Nov. 14, 1967 W. ENKELMANN 3,352,065

MACHINE FOR GRINDING CRANKSHAFTS

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FIG. 1

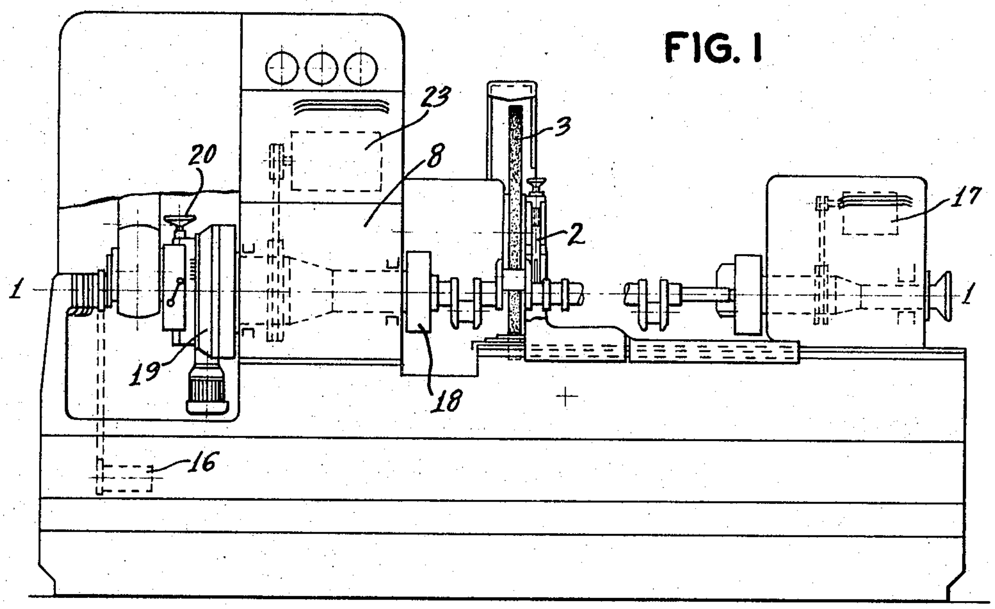

FIG. 2

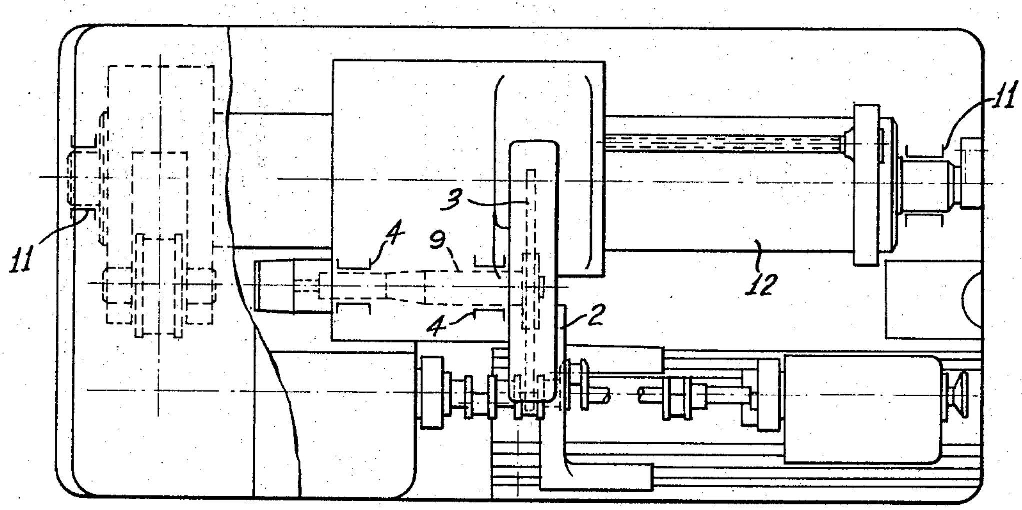

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FIG. 3

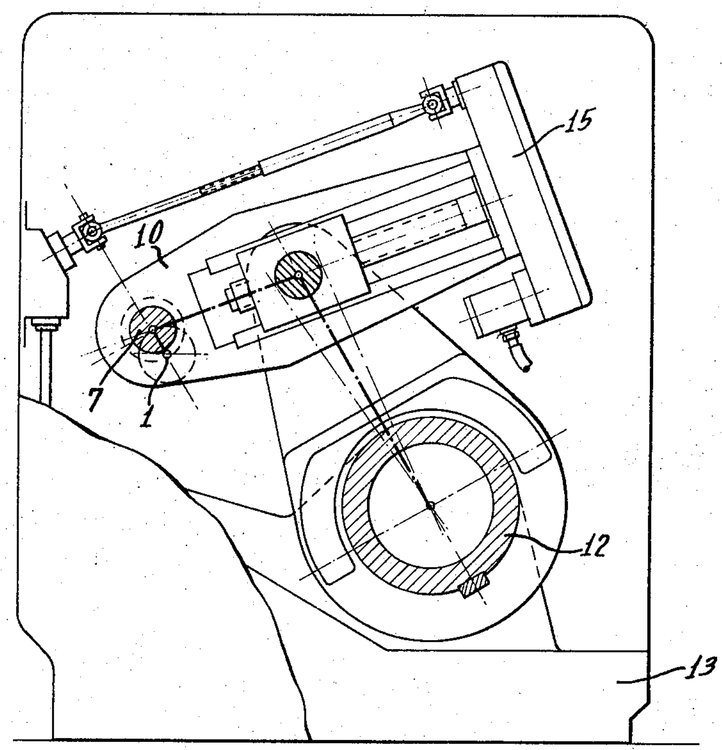
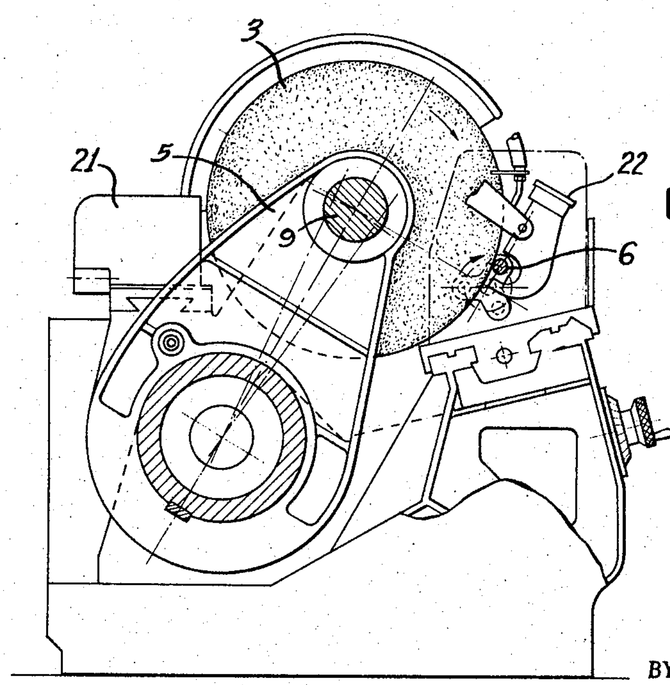


FIG. 4



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MACHINE FOR GRINDING CRANKSHAFTS

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ABSTRACT OF THE DISCLOSURE

This invention relates to a machine for grinding crankshafts in which a grinding wheel mounted on a rocker arm forcibly follows a crankshaft throw to be ground due to the fact that the center of the throw is in alignment with an eccentric pin, which latter is directly connected to the grinding wheel through a connecting rod and a rocker shaft. As a result, the grinding wheel will follow a predetermined geometrical path independent of the position of the crankshaft throw to be ground.

Two methods which differ from each other in principle are known to the art for grinding the throws of crankshafts. One of these methods is the so-called plunge-cut grinding method which is customarily used at the present time and in which the crankshaft rotates about the throw to be ground. The disadvantages particular to this method, and which are particularly pronounced in the case of large crankshafts, are the unbalance of the eccentrically positioned crankshaft, which acts on the grinding machine, and the impossibility of supporting the crankshaft at the main bearings thereof by means of backrests or steady rests during the grinding operation. These disadvantages result in sagging and tumbling movements of the crankshaft which cause the throw to be ground out of round. These disadvantages are compensated for at the present time, at least partially, by the experience of the grinding machine operator.

A method is also known to the art in which the crankshaft rotates about the main bearings thereof while the center of the grinding wheel, rotating within a drum and being eccentrically positioned, follows the center of the throw to be ground at the same distance and in the same angular position. This method eliminates the drawbacks aforementioned since the crankshaft rotates about the normal axis thereof and, accordingly, does not transmit any unbalance to the machine; sagging is eliminated by means of steady rests at the main bearings.

A practical utilization of this method is not possible, however, due to apparatus limitations. An absolutely synchronous path or movement or an allowance relative to the deviation or variation of the angular velocity of the aforementioned drum to the crankshaft is not possible. Any conceivable mechanical transmission has a number of deficiencies, for example in the case of worm gears there are summation errors of graduation, axial impacts, and tumbling and pitch errors which have an adverse effect on the roundness of the throw to be ground. An equally adverse effect is produced by any inaccuracy in the rotation of the drum or in the roundness of the drum bearing.

In accordance with the present invention, a machine for grinding crankshafts is provided which eliminates the aforementioned disadvantages and drawbacks. The invention will be further illustrated by reference to the accompanying drawings in which:

FIGURE 1 is a view in elevation of one embodiment of a machine in accordance with the present invention,

FIGURE 2 is a top view of the machine of FIGURE 1,

FIGURE 3 is a sectional view showing a detail of the advancing means for the grinding wheel, and

FIGURE 4 is a sectional view showing a detail of the rocker shaft which supports the grinding wheel.

Referring to the drawings, a crankshaft to be ground is mounted for rotation about the axis **1** thereof, i.e., about the main bearings thereof, and may thus be supported at the main bearings by the steady rest **2**. A grinding wheel **3**, the bearings **4** of which are mounted in a rocker arm **5**, closely follows the surface of a throw **6** to be ground because the supporting shaft **9** of the grinding wheel **3** and an eccentric **7** mounted at the left-hand end of the headstock **8**, as shown in FIGURE 1, are directly connected by means of a connecting rod **10**, the latter being shown in FIGURES 2 and 3. The connecting rod **10** having a sliding block mounted therein is moved by means of the rotatable eccentric pin **7**. The sliding block is adapted to be shifted and to be locked in position by means of a threaded shaft passing therethrough while being supported on slide bars, all as shown in FIGURE 3. The sliding block is connected on both sides thereof, by means of a pair of pivots, with a bifurcated crank arm which is keyed to a rocker shaft **12**. Thus, the grinding wheel **3**, mounted in the rocker arm **5**, forcibly follows the throw **6** of the crankshaft to be ground due to the fact that the center of the crankshaft throw, the position of which corresponds to the position of the eccentric pin **7** at the end of the headstock **8**, is connected with the rocker arm **5** through the connecting rod **10** and the rocker shaft **12**. As a result, the grinding wheel will follow a predetermined geometrical path independently of the condition or position of the crankshaft throw to be ground. The bearings **11** of the torsion-proof rocker shaft **12** are positioned in the lower part of the machine frame **13**. The bearings and rocker shaft may, however, be mounted in a position offset by about 180° above the grinding wheel **3** so that a type of jointed cross-shaft axle is obtained having certain dynamic advantages. The rocker shaft **12** also serves as a guide or track whereby the grinding wheel **3** may be axially displaced with respect to the throws on the crankshaft.

Advancing of the grinding wheel **3** in a radial direction is effected by an advancing drive **15** mounted in the connecting rod **10**, as shown in FIGURE 3. This advancing drive changes the center distance or axle base of the grinding wheel with respect to the eccentric **7** mounted on the headstock **8** and, thus, also changes the distance of the grinding wheel from the crankshaft throw to be ground. During finish grinding, the distance is set equal to the radius of the grinding wheel plus one-half of the diameter of the crankshaft throw.

The advance in the tangential direction, i.e., round feed or advance, will be subject to an error because of the trigonometric correlations in the coaction of the eccentric pivot stroke, the length of the connecting rod and the radius of the rocker arm. If this error, which causes the speed of the round advance to assume a flat sinusoidal curve, manifests itself as an impermissible difference in the surface quality between the side which faces and is turned away, respectively, from the main center of the crankshaft, the rotary motion, i.e., the speed of rotation of the crankshaft is caused to assume a sine-shaped path or course in the inverse sense using the control device **16** which regulates the speed of the driving motor **23**, whereby this error can be largely eliminated.

In the case of long crankshafts, it is desirable to equally drive the headstock and tailstock ends thereof since impermissible errors may arise as a result of the torsion of the crankshaft. This drive is conventionally effected by driving both ends of the crankshaft synchronously by means of chain drives and this necessarily leads to an error, even though the error is small, as a result of summation errors in graduation of the chain sprockets.

In contrast to this known method, in the present invention the drive **17** on the tailstock end is not synchronized but, instead, a controllable constantly-acting torsional moment is applied to the crankshaft which is independent of the speed of rotation. This drive is either hydraulic or mechanical through a clutch having an adjustable torsional moment. This type of drive may be employed since a residual torsional moment may be present in the crankshaft without exerting an adverse effect on the accuracy of the throw to be ground.

A further advantage of the machine of the present invention resides in the fact that when successively grinding several throws which are offset from the crankshaft axis by $x°$ with respect to each other, the rigid connection **18** between the headstock and the crankshaft need not be disengaged or released. Instead, the eccentric **7** at the other end of the headstock from the connection **18** is rotated by $x°$ about the center of the headstock, using the shifting device **19**, in order to attain the next angular position corresponding to the position of the succeeding crankshaft throw. The eccentric **7** is mounted on the shifting device **19** in a manner such that the stroke of the eccentric is controllable or adjustable by the adjusting means **20** in accordance with the stroke of the crankshaft throw. In a stroke position of zero, i.e., at a position of zero eccentricity, it is possible to also grind the main bearings of the crankshaft on the same machine, which is not possible on machines of conventional construction.

A device **21** for removing the grinding wheel and a measuring device **22** for measuring the roundness of the crankshaft throw during the grinding operation are mounted on the rocker arm on which the grinding wheel is mounted.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. A machine for grinding crankshafts comprising a frame, means for rotatably supporting a crankshaft to be

ground, means for rotating the crankshaft, grinding means mounted on a torsion-proof rocker shaft and adapted to contact a throw on the crankshaft to be ground, and means for axially displacing the grinding means on the rocker shaft.

2. A machine according to claim **1** in which bearings for the rocker shaft are positioned in the lower part of the frame.

3. A machine according to claim **1** in which the grinding means is a grinding wheel.

4. A machine according to claim **1** including means for regulating the speed of the means for rotating the crankshaft.

5. A machine according to claim **1** in which the grinding means is connected by means of a connecting rod to a rotatable eccentric supported by a headstock on the frame.

6. A machine according to claim **5** including means on the connecting rod for advancing the grinding means toward a throw to be ground.

7. A machine according to claim **5** including shifting means for adjusting the angular position of the eccentric, whereby successive throws on the crankshaft may be ground.

8. A machine according to claim **5** including means for adjusting the degree of eccentricity of the eccentric.

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