

No. 795,880.

PATENTED AUG. 1, 1905.

J. B. ALLFREE.
COMPOUND LOCOMOTIVE.
APPLICATION FILED JAN. 27, 1902.

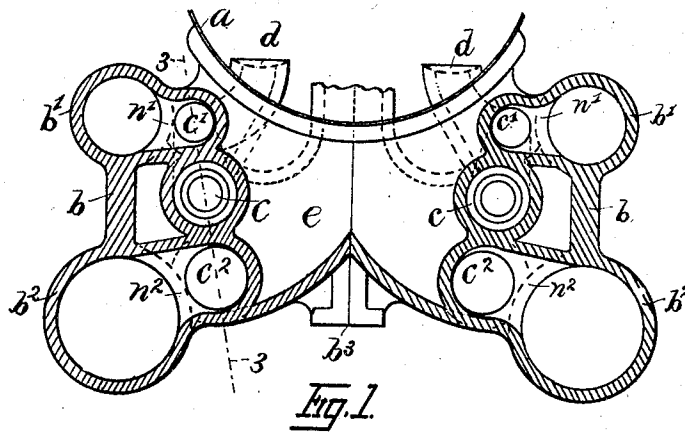


Fig. 1.

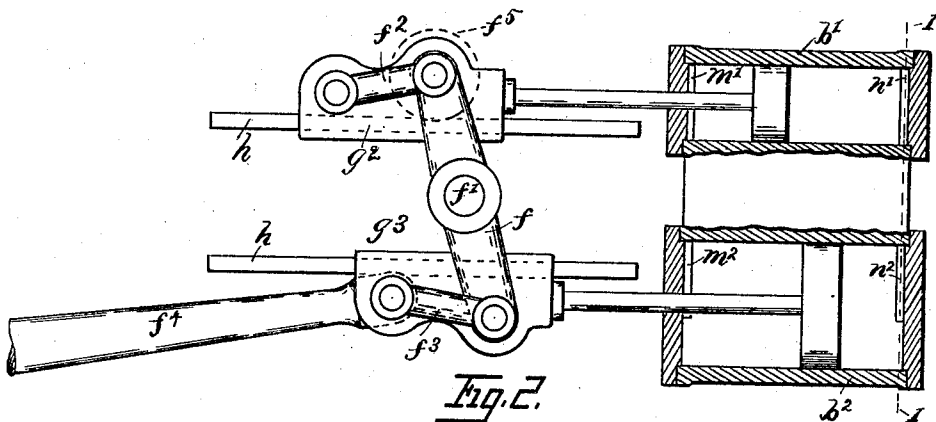
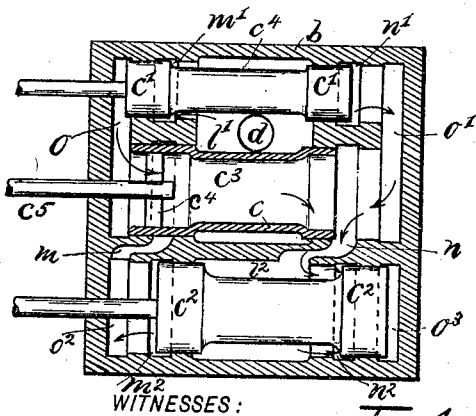


Fig. 2.



WITNESSES:

Fig. 3.

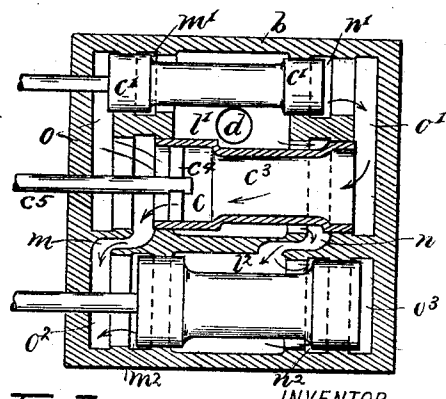


Fig. 4.

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COMPOUND LOCOMOTIVE.

No. 795,880.

Specification of Letters Patent.

Patented Aug. 1, 1905.

Application filed January 27, 1902. Serial No. 91,463.

To all whom it may concern:

Be it known that I, JAMES B. ALLFREE, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new Improvements in Convertible Compound Locomotives, of which the following is a specification, reference being made to the accompanying drawings, in the different views of which similar reference characters denote similar parts.

My invention relates to a convenient and readily-operated convertible simple and compound locomotive; and the objects of this invention are, first, a greater economy in the use of fuel; next, to obtain a greater starting power, and, finally, to balance the locomotive without the use of an excess of balance-weight in the drivers.

It is well known that where steam-pressures exceed one hundred and twenty-five pounds compounding becomes necessary in order to get the highest economy in the use of steam, and where the pressures are from one hundred and eighty to two hundred pounds compounding becomes almost an absolute necessity. It is further well known that in the use of single cylinders on a locomotive in order to get the starting power the cylinders have to be made larger than are advisable for the best economy after acceleration, and especially under high speeds. This fact, taken together with the high steam-pressure, makes even a fair economy impossible in a modern locomotive. Then, again, a most serious defect exists in that type of locomotives having their cylinders on the outside of the frames, because of the great mass of reciprocating weight which is located so far from the central line of the locomotive as to make it necessary to add an excessive amount of balance to the drivers in order to hold the locomotive upon the track. By balancing the drivers against the reciprocating parts, as is now done, the nosing or switching tendency is measurably overcome, but causes excessive hammer-blows upon the rail. By actual experiment it has been found that at high speeds the driver in many cases actually leaves the rail during a portion of its revolution, oftentimes producing wrecks by breaking the rail and creating a great amount of tremor and vibration throughout the entire locomotive, greatly affecting the efficiency, as well as increasing its perishability and danger to life. In my invention I attain these objects, first, by the well-known use of two cylinders, the high-

pressure cylinder preferably placed above and connected to coact with the low-pressure through a lever or beam, the steam first being received into the high-pressure cylinder, exhausting therefrom into the low-pressure, where it is expanded sufficiently low to produce the desired economy.

The next object (that of starting) is attained by the use of the change-valve, through which the locomotive may either be operated as a compound or simple engine. In starting and accelerating the train the live steam may be distributed to both cylinders on each side, both having free exhaust directly into the atmosphere, thus materially increasing the starting and accelerating power of the locomotive.

The third and last object is attained by and through the manner of connecting the two cylinders together, through which the pistons with all other reciprocating parts of each pair are caused to move in opposite directions, thereby balancing each other or one counteracting the effect of the reciprocating mass of its mate, thus reducing the weight of the balancing mass in the drivers to the exact amount necessary to balance the pin and the rotating portion of the connecting-rod. In operation when the locomotive is started all cylinders are acting simple, which gives a greater excess of starting power, permitting much more throttling than would be possible with a single cylinder. Then after acceleration the cut-off would be hooked up to a point that would expand the steam down to a point within the scope of fair economy. When a sufficient degree of acceleration has been attained, the change-valve is operated, throwing live steam only into the high-pressure cylinder and turning its exhaust through the low-pressure, changing the engines from simple to compound, thus giving a great range of power without to such a great degree affecting the economy as would follow in the use of a single cylinder or the compounds that have thus far been constructed. While in the two-cylinder or cross compound locomotives live steam is admitted to both cylinders for starting purposes, the work cannot be so evenly done; neither is it possible to maintain a proper division of work between the two, and as it is difficult to get the reciprocating parts of the low-pressure as light as they are in the high-pressure greater balancing mass becomes necessary. While the four-cylinder single-connected type overcomes in a measure the

difficulty of irregular power as between the two sides of the locomotive, there is always considerable variation as between the high and low pressure cylinders, creating undue friction upon the cross-head to which both are connected, and in starting only two cylinders (the low-pressure of each side) become effective. The greatest objection, however, to this system is that as both pistons move together the reciprocating mass to be overcome by the balance-weight in the drivers becomes so excessive as to render the machine impractical.

In my system I am enabled to bring the reciprocating parts of each pair of high and low pressure cylinders into exact balance, and by reason of the use of four cylinders so arranged that they may all operate simple they may be made materially smaller than in the case where only two cylinders can be employed for starting. If in practice there is any difficulty in making the weights of the high-pressure and low-pressure reciprocating parts the same, whatever difference exists may be readily overcome by weighting the high-pressure end of the beam, bringing all of the parts into perfect reciprocating balance.

In the drawings, Figure 1 is a transverse vertical section on line 1 1. Fig. 2 is a partial side elevation and sectional view. Fig. 3 is an enlarged sectional view on line 3 3, showing one position of change-valve; and Fig. 4 is a view similar to Fig. 3, showing the reverse position of change-valve.

In the reference-letters employed, *a* represents the boiler, and *b* the saddle-casting, as in ordinary locomotive construction, adapted to attachment to the boilers, the cylinders in this case being shown as integral with said saddle-casting, which is shown in halves joined at a central line *b*³, two cylinders on each side *b*¹, the smaller cylinder, for operation by steam at high pressures, being located at upper part of said saddle and the larger cylinder *b*², mainly for operation by low-pressure steam, located, preferably, directly under said smaller cylinder, *c*¹ and *c*² being the steam-distribution valves for cylinders *b*¹ and *b*², respectively, and the intermediate valve *c* being a change-valve for the conversion of the engine from simple to compound or compound to simple, as conditions may require, said valves being supplied with suitable ports, described farther on. *d* is the steam-supply opening into the steam-chamber *u*, communicating with both valves *c*¹ and *c*².

e is the exhaust-chamber communicating with the valves *c*¹ and *c*².

f is a beam or rocking lever, one of the first order, securely journaled at its fulcrum *f*¹ and at its extremities coupled, by means of connecting-links *f*² and *f*³, to respective cross-heads *g*² and *g*³, mounted on suitable guides *h* and *h*, by which means the resultant forces of high and low pressure pistons of each pair

are combined to coact and are communicated to the drivers through connecting-rod *f*⁴, and for the purpose of perfectly balancing of the reciprocating parts so connected, weight mass is preferably added to the upper extremity of said rocking lever or beam, as at *f*⁵. The cylinders are provided with ordinary steam-ports with which the valves *c*¹ and *c*² register, as in ordinary engine practice, *m*¹ and *n*¹ being the ports in smaller cylinder *b*¹ and controlled by the former, said valve *c*¹ and the ports *m*² and *n*², the ports in the larger cylinder *b*² and controlled by the latter said valve *c*².

Between the valves *c*¹ and *c*² I arrange the change-valve, which is tubular and of circular form and contracted at its central part and open at both ends, a spider *c*⁴ being fixed near one end to provide for the attachment of a rod *c*⁵, by means of which the change-valve can be moved longitudinally to change the ports leading to the valves *c*¹ *c*², as will be hereinafter described.

The change-valve *c*, with an opening *c*³ through its entire length, is placed in this case directly between the distribution-valves *c*¹ and *c*² and is in direct communication with the live-steam chamber in common with valve *c*¹ and is adapted to change the exhaust-steam released by latter valve *c*¹ from the high-pressure cylinder through port-channels *o* and *o*¹, either to be admitted into low-pressure cylinder or into the atmosphere, as may be desired, and when the latter condition is in operation and the exhaust-steam is discharged from said high-pressure cylinder into the atmosphere then live steam is being admitted through ports *n* into steam-chamber *u*² and by the distribution-valve *c*² admitted therefrom to the low-pressure cylinder through ports *m*² and *n*², and the two cylinders, with their operating parts, are then acting as similar engines, the change-valve *c* being in position shown in Fig. 3, and whereas when it is desired to operate the engines as a compound system the change-valve is in the position shown in Fig. 4, in which case the exhaust from the high-pressure cylinder through ports *n*¹ and *m*¹, passing through channels *o* and *o*¹ from the former channel, through hollow trunk *c*³ of said change-valve, combining with that from the opposite end of said cylinder, flowing through latter channel *o*¹, and through the port *n* into the steam-chamber *u*², and distributed to the low-pressure cylinder by means of valve *c*², and finally when expansion has been carried sufficiently far the exhaust-steam is released through the channels *o*² and *o*³ into the exhaust-chamber *e*.

The change-valve is provided with any suitable ordinary means, such as a hand-lever, by which it may be readily and easily operated by the engineer, it being at all times balanced.

The operation of my device, the first step being starting of the load, in which case the change-valve is in position shown in Fig. 3,

all cylinders acting as in simple engines and with steam at high pressures, the starting and accelerating power of the locomotive will be at the highest point of efficiency, admitting of throttling to the greatest extent, the effect being such a reduction of intensity of the exhaust as to have no disturbing effect on the fire, this result being due to the large piston area required in a compound system, and all of said piston area being so readily available in high-pressure service and whereas when starting and acceleration have been extended far enough the conversion of the simple system into a compound system by the simple movement of the change-valve to its position shown in Fig. 4.

As there might be several alterations resorted to in the particular construction and arrangements of parts of my device, I wish it understood I hold myself at liberty to make any such alterations as fall fairly within the spirit and scope of my invention, and

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

1. The combination with a locomotive and four cylinders mounted thereon and arranged in two sets, each set comprising a high-pressure cylinder and a low-pressure cylinder, of two change-valves one connected with the valves of each set of cylinders, said change-valves being so constructed and arranged that steam may be admitted to all four of the cylinders at the same time the steam on its way to the low-pressure cylinder passing, at this position of parts, around the exterior of said change-valves and each cylinder being permitted to exhaust independently into the atmosphere.

2. In a compound convertible locomotive, one or more pairs of cylinders, with pistons, rods and cross-heads, preferably the smaller placed above the larger, the reciprocations of said pistons being in direct opposition so that the moving masses or parts practically balance each other, a centrally-pivoted rocking lever mounted midway between said cross-heads and connected at its upper and lower extremities to the respective cross-heads, by means of links, a pair of driving-wheels, a connecting-rod attached, preferably to lower cross-head and to a crank-pin on driving-wheel, a steam-distribution valve to each cylinder

adapted to distribute motive steam to respective cylinders, a hollow change-valve intercepting the exhaust-channels from the smaller or high-pressure cylinder, and the supply-channels to the larger or low-pressure cylinder, adapted to convert said pair of cylinders from a compound to a simple system, providing a passage through the center of the change-valve for the exhaust of the high-pressure cylinder and a passage for high-pressure steam around the change-valve to the low-pressure cylinder or from a simple to a compound system, as set forth.

3. In a steam-engine, a pair of cylinders provided with suitable steam-distribution valves, pistons, rods and cross-heads and guides, one cylinder being larger than the other, a suitable intermediate valve-chamber located between the respective valve-chambers of said cylinders the exhaust-channels leading from the smaller cylinder into said intermediate valve-chamber, preferably at either end thereof, a change-valve of piston type, provided with one long and one short head, and a free opening extending longitudinally through its entire length, adapted to be operated within latter said valve-chamber, a port-opening provided near each end of said change-valve chamber in the seat thereof, and with which said valve is adapted to register and a central steam-chamber provided about said change-valve and its chamber in which is carried steam at high pressure, one of said port-openings that with which the larger head end of said change-valve is adapted to register, leading to the exhaust-outlet, and the other port-opening at opposite end adapted to be controlled by the shorter head end of said change-valve leading to the supply-division of the valve-chamber of the larger cylinder, that by the simple endwise adjustment of said change-valve the system of operation of the pair of said cylinders may be instantly changed from simple to a compound, or from compound to a simple system, of operation, as specified.

That I claim the foregoing I have hereunto signed my name, this 22d day of January, 1902, in the presence of witnesses.

JAMES B. ALLFREE.

Witnesses:

E. B. HETZEL,

D. H. PALMER.