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COUNTERWEIGHT ARRANGEMENT ON CRANK DRIVES

Filed Jan. 2, 1941

Serial No. 372,870

2 Sheets-Sheet 1

Fig.1.

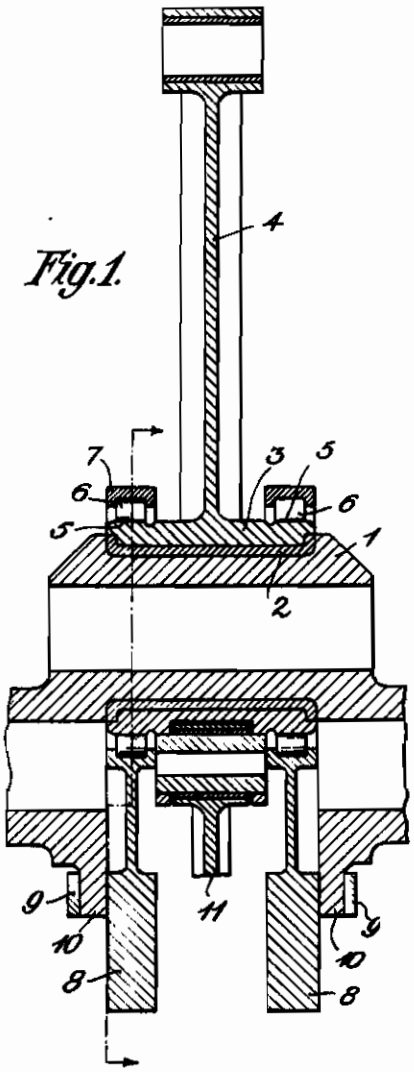

Fig.2.

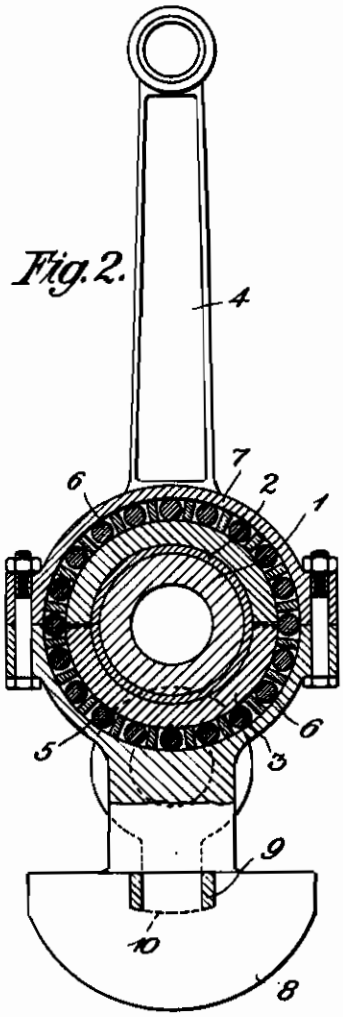

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Fig.3.

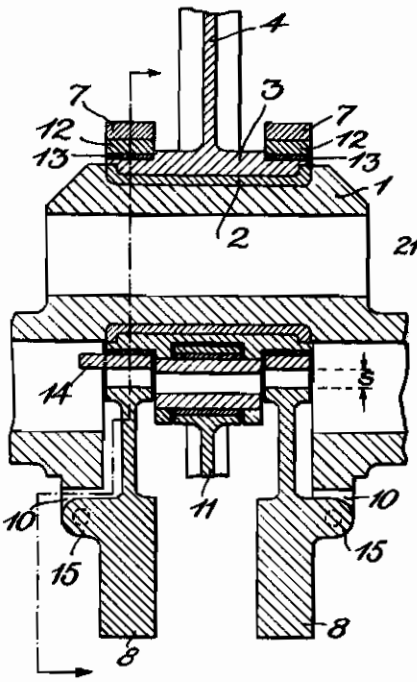

Fig.4.

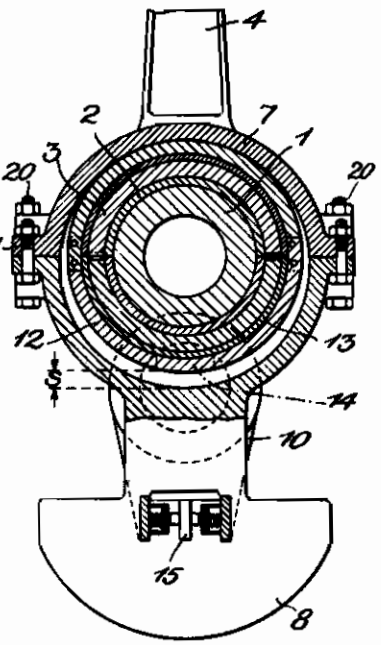

Fig.5.

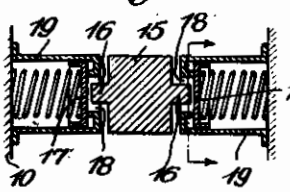

Fig.6.

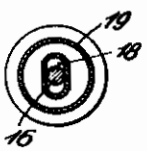

Fig.7.

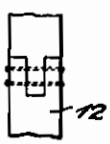

Fig.8.

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COUNTERWEIGHT ARRANGEMENT ON CRANK DRIVES

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Application filed January 2, 1941

The present invention relates to a counterweight arrangement on crank drives, particularly crank drives of piston engines having cylinders mounted in star-shaped fashion, for instance of internal combustion engines.

Hitherto the counterweights were exclusively arranged on the crank shaft. They serve the purpose of balancing the forces occurring at the crank shaft and thereby releasing the bearings of the crank shaft, so that the forces occurring in these bearings may without difficulty be governed. By a simple enlargement of the counterweights it would then always be possible to increase the number of revolutions without increasing the load acting upon the crank shaft bearings, if this measure or step would not be opposed to by the increasing stress on the connecting rod bearings.

The present invention obviates this draw-back and consists in this that the counterweights are arranged on the big end of the connecting rod. Hereby the rotating inertia forces are balanced at the point of origin, i. e. at the big end of the connecting rod itself. If the rotating masses of the connecting rods are balanced, then with increasing number of revolutions the relatively small oscillating inertia forces only are increased. Consequently, the number of revolutions may extraordinarily be increased without exceeding the permissible loads of the bearings at the end of the connecting rod. This arrangement according to the invention has a particularly favorable effect in connection with motors arranged in star-shaped fashion in which the oscillating inertia forces are nearly independent on the crank angle so that they also may be balanced for the greater parts. In the arrangement according to the invention counterweights not only act upon the connecting rod bearings but, by way of the webs of the crank shafts, also upon the crank bearings and this in exactly the same manner as the counterweights hitherto mounted at the crank webs. Without departing from the spirit of the invention, the counterweight masses may exclusively be arranged at the end of the connecting rod or subdivided into counterweights on the main connecting rod and counterweights on the crank shaft. In connection with motors provided with a main—and an auxiliary connecting rod, particularly in connection wtih aircraft motors, arranged in star-shaped formation, the counterweights preferably are exclusively mounted on the connecting rod or on the primary connecting rod respectively. Due to the connecting rod bearings being released of rotating forces exerted by the masess, it is rendered possible to use plain bearings instead of roller bearings. Consequently, the end of the connecting rod itself can be made smaller and lighter and the points of pivoting the auxiliary connecting rod are located further towards the interior. The accelerating forces acting upon the auxiliary connecting rod, therefore, also become smaller. This again reduces the bending moments occurring at the shaft of the main connecting rod and the pressure on the gliding plane or the working surface of the main cylinder. The fact that the counterweights attack far outwardly at both sides of the end of the connecting rod also acts very favorably. This again renders possible to employ main connecting rods the shaft of which has the normal double T-cross section.

By a slight alteration of the construction, the counterweights may also be formed as centrifugal pendulums adapted to absorb torsional vibrations, if the counterweights are suspended with play on rings loosely mounted upon further rings. These last mentioned rings on the one hand are pivotally mounted upon the end of the connecting rod at both sides of this rod and on the other hand are connected to the crank shaft in a manner to rotate with the latter. The amplitudes of the oscillations of the counterweights are limited by resilient steps which are rendered effective only, after a predetermined amplitude of the oscillations of the counterweights has been reached. This arrangement acts in the manner of the well known Taylor- or Salomon-pendulums and has the advantage of slight surface pressures occurring at the points of contact of the rolling off surfaces, because the pendulum rings as well as the bearing rings serving as pendulum shafts have a large diameter or a large bore respectively. Moreover, the amplitudes of the oscillations are rendered very small, because the entire counterweight oscillates in contradistinction to the hitherto known centrifugal pendulums. Due to the small amplitudes of the oscillations no substantial and constant friction occurs.

In the accompanying drawings two constructions according to the invention are shown by way of example.

In these drawings:

Figs. 1 and 2 show in longitudinal- and cross-section respectively simple counterweight arrangements on the end of a connecting rod,

Figs. 3 and 4 show a longitudinal- and a cross-section respectively of a counterweight arrangement simultaneously acting as oscillation absorber, and

Figs. 5 to 8 illustrate on a larger scale details of the modification shown in Figs. 3 and 4.

In the construction illustrated in Fig. 1 a plain bearing 2 is provided upon the crank pin 1. Slideably arranged upon this is the end 3 of the connecting rod. At both sides of the connecting rod 4 and as far as possible towards the exterior the end 3 of the connecting rod 4 is provided with two raceways 5, 5 each supporting a roller bearing 6 on the outer rings 7, 7 of which the counterweights 8, 8 are suspended or favourably a sliding bearing or another suitable bearing. The counterweights each have an external yoke 9, 9, into which engages nooses 10, 10 extending downwardly from the crank shaft web. On rotation of the crank shaft, the nooses 10 carry with them the counterweights, so that with regard to the axis of the crank shaft the counterweights always are located opposite the end of the connecting rod and in this manner neutralize the centrifugal forces of the latter. By means of the nooses 10 the counterweights 8 are also axially fixed.

When using a main connecting rod with a plurality of auxiliary connecting rods, the auxiliary connecting rods 11 preferably are, as may be seen from Fig. 1, arranged in the centre plane of the main connecting rod between the counterweights 8. The operation of this device easily may be understood from the drawing and has been exhaustively explained in the preamble to the specification.

The modification of the device shown in Figs. 3 and 4 substantially corresponds to the device illustrated in Figs. 1 and 2 with the difference, however, that according to the construction shown in Figs. 3 and 4 each of the bearing rings 7, 7 of the counterweights 8, 8 is suspended with a certain play from another bearing ring 12, 12. These bearing rings 12, 12 are arranged upon sliding rings 13, 13 which are provided on the head of the connecting rod in place of the roller raceways. Moreover, the bearing rings 12, 12 are coupled to the crank shaft by pins 14, 14 and rotate with this shaft. Instead of the yokes 9 each of the counterweights 8, shown in this construction, is provided with a downwardly extending outwardly directed flange 15, 15 (Fig. 5) having two stops 16, 18 at each side. Opposite these stops spring buffers 17, 17 are located which are provided at the crank shaft webs 10, 10.

The arrangement is such that the stops 16 have a certain freedom of movement within the plane of oscillation of the counterweights 8 before they come into contact with the spring buffers 17. In a direction vertically to the plane of oscillations the counterweights at the stops 16 are guided in slots 18 of the casings 19 of the spring buffers 17 as may be gathered from Fig. 6. This slot guide has the purpose of preventing oscillating movements of the counterweights in the direction of the axis of the crank shaft. In order to allow an easy mounting of all the bushings and bearing rings without being compelled to divide the crank shaft these rings are subdivided to a large extent. The sliding bearing 2 consists of two ordinary bearing bushing-halves. The big end 3 of the connecting rod also is subdivided in the usual manner and the two parts are screwed together, as shown at 20 in Fig. 4. The sliding ring 13 too is formed of two parts which in the manner of a two-part thin-walled bearing bushing are kept together by pressure exerted by pressing. The bearing ring 12 also is formed of two parts and the ends of the two ring halves are joined by mortise and riveted together as shown in Figs. 7 and 8. The bearing ring 7 of the counterweights 8 also is constructed in two parts and at 21 the two ring halves are screwed together. Instead of subdividing the rings, the pin 1 of the crank shaft also may be subdivided and the two parts may be screwed together for instance by the simultaneous use of a toothed separation joint.

The arrangement according to Figs. 3 and 4 acts in exactly the same manner as the construction according to Figs. 1 and 2 and, moreover, in the manner of a Taylor- or Salomon-pendulum whereby the pendulum mass is energized to an own frequency which counteracts the frequencies occurring at the crank shaft. Instead of the two weights 8, 8 a single weight also could be arranged in the transverse plane of the connecting rod 4 if such an arrangement is not prevented by the auxiliary connecting rods 11. The invention also may be employed in engines with cylinders arranged in series in one row.

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