(No Model.)

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COMPOUND LOCOMOTIVE.

No. 481,149. Patented Aug. 16, 1892.

Fig. 1.

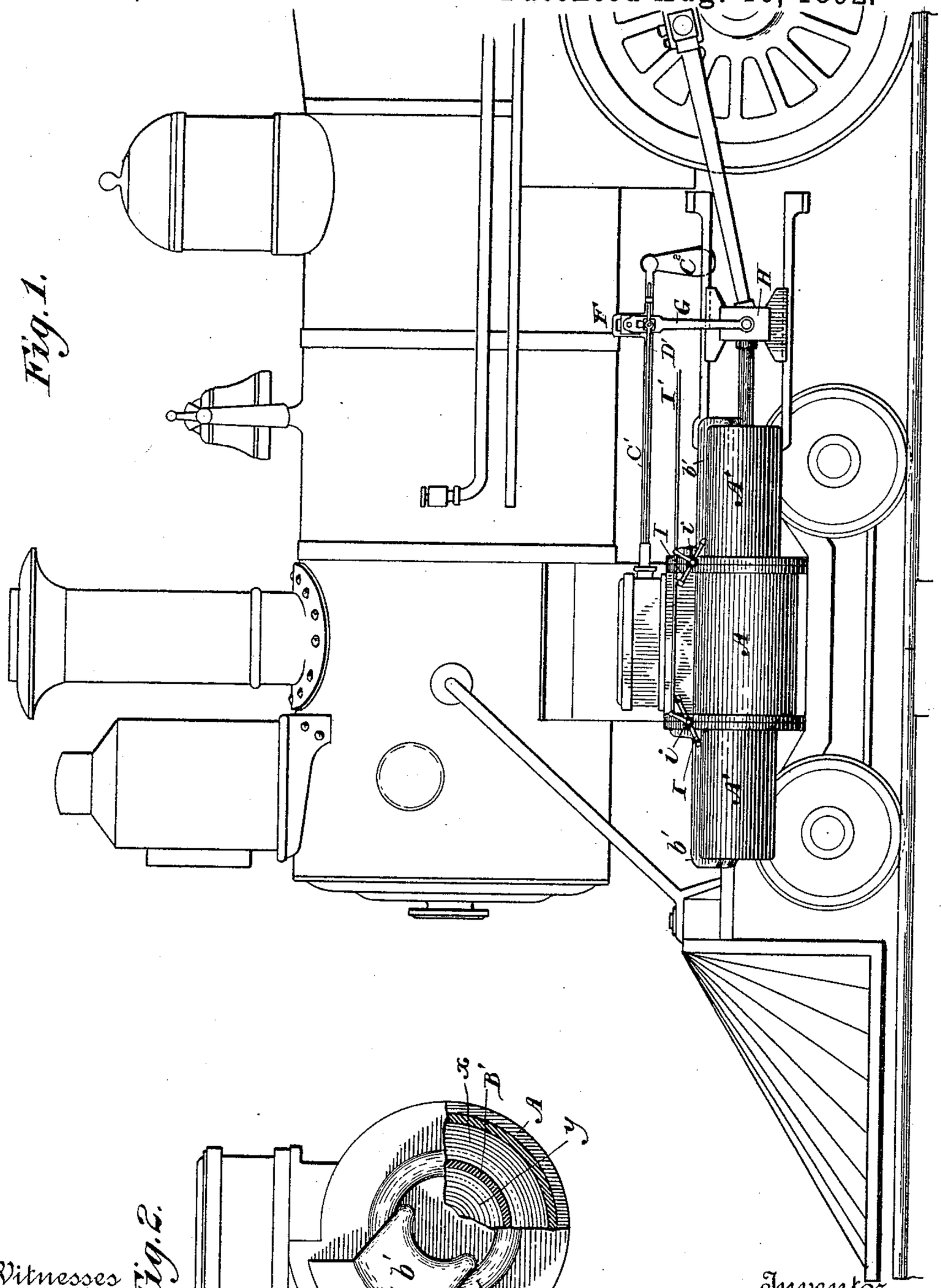

Fig. 2.

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Fig. 6.

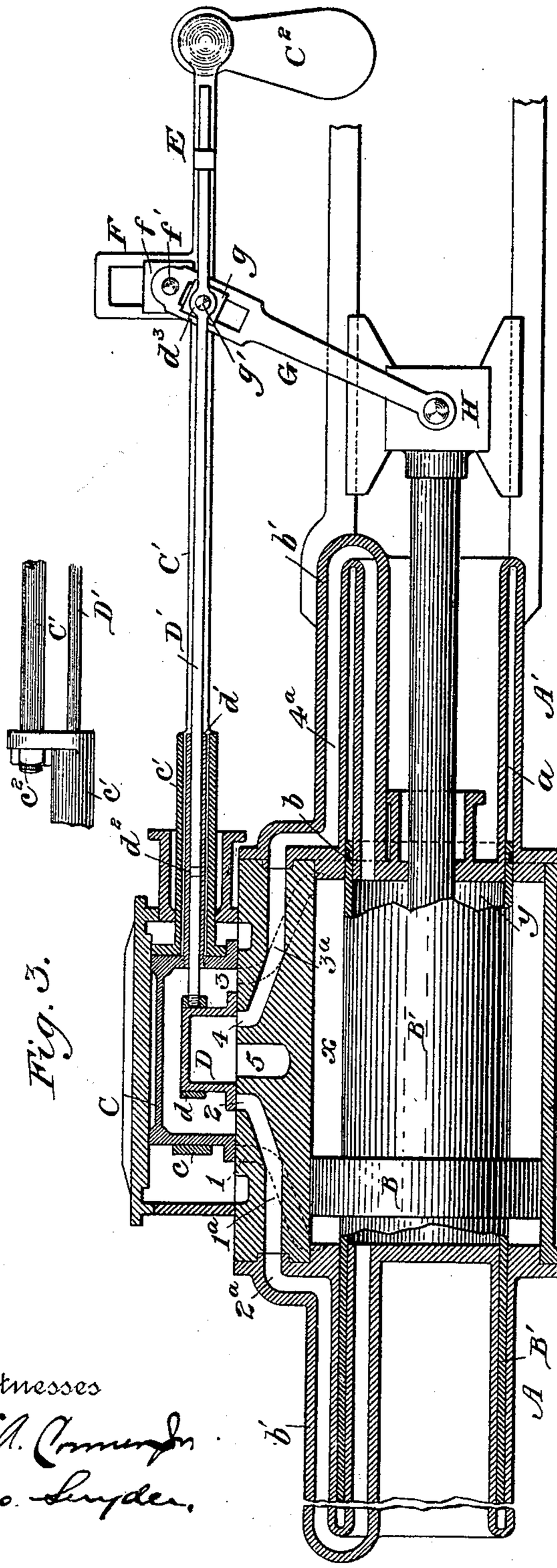

Fig. 3.

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Fig. 4.

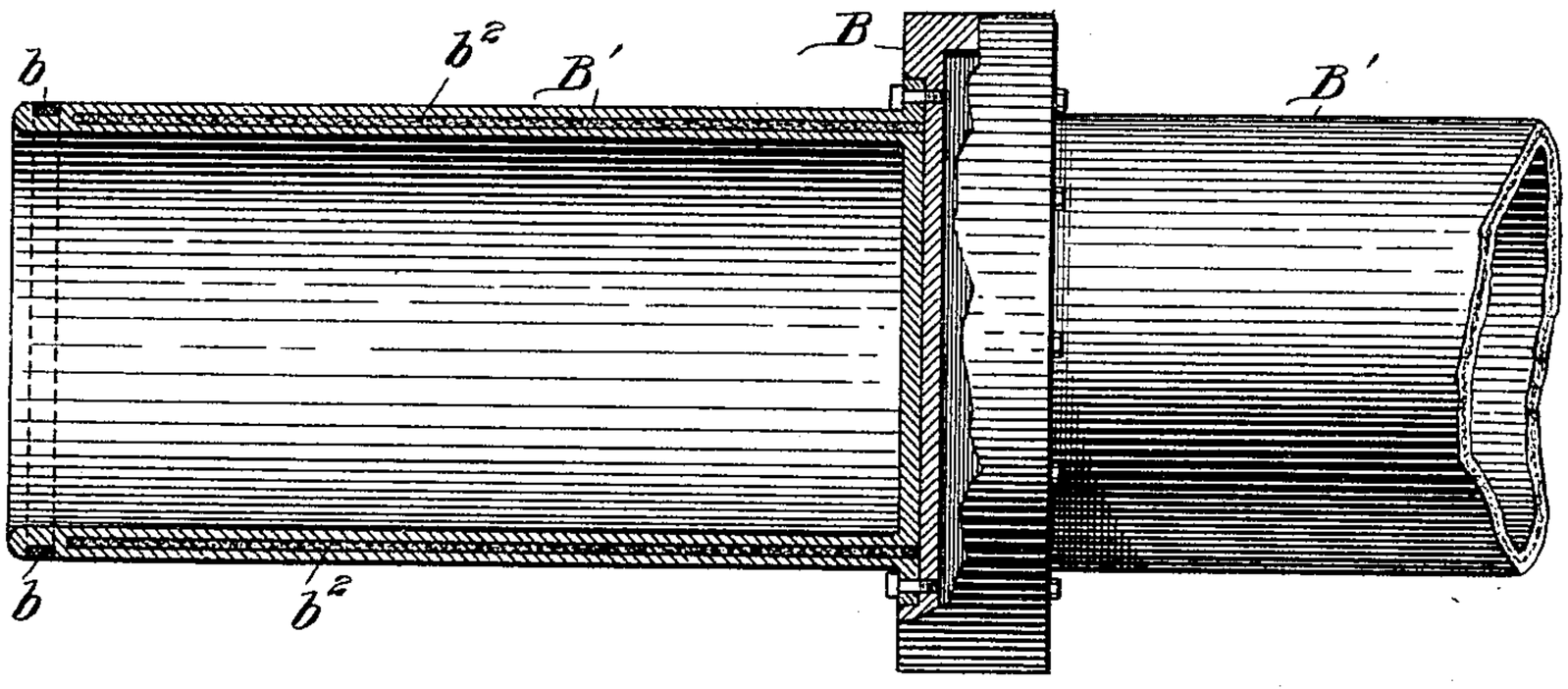
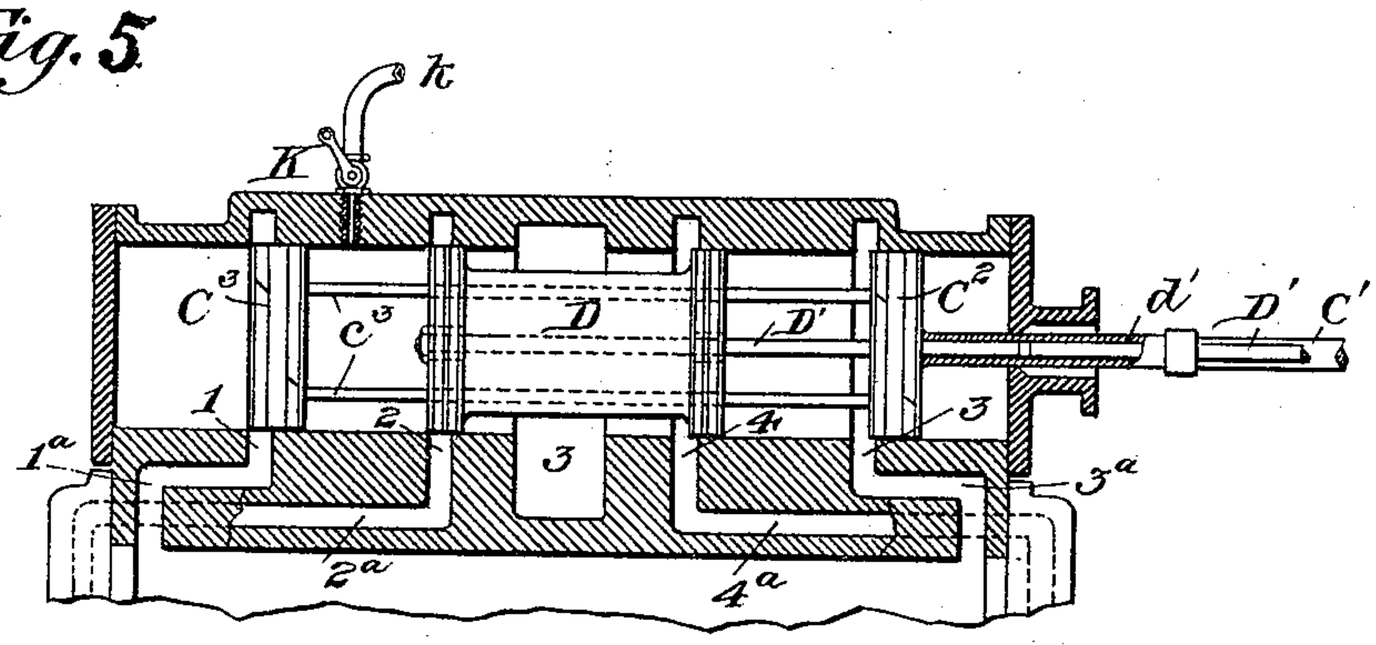


Fig. 5.



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UNITED STATES PATENT OFFICE.

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COMPOUND LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 481,149, dated August 16, 1892.

Application filed August 21, 1891. Serial No. 403,289. (No model.)

To all whom it may concern:

Be it known that I, HARRY CLIFTON 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 and figures of reference marked thereon, which form a part of this specification.

My invention relates to compound engines, and especially to compound locomotives, though not confined exclusively to that class of engines.

It consists in certain improvements in the valve-gear, as hereinafter pointed out in the specification and claims.

In the drawings, Figure 1 is an elevation of the forward part of a locomotive embodying my improvements. Fig. 2 is an end elevation of the left-hand cylinder, partly broken away. Fig. 3 is a longitudinal section of the same cylinder, showing the valve-gear in elevation. Fig. 4 shows a modification of the piston. Fig. 5 shows a modification of the valve, and Fig. 6 is a detail.

Each cylinder A is provided with a piston B, which has on each side a cylindrical shell B′, somewhat longer than the cylinder and less in diameter. These shells slide steam-tight in annular wells *a*, cored or otherwise formed in annular projections A′, cast integral with or attached to the cylinder-heads. A packing-ring *b* is sprung into a groove near the outer end of each shell. The interior of the cylinder is thus divided into two concentric chambers *x* and *y*. The outer or annular chamber *x* I use as a high-pressure cylinder and the inner chamber *y* as a low-pressure cylinder, conducting the exhaust-steam from *x* into *y*, as hereinafter explained. To prevent too great transmission of heat from the chamber *x* to chamber *y*, the shells may be cast hollow and filled with asbestus b^2, in which case the shells are made separate from the piston and bolted thereto, as shown in Fig. 4.

The valve-seat has two sets of admission-ports 1 3 2 4 and a single exhaust-port 5. The ports 1 3 lie farther from the exhaust-port and communicate by passages 1^a 3^a with the high-pressure chamber *x*. The ports 2 4 lie nearer the exhaust-port and communicate with the low-pressure chamber *y* by means of the passages 2^a 4^a, cored out in the valve-seat and in ribs *b′*, which run out around the extensions B′ and into the cylinder-heads. By conducting the high-pressure exhaust from passage 1^a into the opposite passage 4^a the desired compounding effect is reached. This may be done by any suitable valve or valves. I prefer the one shown in Fig. 3, a modified form of which is illustrated in Fig. 5. The main valve C is arranged to open and close, the high-pressure ports 1 3 being given the proper lead and lap. It is actuated by a yoke *c*, to which is secured a sleeve *c′*, which passes out through a stuffing-box at the back end of the steam-chest. An offset c^2 affords a point of attachment for the main-valve rod C′, which is joined to the rocker-arm C^2 and is driven by the ordinary link and eccentrics. The low-pressure ports 2 4 and the exhaust-port 5 are never uncovered by this large main valve C. An auxiliary valve D is inclosed within the main valve C and opens and closes the ports 2 4, placing them alternately in connection with the interior of the main valve and with the exhaust-port 5. The valve D is actuated by a yoke *d*, attached to a rod D′, which passes through a sleeve *d′*, fastened to the valve C and lying concentrically within the sleeve *c′*. A packing-ring d^2 on the rod D′ makes a tight joint between the rod and sleeve. The valves are free to move vertically in their yokes to allow for wear of the valve-seat, and the sleeve *d′* is smaller than the sleeve *c′*, leaving an annular space to permit the valve C to settle downward as it wears on its seat.

By the operation of the main valve C the live steam is admitted alternately to the two ends of the chamber *x*, and the exhaust there-

from flows into the interior of the main valve. Suppose the main valve, as shown in Figs. 3 and 5, is just opening the port 1, admitting steam to the front end of the chamber *x*, then the back end of said chamber is exhausting through port 3 into the said valve. Now if the auxiliary valve D is also drawn back to uncover the port 2, the exhaust-steam from 3 will flow past the valve D and through the passage 2^a to the front end of the chamber *y*, where it expands and adds its effect to that of the live steam in the annular chamber *x*. The exhaust from the back end of the chamber *y* is at the same time taking place through the port 4, valve D, and exhaust-port 5.

It is possible to combine the two valves C and D in one move and then simultaneously by a single valve-rod; but I prefer to make them separate and actuate each one by its own rod, in order to delay the closing of the exhaust and thus reduce the compression. The movement of the auxiliary-valve rod D′ may be effected in any suitable manner. I prefer, however, the mechanism shown, in which the auxiliary-valve rod is actuated by a varying connection between the cross-head and its valve-rod. The auxiliary rod D′ slides in the valve-sleeve *d′* and in an eye E, attached to the main-valve rod C′.

At a suitable point on the rod C′ is formed or attached a lug F, having a vertical rectangular slot, in which slides a block *f*. On a pin *f′*, projecting from said block, is fulcrumed a lever G, the lower end of which is jointed to the cross-head H. The upper end of the lever is slotted to receive a sliding block *g*, carrying a pin *g′*, which engages with an eye d^3 in the rod D′, whereby a varying leverage is exerted upon said rod. With this construction, when the rocker-arm C^2 begins to move backward the cross-head has approached nearly to the middle of its forward stroke and the block *f* is almost at the top of the slot in the lug F and the block *g* near the bottom of the slot in the lever G. The lever thus has considerable leverage on the rod D′ and tends to carry it forward about as fast as the rocker-arm would move it backward if the rod D′ were rigidly connected with said rocker. The result is that the valve D is retarded in its backward stroke and keeps the exhaust open until the rocker-arm gets to the middle of the stroke and the lever has assumed such an inclination as to bring the two sliding blocks near together, when the rocker-arm gets control of the valve D and moves it back to close the exhaust from the front end of the cylinder and open it from the rear end. The auxiliary valve thus remains practically stationary during the greater part of the stroke of the cross-head, since the slight horizontal movement given to the fulcrum *f′* by the eccentric is counteracted by the cross-head, which has considerable leverage on the block *g*. When the cross-head nears the end of the stroke, slows down, stops, and begins its return stroke, the fulcrum *f′* practically coincides with the block *g* and both are moved quickly by the eccentric, the auxiliary valve being moved its full stroke while the crank is thus passing the center.

It is evident that other ways than the one shown of rendering the fulcrum *f′* vertically movable with reference to the main-valve rod may be devised, and I do not limit myself to the specific construction illustrated and described.

Fig. 1 shows the rocker-arm at the commencement of its backward throw with the cross-head retarding the backward movement of the auxiliary valve. In Fig. 3 the rocker-arm is a little past the middle of its backward throw and the valve D is being moved back by it. With but slight variation this valve motion can be applied to ordinary locomotives or other simple engines, thereby greatly reducing the back-pressure and giving a much better indicator-card. A small pipe I is run from the passage 1^a to the passage 2^a and another between the passage 3^a to 4^a. In each pipe is a stop-valve *i*, the handles of the valves being connected by a rod I′, which runs to the cab. On starting the locomotive these valves are opened, which admits live steam to both sides of the high-pressure area of the piston and to one side of the low-pressure area, the latter serving to start the locomotive, which thus operates as a simple high-pressure engine until under way. Upon closing the valves *i* the locomotive immediately becomes a compound.

The piston-valves shown in Fig. 5 need no especial description, since their construction and operation are well understood. The pistons C^3 C^3 are joined by the rods c^3 and constitute the main valve C. The auxiliary valve D is hollow to permit the rod c^3 to pass through it and the steam to get from port 3 to port 2 and from port 1 to port 4, as explained above. A starting-valve K is placed in a pipe *k*, which leads from the boiler, so that live steam can be admitted to both sides of the high-pressure piston area and to one side of the low-pressure area simultaneously.

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

1. The combination, with a main admission-valve controlled by the eccentric, of an auxiliary exhaust-valve actuated by a varying connection between the cross-head and the valve-rod, whereby the movement of the auxiliary valve is delayed during the first part of the stroke of the eccentric in order to hold open the exhaust, substantially as described.

2. The combination, with a main admission-valve controlled by the eccentric, of an auxiliary exhaust-valve actuated by a lever connected with the cross-head and having a varying leverage on the auxiliary-valve rod, substantially as described.

3. The combination, with an engine-cylinder having a main valve controlling the admission of live steam and an auxiliary valve controlling the exhaust, of a rocker-arm, a

rod connecting said arm with the main valve, a rod attached to the auxiliary valve, and a lever having a vertically-movable fulcrum connected with the main-valve rod, said lever being also connected with the auxiliary-valve rod and actuated by the cross-head, substantially as described.

4. The combination, with a main admission-valve and an auxiliary exhaust-valve, of a main-valve rod connected with the eccentric and having a slotted lug F, an auxiliary-valve rod, a slotted lever fulcrumed on a block sliding in the lug F and connected with the cross-head, and a block sliding in the slot in the lever and coupled to the auxiliary-valve rod, substantially as described.

5. The combination, with two independent valves, one of which has a valve-rod driven by the eccentric, of a lever pivoted to the cross-head at one end and having its other end connected with the valve-rod by a vertically-movable fulcrum, and a second valve-rod attached to the other valve and connected with the lever by a sliding joint maintained at a constant level, whereby the distance of said joint from the fulcrum of the lever is constantly changing throughout the stroke, substantially as described.

6. The combination, with the main valve, of the rod C′, having the slotted lug F, containing the sliding block *f*, the slotted lever G, carrying the sliding block *g*, one end of the lever being fulcrumed on the block *f* and the other end jointed to the cross-head H, the auxiliary valve, and the valve-rod D′, connected with the block *g*, substantially as described.

7. The combination, with the cylinder A, having high-pressure steam-passages 1^a 3^a and low-pressure steam-passages 2^a 4^a, of pipes I, joining said passages, stop-valves *i* in said pipes, and a rod I′, adapted to operate both valves simultaneously, substantially as described.

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

HARRY CLIFTON REAGAN, JR.

Witnesses:

HARRY O. BENDER,

EDWD. F. PEACOCK.