April 14, 1964 K. C. WINTHER 3,128,582

CRANKSHAFT BALANCING MEANS

Filed Oct. 1, 1962 4 Sheets-Sheet 1

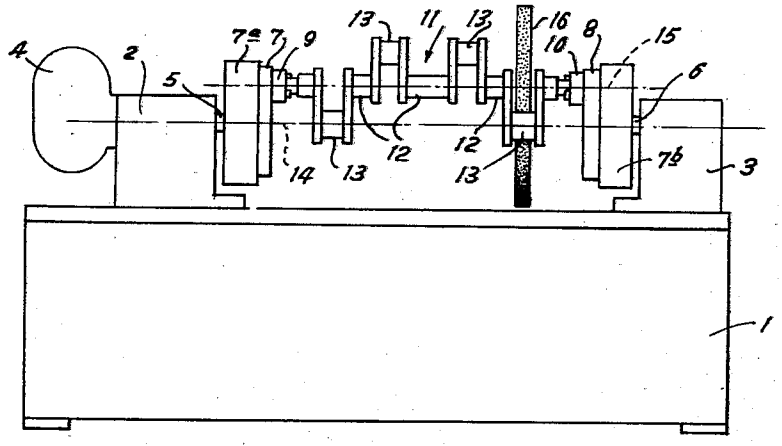


Fig. I

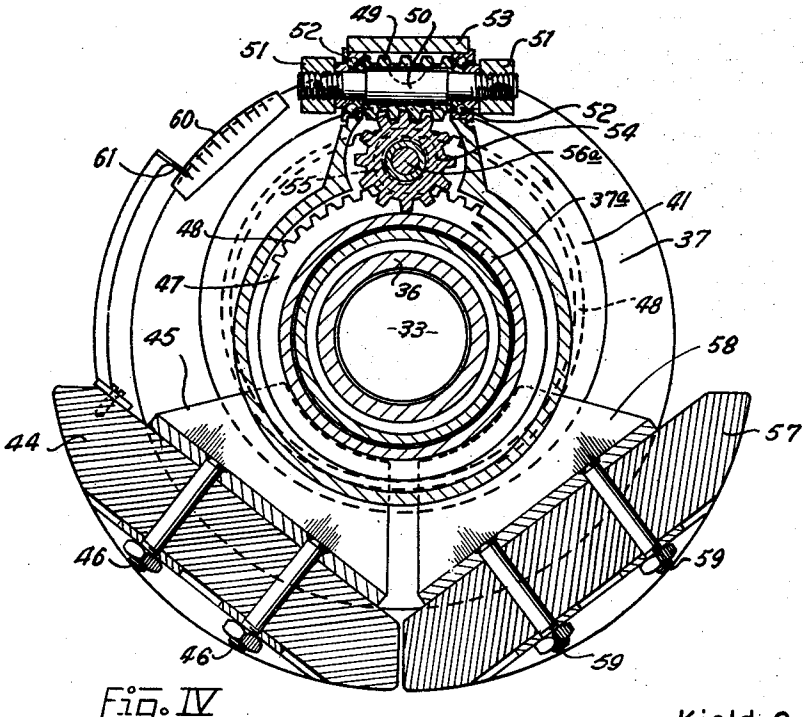


Fig. IV

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CRANKSHAFT BALANCING MEANS

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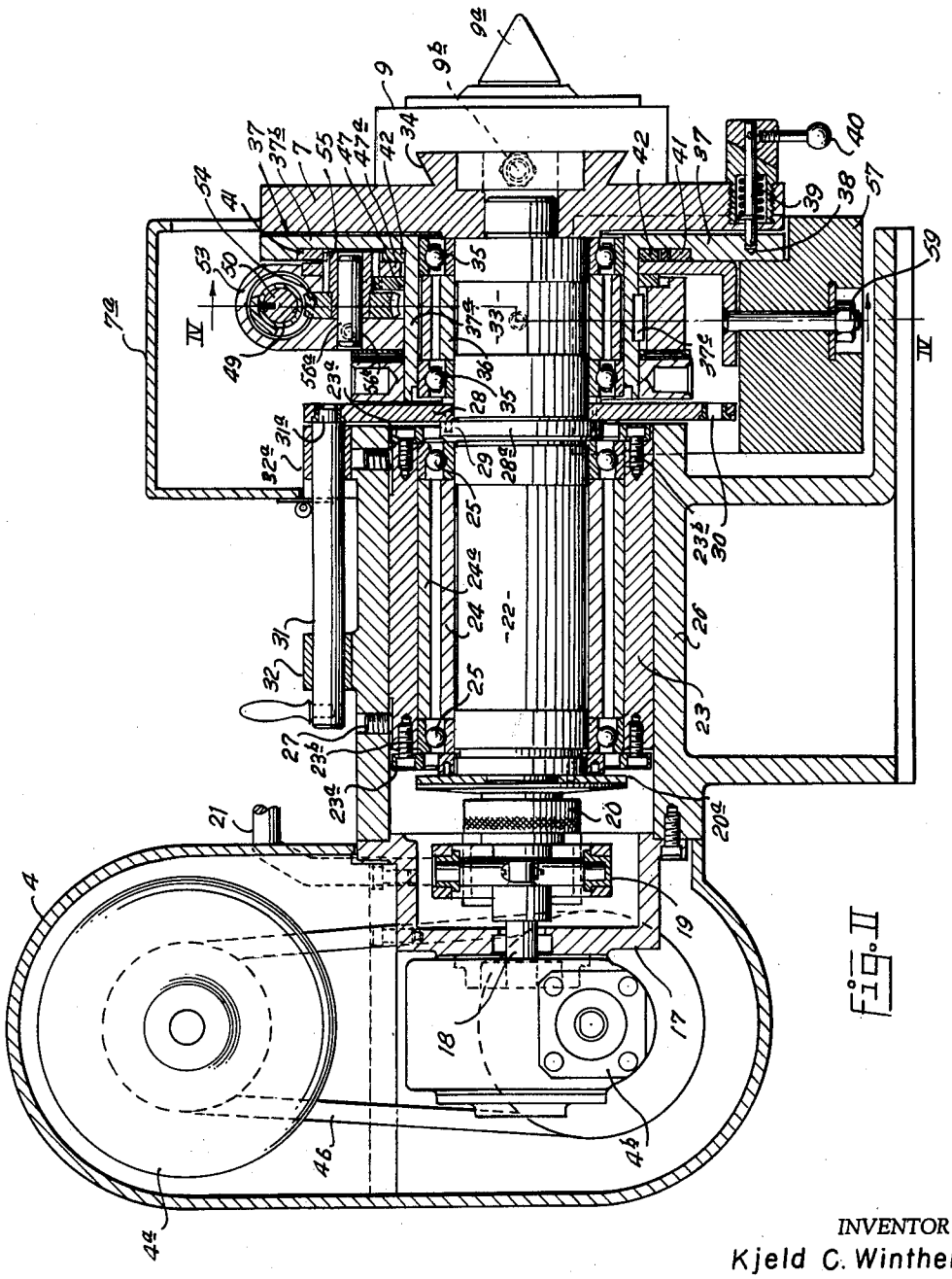


FIG. II

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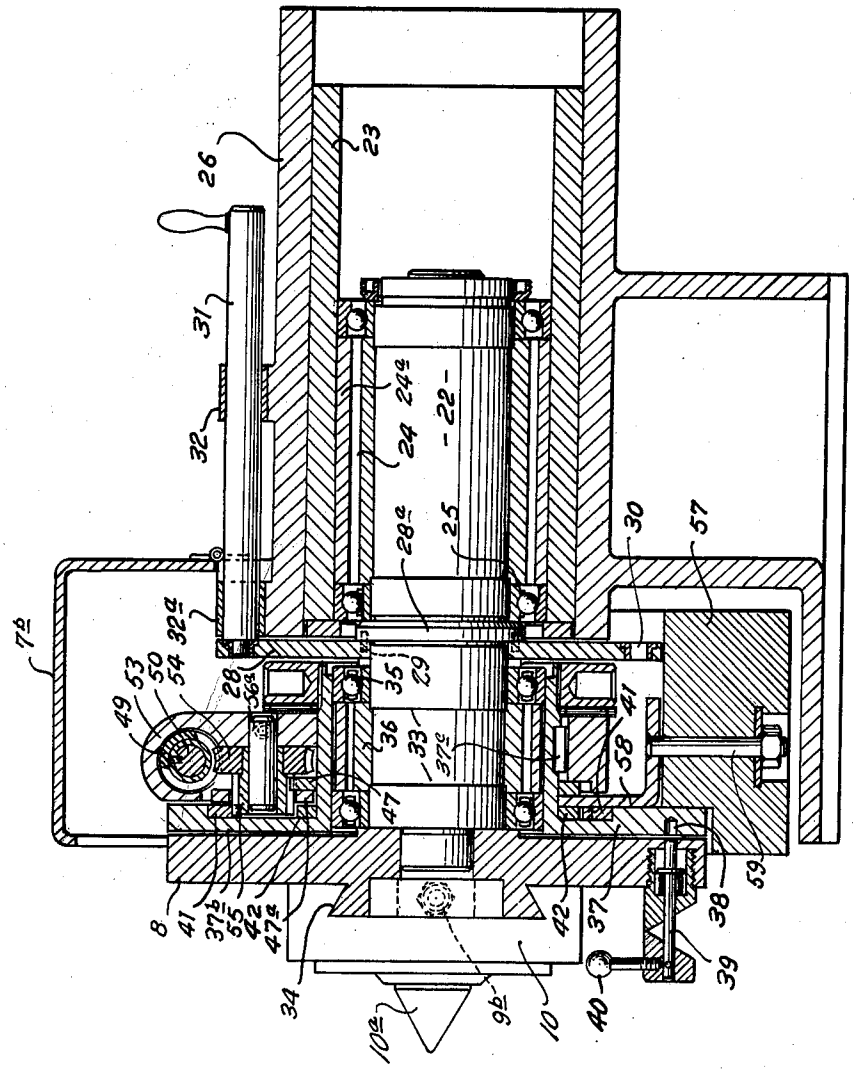


Fig. III

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CRANKSHAFT BALANCING MEANS

Filed Oct. 1, 1962 4 Sheets-Sheet 4

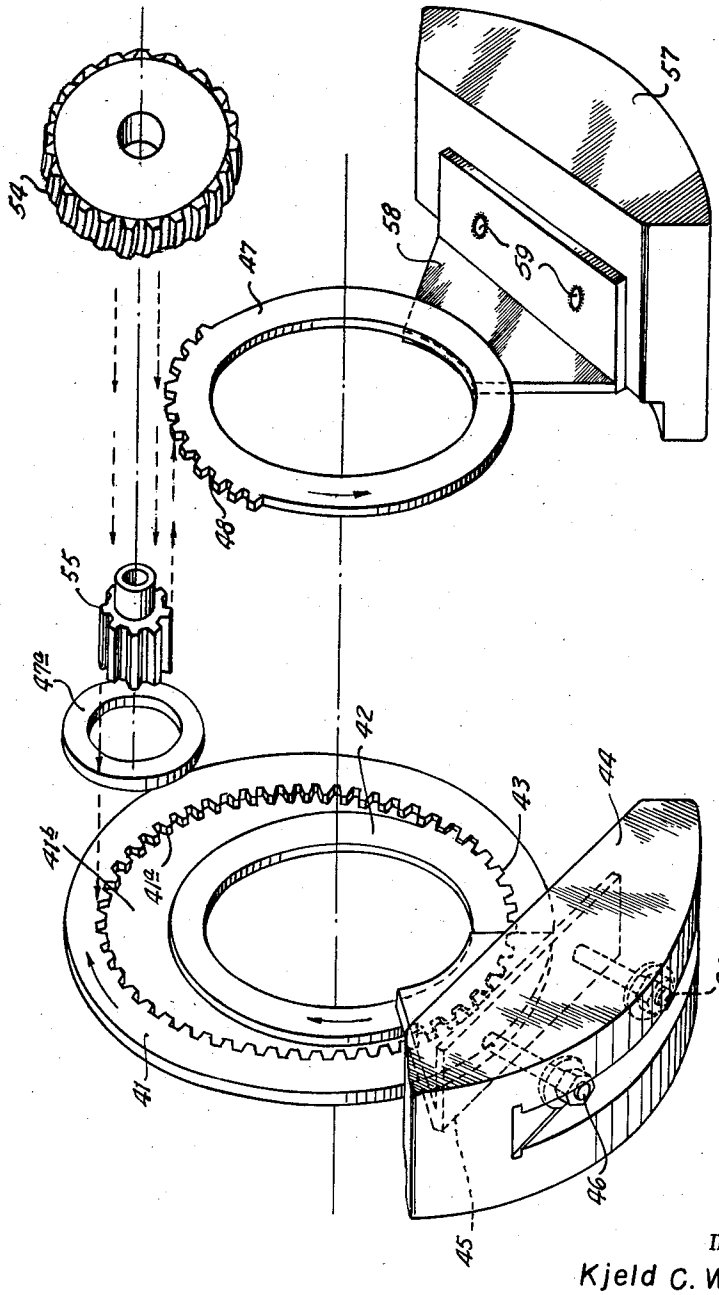


Fig. V

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CRANKSHAFT BALANCING MEANS

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9 Claims. (Cl. 51—237)

This invention is concerned with a crankshaft grinding machine, and is particularly concerned with means for balancing a crankshaft when rotated on an axis offset from the main bearing axis of the crankshaft while grinding the throw bearing or journal.

A crankshaft grinding machine generally comprises a headstock and a tailstock, each having a rotatable spindle mounted therein, with a chuck or live center mounted on the inner end of each spindle for engagement with the ends of the crankshaft. The spindle in the headstock end is rotated by suitable power means, to thereby rotate the crankshaft and the spindle in the tailstock. As the crankshaft is rotated, the journals are ground by engagement with an abrasive grinding wheel.

Such machines include laterally adjustable throw heads on which the work engaging chucks or live centers are mounted, so that the engaging members can be shifted radially of the axis of rotation of the machine spindles to cause the normal axis of rotation of the crankshaft with which the main journals are in alignment to rotate in a planetary motion around the axis of the throw bearings, which are laterally displaced from the normal axis of rotation of the crankshaft as the throw bearing journals are ground.

Obviously when the throw bearings are offset radially so that the work rotates eccentrically with reference to the normal axis of rotation of the crankshaft, the crankshaft is out of balance with respect to the axis of rotation of the machine spindles, and, upon rotation vibrations are set up in the work, and in the machine, of destructive nature.

Therefore, it has been found advisable to provide adjustable counter-balancing weight means to compensate for the unbalance brought about as hereinbefore described, in order to prevent vibration.

This invention is particularly concerned with improvements in the mounting, adjusting and positioning of the counterbalancing weight means so that the counterbalancing weights can be quickly and easily adjusted to the radial adjustment of the throw heads, and are so positioned inboard of the headstock and tailstock of the machine as to prevent the creation of torsional deflective forces caused by undue spacing of the counterweights from the work.

It is, therefore, a primary object of the invention to provide counterweight positioning and adjusting means in a crankshaft grinding machine which are mounted inside the end supports for the spindles for the machine to thereby eliminate torsional windup in the spindles, which causes vibration, and interferences with the close tolerance setting required of the counterbalance weights.

Still another object of the invention is the provision of means in a crankshaft grinding machine to disengageably latch the counterbalance weights to the rotatable spindles of the machine, so that when the crankshaft is rotated about the normal axis of rotation while grinding the main bearings, the counterweights may be disengaged from the spindles.

Another object is the provision of means to disengageably latch the spindles against rotation to permit adjustment of the counterweights relative thereto.

A still further object of the invention is to provide in a crankshaft grinding machine means for more quickly and accurately adjusting the counterweights thereon.

A further object of the invention is to provide counterweight adjustment in a crankshaft grinding machine wherein the counterweights on each end are in equal segments, adjustable radially about the spindle, so as to evenly space and distribute the weights about the spindle, to provide for a three point counterweight balance about the spindles.

Other and further objects of the invention will become apparent upon reading the detailed specification hereinafter following, and by referring to the drawings annexed hereto.

A preferred embodiment of the invention is shown in the attached drawings, wherein:

FIGURE I is a semi-diagrammatical side elevational view of a crankshaft grinding machine, with a crankshaft secured at each end to the adjustable throw heads, showing the normal axis of rotation of the crankshaft offset with relation to the axis of rotation of the spindles of the machine, and showing one of the throw bearings of the crankshaft being ground by engagement with a grinding wheel;

FIGURE II is a cross-sectional, elevational view of the headstock, counterweight assembly and drive means, in which the improvements comprehended by this invention, are incorporated;

FIGURE III is a cross-sectional, elevational view of the tailstock and counterweight assembly incorporating the improvements described and claimed herein;

FIGURE IV is a transverse, cross-sectional view taken on the line IV—IV of FIGURE II; and

FIGURE V is an exploded view in perspective of the various gears employed in adjusting the counterweights radially of the tailstock or headstock assembly.

Numeral references are employed to designate the various parts shown in the drawings, and like numerals indicate like parts throughout the various figures of the drawings.

Referring first to FIGURE I the numeral **1** indicates a supporting base for the crankshaft grinding machine on which is mounted in spaced relationship a headstock assembly **2** and a tailstock assembly **3**.

The motor and differential gear housing **4** is mounted to the outer end of the headstock housing **26**. Mounted inside the housing **4** is an electric motor **4***a* and a differential gear box **4***b*. The differential gears (not shown) in gear box **4***b* are driven from the motor **4***a* by means of a belt **4***c* extending about appropriate sheaves (not shown) mounted exteriorly of the motor and gear box, respectively.

As diagrammatically shown in FIGURE I, the spindles or drive shafts **5** and **6** are rotatably mounted in the headstock **2** and tailstock **3**, the longitudinal axis of which represent the normal axis of rotation of the spindles of the crankshaft grinding machine.

Spindle heads **7** and **8** are positioned adjacent the inner faces of the counterweight housings **7***a* and **7***b*, respectively, at each end of the machine, said spindle heads being rotatable with the headstock and tailstock spindles **5** and **6**, respectively.

Laterally adjustable work engaging throw heads 9 and 10 have live centers 9*a* and 10*a* attached to the inner faces thereof, said work engaging throw heads 9 and 10 being laterally adjustable with reference to the inner faces of the spindle heads 7 and 8, for the purposes hereinafter mentioned.

A conventional crankshaft 11 is rotatably mounted on the machine by engaging the outer ends thereof with the live centers 9*a* and 10*a*. The crankshaft 11 includes main journal bearings 12 and throw bearings 13.

The normal balanced axis of rotation of the crankshaft 11 is indicated at 15, and the axis of rotation of the spindles 5 and 6 of the crankshaft grinding machine are indicated at 14.

It will be noted that the adjustable work-engaging throw heads 9 and 10 have been adjusted laterally of the spindle heads 7 and 8 in order to bring the throw bearings 13 in axial alignment with the axis of rotation of the machine spindles 5 and 6, for grinding the throw bearings by means of the grinding wheel 16 engaged therewith, as the crankshaft is rotated.

Thus it will be seen that the normal axis of rotation 15 of the crankshaft is out of alignment with the axis of rotation of the spindles of the machine, so that upon rotation of the crankshaft, the crankshaft is rotated out of balance, with the main bearings 12 moving in a planetary motion about the axis of rotation 14, and unless balanced in the manner hereinafter described, will impart destructive vibrations to the machine.

The detailed construction of the spindle supports and counterweights adjusting assembly is shown in FIGURES II–V, and the description thereof follows.

The clutch housing 17 is mounted to the outer face of the main bearing housing 26.

A drive shaft 18 is rotatably suspended on suitable hearings through the wall of the housing 17 and is connected to the gears in gear box 4*b* by which the shaft 18 may be rotated.

A clutch engager 19 is slidably keyed to the shaft 18 so that the clutch plate 20*a* of the clutch assembly 20 may be moved into and out of engagement with the spindle 22 by means of a handle 21 extending outwardly of the housing.

An outer bearing sleeve 23 is secured to the inner side of the bore of the spindle housing 26 by means of suitable set screws 27.

Two bearing spacer sleeves 24 and 24*a* are disposed about the spindle 22 to space the bearings 25. The bearings are held in place by the abutment rings 23*a* which are secured to the ends of the sleeve 23 by screws 23*b*. The spindle 22 rotates on the bearings 25.

An annular locking plate 28 is secured to the annular flange 28*a*, secured about the spindle 22, by means of appropriate pins 29. The lockings plate 28 is provided with spaced annular holes 30 in the outer periphery thereof.

A lock pin 31 is slidably disposed through the guides 32 and 32*a*, attached to the spindle housing 26, the inner end thereof being reduced in diameter as indicated at 31*a*, to enter one of the locking holes 30, to thereby lock the spindle 22 against rotation while the counterbalance weights are being adjusted in the manner hereinafter described.

The spindle 22 also includes an extension 33 beyond the flange 28*a*. Said spindle extension 33 is rotatably mounted on bearings 35, separated by bearing spacers 36, the whole assembly being supported and held in place by the tubular sleeve portion 37*a* of the lock sleeve 27, extending thereabout, and the lock flange 28 and spindle head 7 abutted thereagainst.

The lock sleeve 37 includes a tubular portion 37*a* extending about the bearing assemblies 35 and 36, and an annular flange portion 37*b*. A lock recess 38 is provided in the outer face of the annular flange portion 37*b*. The spring-urged lock pin 39, operable by handle 40, is arranged to enter the lock recess 38, to lock the sleeve 37 to the spindle head 7 for rotation with the spindle. The lock sleeve 37 is keyed to the counterweight assembly housing 53, as indicated at 37*c*, so as to rotate the counterweight assembly with the spindle 22 when the pin 39 is engaged in recess 38.

A gear ring 41, having internal teeth 41*a* (FIG. V), is guided and rotatably disposed in a recess formed in the inner face of the annular flange portion 37*b* of the lock sleeve 37.

Gear ring 42, having external teeth 43 thereon, is disposed inside the gear ring 41, with the teeth on ring 42 in mesh with the teeth 41*a* of the gear ring 41 at the lower end thereof (FIG. V).

An annularly disposed counterweight 44 is secured to an angled bracket 45 by means of suitable bolts 46, and the upwardly extending leg of the bracket 45 is secured to the gear ring 42. The gear ring 42 is rotatably disposed about the sleeve portion 37*a* of the lock sleeve 37.

Another gear ring 47 is rotatably disposed about the sleeve portion 37*a* and is longitudinally spaced from the gear ring 42 by an annular spacer ring 47*a*.

The gear ring 47 has teeth 48 formed on the upper, outer periphery thereof, and has secured on the other side thereof an annularly disposed counterweight 57, which is attached thereto by means of an angled bracket 58 through which extends attachment bolts 59.

As shown in FIGURE IV, a worm gear 49 is mounted upon a shaft 50 which is rotatably mounted upon bearings 52 in the bearing support sleeve 53. The worm gear 49 may be rotated by engagement of a wrench with the nuts 51 threaded to the outer ends of the shaft 50.

The worm gear 49 is in mesh with a worm gear 54 secured to the elongated spur gear 55 (FIG. II). A shaft 56*a* is mounted by a set screw in a bore 56*b* in the frame portion 53, and loosely extends into the bore through gear 55 so that the gears 54 and 55 can rotate thereon.

The elongated spur gear 55 extends through the space 41*b* (FIG. V) provided between the upper outer periphery of the gear ring 42 and the inner side of the gear ring 41. In order to provide adequate space 41*b* for the spur gear 55 to extend through, the opening 41*b* inside the gear ring 41 is sufficiently large to receive same. The spur gear 55 is in mesh with the teeth 41*a* on the inner side of the gear ring 41, and also is in mesh with the teeth 48 on the outer gear ring 47, so that upon rotation of the spur gear 55 the gear rings 41 and 47 will be caused to rotate in opposite directions, and the gear ring 42, inside the gear ring 41, will be caused to rotate in the opposite direction from the gear ring 47, whereby the counterweights 44 and 57 are caused to move in opposite directions in an arcuate pattern.

An adjustment indicator scale 60 is provided on the outer rim of the flange 37*b*, as indicatd in FIG. IV. The position of adjustment of the counterweights may be indicated by the pointers 61 attached to the respective counterweights to thereby indicate the approximate position of adjustment of the counterweights for a particular type of crankshaft being ground, so that a table may be prepared to indicate adjustments.

FIGURE III shows the tailstock and counterweight assembly which is identical in construction and operation to the headstock and counterweight assembly, with the exception that there is no motor drive and clutch assembly employed, or needed, in connection therewith. Therefore, the numerals on the tailstock assembly are identical to those indicated on the headstock assembly, and no further description thereof is necessary.

The operation and function of the device hereinbefore described, is as follows:

The crankshaft 11 is secured at each end to the live centers 9*a* and 10*a* and the throw heads 9 and 10 are adjusted laterally by means of dove-tail connections 34 with the spindle heads 7 and 8 and an elongated lead screw go threadedly extending between the members.

If it is desired to grind the throw bearings **13**, the engagement members **9** and **10** will be adjusted laterally until the throw bearings **13** are in axial alignment with the rotating spindles **22** of the machine.

Since in such position, the normal axis of rotation of the crankshaft is offset with relation to the axis of rotation of the spindles, the main bearing **12** will rotate in a planetary motion about the spindle axes. Therefore, it is necessary that the counterweights at each end of the machine be adjusted to compensate for the eccentric vibratory rotation of the crankshaft.

This adjustment is accomplished by rotating the worm gear **49** thereby rotating the spur gear **55** through worm gear **54** to impart rotational movement to the gear rings **41** and **47** in opposite directions. The rotation of gear ring **41** imparts rotation to the gear ring **42** in the opposite direction to the gear ring **47**, thereby causing the counterweights **44** and **57** to move in opposite directions in an arcuate pattern. This adjustment is made until the main bearings of the crankshaft are balanced with the weights **44** and **57**. During the adjustment hereinbefore described, the locking pin **31** is engaged with the locking ring **28**, and locking pin **39** is engaged with flange **37***b* thereby holding the shaft **22** and the counterweights against rotation. This adjustment is made with reference to both the headstock and tailstock.

After the adjustment has been made, the pin **31** is disengaged from the lock flange **28** so that upon rotation of the shaft **22** by the motor after engagement of the clutch wheel **20***a*, the entire counterweight assemblies and the spindle heads **7** and **8** attached thereto, are rotated with the crankshaft, thereby applying the effect of the counterweights to the rotating crankshaft to balance same.

It will be noted that after the adjustment of the counterweights is made, there is a three point balance of the crankshaft, to-wit, the annularly spaced counterweights **44** and **57** providing two points and the main bearings **12** providing the other point.

When it is desired to grind the main bearings **12** this may be quickly done by simply adjusting the adjustable engaging heads **9** and **10** laterally, to bring the normal axis of rotation **15** of the crankshaft into alignment with the axis of rotation of the spindles **22** of the grinding machine. Since no eccentric motion is imparted when the crankshaft is rotated on its normal axis, the counterweights are not needed. The counterweights may be disengaged from the spindles **22** for grinding of the main bearings, by simply disengaging the lock pins **39** from the recesses **38**, thereby freeing the spindle heads **7** and **8** and spindles **22** from engagement with the counterweights, so that the crankshaft may be rotated free of the counterweights.

As hereinbefore mentioned, the rough adjustments may be for different types of crankshafts, and may be made by employment of the scale **60** and pointer **61**.

It will be seen that I have provided counterweight adjustment means in a crankshaft grinding machine, which is quickly and easily adjusted, which accurately positions and distributes the counterweights, which positions the counterweights interiorly of the headstock and tailstock, reducing torsional twist on the spindles, which provides means for quickly disengaging the counterweights from the spindle when the main shafts are to be ground, and for re-engagement therewith when the throw bearings are to be ground, which provides for disengageably locking the spindles and spindle heads against rotation while the counterweights are being adjusted, and which provides for scale means for indicating approximate settings for different types of crankshafts.

It will be understood that other and further embodiments of my invention may be devised without departing from the spirit and scope of the appended claims.

Having described my invention, I claim:

1. In a device of the class described, a supporting frame having an inner end; a spindle rotatably supported in the frame; means for rotating the spindle; a pair of counterweights radially spaced from the spindle adjacent the inner end of the supporting frame; support means for the counterweights movable arcuately with respect to the spindle; means to rotate the support means with reference to the spindle to adjust the counterweights arcuately about the spindle; and means to disengageably attach the counterweights to the spindle for rotation therewith or for disengagement of the spindle from the counterweights to permit rotation of the spindle free of the counterweights.

2. The combination called for in claim 1 wherein the support means for the counterweights include a gear ring disposed about the spindle with internal teeth therein; a gear ring disposed about the spindle with external teeth thereon disposed in the first named gear ring, with the internal and external teeth in mesh; another gear ring disposed about the spindle with external teeth thereon spaced longitudinally from the second named gear ring; and a counterweight attached to each of the second named and third named gear rings.

3. The combination called for in claim 2 with the addition of an elongated spur gear in mesh with the inner teeth on the first named gear ring, and the outer teeth on the third named gear ring.

4. The combination called for in claim 2 wherein the second named gear ring has exterior teeth on the lower side thereof in mesh with the interior teeth in the first named gear ring, and the second named gear ring is sufficiently smaller in diameter than the opening through the first named gear ring as to leave sufficient space interiorly of the first named gear ring to permit the elongated spur gear to enter same.

5. In a device of the class described, a supporting frame; a spindle rotatable in the supporting frame; means for rotating the spindle; a counterweight assembly including a housing, a sleeve member having a tubular portion extending about the spindle and being keyed thereto and a flange portion with a recess on the inner face thereof, a gear ring with interior teeth therein rotatably supported in the recess and disposed about the spindle; a gear ring with external teeth thereon disposed about the spindle within the first named gear ring with the internal and external teeth in mesh; another gear ring with external teeth thereon rotatably disposed about the spindle and spaced longitudinally of the spindle from the second named gear ring; an elongated spur gear rotatably supported by the housing and extending into the first named gear ring to mesh with the teeth therein and being in mesh with the external teeth on the last named gear ring; a worm gear on the end of the spur gear; a worm gear rotatably disposed on the housing in mesh with the first named worm gear; means to rotate the second named worm gear to thereby rotate the spur gear and the other said gears; and a counterweight attached to each of the second and third named gear rings, said counterweights being spaced radially therefrom and being arranged to move arcuately about the spindle in opposite directions when the said gears are rotated.

6. The combination called for in claim 5 with the addition of a scale on the flange portion of the sleeve member, and a pointer attached to, and movable arcuately with, a counterweight to indicate the adjusted position of the counterweight.

7. The combination called for in claim 5 with the addition of a flange-like spindle head on the inner end of the spindle, and means to disengageably attach the spindle head to the counterweight assembly.

8. The combination called for in claim 7 wherein the means to disengageably attach the spindle head to the counterweight assembly includes at least one slot in the outer face of the flange portion of the sleeve member, and a pin carried by the head arranged to retractably enter the slot.

9. In a device of the class described, a supporting frame having an inner end; a spindle rotatably supported in the frame; means for rotating the spindle; a pair of counterweights radially spaced from the spindle adjacent the inner end of the supporting frame; support means for the counterweights movable arcuately with respect to the spindle; means to rotate the support means with reference to the spindle to adjust the counterweights arcuately about the spindle; and means to disengageably attach the spindle to the frame including, an annular flange attached to the spindle, at least one slot in the flange, and a pin slidably attached to the frame arranged to retractably enter the slot.

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