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CRANKPIN GRINDER

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3 Sheets-Sheet 1

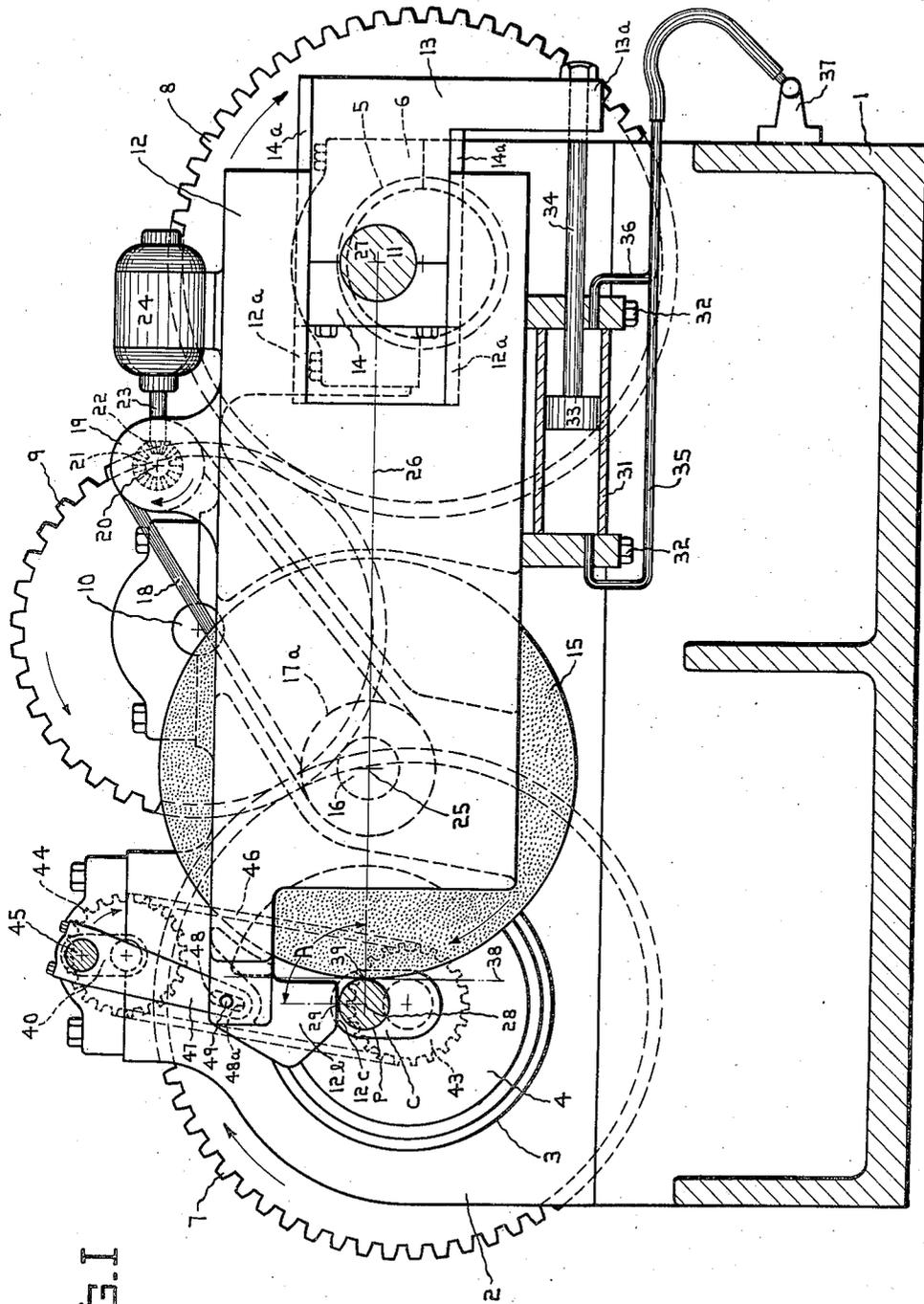


FIG. I

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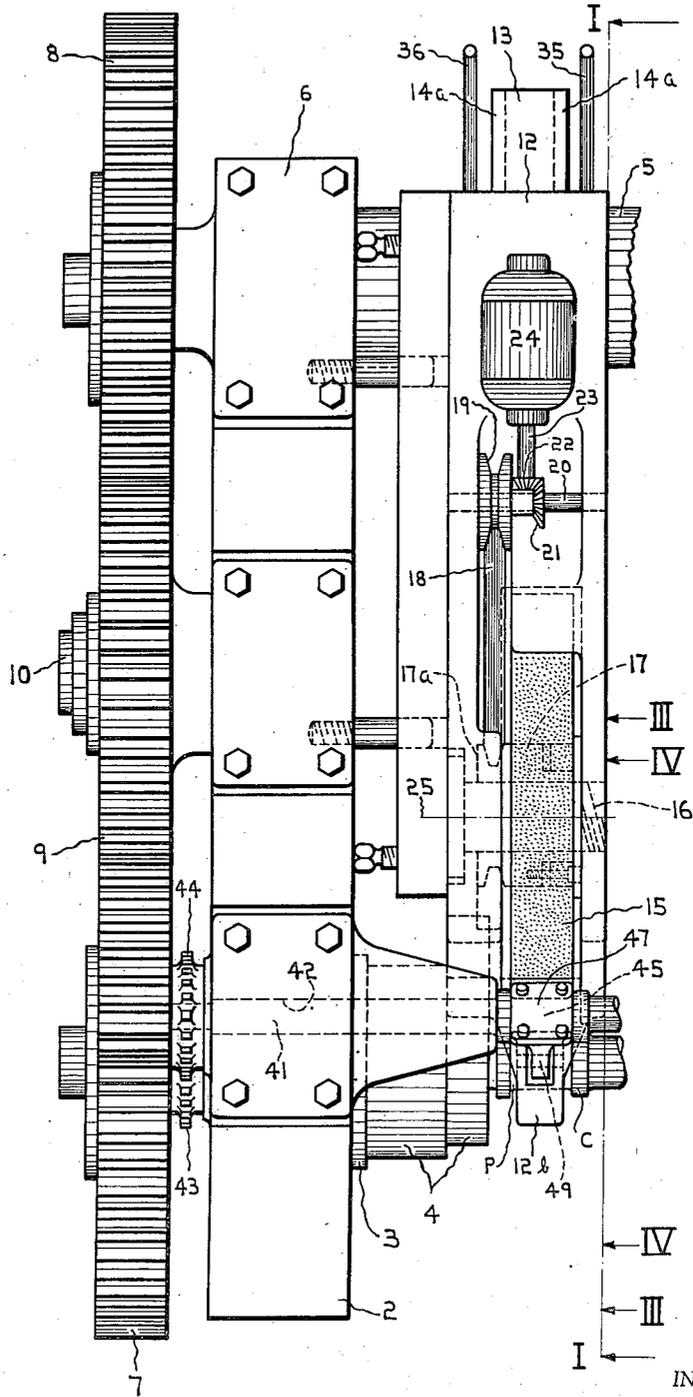
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FIG. II



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# UNITED STATES PATENT OFFICE

2,232,229

## CRANKPIN GRINDER

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Application May 20, 1940, Serial No. 336,225

6 Claims. (Cl. 51—105)

This invention pertains to grinding machines for grinding eccentric portions on rotating work pieces and is particularly related to machine for grinding the crankpins of a multi-throw internal combustion engine crankshaft in a single operation.

Heretofore the operation of grinding the crankpins of such multi-throw crankshafts has been exceedingly difficult because these bearing portions could not be simultaneously ground in a single operation and also difficulty was experienced with the proper supporting of the pin bearing portions while being ground to prevent them from springing out of their true located position during the grinding operation which resulted in inaccuracies in the finished ground pin bearings.

It is therefore the object of this invention to provide a grinding machine which is capable of simultaneously grinding all of the pin bearing portions of a crankshaft in a single operation and all at the same time while also providing work supporting means in conjunction with the grinding wheel to prevent springing of the work piece while it is being ground. With this invention, the use of the ordinary adjustable steady rest in connection with the bearing portion being ground can be completely dispensed with; the grinding wheel carrier incorporating a steady rest which is floatingly mounted on the bearing portion being turned in such a way that the thrusts and forces set up in the bearing and crankshaft by the application of the grinding wheel thereto are fully and completely absorbed from any effect on springing or distorting the shaft from its true position while being ground.

One object of this invention, therefore, is to provide in a grinding machine a member for holding the grinding wheel and for feeding said grinding wheel relative to a position to be ground on a work piece, said grinding wheel carrying device being so arranged that it is floatingly mounted and rests upon the portion being ground so as to absorb all cutting strain imposed upon the work by the grinding wheel.

Another object of this invention is to provide in a grinding machine for grinding relatively limber work an arrangement whereby the grinding wheel is fed radially of the axis of rotation of the work surface to be ground while it is also allowed tangential floating movement in a plane perpendicular to the direction of relative feeding of the grinding wheel and the work and to control this tangential floating movement by

engagement of the grinding wheel carrying device with the work being ground.

Still another object of this invention is to provide in an orbital grinding machine adapted to simultaneously grind a plurality of eccentric portions on a work piece rotated in said machine, a carrier for the grinding wheel, one end of which is pivotally mounted on the crankpin of a master crank which is rotated in synchronism with the work piece to be ground and the other end of which grinding wheel carrier is floatingly supported on the work surface being ground thereon and to have a grinding wheel on said members which may be fed to and from the work surface to be ground during the rotation of the work and master crankshaft.

Another object of this invention is to provide in a crankpin grinding machine, a rotatable work spindle for rotating a crankshaft on its line bearing axis so its crankpins rotate in eccentric paths and to provide a master crankshaft rotatable in synchronism therewith, upon the throws of which master crankshaft is mounted a series of grinding wheel carriers, one end of which carrier is floatingly mounted on the work on the eccentric portions of the work piece to be ground, and to provide grinding wheels on said carriers, and means for feeding the carriers radially of the work to effect the grinding action of said grinding wheels simultaneously on all of the crankpins of the crankshaft to be ground in said lathe.

And still another object of this invention is to provide in an orbital grinding machine, means for rotating a work piece so that its eccentric portion travels in an orbit and to provide a master crankshaft having one or more crankpins having paths of travel commensurate with that of the work to be ground and to provide a grinding wheel carrying unit, one end of which is pivotally mounted on the crankpin of said master crankshaft and the other end of said unit resting upon the work surface to be ground, and to provide a grinding wheel mounted on said carrier lying in a plane defined by the axis of the eccentric portion being ground and the axis of the crankpin of said master crankshaft and to arrange the point of engagement of said grinding wheel carrier on the work to contact said work surface being ground at a position 90 degrees removed from the point of contact of that of the grinding wheel with said eccentric surface.

The further object of this invention is to also provide an auxiliary crankshaft operating in

conjunction with the arrangement above which properly supports the grinding wheel carrying unit when the work piece is removed from the machine and to maintain this grinding wheel carrier in proper operating position so that it may automatically come into contact and become floatingly mounted upon the work being turned during the operation of the lathe.

Further features and advantages of this invention will appear in the detailed description of the drawings in which:

Figure I is a vertical transverse section, on the line I—I of Figure II, showing the general arrangement of the work spindle, master crankshaft, and synchronizing drive between the work spindle and master crankshaft and the grinding wheel tool carrier at the time of completion of the grinding operation on a crankpin of the crankshaft.

Figure II is a fragmentary plan view of the machine shown in Figure I showing the synchronizing drive mechanism between the master crankshaft and work spindle and one of the orbital grinding wheel carriers of the grinding machine.

Figure III is an enlarged fragmentary section on the line III—III of Figure II showing the relationship of the grinding wheel carrier and grinding wheel relative to the work piece at the time of loading and unloading of work in the lathe, with the grinding wheel fully retracted from the work piece.

Figure IV is a similar enlarged fragmentary section on the line IV—IV of Figure II showing the position of the grinding wheel unit and grinding wheel at the time of initial engagement of the grinding wheel unit with the work at the time of infeeding of the grinding wheel to the work piece during the initial portion of the grinding cycle.

For the sake of simplicity this machine is shown in, Figure II, with only one of the orbital grinding wheel carrier units operating on one of the crank-pins of a multi-throw crankshaft, it being obvious that additional units might be added with the extension of the master crankshaft and width of the machine for grinding any number of crankpins simultaneously on a single crankshaft at one time as in an arrangement shown for example, in copending application, Serial No. 334,407 filed May 10, 1940. This machine comprises a base 1 upon which is mounted the housing 2, in which is journaled the work spindle 3 having a suitable chucking device 4 for gripping the work piece or crankshaft C in a usual manner. Also journaled in this housing 2 is a master crankshaft 5 carried in a suitable journal 6. The work spindle 3 and master crankshaft 5 each have identical gears 7 and 8 respectively which are connected together through the idler gear 9, appropriately journaled on a stud 10 fixed in the housing 2 so that the work spindle 3 and master crankshaft 5 rotate in exact synchronism at all times. On the crankpins 11 of the master crankshaft 5 are mounted orbital grinding wheel carriers 12 by means of the journal box 13 having the bearing 14 nicely fitting around the crankpin 11 and having suitable dove tail guideways 14a which nicely slide in mating guideways 12a in the orbital grinding wheel carrier 12. The outer end of this orbital grinding wheel carrier 12 has a projecting portion 12b which has a work engaging surface 12c which rests upon the pin P of the crankshaft C during the grinding operation of the grinding wheel 15 on the crankpin P. This

grinding wheel 15 is appropriately mounted on a stud 16 fixed in the carrier 12 and has a hub 17 carrying the grinding wheel and also a pulley 17a over which passes the driving belt 18 which operates over the pulley 19 journaled on the shaft 20 fixed in the carrier 12. Formed on this pulley 19 is a bevel gear 21 which is driven by a mating bevel pinion 22, carried on the shaft 23 of the driving motor 24 for the grinding wheel 15 on each of the orbitally moving grinding wheel carriers 12.

It is to be noted that the axis of rotation 25 of the grinding wheel 15 lies in a plane 26 passing through the axis 27 of the crankpin 11 of the master crankshaft 5 and the axis 28 of the eccentric work surfaces being ground on the crankpin C. It is also to be noted that the point of contact 29 of the surface 12c with the crankpin D is substantially a right angle with respect to the plane 26, as indicated by the angle A, Figure I.

The feeding of the grinding wheel radially of the work piece is effective along the line 26 by means of the hydraulic feed cylinder 31 carried on each of the tool units 12. This feed cylinder 31 is suitably bolted to the carrier 12 by suitable screws 32 and has a piston 33 and rod 34 fixed to the downwardly extending end 13a of the bearing block 13, so that reciprocation of the cylinder relative to the piston 33 effects relative movements of the tool carrier units 12 in the direction of the line 26 so as to move the grinding wheels 15 radially to and from the crankpin C to be ground. Suitable flexible fluid pressure lines 35 and 36 connected to a manifold 37 fixed on the base 1 serve to provide means for applying pressure to either end of the cylinder 31 to effect this relative feeding movement of the carrier 12.

It is to be noted that the direction of the rotation of the grinding wheel 15, as seen in Figure I, is counterclockwise, so that the direction of its peripheral rotation is toward the work engaging surface 12c in order that this surface will at all times be held in firm engagement with the surface of the crankpin C to keep the carrier and the grinding wheel in proper relationship to the work surface to be ground. It is also to be noted that the entire grinding wheel carrier is free to swing along the line 38 tangentially of the work surface being ground and by this arrangement any irregularities or roughness or eccentricity in the crankpin surface which may raise or lower the surface 12c and similarly move the unit 12 will have no effect on the relationship between the point of grinding action 39 and the axis 28 of the crankpin being ground, with the result that continued grinding action, even though the pin surface be irregular initially to start with, will result in the final high degree of accuracy and finish for the crankpin as the grinding wheel is fed along the line 26 by the feed cylinder 31.

It is thus apparent that this arrangement is equally applicable to grinding a rough irregular crankpin from the rough as in finish grinding as is ordinarily done after the crankpins have been previously turned in a lathe. In fact, this particular device is particularly well adapted to the grinding of the rough crankshaft because the hogging off of the metal by extremely severe grinding can be undertaken with this device, as it is so constructed as to properly perform the work of a steady rest which cannot be applied to a rough crankpin during grinding operation, whereas in this case a steady rest in the form of the projection 12b with its surface 12c can

be immediately applied to the rough bearing during the roughing out grinding operation making such an operation highly practical and which has heretofore been considered impossible of accomplishment.

In order to hold the orbital grinding wheel carrying units 12 in proper relative position for engagement with the work at the beginning of the cutting cycle and to hold them in proper relationship when the work is being removed or a new piece inserted in the machine, an auxiliary crankshaft 40 is provided which is journaled with its line bearings 41 in a suitable bearing 42 in the housing 2 and is driven in exact synchronism with the spindle 3 and master crankshaft 5 through the identical sprockets 43 and 44 respectively mounted on the work spindle and auxiliary crankshaft 40. This auxiliary crankshaft has crankpins 45 which are similarly positioned to those of the work piece C and the master crankshaft 5, and are kept in exact synchronized relationship therewith by means of the chain drive 45 passing over the identical sprockets 43 and 44. About the crankpin 45 is mounted a connecting link 47 which has a slot 48 provided in its lower end through which passes a pin 49 fixed in the grinding wheel carriers 12. Normally when the grinding wheel is in operation grinding the crankpin P as shown in Figure I, the pin 49 is removed from the bottom 48a of this slot 48, so that in effect the link 47 and associated auxiliary crankshaft 40 are wholly inoperative and have no effect whatever on the motion of the carrier 12 during the normal grinding operation.

However, this auxiliary crankshaft and link arrangement becomes effective at the time when the work piece C is removed from the chuck of the lathe, as shown in Figure III, with the grinding wheel fully withdrawn rearwardly to the right along the line 26 by means of the feed cylinder 31, in which case the surface 12c is fully removed from the crankpin P and the pin 49 in the unit 12 then hangs in the bottom 48a of the slot 48 and thereby holds the carrier 12 in approximate position while work is being removed and a new piece inserted into the chucking device of the machine.

As soon as a new piece has been inserted in the machine and fluid pressure is appropriately applied to the cylinder 31 to feed the grinding wheel to the left as shown in Figure IV, the surface 12c of the projection 12b engages against the crankpin P as this forward feeding motion is initially taking place and as this feeding motion continues, the carrier is raised and rides up over the crankpin to be ground bringing the surface 12c into engagement with the crankpin, as shown in Figure I, as the grinding wheel starts to perform its grinding operation down to finished diameter shown in this Figure I. Thus by this arrangement, the auxiliary crankshaft acts as an automatic means for positioning the grinding wheel carriers when work is removed from the lathe, so that these carriers do not drop down out of position for proper automatic engagement with the work during the in-feeding of these grinding wheel carriers.

Having thus fully set forth and described my invention what I claim as new and desire to secure by United States Letters Patent is:

1. In an orbital grinding machine, a frame, a rotatable work holder journaled in said frame, a master crankshaft journaled in said frame, means for rotating said work holder and master

crankshaft in synchronism, a grinding wheel carrier movably mounted on a journal box carried on a crankpin of said master crankshaft, a grinding wheel journaled on said carrier, a fluid pressure cylinder mounted on said carrier having a piston rod connected to said journal box, means for applying fluid pressure to said cylinder to effect relative movement of said carrier and journal box, and an electric driving motor mounted on said carrier, and means for connecting said driving motor to said grinding wheel to effect rotation of said grinding wheel.

2. In an orbital grinding machine, a frame, a rotatable work holder journaled in said frame, a master crankshaft journaled in said frame, means for rotating said work holder and master crankshaft in synchronism, a grinding wheel carrier movably mounted on a journal box carried on a crankpin of said master crankshaft, a grinding wheel journaled on said carrier, a fluid pressure cylinder mounted on said carrier having a piston rod connected to said journal box, means for applying fluid pressure to said cylinder to effect relative movement of said carrier and journal box, an electric driving motor mounted on said carrier, means for connecting said driving motor to said grinding wheel to effect rotation of said grinding wheel, a supplemental supporting crankshaft journaled in said frame, means for rotating said supplemental crankshaft in synchronism with said work holder and master crankshaft, a link journaled on a crankpin of said supplemental crankshaft, and means for loosely connecting said link to said carrier to approximately hold said carrier in operative position relative to said work holder.

3. In a grinding machine, a rotatable work holder, means for rotating said work holder, a grinding wheel carrier, a grinding wheel in said carrier, means for rotating said grinding wheel, means for effecting tangential floating movement of said grinding wheel relative to a work surface on a work piece in said work holder, means dependent upon said work piece for limiting said floating movement of said grinding wheel, and supplemental means rendered effective for automatically taking the place of said work piece to limit said tangential floating movement, by the movement of said carrier from a work piece in said work holder.

4. In a machine tool, a frame, a rotatable work holder journaled in said frame, a work piece in said work holder, a tool carrier movably mounted on said frame, and floatingly supported on said work piece, a tool on said tool carrier, means for moving said carrier to and from engagement with said work piece, means automatically rendered effective for supporting said carrier when said carrier is moved from said work piece, and means for automatically rendering said last mentioned means ineffective when said carrier is moved into engagement with said work piece.

5. In a machine tool, a rotatable work holder, means for rotating said work holder, a tool carrier, a tool movably mounted on said tool carrier, means for actuating said carrier to effect tangential floating movement of said tool relative to a work surface on a work piece in said work holder, means dependent upon said work piece for limiting said tangential floating movement of said tool, means for moving said tool on said carrier parallel with said direction of tangential floating movement, and means for bodily moving said carrier and tool relative to said work holder.

6. In a crankpin finishing machine, means for supporting and rotating a multi-throw internal combustion engine crankshaft, a series of tool carriers, one for each crankpin of said crankshaft, means for independently moving each of said carriers relative to its respective crankpin, a tool movably mounted on each of said tool carriers, means for actuating each of said carriers to effect tangential floating movement of its tool relative to the work surface of its respective

crankpin of said crankshaft, means for each tool carrier dependent upon its respective crankpin for limiting said tangential floating movement of each of said tools, and means for moving each of said tools on said carrier parallel with said direction of tangential floating movement to effect a cutting action of said tool on its respective crankpin.

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