Nov. 27, 1928. 1,692,914

R. WINTZER

COUNTERBALANCING SYSTEM FOR ENGINES

Filed April 22, 1927

Fig. 1.

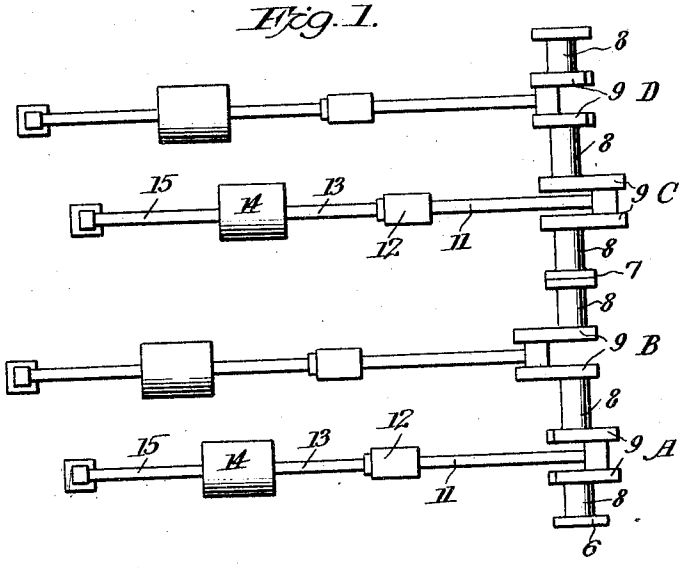


Fig. 2.

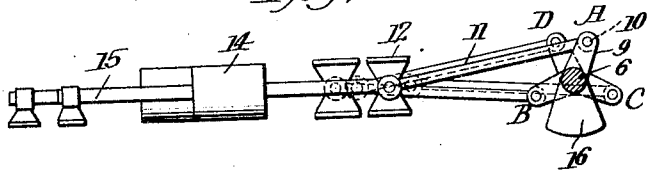
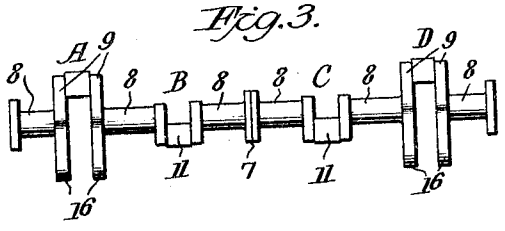


Fig. 3.



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Patented Nov. 27, 1928. 1,692,914

UNITED STATES PATENT OFFICE.

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COUNTERBALANCING SYSTEM FOR ENGINES.

Application filed April 22, 1927. Serial No. 185,832.

This invention relates to reciprocating engines and particularly to a mode of balancing a four cylinder engine having an unusual crank arrangement peculiarly adapted to certain fields of service.

In reversing rolling mills it is the practice to use engines devoid of fly wheels to permit quick reversal, and it is important to have an engine which will run smoothly at low speed and be capable of starting under full load.

In recent years successful efforts have been made to control such engines in starting, stopping and reversal solely by varying the cut-off. At the same time the steam economy has been greatly improved by using short cut-offs and a maximum cut-off at about 5/8 stroke. To secure smooth torque and good starting power it is necessary to use a relatively large number of cylinders, say four double-acting cylinders, and to arrange such cylinders so that the individual working spaces deliver their impulses seriatim at uniform crank intervals.

In a four cylinder engine the desired succession of impulses is best secured by the use of four cranks spaced at intervals of 90°, 45°, 90°, 135°. Inasmuch as a single crank, connecting rod, piston and cross head unit cannot be balanced in both planes by any weight placed on the crank shafts, and since with a crank spacing such as is specified the cranks and connected reciprocating parts do not balance each other in pairs, as they would do if placed at 90° intervals, a difficult balancing problem is presented. This is accentuated by the unusual size of such engines, the heavy masses thus encountered, and the relatively high rotative speeds used.

As a result of a study of the requirements of such an engine I have devised a crank order and an arrangement of counterweights on the shaft by means of which the total longitudinal stresses, occasioned by rotating and reciprocating parts, are almost completely neutralized, without materially exaggerating the transverse stresses occasioned by the rotating parts. This result is accomplished by the use of only two counterweights. A remarkably smooth-running engine is secured.

In the following discussion it will be understood that the connecting rod is considered a revolving mass to the extent of 1/3 of its total mass and a reciprocating mass to the extent of 2/3 of its total mass.

Generally stated, balancing is effected as follows: The crank shaft is so designed that the two crank throws at 45° with each other are placed symmetrically with reference to the longitudinal center line of the engine and preferably are the two end cranks. Each such crank carries a counterweight (which may be formed in two similar parts at opposite sides of the crank pin). The counterweights for the two cranks are identical and their centers of mass lie in a common plane, which is the plane passing through the axis of the crank shaft and bisecting the 45° crank interval. Thus each counterweight is displaced 22½° from a position directly opposite its crank.

Each counterweight somewhat overbalances the related revolving mass, i. e., one 45° crank mass plus 1/3 the mass of its connecting rod. The amount of such overbalancing is a function of the relation of the rotating masses to the reciprocating masses and is so determined that the combined longitudinal forces (i. e. the horizontal forces in the case of a horizontal engine) neutralize each other. I have discovered that this result can be secured by counterweights so located, without materially increasing the unbalanced transverse forces (vertical forces in the case of a horizontal engine).

As indicating the degree of overbalancing characteristic of this invention, it may be mentioned that good results were secured with a uniflow engine having tail rods by using about 25% overbalancing.

In the accompanying drawings a typical engine embodying the invention is illustrated by way of example, only the reciprocating and rotating parts being shown.

Fig. 1 is a plan view.

Fig. 2 is a side elevation.

Fig. 3 is an end elevation.

The crank shaft 6 is shown as constructed in two sections connected by flanges 7. The main bearing journals are shown at 8, the cheek pieces of the crank throws at 9 and crank pins at 10.

The connecting rods are shown at 11, crossheads at 12, piston rods at 13, pistons at 14

and tail rods at 15. The pistons are shown as of the elongated type used with terminal exhaust engines.

There are four cranks distinguished by the letters "A", "B", "C" and "D". The angular spacing is as follows,—A and C, 90°; C and B, 135°, B and D, 90°; D and A, 45°. The cylinder arrangement is symmetrical relatively to the longitudinal center line of the engine when viewed in plan. It is important that the cranks A and D, which are the 45° cranks to be counterweighted should be symmetrically disposed relatively to the longitudinal center line of the engine, and it is preferred but not essential that they be the end cranks as shown.

Each of the cranks A and D is provided with counterweights 16 preferably formed as extensions of the cheek pieces 9. The centers of mass of such counterweights lie in the plane which bisects the angle between cranks A and D, and the mass of each counterweight is such that the combined horizontal forces neutralize each other. To secure this result crank A and crank D are, each, together with ⅓ the mass of their respective rods 11, somewhat overbalanced by their respective counterweights 16.

The crank arrangement shown in the drawing is that believed to be best. Here crank A leads crank B, crank B leads crank C and crank C leads crank D by the uniform angle of 135°. Thus crank A leads crank D by 45°.

The invention is not limited to the specific embodiment illustrated. For example, the two cranks at 45° with each other are those to be counterweighted. It is desirable, but not strictly essential, that the counterweights be located as closely as possible to the cranks which they counterbalance. Moreover, although as stated, it is preferred to make these two cranks the end cranks of the four, any arrangement in which these two cranks are symmetrically located on opposite sides of the longitudinal center line of the engine, would fall within the broad scope of the invention.

What is claimed is,—

1. In an engine, the combination of a crank shaft having four cranks, which considered successively along the length of the shaft, are spaced each 135° angularly from the next, whereby the two end cranks are at 45° with each other; piston and connecting rod units of substantially uniform mass, one connected with each crank; and a pair of counterweights of substantially identical mass with one another mounted on said crank shaft near the ends thereof, and approximately opposite the end cranks, the centers of mass of said counterweights lying in a plane which bisects the angle between the end cranks.

2. In an engine, the combination of a crank shaft having four cranks, which considered successively along the length of the shaft, are spaced each 135° angularly from the next, whereby the two end cranks are at 45° with each other; piston and connecting rod units of substantially uniform mass, one connected with each crank; and a pair of counterweights each formed as extensions of the two cheek pieces of the two end cranks arranged with their centers of mass in a plane passing through the axis of said shaft and bisecting the 45° crank interval, said counterweights overbalancing their respective cranks in such degree that the forces of the revolving and reciprocating parts of the engine in a direction parallel with the piston paths are substantially neutralized.

3. In an engine, the combination of a four throw crank shaft, having cranks spaced at successive angular intervals of 90°, 45°, 90° and 135°, one with another, the two cranks at 45° from each other being symmetrically located on opposite sides of the longitudinal center line of the engine; reciprocating parts of uniform mass and including a piston and connecting rod, each connected with a corresponding crank; and a pair of counterweights of substantially identical mass with each other, mounted on said shaft approximately opposite those cranks which are at 45° with each other, the centers of mass of said weights lying in a plane which substantially bisects said 45° angle.

4. In an engine, the combination of a four throw crank shaft having cranks spaced at successive angular intervals of 90°, 45°, 90° and 135° one with another, the two cranks at 45° from each other being at opposite ends of the shaft, reciprocating parts of uniform mass and including a piston and connecting rod, each connected with a corresponding crank; and a pair of counterweights of substantially identical mass with each other, mounted on said shaft approximately opposite those cranks which are at 45° with each other, the centers of mass of said weights lying in a plane which substantially bisects said 45° angle.

5. In an engine, the combination of a four throw crank shaft having cranks spaced at successive angular intervals of 90°, 45°, 90° and 135° one with another, the two cranks at 45° from each other being symmetrically located on opposite sides of the longitudinal center line of the engine; reciprocating parts of uniform mass and including a piston and connecting rod each connected with a corresponding crank; and a pair of counterweights of substantially identical mass with each other, mounted on said shaft and approximately opposite those cranks which are at 45° with each other, the centers of mass of said weights lying in a plane which substantially bisects said 45° angle, said counterweights overbalancing their respective cranks in such degree that the forces of the revolving and reciprocating parts of the engine in

a direction parallel with the piston paths are substantially neutralized.

6. In an engine, the combination of a four throw crank shaft having cranks spaced at successive angular intervals of 90°, 45°, 90° and 135° one with another, the two cranks at 45° from each other being at opposite ends of the shaft; reciprocating parts of uniform mass and including a piston and connecting rod, each connected with a corresponding crank; and a pair of counterweights of substantially identical mass with each other, mounted on said shaft approximately opposite those cranks which are at 45° with each other, the centers of mass of said weights lying in a plane which substantially bisects said 45° angle, said counterweights overbalancing their respective cranks in such degree that the forces of the revolving and reciprocating parts of the engine in a direction parallel with the piston paths are substantially neutralized.

In testimony whereof I have signed my name to this specification.

RUDOLPH WINTZER.