J. G. VINCENT.

BALANCED CRANK SHAFT.

APPLICATION FILED MAR. 23, 1916.

1,315,059.

Patented Sept. 2, 1919.

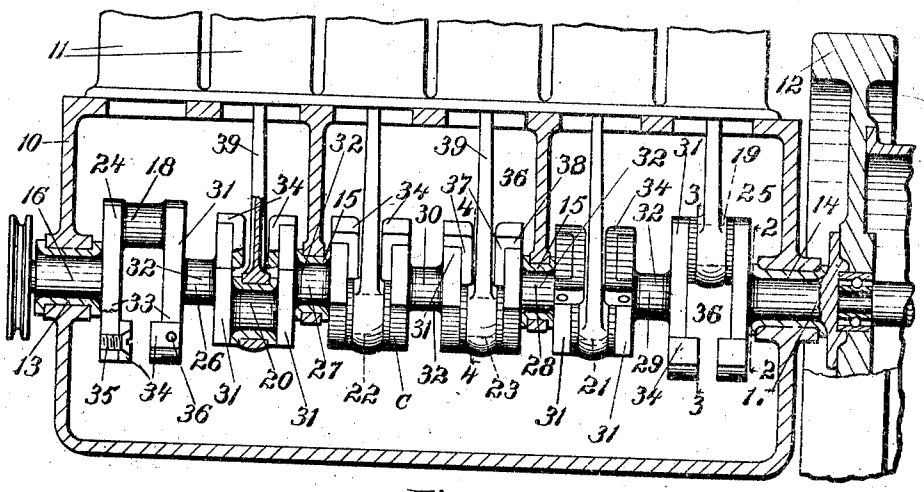


Fig. 1

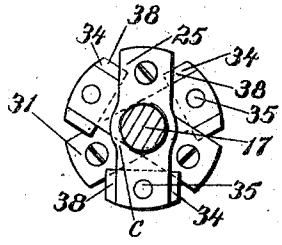


Fig. 2.

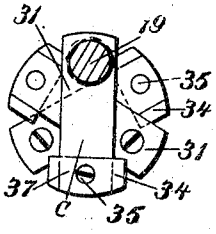


Fig. 3.

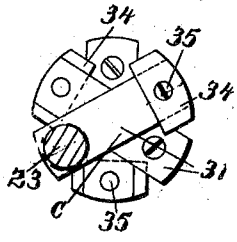


Fig. 4.

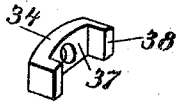


Fig. 5.

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UNITED STATES PATENT OFFICE.

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BALANCED CRANK-SHAFT.

1,315,059. Specification of Letters Patent. Patented Sept. 2, 1919.

Original application filed January 31, 1916, Serial No. 75,415. Divided and this application filed March 23, 1916. Serial No. 86,038.

To all whom it may concern:

Be it known that I, JESSE G. VINCENT, a citizen of the United States, and resident of Detroit, Wayne county, State of Michigan, have invented certain new and useful Improvements in Balanced Crank-Shafts, of which the following is a specification.

This application is a division of application Serial No. 75,415, filed January 31, 1916.

This invention relates to hydrocarbon motors and particularly to multi-cylinder motors. As shown it is adapted to six, or a multiple of six cylinders, there being six crank pins provided on the crank shaft, to each of which one or more connecting rods may be connected. Preferably the crank pins are arranged in pairs equidistant around the shaft, or 120 degrees apart. Thus they are in three radial planes equally separated.

Such a crank shaft as above described is in static balance because all of the offcenter weights, that is, the connecting arms and crank pins, are distributed equally around the axis of the crank shaft, but since these offcenter weights are connected with the shaft at different points in the length thereof, the shaft, in rotation, is not in perfect balance, the centrifugal forces generated by the various offcenter weights tending to pull the shaft in different directions at different points in its length and thus causing deflections or distortions in the shaft which result in vibrations to the motor.

It is the salient object of the present invention to remedy these defects by applying counterweight means to the shafts substantially at each point thereon where there is an offcenter weight, so that such means will apply to the same point on the shaft a counterbalancing centrifugal pull in the opposite and therefore corrective direction.

This and other objects of the invention will appear from the following description taken in connection with the drawings which form a part hereof, and in which:—

Figure 1 is a vertical longitudinal sectional view of a hydrocarbon motor embodying this invention;

Figs. 2, 3 and 4 are transverse sections on the lines 2—2, 3—3 and 4—4, respectively, of Fig. 1; and

Fig. 5 is a perspective view of a counterweight block.

Referring to the drawings, 10 represents the supporting base or crank case of a hydrocarbon motor, and 11 are the cylinders mounted thereon. The motor crank shaft is represented generally by the letter C and it is mounted to rotate in the crank case and is provided with the usual fly-wheel 12. The crank case has front and rear end bearings 13 and 14 and one or more intermediate bearings 15, all of which are alined and axially spaced to provide for the throws of the crank shaft. In the form of the invention shown there are two intermediate bearings, and these intermediate bearings and the two end bearings, four in all, wholly support the crank shaft C.

The crank shaft comprises end bearing portions 16 and 17 and a series of crank pins 18, 19, 20, 21, 22 and 23, which are preferably arranged in pairs in three equally spaced radial planes 120 degrees apart, the pins 18 and 19 at the respective ends being in line in one plane, the pins 20 and 21 being in line in another, and the pins 22 and 23 being in line in a third plane. In other words, it is a six-throw crank shaft comprising a forward half having suitable bearing portions and three crank pins 18, 20 and 22 arranged in three radial planes 120 degrees apart and a rearward half in "looking glass" symmetry with the forward half, the crank pins 19, 21 and 23 being also arranged in three radial planes 120 degrees apart, and alined with the respective crank pins of the forward half as above described. The forward crank pin 18 is connected to the bearing portion 16 by a connecting or crank arm or cheek 24 and the rearward pin 19 is connected to the bearing portion 17 by a similar arm or cheek 25. Crank pins 18 and 20 are 120 degrees apart and are joined by a long connecting arm 26, and the same is true of pins 20 and 22, 23 and 21, and 21 and 19, the connecting arms between these pins being indicated as 27, 28 and 29, respectively. Between pins 22 and 23, which are in line, is a connecting piece or arm 30. In the particular form of shaft shown these connecting arms are so formed that the shaft may be supported in one or several intermediate bearings, each arm comprising two cheek portions 31 connected to the associated crank pins and a bearing portion 32 arranged between and connecting the cheek portions. Two only of these bearing por-

tions 32 however, are used, these being substantially equally spaced between the end bearings, and the portions 32 that are not used to support the shaft have the sole function of forming part of the long connecting arms which join or connect the associated crank pins.

It will be understood that the crank pins and the greater part of the connecting arms are offcenter weights upon the crank shaft and the centrifugal force generated by them when the shaft is in rotation tends to pull the shaft in different directions at different points in its length. To counterbalance these offcenter weights the shaft is provided with counterweight means arranged substantially across the center of the shaft from the respective weights, such counterweight means being either formed integral with or attached to the connecting arms of the crank shaft. As shown, each of the arms 24 and 25 extends across the center of the shaft as at 33 and is provided with a counterweight block 34 which may be detachably secured to the extension 33 by a screw 35 or riveted to it as at 36. The extension and block are of sufficient size or weight to counterbalance the arm and one half of the crank pin to which it is connected. Also, each of the connecting arms 26, 27, 28 and 29 is provided with counterweight means which extends to a point such that its center of weight is across the center, and 120 degrees removed, from the axes of the two crank pins which the respective arm connects. Thus each of the cheek portions 31 of these arms extends across the center of the shaft forming similar extensions 33 and is provided with counterweight blocks 34 similarly secured, and each pair of extensions and blocks when so formed on an arm becomes a counterweight or counterweight means which counterbalances the arm to which it is connected and one half of its two associated crank pins. The middle arm 30 also extends its cheeks 31 across the center of the shaft to form extensions 33 and counterweight blocks 34 are secured to them in like manner so that this arm and one half of each of its associated crank pins are properly counterbalanced.

Referring more particularly to the counterweight blocks 34 it will be seen that they are formed of a body portion 37 and lugs 38 and they are secured to the extensions with the body portions directly opposite the crank pins to more nearly effect an exact counterbalance thereof, there being only sufficient clearance left between adjacent blocks for the connecting rods 39 mounted on the crank pins.

Although the present application is directed to a species of the broad invention described and claimed in the aforementioned application 75,415, in order to aid in a complete understanding of the system of balancing involved in this application, a brief description of the same will be given.

Each of the crank pins is in effect a beam fixed at its ends to the adjoining cheeks and loaded with the centrifugal pull produced by the rotation of the shaft and other forces due to the operation of the engine. If the load is designated as P, half of the same or P/2 is transmitted to each of the adjoining cheeks producing tension therein tending to bend the shaft. Each of the cheeks is balanced by a corresponding cheek on the opposite side of the shaft axis, and if a weight is attached to the balancing cheek of such mass that it will produce a force equal to P/2 it will balance the tension in the crank pin cheek caused by the force P/2 due to the load of the crank pin. But this alone will not entirely prevent distortion or deflection of the shaft. In addition to the pull P/2 produced by the load on the crank pin there is also a bending moment at the point where the pin joins the cheek. This bending moment is transmitted through the cheek to the shaft proper and tends to deflect the same. Hence in order to entirely prevent deflection of the shaft it is necessary to produce a bending moment equal and opposite to the one mentioned above. This may be done in several ways. In the embodiment of the invention described herein it is accomplished by locating the balance weights 34 on the same side of the cheek as the crank pin. In other words the center of gravity of the balance weight is located between the center lines of adjacent crank cheeks. Thus it will be apparent that the balance weight sets up a moment which is of opposite sense to that produced by the load on the crank pin, and counteracts the latter. In this manner the pull and bending moment set up by the load on the crank pin including the centrifugal pull are counteracted by an opposite pull and moment. In other words, the tendency to deflect the crank shaft caused by the off center masses of cheeks, crank pins, etc., is opposed by an opposite tendency, so that there is no actual deflection of the shaft. Hence a crank shaft having one or more throws and balanced according to this invention will rotate at any angular velocity without deflection.

Other forms of the invention may be made without departing from the spirit or scope hereof, it being understood that the detail forms of the invention shown are by way of illustration only and do not represent the only forms in which the invention may be embodied.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—

1. In a hydrocarbon motor, in combination, a crank case having four alined and spaced bearings, a crank shaft supported

wholly in said bearings and having a pair of crank throws in each of the three spaces between the bearings, each of said pairs of crank throws including two crank pins, the two crank pins of the middle pair of throws being axially alined and the two crank pins of each of the end pairs being 120 degrees apart, said crank shaft also having counterweight means in each of said three spaces across the center of the crank shaft from the crank pins in the respective spaces, said means constructed and arranged to produce a tendency to deflect the shaft equal and opposite to the tendency produced by the said pins, and connecting rods mounted on said pins.

2. In a hydrocarbon motor, in combination, a crank case having a bearing at each end and two intermediate bearings substantially equally spaced, a crank shaft supported wholly in said bearings and having a pair of crank throws between the intermediate bearings and a pair of crank throws between each intermediate bearing and the nearest end bearing, each of said pairs of crank throws including two crank pins, the crank pins of the middle pair of throws being in axial alinement and the crank pins of the end pairs of throws being 120 degrees apart, said crank shaft also having a plurality of counterweight blocks for each pair of crank throws, said blocks being arranged across the center of the crank shaft from the crank pins and being constructed and arranged to produce a tendency to deflect the shaft equal and opposite to the tendency produced by the said pins.

3. In a hydrocarbon motor, in combination, a crank case having four alined and spaced bearings, a crank shaft supported wholly in said bearings and having a pair of crank throws in each of the three spaces between the bearings, each of said pairs including two crank pins, the six said crank pins being symmetrically arranged in three radial planes 120 degrees apart, said cank shaft also having counterweight means in each of the three spaces across the center of the crank shaft from the crank pins in the respective spaces constructed and arranged to produce a tendency to deflect the shaft equal and opposite to the tendency produced by the said pins, said means in the middle of the three spaces comprising a plurality of blocks having their centers of weight in the same radial plane and said means in each of the other two spaces comprising a plurality of blocks having their respective centers of weight in different radial planes.

4. In a hydrocarbon motor, in combination, a crank case having four alined and spaced bearings, a crank shaft supported wholly in said bearings and having a pair of crank throws in each of the three spaces between the bearings, each of said pairs including two crank pins, the six said crank pins being symmetrically arranged in three radial planes 120 degrees apart, said crank shaft also having counterweight means in each of the three spaces across the center of the crank shaft from the crank pins in the respective spaces constructed and arranged to produce a tendency to deflect the shaft equal and opposite to the tendency produced by the said pins, said means in the middle of the three spaces comprising a plurality of blocks having their centers of weight in the same radial plane and said means in each of the other two spaces comprising at least two separate blocks having their respective centers of weight in radial planes 120 degrees removed from each other.

5. In a hydrocarbon motor, in combination, a crank case having four alined and spaced bearings, a crank shaft supported wholly in said bearings and having a pair of crank throws in each of the three spaces between the bearings, each of said pairs including two crank pins, the six said crank pins being symmetrically arranged in three radial planes 120 degrees apart, said crank shaft also having counterweight means in each of the three spaces across the center of the crank shaft from the crank pins in the respective spaces constructed and arranged to produce a tendency to deflect the shaft equal and opposite to the tendency produced by the said pins, said means comprising at least two separate blocks in each of said three spaces, the two blocks in each of the end spaces being arranged in radial planes 120 degrees apart and the two blocks in the middle space being arranged in the same plane and 120 degrees from both of the planes in which the blocks of the end spaces are arranged.

In testimony whereof I affix my signature.

JESSE G. VINCENT.