

No. 701,477.

Patented June 3, 1902.

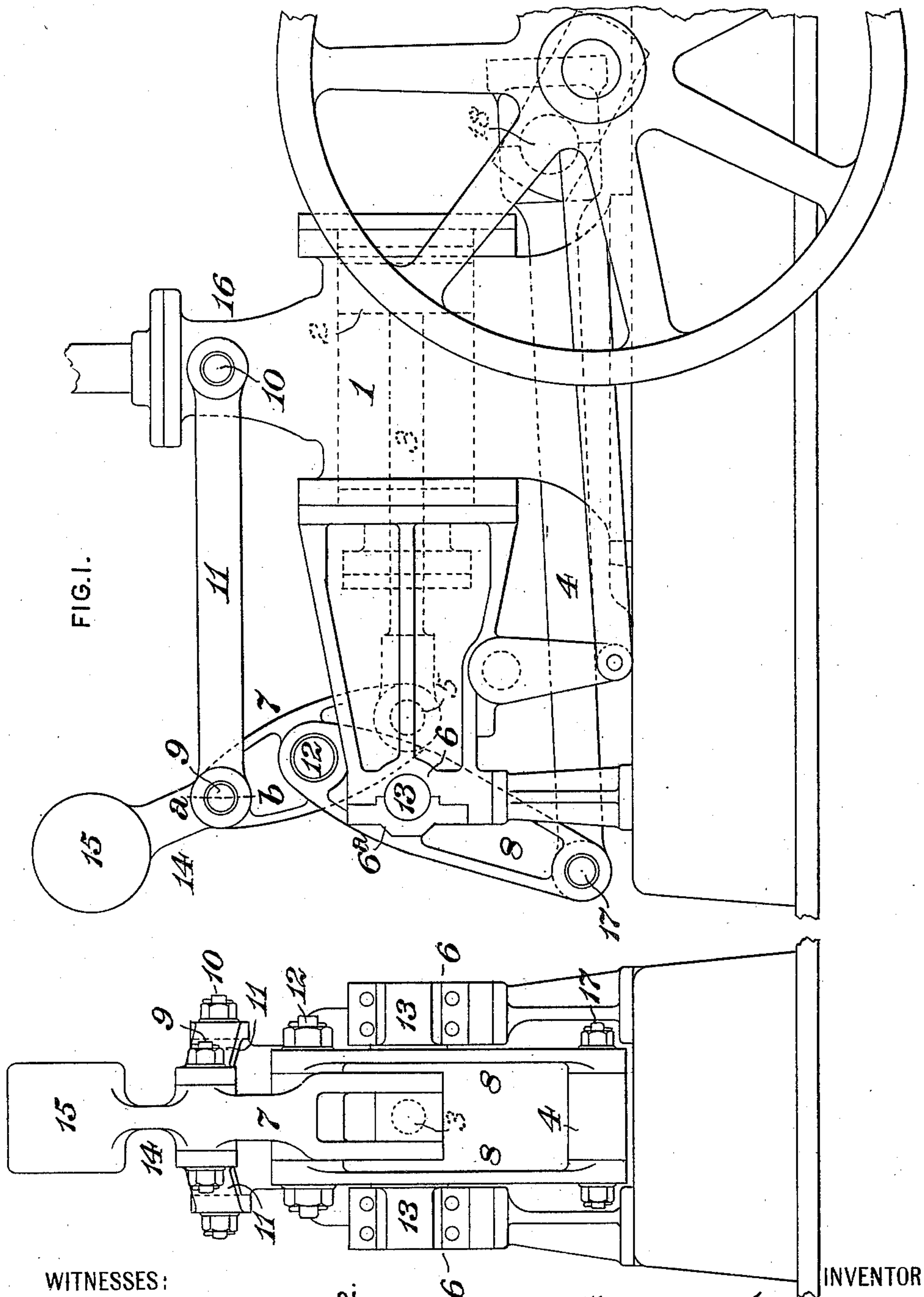
M. N. FORNEY.

MEANS FOR COUNTERBALANCING THE MOMENTUM OF RECIPROCATING ELEMENTS.

(Application filed Dec. 2, 1901.)

(No Model.)

2 Sheets—Sheet 1.



WITNESSES:

James C. Heron.
S. R. Bell.

FIG. 2.

M. N. Forney
by J. Snowden Bell,
ATTORNEY

INVENTOR

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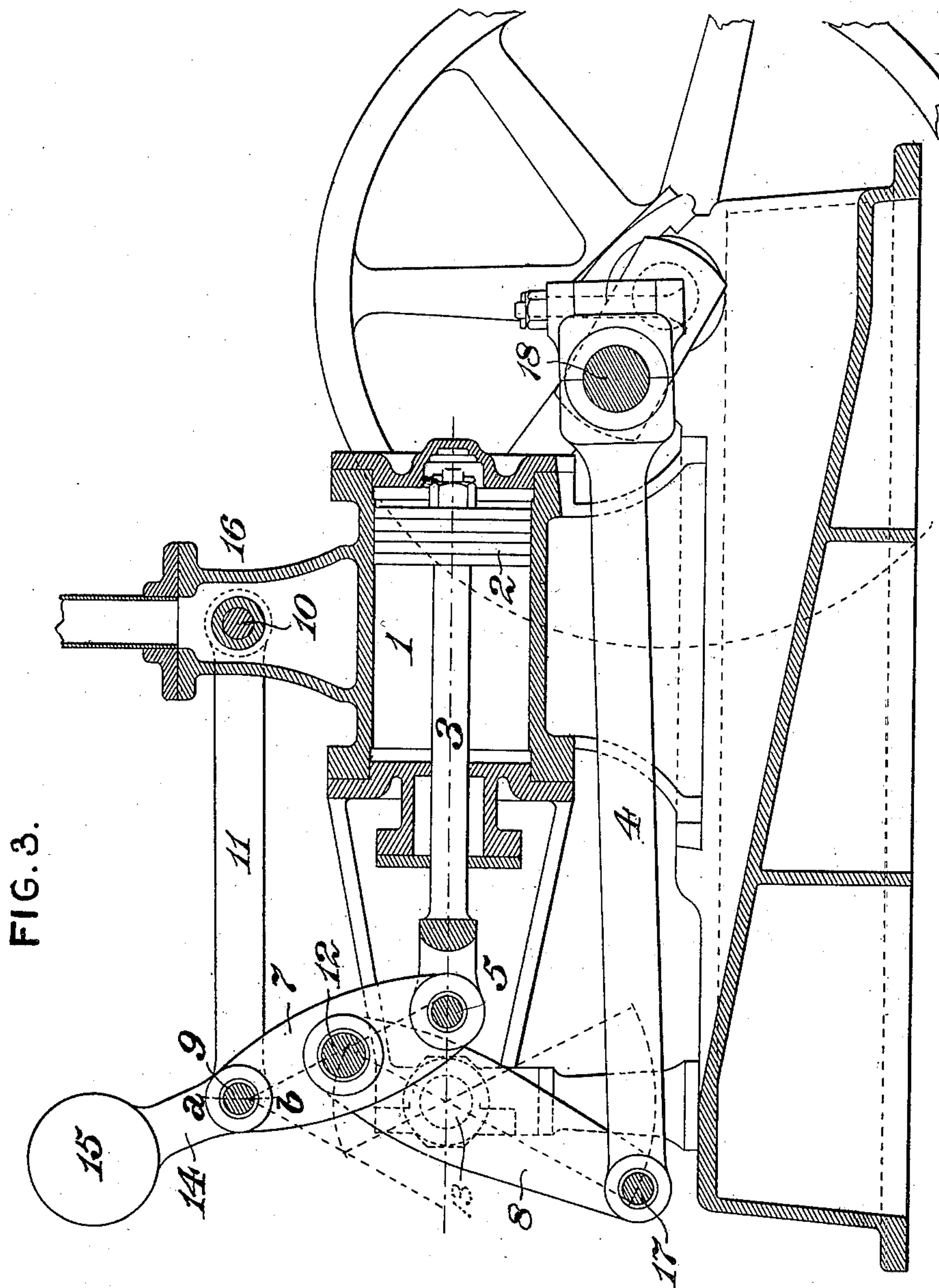
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WITNESSES:

James C. Herrow.
S. R. Bell.

INVENTOR

M. N. Forney
by J. Howard Bell,
ATTORNEY

UNITED STATES PATENT OFFICE.

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

MEANS FOR COUNTERBALANCING THE MOMENTUM OF RECIPROCATING ELEMENTS.

SPECIFICATION forming part of Letters Patent No. 701,477, dated June 3, 1902.

Application filed December 2, 1901. Serial No. 84,292. (No model.)

To all whom it may concern:

Be it known that I, MATTHIAS N. FORNEY, of the borough of Manhattan, in the city and State of New York, have invented a certain
5 new and useful Improvement in Means for Counterbalancing the Momentum of Reciprocating Elements, of which improvement the following is a specification.

My present invention, which is an improvement on those for which Letters Patent of
10 the United States Nos. 489,648 and 528,294 were granted and issued to me under dates of January 10, 1893, and October 30, 1894, respectively, while more particularly designed
15 for application to simple or single expansion-engines is also applicable in compound engines; and its object is to further improve the general systems of means for counterbalancing the momentum of reciprocating
20 elements without inducing disturbing action at right angles to the movement of such elements set forth in said Letters Patent by effecting a reduction in cost and promoting a more convenient disposition of parts.

25 The improvement claimed is hereinafter fully set forth.

In Letters Patent Nos. 489,648 and 528,294 aforesaid the upper end of what is therein termed the "primary oscillating lever" is
30 pivotally connected to a sliding block, which is fitted to work on or between a fixed guide or pair of guides. The purpose of this sliding block and guides is to allow the upper end of the primary oscillating lever to vibrate or oscillate about its pivotal connection
35 with the sliding block and at the same time to move up and down in a vertical straight line. This construction is unsatisfactory, in the particular that the guides are expensive
40 to make and maintain and are so located that it is not entirely convenient and is somewhat costly to provide adequate supports for them.

Under my present invention the sliding
45 block and guides are dispensed with, and their function is performed by a pair of radial links, to one end of which the primary lever is pivotally connected, the other end being similarly connected to a fixed support. These
50 links are of such length that the short arc in

which their ends, to which the lever is connected, vibrate coincides very closely with a straight line, so nearly, in fact, as not to introduce any material error in the horizontal movement of the lower end of the lever, to
55 which the piston-rod is connected, and which must, therefore, be constrained so as to move in a straight line.

My invention further consists in the combination, with the primary oscillating lever, 60 of a counterweight attached to an extension of the primary oscillating lever above its pivotal connection with the radial link or pair of links. In the construction set forth in Letters Patent No. 528,294 the weight of the
65 piston and its rod was balanced partly by the weight of the connecting-rod and that of the lower extension of the secondary levers and, if required, by a counterweight attached to these levers. It has been developed by
70 study and experiment that a more perfect balance can be obtained by dividing the weight of these parts and attaching about one-half as much weight to the extension of the primary lever referred to above. By this
75 means a much steadier movement of the engine is produced than is possible with the distribution of balancing-weight set forth in my prior patents hereinabove specified.

In the accompanying drawings, Figure 1 is
80 a side view in elevation of a stationary engine, illustrating an application of my invention; Fig. 2, an end view of the same as seen from the left with the caps of the journal-bearings removed in order to show the jour-
85 nals in full lines, and Fig. 3 a vertical longitudinal central section.

While my invention is herein shown and will be described as applied to a stationary steam-engine, it is equally applicable to lo-
90 comotive or marine engines and to engines using motive fluid other than steam.

Referring to the drawings, the cylinder 1, which is of the ordinary construction, is fitted with a piston 2, secured upon a piston-rod 3, 95 the outer end of which is connected to a lever 7, which in my prior patents was termed a "primary" lever and which in my present invention is pivotally connected at its upper end by a pin 9 to a radial link or pair of radial
100

links 11. The opposite ends of these links are connected to a fixed support, which in this instance is shown as an extension 16 of the cylinder-casting, by another pin 10, about which
 5 said links can oscillate, so that the center of the pin 9 at the opposite ends of the links will move in an arc *a b* and the links carry with them the lever 7 through their connection thereto by the pin 9. A counterweight 15 is
 10 secured to the extension 14 of the lever 7 above the pivot 9, said counterweight having been, as already stated, shown by experiment to be important for the steady running of the engine. A double-armed secondary lever 8,
 15 which is composed of two parallel side members, each having a journal 13 projecting from its outer face, has its journals mounted in fixed bearings 6 on the frame, which bearings are provided with caps 6^a, and is coupled
 20 at its upper end to a pin 12, located on the primary lever between the pins 5 and 9 thereof. The lower end of the secondary lever carries a pin 17, to which one end of the connecting-rod 4 is coupled, the opposite end of the
 25 connecting-rod being coupled to the pin 18 of a crank fixed on the engine-shaft.

The operation of the counterbalancing system above described is similar to that of the corresponding members set forth in my prior
 30 patents. The reciprocating movements of the piston 2 are transmitted through the primary lever 7 to the upper arm of the secondary lever 8 and are transmitted in opposite direction from the lower arm of the secondary lever to the connecting-rod 4, by which the engine-shaft is rotated. It will be seen that the
 35 center of the pin 9, which couples the primary lever 7 to the radial links 11, will move in an arc *a b* and also that in order that the center of the lower pin 5, to which the piston-rod is attached, may move in a straight horizontal line the path of the center of the pin 9 should, theoretically, be in a vertical straight line; but inasmuch as the arc *a b* approximates
 40 very closely to a right line within the compass in which the center of the pin 9 moves the divergence of the center of the pin 5 from a true path due to this cause is so slight as not to be of practical importance.

50 The construction of my present invention is less expensive than that of the sliding block and guides of my prior patents, and the only support required for the link or pair of links is the connecting-pin 10, which while in this
 55 instance shown as attached to an extension of the cylinder-casting may be supported on any other convenient fixed point, in the discretion of the constructor.

It will be seen that the counterweight 15
 60 and the connecting-rod both move coincidentally and in the opposite direction to the piston 2. Their momentum therefore is made to counteract or balance that of the piston, and, as explained, by attaching substantially
 65 one-half of the balancing-weight to an ex-

tension of the lever 7 and the remainder to the lower part of the lever 8 a much steadier movement of the engine results than under the prior constructions.

It may in some cases be desirable to couple 70 the connecting-rod to the primary lever and piston-rod by the pin 5 or other connection and place the crank-shaft to the left of the cylinder instead of to the right, as shown in the drawings, or two cylinders might be used, 75 as shown in Fig. 4 of Patent No. 489,648. In the latter case the connecting-rod may be connected either to the secondary lever, as shown in that figure, or to the primary lever, as explained above, and all these forms of construction would embody the operative principle 80 and essential structural features of my present invention.

I claim as my invention and desire to secure 85 by Letters Patent—

1. The combination with a reciprocating element, of an articulated system of oscillating levers or links, connected to the reciprocating element and forming a guide to insure rectilinear motion thereof, a link coupling 90 said system of levers to a fixed support, and a rod connected to said system of levers and to a crank and moving in opposite direction to the reciprocating element.

2. The combination, with a reciprocating 95 piston and rod, of an articulated system of oscillating levers and links, coupled to the piston-rod and forming a guide to insure rectilinear motion thereof, a link coupling said system of levers to a fixed support, a connecting-rod which is coupled to said system of levers 100 and to a crank, and moves in opposite direction to the piston-rod, and a counterbalance-weight connected to the system of levers and also moving in opposite direction to the piston-rod, the aggregate of said counterbalance-weight and of the weight of the connecting-rod being sufficient to counterbalance the piston and rod. 105

3. The combination, with a reciprocating 110 piston and rod, of a primary lever connected at one end to the piston-rod, a link coupled to the primary lever and to a fixed support, a connecting-rod coupled at one end to a crank and at the other end to the primary lever, and 115 a counterbalance-weight connected to the end of the primary lever opposite that adjacent to which the piston-rod is connected.

4. The combination, with a reciprocating piston and rod, of a primary lever connected 120 at one end to the piston-rod, a link coupled to the other end of the primary lever and to a fixed support, a secondary lever journaled in fixed bearings and having one of its arms pivotally connected to the primary lever between the link and piston-rod connections 125 thereof, and a connecting-rod coupled to the opposite arm of the secondary lever and to a crank.

5. The combination, with a reciprocating 130

piston and rod, of a primary lever connected at one end to the piston-rod, a counterbalance fixed to the opposite end of the primary lever, a link coupled to the primary lever and to a
5 fixed support, a secondary lever journaled in fixed bearings and having one of its arms pivotally connected to the primary lever between the link and piston-rod connections thereof, and a connecting-rod coupled to the opposite arm of the secondary lever and to a crank.

MATTHIAS N. FORNEY.

Witnesses:

H. W. NICHOLS,

MARY E. O'MALLEY.