(No Model.)

3 Sheets—Sheet 1.

R. C. WRIGHT.

COMPOUND LOCOMOTIVE.

No. 438,969. Patented Oct. 21, 1890.

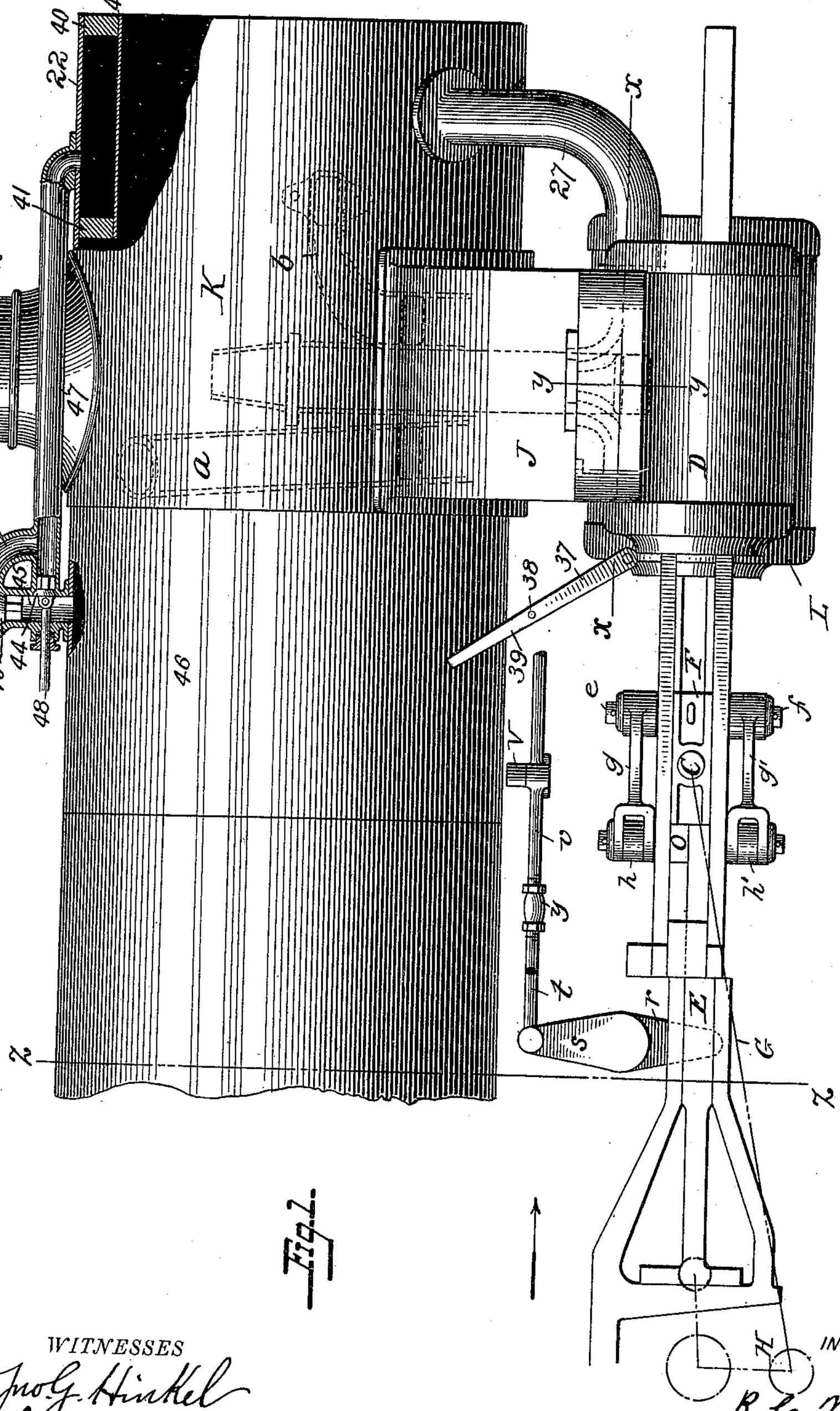

Fig. 1.

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Fig. 2.

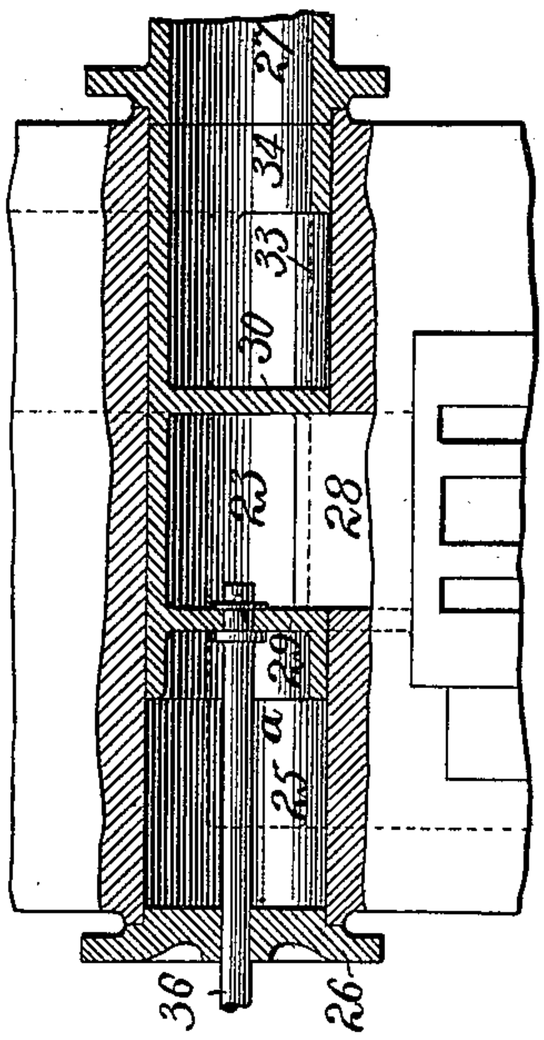

Fig. 3.

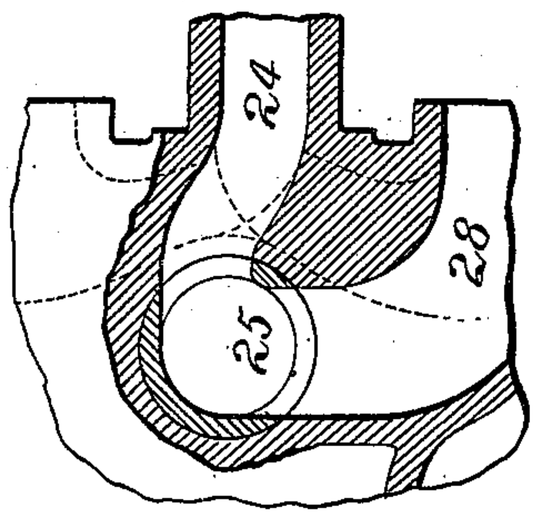

Fig. 4.

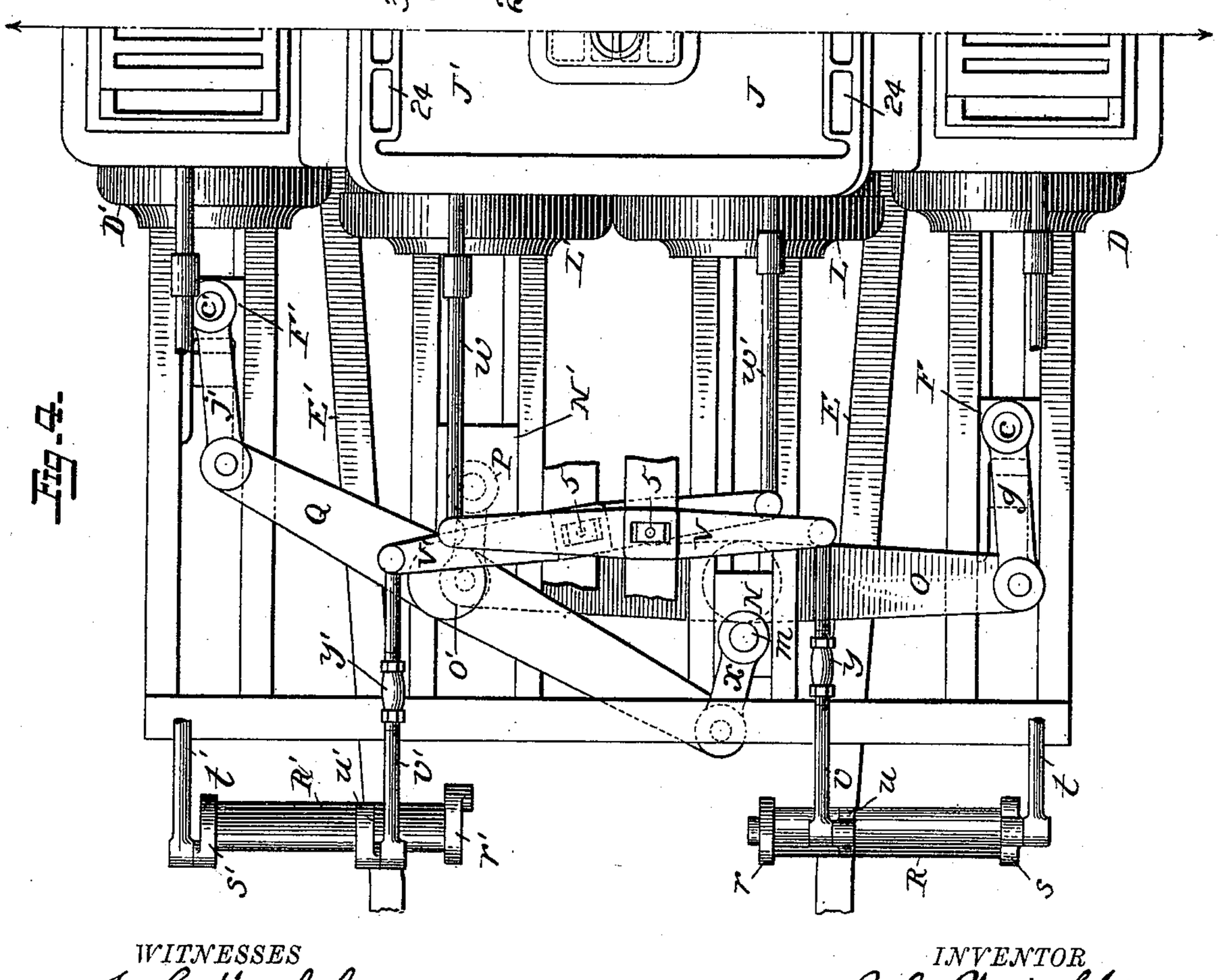

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Fig. 5.

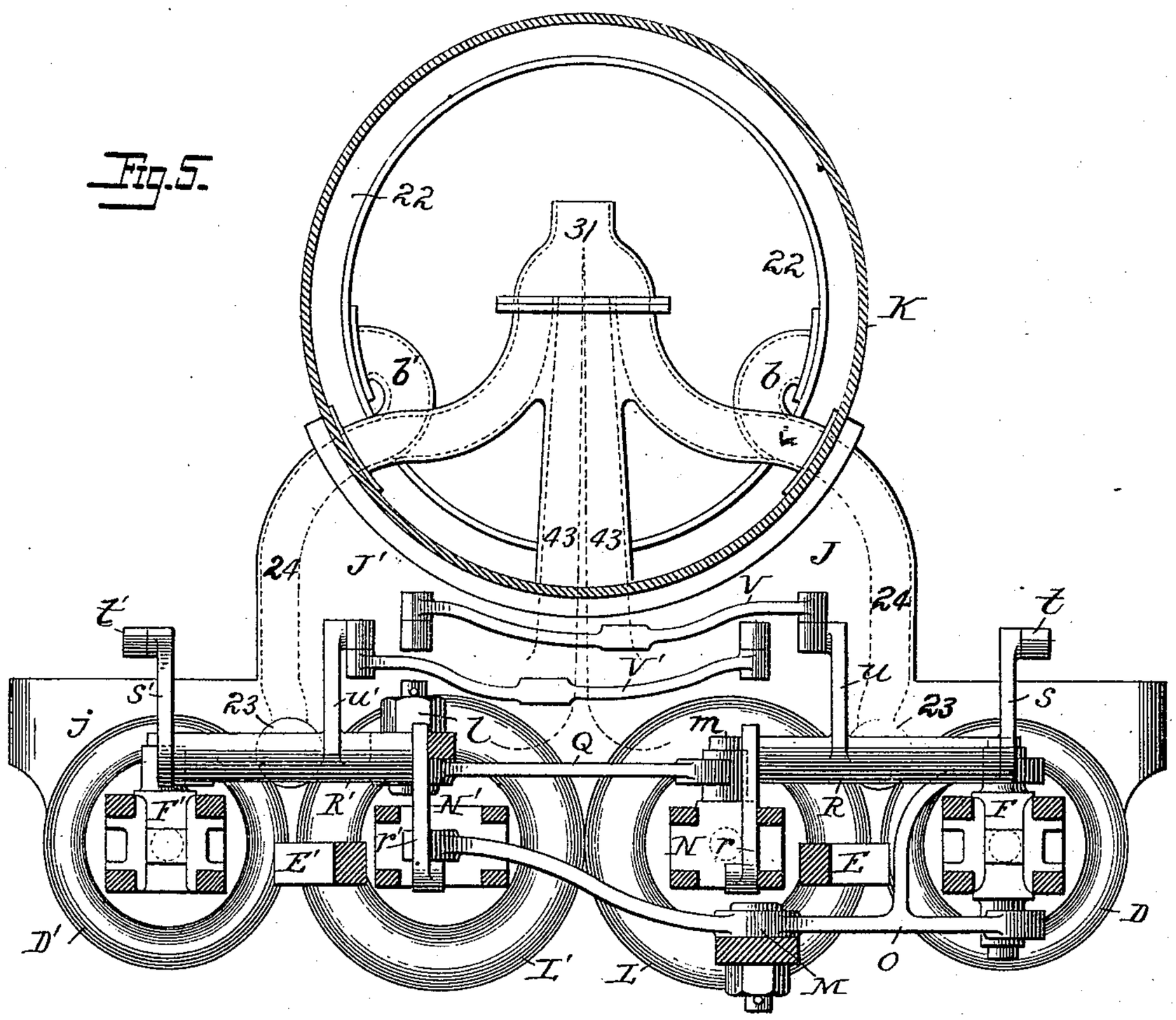


Fig. 6.

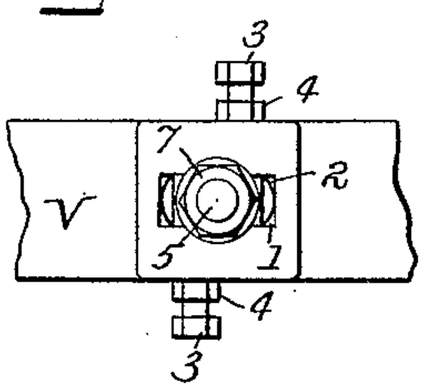
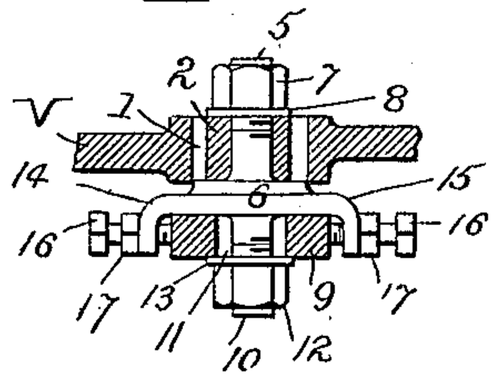


Fig. 7.



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UNITED STATES PATENT OFFICE.

RANSOM C. WRIGHT, OF PHILADELPHIA, PENNSYLVANIA.

COMPOUND LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 438,969, dated October 21, 1890.

Application filed July 31, 1889. Serial No. 319,360. (No model.)

To all whom it may concern:

Be it known that I, RANSOM C. WRIGHT, a citizen of the United States, residing at Philadelphia, in the State of Pennsylvania, have invented new and useful Improvements in Compound Locomotives, of which the following is a specification.

My invention relates to improvements in locomotives in which the steam is used in the cylinders and then exhausted in the open air in the usual way, or after being used in the first pair of cylinders is exhausted into a receiver, from which it is again used in another pair of cylinders at its lower pressure before being exhausted into the open air, the object being to more effectually utilize the full power of the steam, thereby greatly economizing in the amount of fuel necessarily consumed for a given amount of work, the mechanism for changing the locomotive from a simple high-pressure engine to one of high and low pressure combined, or a compound, being worked at the will of the engineer, so that the locomotive will have its full usual power to start trains quickly and to work compound after some speed has been attained, or either way deemed best. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of the locomotive. Fig. 2 is a section of the compounding-valve on line *x*, Fig. 1. Fig. 3 is a section of the compounding-valve on line *y*, Fig. 1. Fig. 4 is a plan view, the boiler being removed. Fig. 5 is a section on the line *z*, Fig. 1, looking toward the cylinders. Fig. 6 is a plan of the valve-lever fulcrum. Fig. 7 is a vertical section of the valve-lever fulcrum.

Similar reference-signs refer to similar parts throughout the several views.

My mechanism is additional to the usual locomotive, the following prominent parts of which I use as the high-pressure engine, as shown in Figs. 1, 4, and 5: The cylinders D D′, placed outside of the frames E E′ and connected by means of the cross-heads F F′ and the connecting-rods G to the crank-pins H, placed at right angles to each other, the cylinders D D′ each being made with a half-saddle J J′, reaching to the center of the engine, where they are secured together and formed at their upper part to receive the smoke-box K, to which they are also secured. So far the engine is of the usual construction.

In each half-saddle J J′, I construct an additional cylinder L L′, Figs. 1, 4, and 5, and in order to make room for the cylinders L L′, to be of large diameter, I construct the frames E E′ in a manner to remove them from the space required for the cylinders L L′. Ordinarily the frames E E′ run straight or are parallel to the center line of the engine; but at a point most convenient after passing the driving-wheels, Fig. 4, I incline the frames E E′ outward toward the cylinders D D′, to which I closely carry them, carrying them away from the center of the engine, and thus gain the room required for the larger cylinders L L′.

The cylinders D D′ receive steam direct from the boiler by means of the throttle-valve and the pipes *a*, in the usual way. The cylinders L L′ receive the exhaust-steam of the cylinders D D′ from the receiver 22, where it has been received through the compounding-valves 23 and exhaust-pipes, the connection from the receiver 24 to the cylinders L L′ being through the pipes *b*.

Each low-pressure cylinder is coupled to a high-pressure cylinder, those being the most removed from each other being coupled together in order to gain a longer lever and have less angularity when the pistons are at full-stroke. The right-hand high-pressure cylinder D will couple to the left-hand low-pressure cylinder L′, and the left-hand high-pressure cylinder D′ will couple to the right-hand low-pressure cylinder L. The levers O or Q will be fulcrumed at the center of their length when the stroke of the high and low pressure cylinders is desired to be the same; but as the low-pressure cylinders have less power, it may be desirable to remove the fulcrum toward the high-pressure cylinders, for the purpose of more perfectly balancing the two pistons coupled together, and at the same time provides more room for expansion in the low-pressure cylinders.

By reference to Figs. 1, 4, and 5 it will be seen I have two methods of coupling the high and low pressure cylinders together. Only one lever of each style is shown in the drawings, but both of which I will describe. The supports for the fulcrums I have not shown, ex-

cept in Fig. 5, as their introduction would complicate the drawings. They reach from the cylinder to the bar supporting the back end of the guides, or from frame to frame, as desired.

The first method of coupling a high and low pressure cylinder is as follows: The right-hand high-pressure cylinder D has a cross-head F, with the usual wrist-pin C for attaching the connecting-rod G, and in addition I have constructed above the cross-head F a pin *e* and below the cross-head F a pin *f*, to each of which pins *e f*, I attach links *g g'*, these links *g g'* being connected to a lever O, the lever being forked at this end, one prong of the fork *h* going below the cross-head F and frame E and the other prong *h'* bending upward and outward beyond the frame E and above the cross-head F, the lever being fulcrumed at M under the cross-head N of the low-pressure cylinder L, and the inner end of the lever O' is formed upward to come central with the cross-head N' of the left-hand low-pressure cylinder L', to which it is attached by a link P. To couple the opposite cylinders D' L with this form of lever the same cross-heads are used, the cylinder D' having the cross-head F, with the upper pin *e* and lower pin *f* coupled to the links *g g'*; but the lever O will be turned over, so that the pin *e* will couple to the prong *h* and the pin *f* will couple to the prong *h'*. The fulcrum M will be above the cross-head F of the low-pressure cylinder L' and the inner end of the lever O' will form down and come central to the cross-head N, to which it will couple. The prong *h'* will go over the frame E' and below the cross-head F of the cylinder D', the body of the lever O being above the frame E'. Thus it will be seen that with this form of lever O the pull on all the cross-heads is central, and the levers, although having the same vertical center, are entirely clear of each other and of all other parts. The other form of lever Q is also shown in Figs. 4 and 5.

The cross-head F' of high-pressure cylinder D' is constructed with the usual wrist-pin C' for the connecting-rod G, and in addition I have constructed a pin *j*, to which I couple a link *j'*, which is attached to the lever Q. The lever Q, being perfectly straight, extends above the cross-heads F' N' N, and frame E' is fulcrumed at *l* above the cross-head N', and is coupled to the pin *m*, formed above the cross-head N of the low-pressure cylinder L, by a link *x*. When the lever Q is used, they are precisely alike for both pairs of cylinders. The links are the same. The cross-heads are the same, except that they are turned over so that pins *j m* reach down and are coupled to the links *j' x* below the cross-heads F N N' and below the frame E. Thus it will be seen that when this form of lever Q is used all of the parts are alike for both pairs of cylinders, only the cross-heads being reversed. The levers Q are very simple in form, but do not pull so central upon the cross-heads as the levers O, a fault easily remedied by a sufficient bearing of the cross-heads within the guides.

The pistons of each pair of cylinders, which are coupled together by the levers O or Q, move in exactly opposite directions, one commencing the stroke at the forward end of the cylinder, while the other commences its stroke at the back end of the cylinder, and as they always move in exactly opposite directions it is necessary to provide a valve-moving mechanism which will admit steam to the opposite ends of the coupled cylinders at the same time. This I accomplish as follows:

By reference to Figs. 1, 4, and 5 it will be seen I employ rock-shafts R R' with lower inner arms *r r'*, to which are attached the usual links worked by eccentrics on the main axle. At the outer end of the rock-shafts R R' are upper arms *s s'*, to which are attached the valve-rods *t t'* of the high-pressure cylinders D D'. So far the mechanism is the same as heretofore known and employed; but at a convenient position on each rock-shaft R R', I construct an additional arm *u u'*, reaching upward. To these arms *u u'*, I attach valve-rods *v v'*, which are coupled to valve-levers V V' interposed between the valve-rods *v v'* and the valve-stems *w w'*. The valve-levers V V', being fulcrumed between the valve-rods *v v'* and valve-stems *w w'*, cause the valves to move the opposite way to the arms *u u'*, from which they receive their motion, and exactly opposite to the valves of the high-pressure cylinders.

The valve-rods *v v'* are provided with right and left hand threaded adjusting-nuts *y y'*. The fulcrums 5 5' of the valve-levers V V' may be in the center of their length, or otherwise, to suit the amount of valve travel desired for the low-pressure valves.

By reference to Figs. 6 and 7 it will be seen that I have provided an adjustable fulcrum for the valve-levers V V' to more perfectly adjust the movements of the valves of the low-pressure cylinders L L'. The valve-levers V are slotted lengthwise at the point of fulcrum, and in the slot 1 is placed a box 2, held to the lever V by set-screws 3 3 and jamb-nuts 4 4, the box 2 being free to revolve around a fulcrum-pin 5, formed on the saddle 6, the pin 5 having a nut 7 and washer 8 to secure the box 2 and lever V to it. The saddle 6 rests upon a support 9, and is secured to the support 9 by a pin 10, formed on the saddle 6 and passing through a slotted hole 11, and provided with a nut 12 and washer 13 to hold the saddle 6 down to its support 9. The saddle 6 also has projecting flanges 14 15, which pass over and by the side of the support 9, and which are provided with adjusting-screws 16 and jamb-nuts 17. By loosening the set-screws 3 3' and jamb-nuts 4 4' the box 2 is free to move in the slot 1 of the lever V. By loosening the nut 12 the saddle 6 can be moved on its support 9 by adjusting the screws 16 and jamb-nuts 17, as necessary,

and the required adjustment is made without moving the lever. By tightening all the screws and nuts all is again secure for operation and free to move in the proper direction to do its work.

The valve-levers V V′ may be straight or curved, as shown in Fig. 5. The valve-lever V is coupled above the valve-rod *v* and valve-stem *w′*. The valve-lever V′ is coupled below the valve-rod *v′* and below the valve-stem *w*, thus securing ample room for their fulcrums and for one lever to clear the other, although they are upon the same vertical center.

The compounding-valves 23, Figs. 2 and 3, are two in number, each placed between a high and low pressure cylinder in a cylindrical seat 25, formed, in each cylinder-saddle J J′. (See Figs. 1, 4, and 5.) The seat 25 reaches entirely through the saddle and is covered by a cap 26 at the back end and by an exhaust-pipe 27 at the front end. Each seat 25 has three openings in it—one 28 from the exhaust-port of the high-pressure cylinder D or D′, another opening 24 being exhaust-pipe of the high-pressure cylinders D D′ when working non-compound, and another opening in and through the exhaust-pipe 27, this being the exhaust-pipe of the high-pressure cylinders D D′ when working compound.

The compounding-valves 23 are hollow cylinders, each having two partitions 29 30 across them, these partitions 29 30 being placed so that the distance between them is equal to the width of the opening 28 from the exhaust-port of the high-pressure cylinders D D′, and of the exhaust-pipes 24 through the outer cylindrical shell of the compounding-valves 23 there are openings of a size corresponding to the passage 28 and the exhaust-pipe 24, and exactly opposite to them, between the partitions 29 30, these openings form a free and unobstructed passage from the passage 28 through the compounding-valves 23 to the exhaust-pipe 24, so that when the valve 23 is placed in the position described the high-pressure cylinders D D′ will exhaust directly into the open air through the exhaust-pipes 24, exhaust-nozzle 31, and smoke-stack 32. The compounding-valves 23 have another opening 33 just forward of the partition 30, corresponding in size to the opening of the passage 28 from the exhaust-port of the high-pressure cylinders D D′, and when the valve 23 is drawn back to place the opening 33, opposite the passage 28, the passage to exhaust-pipe 24 is closed, and the high-pressure cylinders D D′ will exhaust into the compounding-valve 23, and through its open end 34 into the pipe 27 and receiver 22, to which the pipe 27 leads and to which it connects, thus exhausting the high-pressure cylinders D D′ into the receiver 22, where it is stored for supplying power to the low-pressure cylinders L L′, the passage to the low-pressure cylinders being by means of pipes *b b′*.

Each compounding-valve is provided with a stem 36, which passes through a cap 26, where it may be provided with a stuffing-box, and is connected to an arm 37 on a shaft 38. This shaft 38 reaches across the engine from one valve 23 to the other valve 23, and has an upper arm 39, which is connected to a rod running to the cab and within easy operating reach of the engineer, so that by the will of the engineer, by moving the valves 23 to the positions described, the locomotive exhausts into the open air, working as a simple high-pressure engine, just as the practice now exists, or it exhausts into the receiver, supplying power to the low-pressure cylinders L L′, and the locomotive becomes a compound of high and low pressure, thus utilizing to a much greater extent the full power of the steam, and consequently decreasing the amount of fuel required to produce the power.

The exhaust-receiver 22 is formed in the regular extension of the smoke-box K, and is constructed as follows: A ring 40 is secured by rivets to the front of the smoke-box K on its inner diameter, and a ring 41 is secured by rivets to the smoke-box K on its inner diameter. At a sufficient and convenient distance back of the ring 40, on the inner diameter of the rings 40 41, is secured a sheet of metal 42, secured by rivets, thereby forming the space 22, into which the exhaust-steam is received from the high-pressure cylinders D D′ through the pipes 27. Pipes *b* are connected from the exhaust-receiver 22 to the low-pressure cylinders L L′. These pipes connect into the saddles J J′, and pass over the compounding-valve seat 25, as seen in Figs. 2 and 3. In the same figures will be seen the passages *a* for the high-pressure cylinders D D′, which also pass over the compounding-valve seat 25. The exhaust-pipes 24, Figs. 1, 4, and 5, of the high-pressure cylinders D D′ after they leave the saddles J J′ curve inward and upward and join the exhaust-pipes 43 of the low-pressure cylinders L L′ at the center of the engine, where all the pipes 24 43 are clustered into one, all opening into and discharging through a common nozzle 31, placed central under the smoke-stack 32.

The live-steam valve 44, Fig. 1, is placed in a chamber 45, placed upon and opening into the boiler 46. The valve 44 is seated upon a pipe 47, which connects into the exhaust-receiver 22. The valve 44 has a stem 48, by means of which it is lifted off its seat when live steam from the boiler 46 will pass into the pipe 47 and so into the receiver 22, and thence by means of the pipes *b* to the low-pressure cylinders L L′, the stem 48 being connected directly into the cab and within easy reach of the engineer, or by means of a central fulcrumed lever and a link coupled to the lever 39 of the compounding-valves 23 in such a manner that when the locomotive is working as a simple high-pressure engine the valve 44 shall be opened to admit a quantity of live steam from the boiler to the cylinders

L L′, so their valves and pistons shall not run dry, the object being to reduce the friction upon the valves and pistons of the low-pressure cylinders L L′. When the locomotive is non-compound, the valve 44 shall remain closed. In the same chamber 45 as the live-steam valve 44 is a spring-valve 49, surmounted by a suitable spring 50, held to proper tension by a screw-cap 51, and with a pipe 52 leading from above the valve-seat to the pipe 47. The object of this spring-valve is to permit the steam which would escape into the open air to be carried to the receiver, where it can be utilized in the low-pressure cylinders, instead of being lost when the engine is started non-compound.

I am aware that locomotives have been constructed with levers interposed between the cylinders and the driving-wheels, and that the power was transmitted through those levers; but in those instances the locomotives were simple high-pressure engines and not compounded, had cylinders placed only outside of the frames, and employed the levers entirely different and for entirely different purposes to those for which I employ them.

I am also aware that four-cylinder locomotives have been built with a pair of cylinders outside of each frame, one of each pair of cylinders connected to a crank-pin secured to a driving-wheel and the other crank-pin suspended and a cylinder and attachments counterbalancing the other, the pistons moving in opposite directions; but such mechanism resembles mine in no respect except the movements of the pistons, and the pairs of cylinders are in no wise coupled like mine or for like purpose, nor do they accomplish the same results.

I am aware that safety-valves have been constructed with pipes connected to them to blow escaping steam into the tank to heat the water; but such valves are not for the same purpose or use as my live-steam spring-valve. They utilize the steam to warm the water. I utilize it to lubricate the low-pressure pistons and valves. I therefore do not, broadly, claim the use of levers interposed between the cylinders and driving-wheels or the use of four cylinders in a locomotive or a safety-valve with a connected pipe to any reservoir or tank, except as herein specified and claimed.

Without limiting myself to the precise construction and arrangement of parts, I claim—

1. In a compound locomotive, the combination, with the high-pressure cylinders, pistons within the cylinders, and the usual piston-rods, connecting-rods, and cranks for communicating motion to the driving-wheels, of low-pressure cylinders, pistons, and piston-rods, and levers connecting the low-pressure piston of each side with the high-pressure piston of the opposite side, substantially as described.

2. In a locomotive, the combination, with a high and a low pressure cylinder upon each side, of a piston within each cylinder and two levers, each connecting the piston of a high-pressure cylinder upon one side with the piston of the low-pressure cylinder upon the other side, and connections between said pistons and the shaft of the locomotive, substantially as described.

3. In a locomotive, the combination, with a high and a low pressure cylinder upon each side and a piston in each cylinder, of a cross-head upon each piston and two levers to connect the piston of the low-pressure cylinder of one side with that of the high-pressure cylinder of the other side, means for connecting the pistons with the shaft of the locomotive, and a valve for each cylinder, substantially as described.

4. In a locomotive, the combination of a high-pressure and a low-pressure cylinder upon each side, a piston in each cylinder, and two levers, one above and one below the frame of the locomotive, each of the levers connecting the high-pressure cylinder of one side with the low-pressure cylinder of the other side of the locomotive, substantially as described.

5. In a locomotive, the combination, with a high and a low pressure cylinder upon each side, of a piston in each cylinder, the one in the high-pressure cylinder being connected with and traveling in the opposite direction from the one in the low-pressure cylinder upon the opposite side, and means for admitting steam independently to and exhausting it from said cylinders, and connections between the pistons and the shaft of the locomotive, substantially as described.

6. In a locomotive, the combination, with a high-pressure cylinder and a low-pressure cylinder upon each side, of a piston and a valve for each cylinder, a lever connected with each low-pressure-cylinder valve, and two rock-shafts for connecting the levers of the low-pressure valves with the high-pressure valves upon the opposite side and moving them in opposite directions at the same time, substantially as described.

7. In a locomotive, the combination, with a high-pressure cylinder and a low-pressure cylinder upon each side, of a piston and a valve for each cylinder, a lever connected with each low-pressure valve, and a rock-shaft upon each side, each rock-shaft having an upper and a lower arm for connecting with the eccentric and the high-pressure valve, and an additional arm for connecting with and operating one of said levers, substantially as described.

8. In a locomotive, the combination, with a high-pressure cylinder and a low-pressure cylinder on each side, of a piston and a valve for each cylinder and adjustable connections between the high-pressure-cylinder valve on one side with the low-pressure-cylinder valve on the other side, substantially as described.

9. In a locomotive, the combination, with a high-pressure cylinder and a low-pressure cylinder on each side, of a piston and a valve

for each cylinder, a lever for connecting the low-pressure valve on one side with the high-pressure valve on the other side, and an adjustable fulcrum for each lever, substantially as described.

10. In a locomotive, the combination, with a high-pressure cylinder and a low-pressure cylinder on each side, of a piston and a valve for each cylinder, a lever for connecting the low-pressure valve on one side with the high-pressure valve on the other side, and an adjustable fulcrum for each lever, consisting of a slotted support, a saddle having side flanges and an upper and a lower pin, and adjusting-screws, substantially as described.

11. In a compound locomotive, the combination, with the high and low pressure cylinders and a receiver, of a compound valve for each pair of cylinders having two ports and a partition between them, one of the ports adapted to communicate with the high-pressure cylinder and the exhaust-pipe, and the other port being adapted to communicate with the said cylinder and the receiver, and means for moving said valve, substantially as described.

12. In a compound locomotive, the combination, with each of the saddles, of a compound valve located therein, the seat for the valve being provided with three ports and the valve having two ports and an open end, a receiver, said valves communicating with the receiver, and means for operating said valve, substantially as described.

13. In a compound locomotive, the combination, with the receiver, of a pipe leading from the boiler to the receiver, and an automatic valve for establishing communication between the boiler and the receiver, substantially as described.

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