Oct. 20, 1931. E. L. THEARLE 1,828,627

MEANS FOR BALANCING STEAM LOCOMOTIVES

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Fig. 1.

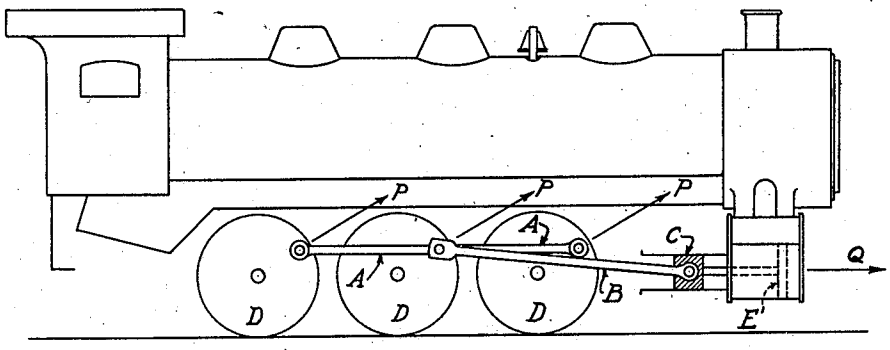


Fig. 2.

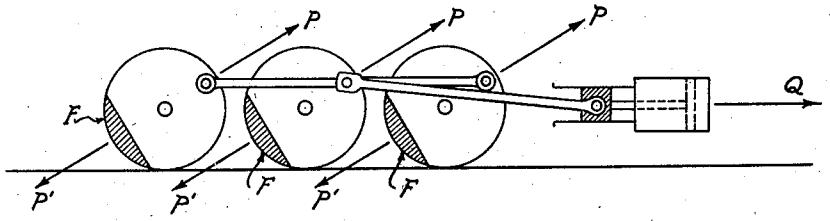
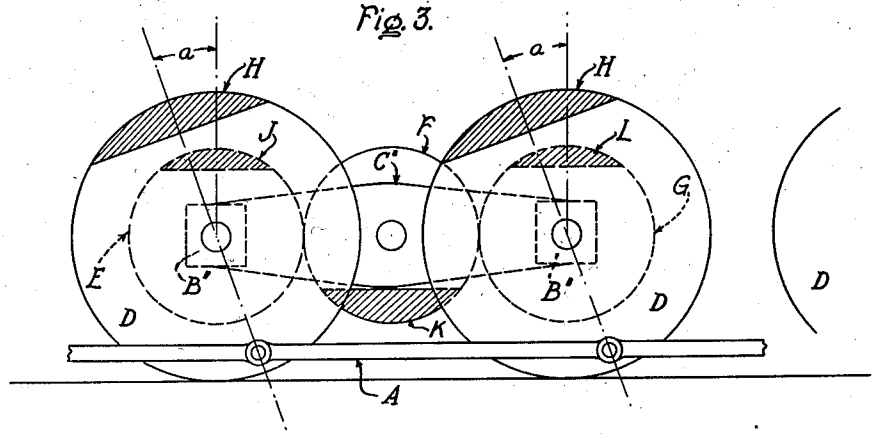


Fig. 3.



Inventor:
Ernest L. Thearle,
by Charles E. Mullen
His Attorney.

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Fig. 4.

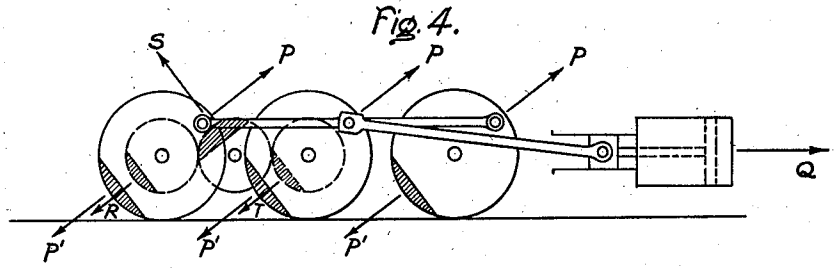


Fig. 5.

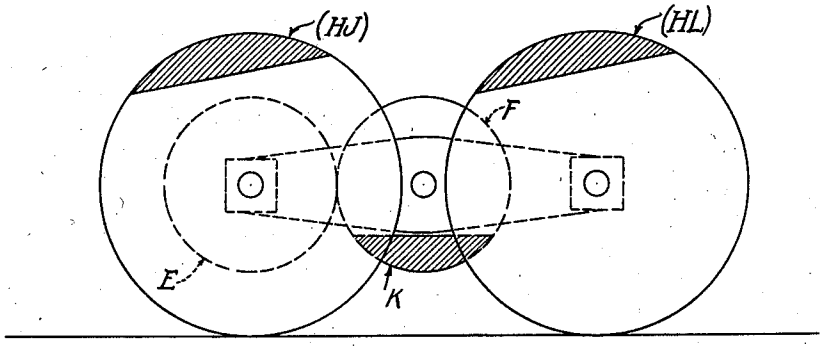


Fig. 6.

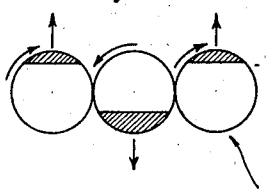
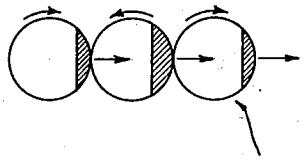


Fig. 7.



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Fig. 8.

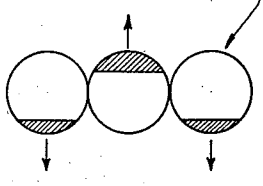
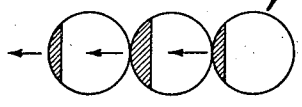


Fig. 9.



FORCES ADD

Inventor:
Ernest L. Thearle,
by Charles E. Mullen
His Attorney.

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UNITED STATES PATENT OFFICE

ERNEST L. THEARLE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

MEANS FOR BALANCING STEAM LOCOMOTIVES

Application filed November 7, 1930. Serial No. 494,081.

The main moving parts of a locomotive may, for the purpose of balancing, be divided into two groups, one group of rotating masses, and the other of reciprocating masses. Among the rotating masses would be the driving wheels, side rods and pins, and a portion of the main connecting rods. Among the reciprocating masses would be included the pistons, piston rods, valves and operating gear, crossheads, and the remainder of the main connecting rods.

The first mentioned group of rotating weights, considering only one side of the locomotive, produce an unbalanced force on the locomotive which is in the nature of a rotating force, constant in magnitude for any one locomotive speed. This unbalance may be corrected for by the addition of compensating rotating weights on the driving wheels, which is now common practice.

The second group of reciprocating weights produce unbalanced forces on the locomotive which are always horizontal and act in the plane of the cylinders, these forces varying in amount from a maximum in a forward direction to a maximum in a backward direction during each revolution of the driving wheels. Since the pistons and cross heads of a locomotive do not move together, these unbalanced reciprocating weights produce forces on the locomotive causing it to "nose" or oscillate about a vertical axis as it moves along the track. This is a very dangerous and undesirable condition.

If this horizontal unbalance is corrected for by applying still heavier balance weights on the driving wheels, so that the net horizontal forces disappear, then the rotating weights are overbalanced and vertical unbalance forces are introduced which cause a pounding of the drivers on the track. This action subjects the rails to unduly severe treatment and increases the cost of trackage maintenance.

My invention has for its object the provision of an improved construction or arrangement of parts whereby both the reciprocating and rotating elements of a locomotive may be effectively balanced.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawings which are illustrative of my invention, Fig. 1 is a diagrammatic view of a steam locomotive of ordinary construction; Fig. 2 is a diagrammatic view illustrating the usual application of balancing weights to the driving wheels; Fig. 3 illustrates the application of means for balancing the reciprocating masses; Fig. 4 shows the application of the arrangement shown in Fig. 3 to a locomotive; Fig. 5 shows a modification of the construction shown in Fig. 3, and Figs. 6 to 9 inclusive are diagrams illustrating the operation of the balancing parts.

The following is a description of my improved arrangement of parts for counter balancing the horizontal reciprocating weights without introducing a vertical unbalance, thus eliminating both the swaying of the locomotive and severe pounding of the rails.

In Fig. 1 are represented the main moving parts of a locomotive. The three drivers D are connected by side rods A. The connecting rod B transmits forces from the crosshead C and piston E. It also shows the forces exerted on a locomotive by unbalanced masses. The forces P indicated by arrows are exerted on the locomotive by the rotating masses of side rods and in part by the connecting rod. The horizontal force Q also indicated by an arrow is exerted on the locomotive by the reciprocating crosshead, piston rod, piston, and by a portion of connecting rod.

Fig. 2 shows how the rotating forces P may be balanced by the addition of balancing weights F to the drivers, introducing forces P′ always equal and opposite to forces P. This leaves the horizontal unbalanced force Q, due to reciprocating masses. If the weights F are made large enough so that when forces P and P′ are horizontal, P′ is enough greater than P to balance Q, then when forces P′ and P are vertical, this excess of P′ over P will cause pounding of drivers on the rails.

Fig. 3 shows a mechanism which when applied to any pair of drivers will introduce a horizontal force to balance the reciprocating weights without producing a vertical component increasing rail pressure.

In this figure, a link C′ is carried by driver journal boxes B′ and B′. Mounted on the driver axles are gears E and G which mesh with a similar gear F carried by the link C′. These three gears are of the same size. Gears E and G carry equal counterweights J and L, and gear F carries a counterweight K such that if J, L and K represent the moments of these weights about their respective axes of rotation, then $K-2J=2L$. The gears E, F and G are meshed so that K is opposite weights J and L, when in the position shown in Fig. 3. One of these devices is placed on each side of the locomotive. The counterweights H placed on the drivers are just sufficient to balance the rotating weights. The weights J, K and L are so proportioned that the sum of their effects, $J+K+L$, is just sufficient to balance the horizontal forces due to reciprocating weights. Since these balancing devices cannot be placed in the same vertical plane as the forces which they balance, the gears J, K and L must be displaced by an angle "a" (Fig. 3) from the rotating weights on the wheels, in order to be most effective. The correct positions and amounts of these weights may be calculated by known methods.

Fig. 4 shows how the application of such a device to a locomotive will balance the horizontal force Q without introducing a vertical unbalance. In this figure, the sum of horizontal components of forces R, S and T indicated by arrows are equal and opposite to the force Q, thus balancing th same. The vertical component of force S annuls the effect of vertical components of R and T, thus introducing no vertical unbalance. This relation exists during the entire revolution.

Fig. 5 shows a modification of the same arrangement, in which the weights J and L have been replaced by equivalent weights HJ and HL on the drivers. This removes the necessity for gear G. Gear E carries no weight but serves only to drive gear F which carries weight K. The principle of operation is the same as in Fig. 3, the only difference being in the structure; since gears E and G (Fig. 3) rotate in synchronism with drivers D, weights J and L may be replaced by equivalent weights on the drivers, which when added to the original weights H, are represented by HJ and HL.

The action of the arrangement illustrated in Fig. 3 is shown by Figs. 6, 7, 8 and 9, at four different points during the revolution

As one illustration of my invention I have shown it in connection with a steam locomotive where it is of particular application, but it is to be understood that it is also applicable to other forms of apparatus and other types of prime movers wherein reciprocating members are employed to transmit power to rotary members.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a system of power transmission, the combination of a reciprocating power developing motor, rotors, shafts for the rotors, reciprocating members which transmit motion from the motor to the rotors, balancing weights on the rotors for counterbalancing the effect of the mass of the members thereon, a balancing weight acting in opposition to the added weights on the rotors for counter-balancing the mass of the reciprocating parts, and means for rotating the last mentioned mass in synchronism with the first mentioned balancing weights and maintaining said weights in predetermined angular relation.

2. In a system of power transmission, the combination of a reciprocating piston and its cylinder, driving wheels, axles therefor, reciprocating rods actuated by the piston which are connected to the wheels for rotating them, balancing weights on the wheels for counterbalancing the effect of the mass of the rods thereon, a balancing weight acting in opposition to the balancing weights on the wheels for counterbalancing the effect of the mass of the reciprocating parts, and means driven by one of the axles for rotating the last named weight.

3. In a system of power transmission for locomotives, the combination of a reciprocating piston and cylinder, driving wheels, axles therefor, reciprocating members actuated by the piston which are connected to the wheels for rotating them, balancing weights on the wheels for counterbalancing the effect of the mass of the members thereon, a balancing weight, a shaft on which the weight is mounted, said weight being angularly displaced from the weights on the wheels for counterbalancing the effect of the mass of the reciprocating parts, a support for the said weight located at one side of the driving wheels, and gears also located at one side of the wheels and actuated by one of the axles for driving the weight and maintaining a definite angular relation between all of said balancing weights.

4. In a system of power transmission for locomotives, the combination of a reciprocating piston and cylinder, driving wheels, axles therefor, reciprocating members actuated by the piston which are connected to the wheels for rotating them, a balancing weight on each of said wheels for counterbalancing the effect of the mass of the members thereon, a balancing weight, a shaft on which the weight is mounted, said weight occupying such an angular position thereon as to act in opposition to both of the weights on the driv-

ing wheels, a support for the shaft and its weight located at one side of the driving wheels and carried by the axles thereof, and gearing driven by one of the axles for rotating the weight on said shaft.

5. In a system of power transmission for locomotives, the combination of a reciprocating piston and its cylinder, driving wheels, axles therefor, reciprocating means for transmitting power from the piston to the wheels, a counterbalancing weight mounted on each wheel, a weight for counterbalancing the mass of the reciprocating means which occupies a position that is angularly displaced from the positions of the weights on the wheels by approximately 180°, and means for rotating said weight at the same speed as and opposite in direction to the weights on the driving wheels.

In witness whereof, I have hereunto set my hand this sixth day of November, 1930.

ERNEST L. THEARLE.