(No Model.)

2 Sheets—Sheet 1.

C. H. BATCHELLOR.

COMPOUND ENGINE.

No. 459,851. Patented Sept. 22, 1891.

Fig. 1

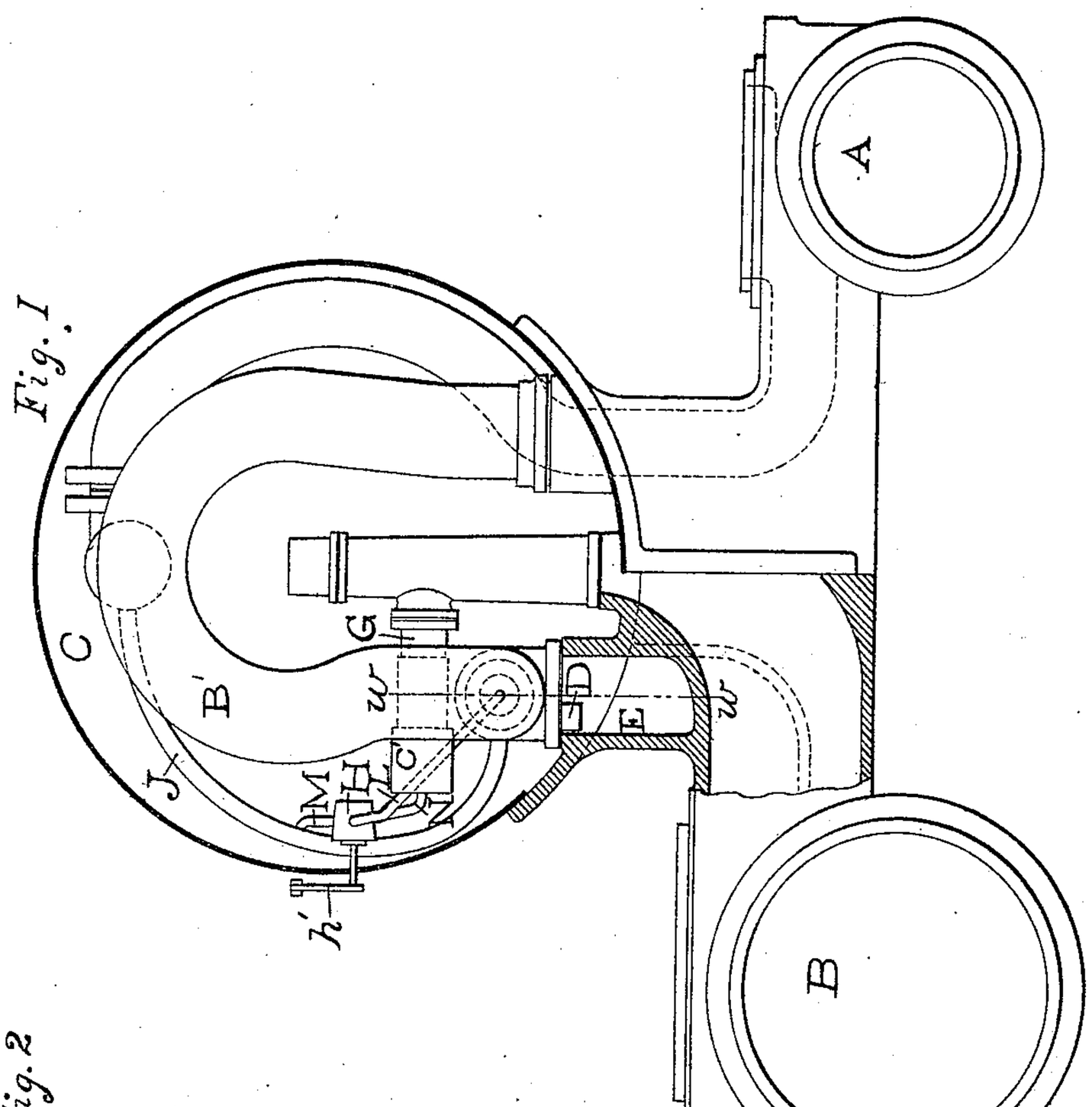
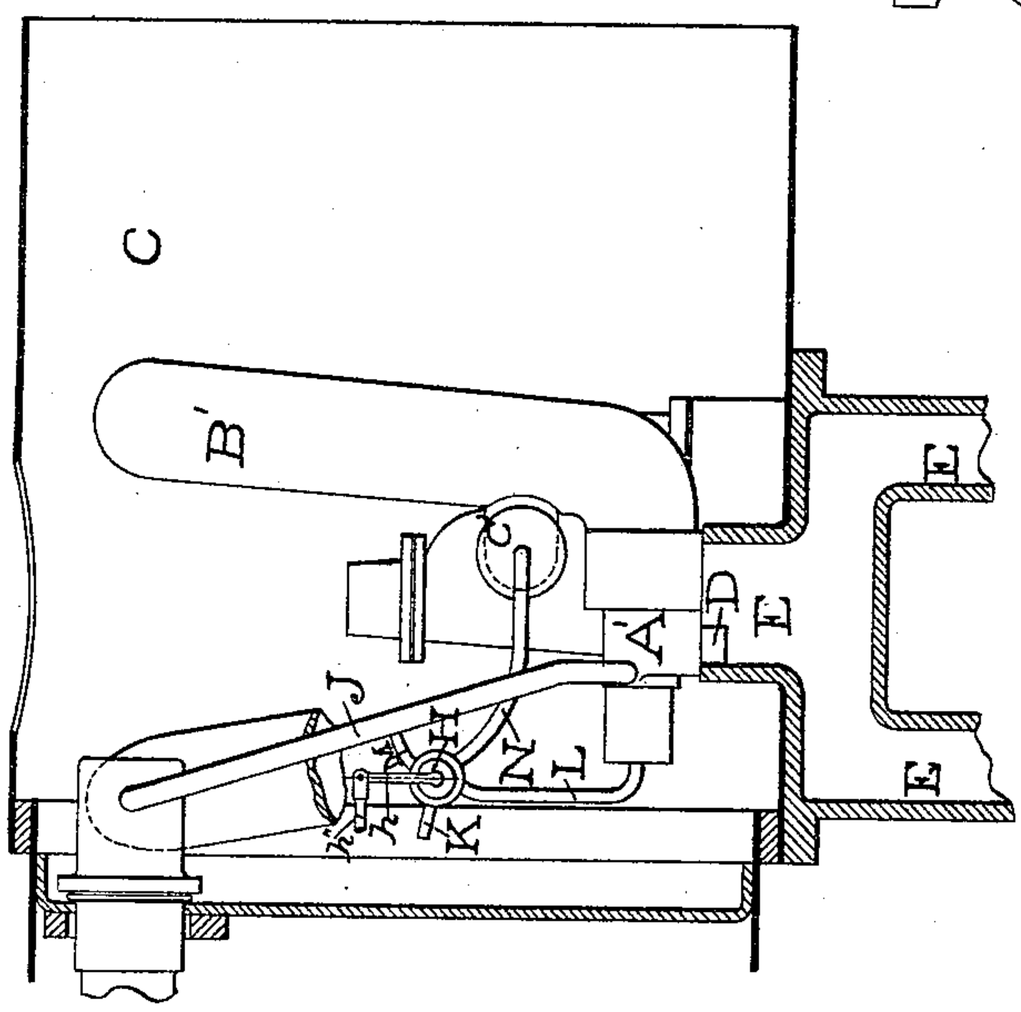


Fig. 2



WITNESSES

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

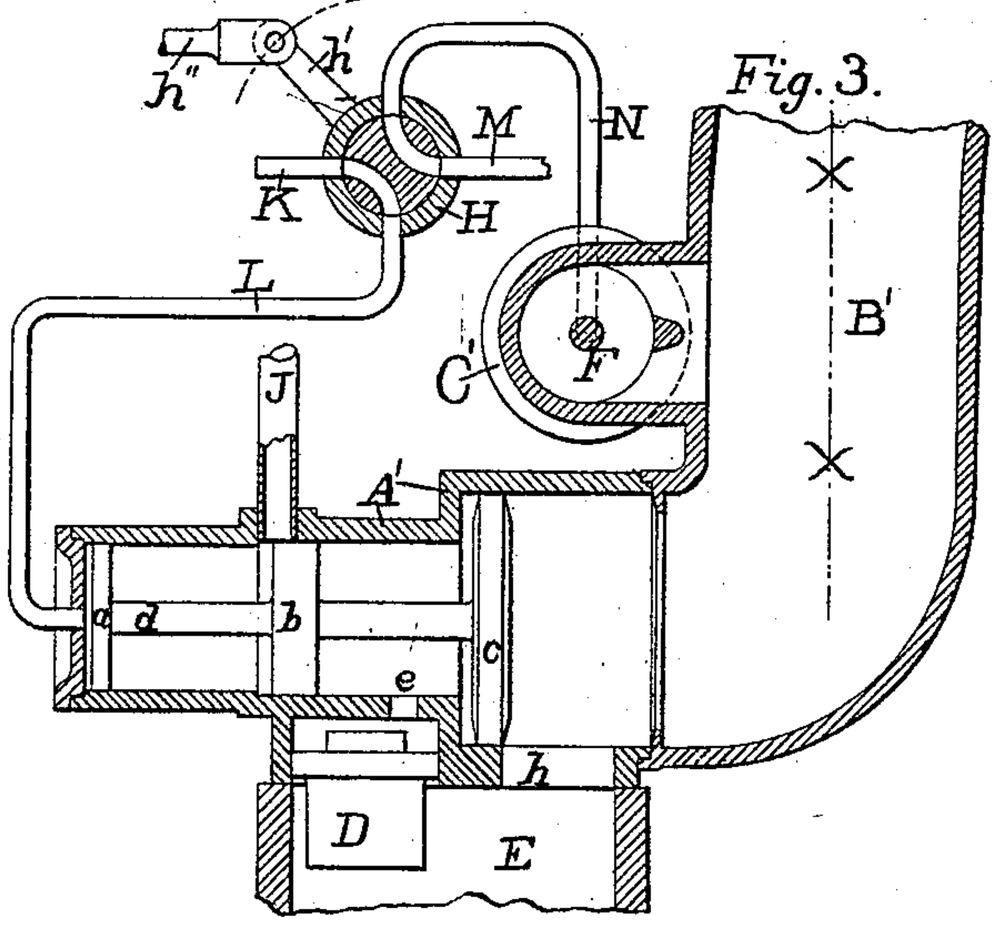

Fig. 4.

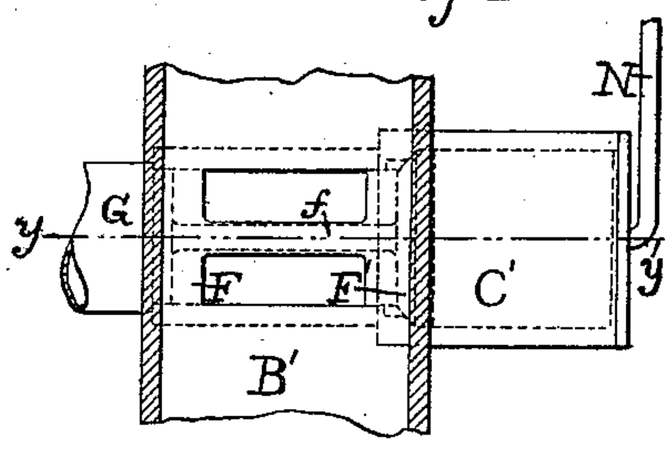

Fig. 5.

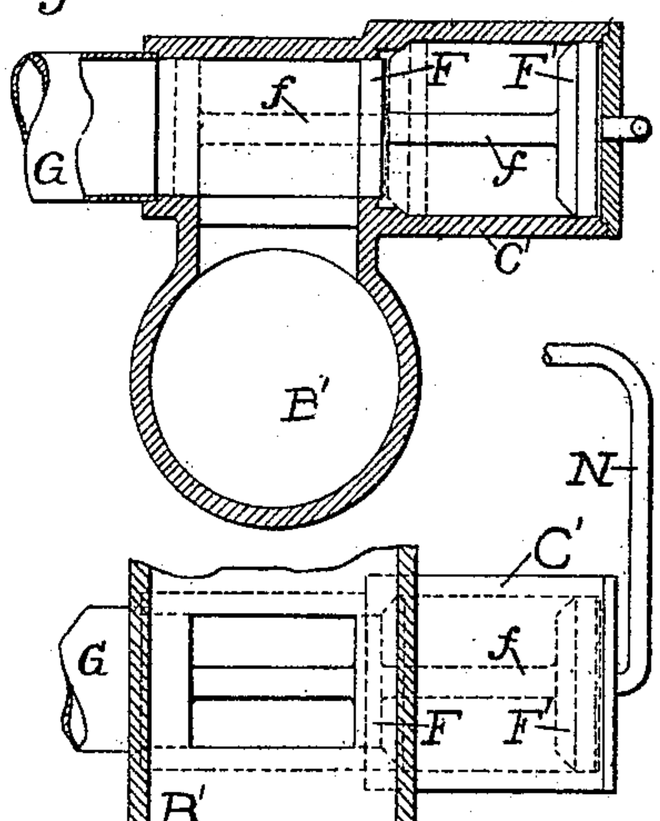

Fig. 6.

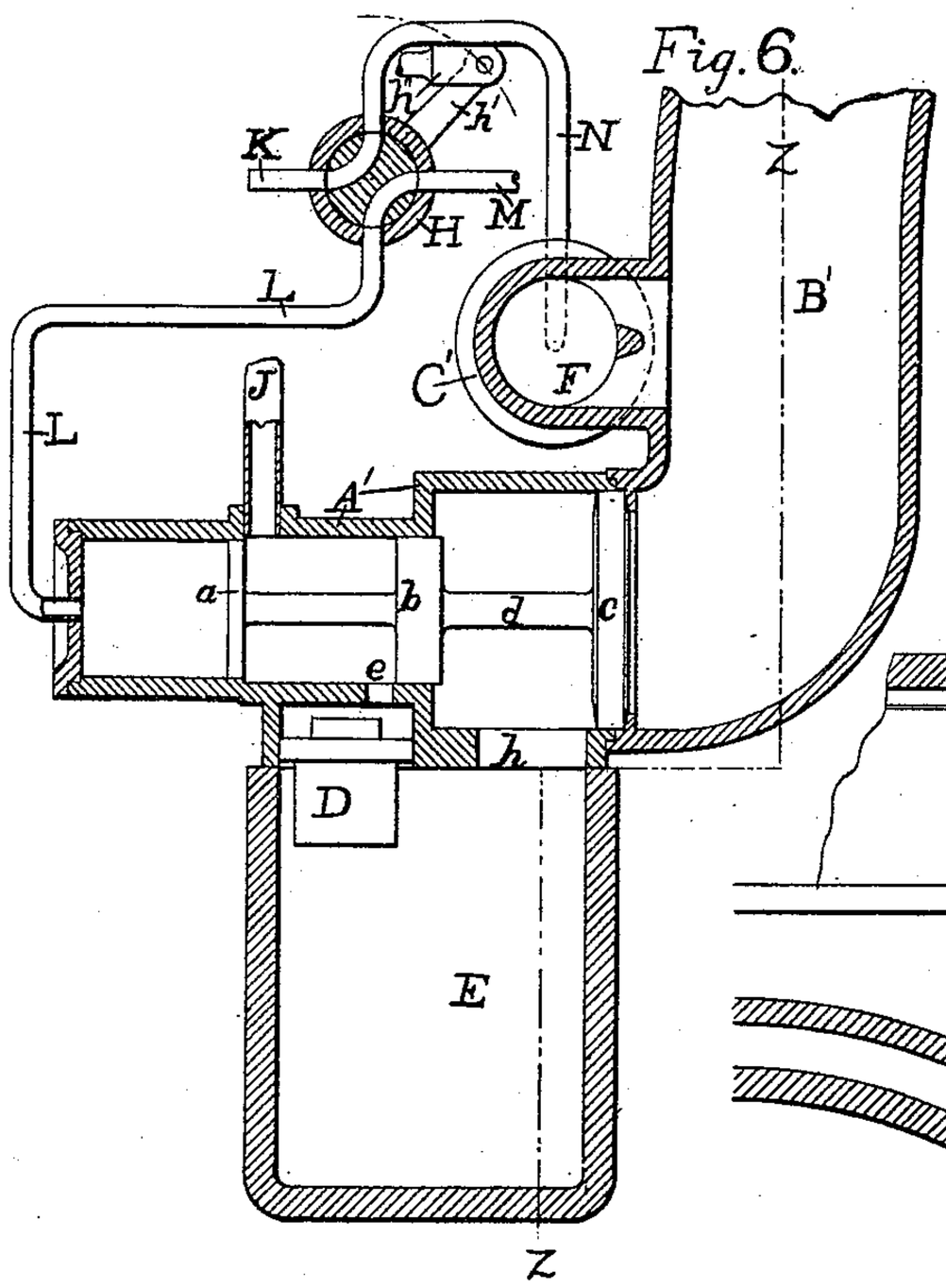

Fig. 7.

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CLIFFORD H. BATCHELLOR, OF PROVIDENCE, RHODE ISLAND.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 459,851, dated September 22, 1891.

Application filed December 13, 1890. Serial No. 374,545. (No model.)

To all whom it may concern:

Be it known that I, CLIFFORD H. BATCHELLOR, of the city and county of Providence, in the State of Rhode Island, have invented certain new and useful Improvements in Compound Engines; and I do hereby declare the following specification, taken in connection with the accompanying drawings, forming a part of the same, to be a full, clear, and exact description thereof.

My invention relates to that class of compound engines in which live steam may, when desired, be admitted to both the high-pressure and the low-pressure cylinders, instead of having the engine always work upon the compound system.

The object of my invention is to provide means whereby the engine may be started with live steam in both cylinders and then either be automatically thrown into the compound system upon the attainment of a predetermined pressure in the receiver or be allowed to run upon the simple system—that is, with live steam working both cylinders—for any length of time desired and then be caused to be thrown into the compound system upon the attainment of the predetermined pressure in the receiver; also, at the same time to make provision whereby the engine may when running upon the compound system be thrown back into the simple system whenever desired, or vice versa, the change from the simple to the compound system at all times being effected only when a predetermined pressure in the receiver has been attained, and such change being then effected in each case automatically by the steam-pressure itself.

To this end the invention consists in the employment of a controlling-valve and in certain combinations and arrangements of parts in connection with said controlling-valve, whereby the desired results may be secured by the simple manipulation of said controlling-valve, the arrangement being such that when said valve is in one position live steam will be admitted to both cylinders as long as said valve remains in that position, and when said valve is in another position the engine will be automatically thrown into the compound system upon the attainment of a predetermined pressure in the receiver.

In the accompanying drawings I have shown my invention as applied to a locomotive-engine, for use in which said invention is especially adapted, although it is likewise applicable to other types of engines, as stationary or marine.

Referring to the drawings, Figure 1 is a front view, partly in section, of a locomotive-engine, showing my improvements applied thereto. Fig. 2 is a side elevation of the forward end of a locomotive-engine, showing the arrangement of the parts embodying my invention. Fig. 3 is a central longitudinal section of a portion of the receiver which connects the high and low pressure cylinders and of the mechanism connected therewith, the section being taken on the line *w w* of Fig. 1. Fig. 4 is a section through the receiver on the line *x x* of Fig. 3. Fig. 5 is a section taken on the line *y y* of Fig. 4. Fig. 6 is a central longitudinal section of the receiver and connected mechanism corresponding to Fig. 3, but showing the operative parts in another position; and Fig. 7 is a section taken on the line *z z* of Fig. 6.

A represents the high-pressure cylinder and B the low-pressure cylinder, which are of different diameters and arranged upon opposite sides of the engine, as common.

Arranged within the smoke-box C and leading from the exhaust-port of the high-pressure cylinder to the steam-chest of the low-pressure cylinder is the connecting pipe or receiver B′. Connecting with the receiver B′ is a cylindrical chamber A′, in which are arranged to work three piston-valves *a b c*, of different diameters, all secured to a common valve-rod *d*, as shown in Figs. 3 and 6. Communicating with this chamber is a pipe J, which connects with the main steam-pipe. Arranged at the side of the receiver B′ is another cylindrical chamber C′, within which work two piston-valves F F′, of different diameters, both mounted on a common valve-rod *f*, as shown in Fig. 5. A pipe G, communicating with the chamber C′, leads to the atmosphere.

H is a four-way controlling-valve, which has four pipes K L M N communicating therewith. The pipe K leads to the atmosphere; the pipe L communicates with the chamber A′, as shown in Figs. 3 and 6; the pipe M communicates with the boiler, and the pipe N communicates with the chamber C′. Said controlling-valve

H is provided with a handle h', which may be operated by means of a rod h^2, extending to the cab.

E is a steam-pipe, which communicates with the steam-chest of the low-pressure cylinder, and *e* is an opening through the wall of the chamber A′, which communicates with the steam-passage E through a reducing-valve D, said reducing-valve being preferably of a character to reduce the steam from the boiler in proportion to the difference between the areas of the pistons of the high and low pressure cylinders, respectively.

h is another opening through the wall of the chamber A′ for connecting the pipe E with the receiver B′, as shown in Figs. 3 and 6.

The operation of the parts is as follows: The parts, including the controlling-valve H, being in the position shown in Fig. 3, with the pipe L in communication with pipe K and pipe N in communication with pipe M, and the engine being at rest, when the throttle-valve is opened steam from the boiler will be admitted to the high-pressure cylinder through the usual connections and through the pipe J to that portion of the chamber A′ which lies between the piston-valves *a* and *b*. The steam thus entering the chamber A′ will immediately, by reason of the difference between the areas of said pistons *a* and *b*, throw the three piston-valves *a*, *b*, and *c* into the position shown in Fig. 6, and when said valves are in that position direct boiler-steam will then be admitted through the passage *e* to and through the reducing-valve D to the steam-passage E, which communicates with the steam-chest of the low-pressure cylinder, the piston of which will thus be worked by live steam, reduced in pressure, however, by the reducing-valve D. If desired, the valve-rod *d* may be connected with a dash-pot or other suitable arrangement to prevent the slamming of the valves *a b c*. The movement of the piston-valves *a b c*, just described, it will be observed, will cause the valve *c* to close the opening or port *h*, as shown in Fig. 6, and thus cut off communication between the receiver B′ and the steam-passage E. The engine will then run with both cylinders working on direct steam, the high-pressure cylinder exhausting into the receiver B′ until such time as the accumulated exhaust in the receiver B′ shall have reached a predetermined pressure dependent upon the difference between the areas of the piston-valves *b* and *c*. In other words, in the construction of the valves *b* and *c* it is to be determined what pressure it is desired shall be attained in the receiver B′ before the engine shall be thrown into the compound system, and said valves are then constructed with the proper proportional areas to effect the desired result. While the engine is working, as above described, the valves F and F′ in the chamber C′ are to be in the position shown in dotted lines in Figs. 4 and 5, and so as to cut off the communication from the receiver B′ to the atmosphere through the pipe G, said valves F F′ being held in that position by the pressure upon the face of the valve F′ of the steam supplied to the chamber C′ through the pipe M, valve H, and pipe N. When the predetermined pressure has been attained in the receiver B′, said pressure will act, by reason of the difference between the areas of the piston-valves *b* and *c*, to throw the valves *a b c* from the position shown in Fig. 6 back into the position shown in Fig. 3. This will have the effect to cut off the boiler-steam from the steam-passage E and hence from the low-pressure cylinder, and to open communication between the receiver B′ and said passage E through the opening or port *h*, whereupon the low-pressure cylinder will be worked by the exhaust from the high-pressure cylinder and the engine be run upon the compound system. It will be observed that this change from the simple to the compound system is effected automatically by the pressure in the receiver whenever that pressure has reached the predetermined point, and no hand manipulation whatever is required to effect said change. When the engine is thus thrown into the compound system it will continue to run compound until brought to rest, unless the controlling-valve H is manipulated to throw the engine back into the simple system, as hereinafter described. If, now, it be desired to prevent the engine from being automatically thrown into the compound system—or, in other words, to keep the engine running upon the simple system, for any desired length of time—all that is necessary to be done is to turn the controlling-valve H from the position shown in Fig. 3 into the position shown in Fig. 6, whereby the pipe L will be disconnected from pipe K and connected instead with the pipe M and the pipe N will be disconnected from the pipe M and connected instead to the pipe K. This will have the effect to close the communication of the chamber A′ with the atmosphere and to open said chamber in front of the valve *a* to steam-pressure and at the same time to take away the steam-pressure from the chamber C′ in front of the valve F′ and to open said chamber in front of said valve F′ to the atmosphere. This latter change will cause the valves F and F′ to be thrown into the position shown in full lines in Fig. 5 by means of the steam-pressure in the receiver acting upon the differential area of the valve F′, and thus open the receiver B′ to the atmosphere through the pipe G. As the chamber A′ is now connected to a steam-supply through the pipe L, there will be a pressure of steam upon the front of the piston-valve *a* in addition to the pressure of the steam coming through the pipe J upon the differential area of the valve *b*, and as the receiver B′ is now open to the atmosphere through the pipe G there will be no accumulation of steam in the receiver, and consequently no effective pressure to act upon the piston-valve *c* to overcome the steam-pressure upon the

valves *a* and *b*, with the result that the valves *a b c* will remain in the position shown in Fig. 6, and the engine will continue to run upon the simple system as long as the controlling-valve H is left in the position shown in that figure.

Whenever it is desired to have the engine run upon the compound system, all that is necessary to be done is to move the controlling-valve H from the position shown in Fig. 6 back to the position shown in Fig. 3. When this is done, the valves F and F′ will, by means of the steam which will be admitted to the chamber C′ through the pipe N, so as to act upon the face of the valve F′, be thrown back to the position shown in dotted lines in Figs. 4 and 5, thus cutting off the connection between the receiver B′ and the atmosphere, whereby the exhaust from the high-pressure cylinder will be caused to accumulate in the receiver. As soon as this accumulation of steam in the receiver has reached the predetermined pressure the valves *a b c* will be automatically moved into the position shown in Fig. 3, the pipe L having been cut off from a steam-supply and opened to the atmosphere, and the engine will thus be automatically thrown into the compound system upon the attainment of the predetermined pressure in the receiver, as before described. If, now, the engine be running on the compound system—that is, with the parts in the position shown in Fig. 3—and it is desired at any time to throw it into the simple system, all that it is necessary to do is to move the controlling-valve H into the position shown in Fig. 6. This will cut off the supply of steam from the pipe N, and consequently remove the pressure from the face of the piston-valve F′, thus allowing the valves F and F′ to be thrown into the position shown in full lines in Fig. 5, by means of the pressure in the receiver B′ acting upon the differential area of the valve F′, and thus open the receiver B′ to the atmosphere through the pipe G, as before described. At the same time the pipe L will be connected to the steam-supply through the pipe M, and steam will thus be admitted to act upon the face of the piston-valve *a*, the pressure on which, in addition to the pressure of steam from the pipe J upon the differential area of the valve *b*, will act to quickly throw the valves *a b c* into the position shown in Fig. 6, even before the receiver-pressure on the valve *c* is materially reduced. This will have the effect to close the port *h* and cut off communication between the receiver B′ and the steam-passage E before the pressure in said passage is materially reduced, and at the same time to open the port *e*, so as to permit the live steam from pipe J to pass to and through the reducing-valve D to the steam-passage E. The engine will thus be caused to run upon the simple system, and will continue so to run as long as the controlling-valve H is left in the position shown in Fig. 6. If at any time thereafter it be desired to change back again to the compound system, by simply moving the controlling-valve H to the proper position the exhaust from the high-pressure cylinder will be accumulated in the receiver, and upon the attainment of the predetermined pressure in the receiver the engine will be again automatically thrown into the compound system. It will thus be seen that by means of the mechanism above described all the desired results may be obtained simply by a manipulation of the controlling-valve. Thus with said controlling-valve in the proper position the engine may be started with live steam working both cylinders, and then as soon as the predetermined pressure in the receiver is reached be automatically thrown into the compound system. Again, with said controlling-valve in another position the engine will not only start with live steam in both cylinders, but will continue to run upon the simple system for any desired length of time and until the position of the controlling-valve is changed, when by simply moving said controlling-valve the engine will be automatically thrown into the compound system upon the attainment of the predetermined pressure in the receiver. And finally the engine when running compound may be immediately thrown into the simple system at any time by simply moving the controlling-valve into the proper position, the change from compound to simple being made with no interruption to continuous pressure in the low-pressure cylinder. The engine is thus always entirely under the control of the engineer, who may at will, by a simple manipulation of the controlling-valve, throw the engine from the simple system into the compound, or vice versa, or allow it to be automatically thrown into the compound system as soon after starting as the predetermined pressure is reached in the receiver. Again, it will be observed that in all cases the change from the simple to the compound system is automatically effected by the pressure in the receiver, and is never effected until that pressure has reached a predetermined point sufficient to effectively work the low-pressure cylinder when admitted thereto.

The advantages of the improvements hereinbefore described when applied for use in a locomotive-engine, for example, will be apparent. By means thereof live steam may be admitted to the low-pressure cylinder in starting, which is very desirable in a compound locomotive. Again, both cylinders may, when desired, be worked with live steam for any length of time after starting, instead of having the engine run almost immediately into the compound system, as has usually been the case. Again, the engine may when running compound be at any time thrown back into the simple system and so run for any desired length of time—as, for instance, while climbing a long or heavy grade—and then, when desired, be returned again to the compound system, and finally the engine will not in any

case be thrown into the compound system until an effective working pressure has been attained in the receiver, and so that when the engine begins to run compound the work will be practically equally distributed between the high and the low pressure cylinders, which is very desirable.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a compound engine, the combination, with the high and low pressure cylinders and a receiver connecting the two, of a valve for opening or closing said receiver to the atmosphere, a valve for opening or closing the communication between said receiver and the low-pressure cylinder, and a valve for opening or closing said low-pressure cylinder to live steam, all of said valves being automatically operated by steam-pressure, substantially as described.

2. In a compound engine, the combination, with the high and low pressure cylinders and a receiver connecting the two, of a valve for opening or closing said receiver to the atmosphere, a valve for opening or closing the communication between said receiver and the low-pressure cylinder, a valve for opening or closing said low-pressure cylinder to live steam, all of said valves being automatically operated by steam-pressure, and a controlling-valve to control the admission or exclusion of steam to operate said automatically-operated valves, substantially as described.

3. In a compound engine, the combination, with the high and low pressure cylinders and a receiver connecting the two, of a chamber communicating with said receiver, differential piston-valves working in said chamber, a pipe communicating with said chamber, and a controlling-valve for connecting said pipe either with a steam-supply or with the atmosphere, whereby by the manipulation of said controlling-valve said piston-valves will be automatically moved by steam-pressure to open or close said receiver to the atmosphere, as may be desired, substantially as described.

4. In a compound engine, the combination, with the high and low pressure cylinders and a receiver connecting the two, of a chamber communicating with the steam-passage leading to the low-pressure cylinder, differential piston-valves working in said chamber, a pipe connecting said chamber with the boiler, a second pipe communicating with said chamber, and a controlling-valve for connecting said last-named pipe either with a steam-supply or with the atmosphere, whereby by the manipulation of said controlling-valve said piston-valves will be automatically moved by steam-pressure to open said low-pressure cylinder either to live steam from the boiler or to exhaust-steam from the receiver, as may be desired, substantially as described.

5. The combination, with the high and low pressure cylinders and a receiver connecting the two, of a chamber communicating with the steam-passage leading to the low-pressure cylinder, piston-valves working in said chamber, a pipe connecting said chamber with the boiler, a second pipe communicating with said chamber, a controlling-valve for connecting said last-named pipe either with a steam-supply or with the atmosphere, and a reducing-valve located between said chamber and the low-pressure cylinder, whereby by the manipulation of said controlling-valve said piston-valves will be automatically moved to open said low-pressure cylinder either to live steam from the boiler or to exhaust-steam from the receiver and when opened to live steam from the boiler the pressure of said live steam will be reduced by said reducing-valve, substantially as described.

6. The combination, with the high and low pressure cylinders and a receiver connecting the two, of a chamber communicating with the steam-passage leading to the low-pressure cylinder, differential piston-valves working in said chamber, a pipe connecting said chamber with the boiler, a second pipe communicating with said chamber, a controlling-valve for connecting said last-named pipe either with a steam-supply or with the atmosphere, and a proportional reducing-valve located between said chamber and the steam-passage leading to the low-pressure cylinder, whereby by the manipulation of said controlling-valve said piston-valves will be automatically moved to open said low-pressure cylinder either to live steam from the boiler or to exhaust-steam from the receiver and when opened to live steam from the boiler the pressure of said live steam will be reduced by said reducing-valve proportionately to the difference in areas between the pistons of the high and low pressure cylinders, substantially as described.

7. The combination, with the high and low pressure cylinders and a receiver connecting the two, of valves adapted to be automatically operated for opening the low-pressure cylinder either to live steam from the boiler or to exhaust-steam from the receiver, valves adapted to be automatically operated for opening or closing said receiver to the atmosphere, and a hand-operated controlling-valve having suitable connections with a steam-supply and with the atmosphere, whereby with said controlling-valve in one position the engine will be automatically thrown from the simple to the compound system upon the attainment of a predetermined pressure in the receiver and with said controlling-valve in another position the engine will continue to run upon the simple system as long as desired, substantially as described.

8. The combination, with the high and low pressure cylinders and a receiver connecting the two, of the two chambers A′ and C′, the four-way controlling-valve H, the pipes K and M, connecting said controlling-valve with the atmosphere and with a steam-supply, respectively, and the pipes L and N, connecting said controlling-valve with the chambers A′ and C′, respectively, substantially as described.

9. The combination, with the high and low pressure cylinders and a receiver connecting the two, of the chamber C′, communicating with said receiver and with the atmosphere, the differential piston-valves F and F′, secured to a common valve-stem, the connecting-pipe N for admitting steam to the said chamber C′ in front of the piston F′ or for opening the same to the atmosphere, and the controlling-valve H for controlling the admission of steam to the pipe N or opening the same to the atmosphere, substantially as described.

10. The combination, with the high and low pressure cylinders and the receiver connecting the two, of the chamber A′, having an opening or port *e* leading to the low-pressure cylinder, the differential piston-valves *a* and *b*, secured to a common valve-stem, the pipe J, connecting said chamber A′ with the boiler, the pipe L for admitting steam to the said chamber A′ in front of the piston *a* or for opening the same to the atmosphere, and the controlling-valve H for controlling the admission of steam to the pipe L or opening the same to the atmosphere, substantially as described.

11. The combination, with the high and low pressure cylinders, of the receiver B′, the chamber A′, secured to said receiver and having openings or ports *e* and *h* for the passage of steam, the pipe L, communicating with said chamber A′, the steam-passage E, leading to the low-pressure cylinder, the differential valves *b* and *c*, secured to a common valve-stem for opening and closing the ports *e* and *h*, respectively, and the reducing-valve D in communication with the port *e* for reducing the pressure of the live steam before its admission to the low-pressure cylinder, substantially as described.

CLIFFORD H. BATCHELLOR.

Witnesses:
W. H. THURSTON,
S. J. MURPHY.