for shifting the said auxiliary valve.

4. The combination with high and low pressure cylinders, a distributing valve cooperatively joined with each set of high and low pressure cylinders, a receiver in communication with the distributing valves, and an air reservoir, of an auxiliary valve mechanism having inlet and outlet ports that communicate with said distributing valves and ports that communicate with said receiver and said air reservoir, and having provisions in virtue of which when the auxiliary valve is under one adjustment it controls the feeds and exhausts to effect a compound action of the two sets of cylinders, under another adjustment to work all the cylinders under high pressure, and under a third adjustment to convert the several cylinders into air compressors, and means for shifting the auxiliary valve.

5. In a locomotive engine; the combination with an air reservoir, a pair of pressure cylinders, a separate distributing valve for each of the pressure cylinders, an exhaust receiver common to both cylinders and their coöperating distributing valves; of a supplemental exhausting valve in communication with the stack and with the exhaust receiver, the said supplemental valve including a supplemental exhaust port adapted when the valve is adjusted to cut off the stack exhaust from the receiver to connect the said receiver with the air reservoir, as set forth.

6. In a locomotive engine; the combination with a pair of high pressure cylinders and a pair of low pressure cylinders one for each high pressure cylinder, a distributing valve for each set of high and low pressure cylinders, a receiver common to both sets of cylinders, and their coöperating distributing valves; of a supplemental valve exhausting mechanism in communication with the stack and with the two distributing valves, the said supplemental valve mechanism including a supplemental exhaust port adapted when the valve is adjusted to cut off the stack exhaust to exhaust to the air reservoir, as set forth.

7. The combination with the two sets of high and low pressure cylinders and their controlling valves, the latter having their ports so arranged that under one adjustment of the said valves they effect a high pressure action in all the cylinders and under another adjustment of the valves to work the said cylinders compound, and a receiver common to both sets of cylinders and their distributing valves having connection with the stack; of a supplemental exhausting valve located in the said stack connection and having ports and feeds that connect with the high pressure cylinder distributing valves, and provided with a supplemental port adapted to connect with the aid reservoir for the brake and signal mechanism, automatically actuated relief valves, and means operable from the engine cab for simultaneously shifting the relief valves and the supplemental exhaust valves, as set forth.

8. The combination with the high and low pressure cylinders, a distributing valve therefor at one side of the locomotive, corresponding parts on the other side of the locomotive, a receiver common to both sets of cylinders and valves, and an air reservoir, of a supplemental valve mechanism having provisions in virtue of which when the supplemental valve is under one adjustment, the fluid will be conducted from the receiver against the low pressure side of the distributing valve, and under another adjustment, the pressure of the receiver will be conducted to the air reservoir, said supplemental valve having ports adapted to communicate with ports in the distributing valves, relief valves connected with the live steam feeds to the distributing valves, and other relief valves in the leads that join the supplemental valve with the distributing valves, as set forth.

9. The combination with two sets of high and low pressure cylinders and their pistons, of a distributing valve for each pair of cylinders, an exhaust receiver between the distributing valves and in communication therewith, an air reservoir, said distributing valves having similar arrangement of ports at diametrically opposite sides, and connections between said distributing valves and their respective cylinders at their respective sides, a supplemental exhaust valve in communication with each distributing valve and with the receiver and with the air reservoir, and in communication with the stack, said supplemental valve also having a live steam inlet and having provisions in virtue of which under one adjustment of the supplemental valve, the pressure is led from the receiver to the low pressure side of the distributing valves, under another adjustment

of the supplemental valve, the live steam is fed through the supplemental valve into the low pressure side of the distributing valves, and under a third adjustment to cut off the stack and lead the fluid pressure from the receiver into the air reservoir, and means for shifting the supplemental valve, as set forth.

10. The combination with the high and low pressure cylinders, and a distributing valve therefor at one side of the locomotive, corresponding parts on the other side of the locomotive, the said distributing valve having a like arrangement of high and low pressure ports at diametrically opposite sides thereof, the shiftable member of said distributing valve having grooves for connecting adjacent ports of the valve, and a receiver into which the said distributing valves discharge; of a supplemental exhausting valve in communication with the receiver, the stack, and with the distributing valves at the opposite sides of the locomotive, the said supplemental valve having its ports, which include a live steam inlet, arranged, when under one adjustment to admit live steam through the said supplemental valve to the low pressure side of the two distributing valves, and under another adjustment to feed the fluid pressure from the receiver against the low pressure side of the valves, as set forth.

11. The combination with the high and low pressure cylinders, and a distributing valve therefor mounted on one side of the locomotive, and similar cylinders and a valve therefor on the opposite side of the locomotive, a relief valve in each feed pipe for the distributing valve, a receiver space common to both of the aforesaid distributing valves, and air reservoir, of a supplemental exhausting valve for connecting said reservoir with the receiver, the said supplemental valve having passages through which the receiver exhausts to the stack, and passages for connecting the receiver with the reservoir, and another passage for connecting the low pressure side of the distributing valve, a relief valve in each lead from the supplemental valve to the distributing valve, and means for shifting the said supplemental valve from the engine cab while the train is in motion, as set forth.

12. The combination with two sets of high and low pressure cylinders, a distributing valve coöperatively joined with each set of high and low pressure cylinders, of a receiver in communication with the distributing valves and an air reservoir, an auxiliary exhaust valve mechanism also in communication with said receiver and said reservoir, said auxiliary valve mechanism having inlet and exhaust ports that communicate with the several high and low presure cylinders, and having ports that communicate with the distributing valves, said auxiliary valve mechanism being arranged under one adjustment to permit compound action of the engine, under another adjustment to permit all cylinders of the engine to work under high pressure and under a third adjustment to convert the several cylinders into air compressors, and means for shifting said auxiliary valve.

13. The combination with two pairs of cylinders, a distributing valve for each pair of cylinders, each distributing valve being coöperatively joined with each cylinder of its respective pair, an exhaust receiver in communication with each of said distributing valves and an air reservoir, an auxiliary valve mechanism in communication with each of said distributing valves and with said receiver and said air reservoir, said auxiliary valve and said distributing valves having provisions in virtue of which under one adjustment of the auxiliary valve said cylinders will run compound, under another adjustment of said auxiliary valve said cylinders will operate as an air compressor and under a third adjustment all of said cylinders will work under high pressure, and means for shifting said auxiliary valve.

14. In a locomotive engine, the combination with a pair of cylinders, and a separate distributing valve coöperatively joined with each cylinder, of an exhaust receiver in communication with the distributing valves, and an air reservoir, of an auxiliary valve mechanism having inlet and exhaust ports that communicate with the receiver and with the distributing valve, and having a port that communicates with the air reservoir, said valve having provisions in virtue of which when under one adjustment, the feeds and the exhausts are controlled to feed a working agent pressure into the cylinders and under another adjustment to convert both cylinders into air compressors, and means for shifting the auxiliary valves.

15. The combination with two sets of high and low pressure cylinders and their controlling valves, and a receiver common to both the distributing valves and having connection with the stack, and an air reservoir, of a supplemental exhaust valve located in the said stack connection, and having ports and feeds that connect with the high pressure cylinder distributing valves, and provided with a supplemental port adapted to connect with the air reservoir for the brake and signal mechanism, said supplemental valve having provisions in virtue of which when under one adjustment, a high pressure action is effected in all the cylinders and under another adjustment of the valves the cylinders are worked compound automatically actuated relief valves in the several feeds of the distributing valves, and means operable from the engine cab for simul-

taneously shifting the relief valves and the supplemental exhaust valve as set forth.

16. The combination with two sets of high and low pressure cylinders, a distributing valve coöperatively joined with each set of high and low pressure cylinders, of a receiver in communication with the distributing valves and an air reservoir, an auxiliary exhaust valve mechanism, also in communication with the receiver and the air reservoir and having inlet and exhaust ports in communication with the several distributing valves, said auxiliary mechanism having provisions in virtue of which when under one adjustment the working agent is fed to the cylinders to operate the engine compound, under another adjustment to feed the working agent to the cylinders to operate the engine under high pressure and under a third adjustment to convert the several cylinders into air compressors, and means for shifting said auxiliary valve.

17. The combination with two pairs of cylinders, a distributing valve for each pair of cylinders, each distributing valve being coöperatively joined with each cylinder of its respective pair, an exhaust receiver in communication with each distributing valve and an air reservoir, an auxiliary valve mechanism in communication with each distributing valve and with said receiver and said air reservoir, said auxiliary valve and distributing valves having provisions in virtue of which when the auxiliary valve is under one adjustment the working agent is fed into the cylinders to operate the same compound, and when the auxiliary valve is under another adjustment to convert the cylinders into air compressors, and when the auxiliary valve is under a third adjustment to feed the working agent to the cylinders to operate them under high pressure, and means for shifting said auxiliary valve.

SAM. K. McLAIN.
FRANKLIN A. PIERCE.

Witnesses:
W. W. Rogers,
H. B. Seybold.