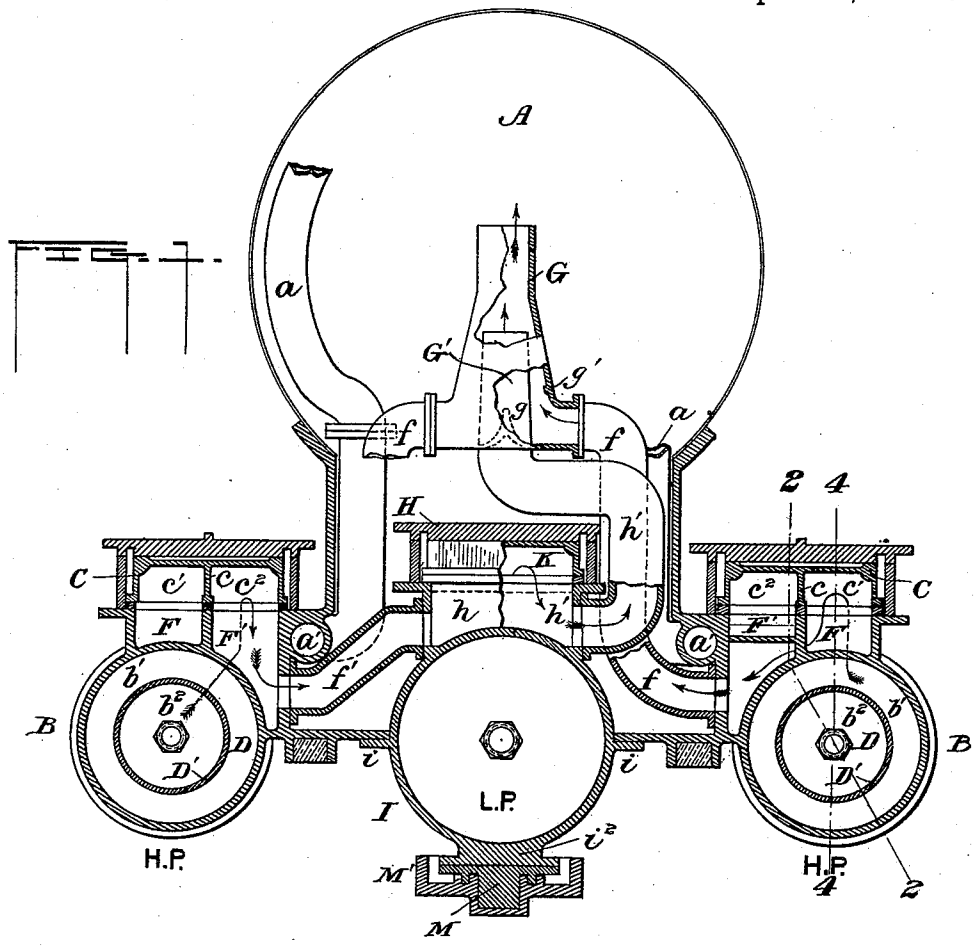
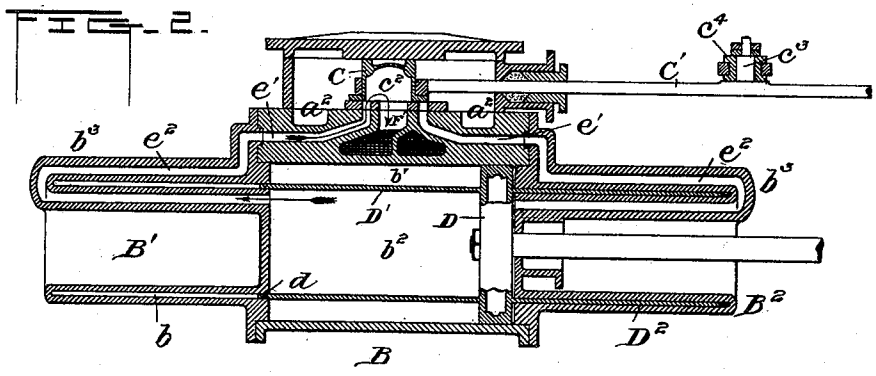
(No Model.) 3 Sheets—Sheet 1.

H. C. REAGAN, Jr.

COMPOUND LOCOMOTIVE.

No. 473,437. Patented Apr. 19, 1892.





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(No Model.) 3 Sheets—Sheet 2.

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FIG. 3.

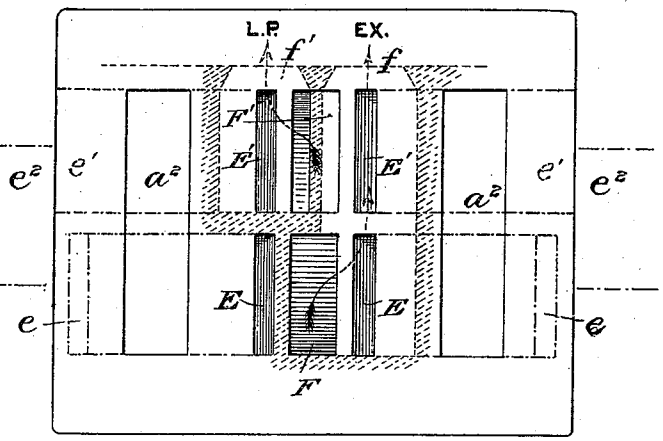

FIG. 5.

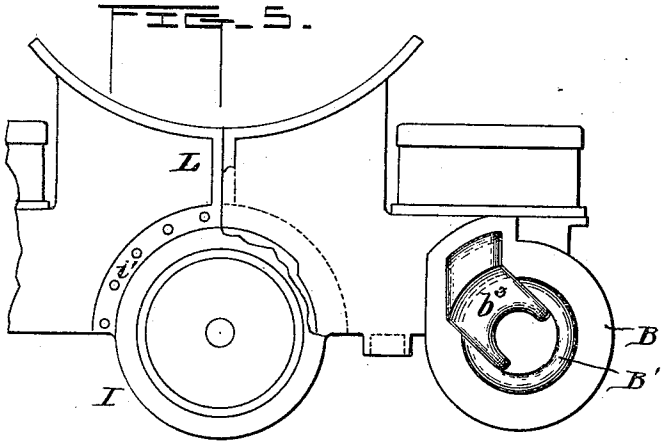

FIG. 9.

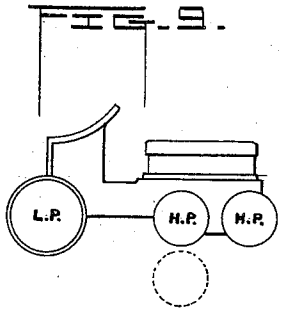

FIG. 4.

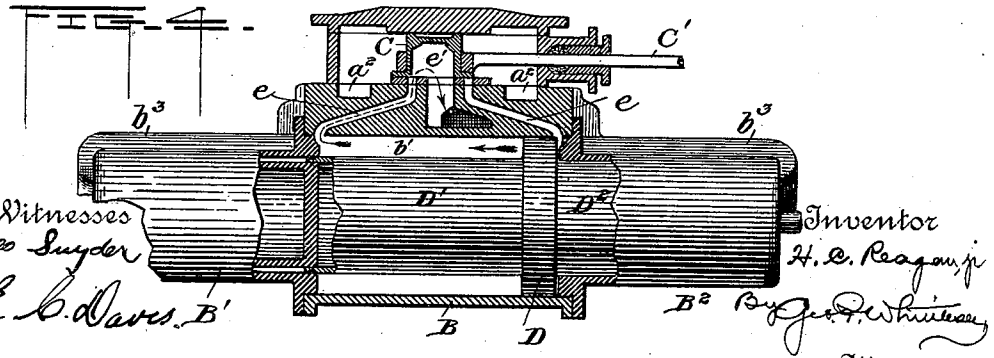

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FIG. 6.

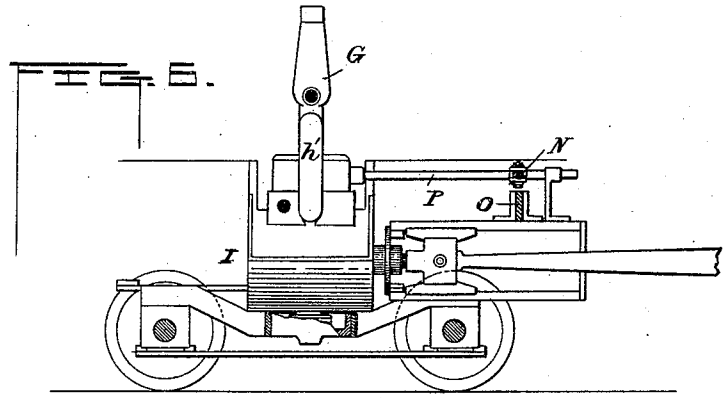


FIG. 7.

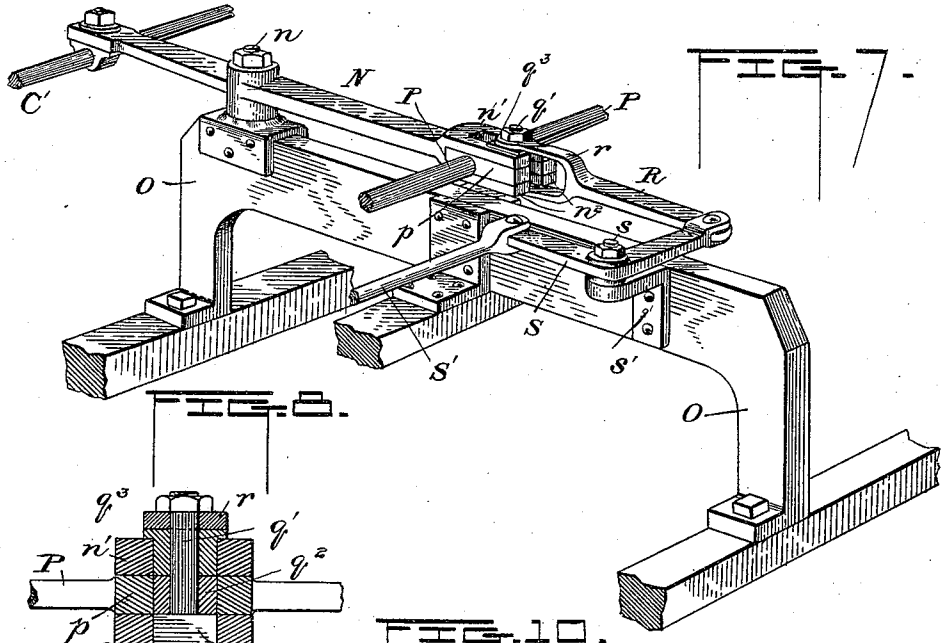
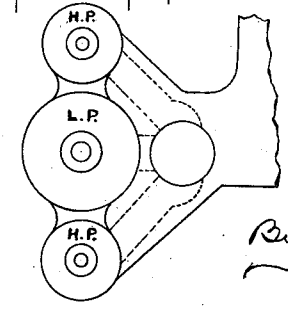


FIG. 8.

FIG. 10.



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UNITED STATES PATENT OFFICE.

HARRY C. REAGAN, JR., OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF TWO-THIRDS TO EDWARD F. PEACOCK, OF SAME PLACE, AND THOMAS PRAY, JR., OF NEW YORK, N. Y.

COMPOUND LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 473,437, dated April 19, 1892.

Application filed June 30, 1891. Serial No. 397,988. (No model.)

To all whom it may concern:

Be it known that I, HARRY C. REAGAN, Jr., a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Compound Locomotives; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

My invention relates to compound steam-engines; and its object is to improve the efficiency of such engines by the construction and arrangement hereinafter set forth, and particularly pointed out in the claims.

I have illustrated my invention as embodied in a locomotive; but it is applicable to stationary or marine engines, as will be plainly understood. I provide the engine with three cylinders, two of which are high-pressure and the third a low-pressure cylinder, the diameter of the latter being greater than that of the high-pressure cylinders. Steam is admitted to the high-pressure cylinders, in which it is divided into two portions by means of an annular piston or otherwise, as hereinafter described. The exhaust-passages are so contrived that one portion of steam goes directly to the exhaust-nozzle, while the other portion is conducted to the steam-chest of the low-pressure cylinder, and after further expansion in said cylinder it is exhausted into the nozzle. The construction of the nozzle is such that it acts as an injector, the blast of high-pressure steam operating to create a vacuum in the low-pressure cylinder.

In the drawings, Figure 1 is a cross-section of a locomotive, showing the three cylinders and other parts. Fig. 2 is a longitudinal section of the high-pressure cylinder shown at the right of Fig. 1, taken on line 2 2. Fig. 3 is a plan of the valve-seat of the same cylinder. Fig. 4 is a longitudinal section of the same cylinder on line 4 4. Fig. 5 is a front view of the cylinder, the low-pressure cylinder, and the saddle. Fig. 6 is a side sectional elevation of the truck and the low-pressure cylinder. Fig. 7 is a perspective view of the valve-motion for the low-pressure cylinder. Fig. 8 is a detail cross-section on line 8 8, Fig. 7. Figs. 9 and 10 show modified arrangements of the cylinders.

The reference-letter A indicates the smoke-box of the boiler, containing the two steam-pipes a, which lead to the live-steam passages a', connected with the steam-chests of the high-pressure cylinders B by the usual receiving-ports a^2. The steam-chests each contain a slide-valve C, which differs from the ordinary slide-valve in having a longitudinal partition c, dividing it into two compartments c' c^2. The valve is operated by the valve-rod C′ and the usual link-motion.

The piston D, which may be hollow, as shown, has cast integral with it or rigidly attached to it on each side a cylindrical flange or shell D′ D² of smaller diameter than the piston and concentric therewith. Near the outer end of each shell a packing-ring d is sprung into a groove, to make a steam-tight joint between the shell and the walls of an annular well, in which it reciprocates with the movements of the piston. These wells b are formed in annular projections B′ B² on the cylinder-heads. The depth of the wells and length of the shells is greater than the stroke of the piston, so that the shells never leave the wells. The shells thus divide the interior of the cylinder into two concentric compartments b' b^2 on each side of the piston.

Upon reference to Fig. 3 it will be seen that the steam-ports are divided in two by a partition; or, in other words, there are two distinct and separate steam-ports E E′ at each end of the valve-seat. The exhaust-port F F′ is similarly divided, and the partition c in the valve is arranged to lie along the partitions dividing the ports. The effect is as though there were two separate valve-seats and two separate valves side by side. The outer set of ports—*i. e.*, those lying farthest from the center of the engine—conduct the steam, preferably, to and from the outer compartment b' of the cylinder, while the inner set preferably control the flow of steam to the inner compartment b^2. The outer steam-passages e are cast,

as usual, in the walls of the cylinder. The inner steam-passages e' are connected with passages e^2, cored out in ribs b^3, which run out around the annular projections B' B² on the cylinder-heads and back into said heads, as shown. The passages e open into the outer compartment b', and the passages e' e^2 into the inner compartment b^2 of the cylinder. The live steam passes into both compartments b' b^2 when the valve uncovers the ports E E'; but when the exhaust takes place the steam from the outer compartment only is allowed to go direct to the nozzle G, which it reaches through the passage f. The exhaust from the inner compartment b^2 is led to the passage f', which conducts it to the receiving-ports h at the ends of the steam-chest H of the low-pressure cylinder I. The valve K of the low-pressure cylinder is a common slide-valve, which directs the exhaust-steam into the passage h', leading to the low-pressure exhaust-nozzle G'. The construction of this nozzle is an important feature of my invention. The lower portion is conical and has two opposite openings to connect with the high-pressure exhaust-passages f. The low-pressure nozzle G' projects up centrally inside of this cone, and between it and the walls of the cone are diametrically-opposite webs g, preferably curved as shown. The high-pressure exhaust-steam entering from each side is directed upward by these webs, a lip g' aiding to guide the blast of steam diagonally across the cone, so as to surround the nozzle G'. The action of the high-pressure blast on the low-pressure nozzle is similar to an ejector, and creates a vacuum behind the low-pressure piston, which materially increases its efficiency.

The low-pressure cylinder I is provided with flanges i, by means of which it is secured to the bottom of the saddle L, the ends of which are cut out to fit over the ends of the valve-seat of the low-pressure cylinder, as shown in Fig. 5. The heads of this cylinder have wide semi-cylindrical flanges i', overlapping the saddle and bolted thereto. A plate i^2 may be cast upon the under side of the cylinder, to which is fastened the center pin M, which is mounted in a suitable center plate M' on the truck.

The two high-pressure pistons are connected with their cranks by the ordinary rods, the cranks being set quartering, as usual. The valve-rods are operated by any suitable valve-motion, preferably the common link. The crank of the low-pressure cylinder is set opposite to that of one of the high-pressure cylinders. To avoid complicating the valve-gear, I prefer to operate the valve-rod K' of the low-pressure cylinder by a lever N, fulcrumed at some suitable point on the frame and taking its motion from the valve-rod of the cylinder which has its crank set at one hundred and eighty degrees with that of the low-pressure cylinder. I prefer the arrangement shown in Fig. 2, in which the high-pressure valve-rod C' has a stud c^3, on which is pivoted a block c^4. The end of the lever N is forked to straddle the block, so that the block can slide in the fork as the rod reciprocates. The lever is fulcrumed on a stud n, secured to a girt O, bolted at each end to the frame. The inner end of the lever is bifurcated both vertically and horizontally, as shown. The low-pressure valve-rod P has a U-shaped section p, which lies between the upper and lower forks n' n^2 of the lever and corresponds therewith in shape. A block is slipped into the jaws of the three forks and thus unites them, so that the vibrations of the lever N impart reciprocating movements to the low-pressure rod P synchronously with but directly opposite to those of the high-pressure rod C'.

I prefer to so arrange the parts as to make it possible to vary the relative points of cut-off of the high-pressure and low-pressure valves. To this end I construct the block which unites the forks as follows: A square base Q fits the lower fork n^2 of the lever, having a flange q. A round stud q' rises from the base, and upon it are fitted the pieces q^2 q^3, the former filling the space between the stud and the fork p, and the latter the space within the fork n' of the lever. The piece q^3 has a flange to rest on the upper surface of the fork n'. The block thus made up is received between the upper and lower jaws of a fork r, formed at the end of a link R, which extends in line with the lever N, and is jointed to one end of a bell-crank S, fulcrumed on a pin s, carried by a bracket s' bolted to the girt O. To the other end of the lever S is attached a rod S', which runs to the cab. By operating this rod the engineer can slide the block in or out of the forks n' p n^2, and thereby alter the effective length of the inner arm of the lever N, thus changing the travel of the low-pressure valve to compensate for differences in the travel of the high-pressure rod or for other purposes.

Instead of arranging the two compartments for high-pressure steam concentrically, as hereinbefore described, I may place the compartments side by side or one above the other. This may be readily accomplished by using two ordinary cylinders and pistons, as shown in Fig. 9.

The double valve above described can be used to admit the steam simultaneously to both cylinders and to send the exhaust from one of them to the nozzle and from the other to the low-pressure cylinder. I may also use two low-pressure cylinders, one on each side of the engine, as shown in Fig. 10, with two high-pressure cylinders adjacent thereto, one of which exhausts into the low-pressure cylinder.

In Fig. 9 the rods of both the high-pressure cylinders would be connected with one cross-head, while in Fig. 10 the same cross-head would serve for all three cylinders.

It is evident that my arrangement of nozzles can be applied to ordinary locomotives, the exhaust from one cylinder operating to create a vacuum in the other.

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

1. A compound engine having its high-pressure valve divided into compartments and having suitable ports and passages whereby the exhaust-steam is divided into two portions, one of which only is led to the low-pressure cylinder, substantially as described.

2. A compound engine having its high-pressure cylinder provided with a tubular piston, whereby the steam is divided into two portions, a suitable valve-gear for leading one of said portions to the low-pressure cylinder, substantially as described.

3. A compound engine having its high-pressure-cylinder heads provided with annular wells, and a piston having annular shells on each side adapted to slide in said wells and a valve admitting steam both inside and outside of said shells, substantially as described.

4. The combination, with a low-pressure cylinder, of a high-pressure cylinder having a piston provided with cylindrical shells dividing said cylinder into two compartments, and a double valve admitting steam to both compartments and directing the exhaust from one compartment to the atmosphere and from the other compartment to the low-pressure cylinder.

5. The combination, with the high-pressure cylinder having its heads provided with annular extensions containing annular wells, of a piston having cylindrical shells sliding in said wells, and a double slide-valve having its seat provided with a double set of admission and exhaust ports, substantially as described.

6. A compound engine having a low-pressure cylinder, and a plurality of high-pressure cylinders arranged to divide the high-pressure steam into separated portions, with suitable valve-gear for directing one portion of the high-pressure exhaust into the low-pressure cylinder and the other portion into the atmosphere, substantially as described.

7. In a compound locomotive, the combination, with the low-pressure cylinder, of high-pressure cylinders on each side of the engine divided into two compartments, and a valve on each side arranged to admit steam to both high-pressure compartments simultaneously and to exhaust it from only one of said compartments to the low-pressure cylinder, the other exhausting directly into the atmosphere, substantially as described.

8. The combination, with the frame, of the girt O, the lever N, fulcrumed thereon, connected at one end with the high-pressure valve-rod, and having at its other end a double fork, the low-pressure valve-rod P, having the fork p, and a block uniting the fork p with the double fork of the lever, substantially as described.

9. The combination, with the valve-rod C′, of the lever N, having a double fork $n' n^2$, the rod P, having a fork p, the block consisting of a base Q, stud q, and pieces q^2 q^3, received in the forks, the forked link R, carrying said block, and a bell-crank lever, to which said link is jointed, substantially as described.

10. A compound engine having its high-pressure cylinder divided into compartments, whereby the steam is separated into two portions, and a valve adapted to exhaust only one of said portions to the low-pressure cylinder, the other being exhausted directly into the atmosphere, substantially as described.

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

HARRY C. REAGAN, JR.

Witnesses:

HARRY V. BENDER,

EDWD. F. PEACOCK.