(No Model.) 2 Sheets—Sheet 1.

M. N. FORNEY.

COUNTERBALANCE AND GUIDE FOR RECIPROCATING MECHANISMS.

No. 489,648. Patented Jan. 10, 1893.

FIG. 1.

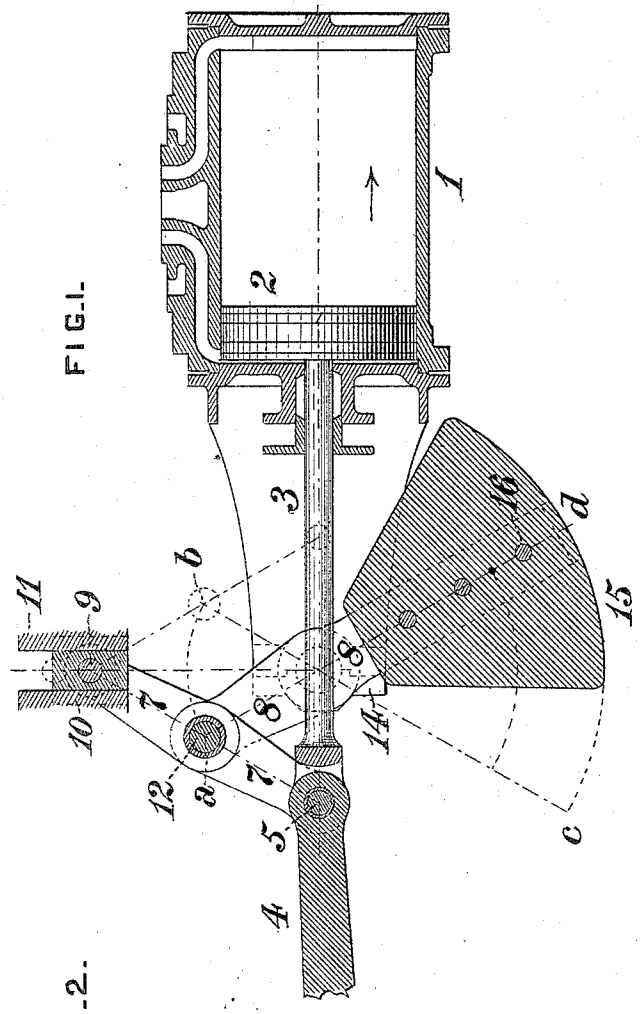


FIG. 3.

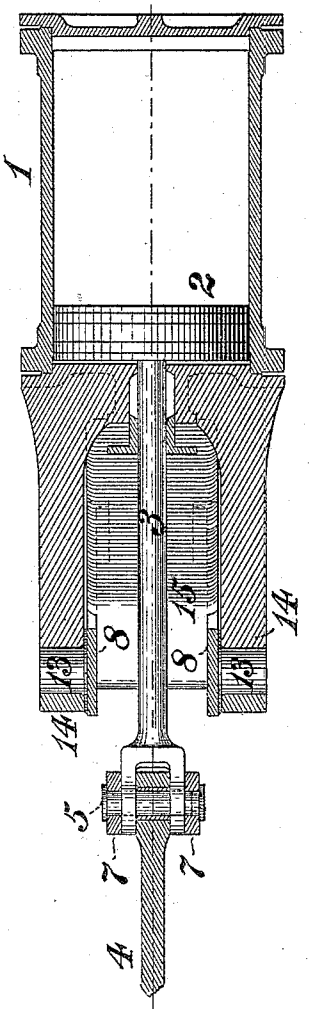
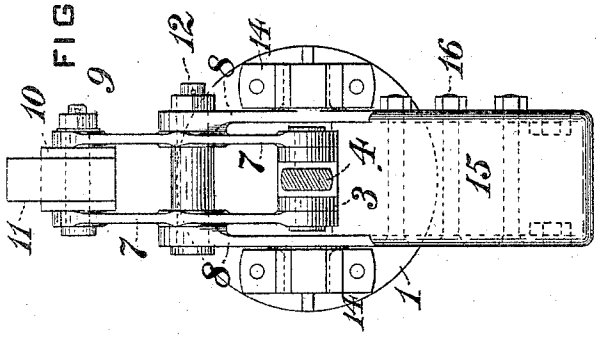


FIG. 2.



WITNESSES:

R. A. Whiddesey

F. E. Gaither

INVENTOR

M. N. Forney,

by Howson & Sell,

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 2 Sheets—Sheet 2.

M. N. FORNEY.

COUNTERBALANCE AND GUIDE FOR RECIPROCATING MECHANISMS.

No. 489,648. Patented Jan. 10, 1893.

FIG. 4.

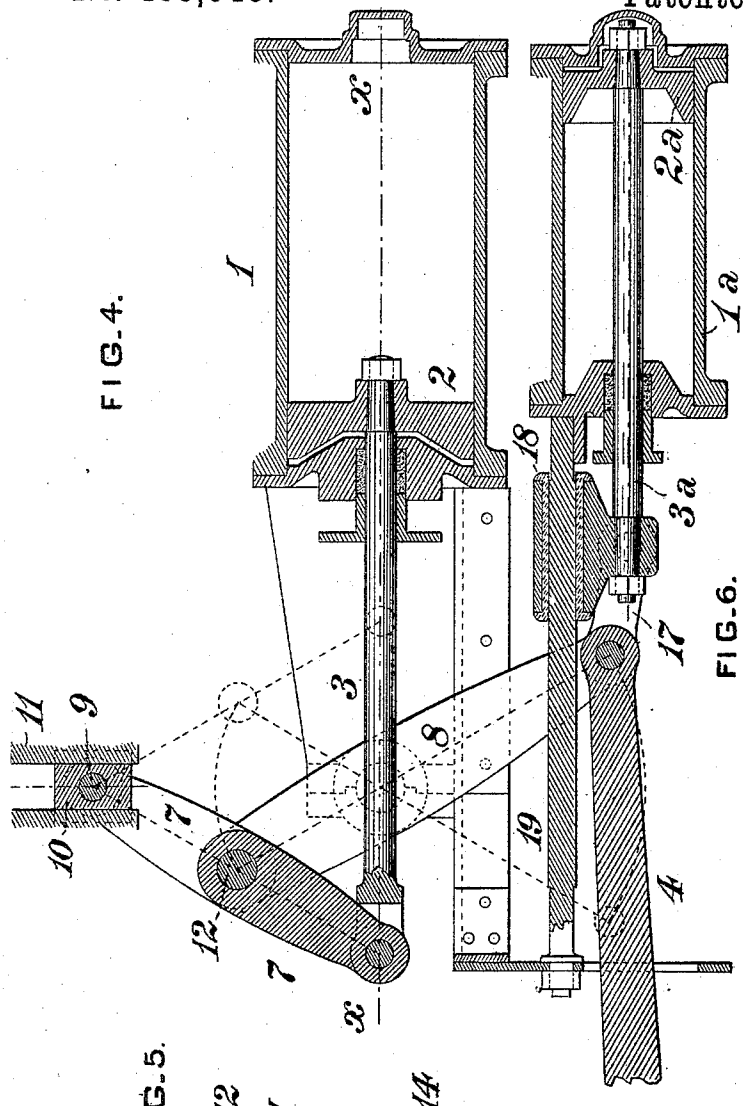


FIG. 6.

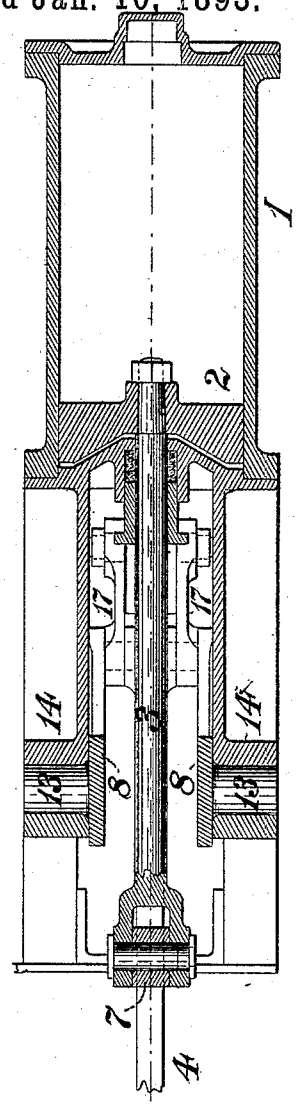
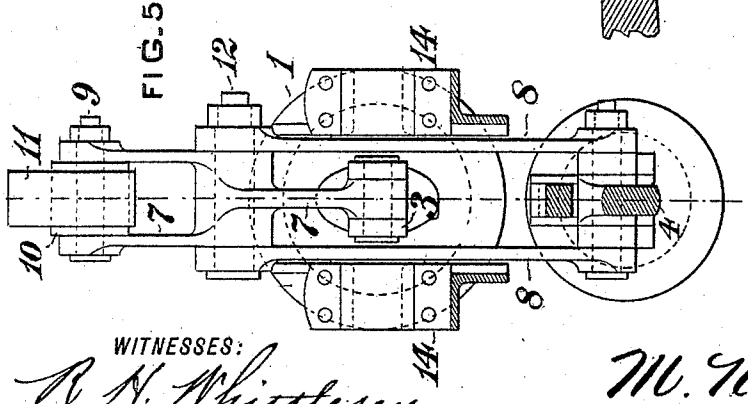


FIG. 5.



WITNESSES:

R. N. Whittesey

F. E. Gaither.

INVENTOR

M. N. Forney,

by J. Rowden Bell,

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

MATTHIAS N. FORNEY, OF NEW YORK, N. Y.

COUNTERBALANCE AND GUIDE FOR RECIPROCATING MECHANISMS.

SPECIFICATION forming part of Letters Patent No. 489,648, dated January 10, 1893.

Application filed March 31, 1892. Serial No. 427,227. (No model.)

To all whom it may concern:

Be it known that I, MATTHIAS N. FORNEY, of the city, county, and State of New York, have invented a certain new and useful Improvement in Counterbalances and Guides for Reciprocating Mechanism, of which improvement the following is a specification.

My invention is more particularly designed for application in, although not limited to, simple and compound engines, and its object is to enable the momentum of reciprocating parts to be counterbalanced without inducing a disturbing action at right angles to the movement of such parts, as well as to insure the rectilineal movement of the reciprocating parts without the employment of the ordinary cross head and guides.

To this end, my invention, generally stated, consists in the combination, with a reciprocating element, of a system of oscillating levers, and a counterbalance connected to said levers and moving in a reverse direction to the movement of the reciprocating element.

The improvement claimed is hereinafter fully set forth.

The reciprocating parts of engines have heretofore been and are now usually counterbalanced by the attachment of counterweights to the main shaft of the engine opposite to the crank or cranks. Such attachment serves to counteract the momentum of the piston and connected parts in their rectilineal movement, but as the counterweight necessarily traverses a circular path, it induces a disturbing action on the shaft at right angles to the direction of movement of the piston. This disturbance is, in all cases, objectionable, and is found in locomotive engines to be a serious disadvantage, it being said to be sometimes sufficient, at high speeds, to bend the rails below the wheels and impose dangerous strains on bridges and other structures of the permanent way. My invention is designed to substantially eliminate this disturbing action by means of a construction which at the same time dispenses with the ordinary guiding devices, and which, in a form adapted for practical application, will now be described.

In the accompanying drawings: Figure 1 is a vertical longitudinal central section through the cylinder of a steam engine in which my invention is applied; Fig. 2, an end view as seen from the left of Fig. 1; Fig. 3, a horizontal central section; Fig. 4, a vertical longitudinal central section through the cylinders of a steam engine of the compound type, illustrating another form of application of my invention; Fig. 5, an end view, as seen from the left of Fig. 4, and; Fig. 6, a horizontal central section, on the line x, x, of Fig. 4.

Referring to Figs. 1, 2 and 3, the cylinder 1, which is of the ordinary construction, is fitted with a piston 2, secured upon a piston rod 3, the outer end of which is coupled to a connecting rod 4, through which power is transmitted to a crank pin for the rotation of a shaft. In lieu of being secured to a cross head, fitted to slide in guides, as in common practice, the outer end of the piston rod is coupled, preferably, as shown, by the connecting rod pin 5, to a system of oscillating levers 7, 8, forming what is known as a "parallel motion," by means of which the outer end of the piston rod is caused to move in a straight line, thereby dispensing with the cross head and guides ordinarily employed for this purpose. The two levers, 7, which are coupled at their lower ends, one on each side, to the piston rod 3, and which may be termed primary levers, are pivotally connected at their upper ends, as by a pin 9, to a sliding block 10, which is fitted to work on or between a fixed guide or guides 11, and are intermediately coupled, by a pin 12, to the upper ends of a pair of secondary levers 8, which are arranged on the outside of the primary levers 7, in order to insure greater stability and to permit the primary levers to work freely between them, and are provided with journals 13, which are mounted in fixed bearings 14, forming fulcra about which the secondary levers 8 are adapted to oscillate as indicated by the dotted lines a, b, and c, d, Fig. 1.

In operation, assuming the piston and piston rod to be in the position shown in Fig. 1, and to be moved toward the right, as indicated by the arrow, the lower ends of the primary levers 7 will also move to the right, and the coupling pin 12, by which their middle portions are connected to the upper ends of the secondary levers 8, will move in the arc $a\ b$, described in the oscillation of the secondary

levers about the axial line of their journals 13. The upper ends of the primary levers, however, being coupled to the sliding block 10, which is only free to move in a vertical rectilineal path, are constrained to move in the same path as said sliding block. The primary levers 7, therefore, oscillate about the axis of the coupling pin 12, and their lower ends tend to describe an arc from said axis, curved in the opposite direction to the arc described by the upper ends of the secondary levers 8. The arms of the primary levers on opposite sides of the coupling pin 12 are equal in length, and equal to the distance between the axis of said pin and the axis of the journals 13 of the secondary levers, and it therefore results from the conjoined action of the primary and secondary levers, that the lower ends of the primary levers, and the connected outer end of the piston rod, are compelled to move in a right line. So far as above described, this construction, which dispenses with the ordinary cross head and guides, is in substantial accordance with a known form of parallel motion, and is not therefore, in and of itself, claimed as new.

My present invention utilizes the known function of the above construction, and combines therewith that of counterbalancing the reciprocating parts, by forming arms on the secondary levers extending from their journals in opposite direction to those to which the primary levers are coupled, and connecting to said opposite arms a counterbalance which moves therewith in opposite direction to the piston and piston rod and thus balances or counteracts their momentum. As shown in Figs. 1 to 3, the counterbalance is a dead weight 15, which is secured to the lower arms of the secondary levers by bolts 16, but such specific form is not, as will hereinafter be shown, of the essence of my invention.

It will be observed that the path of the center of gravity of the weight 15 is in an arc of a circle and not, as would be more desirable, in a right line as in the case of the piston and rod. The disturbance due to the difference in the direction of motion of the counterbalance and of the piston respectively is, however, very slight, and is represented by the versed sine of the arc described by the center of gravity of the counterbalance, whereas that of a revolving counterbalance, set oppositely to the crank as in ordinary practice, would be represented by the diameter of the circle described by its center of gravity. The construction above described induces much less disturbance at right angles to the piston, and at the same time counteracts the momentum of the piston and connected reciprocating parts. The elimination of the cross head and guides is a further feature of advantage, these being expensive to construct and maintain, particularly on locomotive engines, where they are exposed to grit and dust and their proper lubrication is difficult.

Figs. 4, 5, and 6 illustrate another form in which the essential features of my invention as before described are embodied, in an application thereof to a compound steam engine. The construction and relation of the low pressure cylinder 1, its piston 2, piston rod 3, and the primary and secondary levers 7, 8, are as before described, but in lieu of employing a dead weight 15, as a counterbalance, as in the former instance, the lower arms of the secondary levers 8 are coupled to the piston rod 3^a of the high pressure piston 2^a, which reciprocates in the high pressure cylinder 1^a, said high pressure piston and rod performing the same function, in combination with the system of oscillating levers and the low pressure reciprocating members, as is performed by the counterweight 15, and acting as the mechanical equivalent thereof. The secondary levers 8 are coupled to the high pressure piston rod by a pair of links 17, and said piston rod is secured to a cross head 18, sliding on a guide 19, for the reason that the parallel motion function of the primary and secondary levers is operative only upon the low pressure piston rod and piston.

While I have herein described and shown my invention as applied in counterbalancing and guiding reciprocating parts of steam engines, for which special function it is desirably applicable, I do not limit myself to such specific application, as it will be obvious that it is likewise applicable, without variation of principle or substantial modification of structure, in connection with the reciprocating elements of other mechanisms. Neither do I desire to confine myself to the specific arrangement of oscillating levers described and shown, for the reason that a counterbalance adapted to move in opposite direction to a reciprocating member, and connected to some other form of linked or articulated parallel motion mechanism, would, in combination therewith, present all the essential features of, and operate similarly to and with the same result as, the specific constructions herein in detail described and shown.

I claim as my invention and desire to secure by Letters Patent:

1. The combination, with a reciprocating element of mechanism, of an articulated system of oscillating levers or links, connected to the reciprocating element and forming a guide to insure rectilineal motion thereof, a guiding member for said system of levers, and a counterbalance connected to said system of levers and moving in opposite direction to the reciprocating element, substantially as set forth.

2. The combination, with a reciprocating element of mechanism, of a primary oscillating lever coupled at one end to the reciprocating element and having a movable fulcrum at its opposite end, a double armed secondary lever, oscillating in fixed bearings and having one of its arms pivotally connected to the primary lever at the middle thereof, and a counterbalance connected to the opposite

arm of the secondary lever, substantially as set forth.

3. The combination, with a reciprocating element of mechanism, of a primary oscillating lever coupled at one end to the reciprocating element and having a movable fulcrum at its opposite end, a double armed secondary lever, oscillating in fixed bearings and having one of its arms pivotally connected to the primary lever at the middle thereof, and a dead weight connected to the opposite arm of the secondary lever, substantially as set forth.

4. The combination, with a reciprocating piston and piston rod, of a primary lever coupled at one end to the piston rod and at the other to a sliding block, a fixed guide on which said block is fitted to move rectilinearly, a double armed secondary lever journaled in fixed bearings and having one of its arms pivotally connected to the primary lever at the middle thereof, and a counterbalance connected to the opposite arm of the secondary lever, substantially as set forth.

MATTHIAS N. FORNEY.

Witnesses:
FREDERICK HOBART,
FRANK J. FRENCH.