Aug. 20, 1946. J. A. CAMERON 2,406,134

TOOL GRINDING MACHINE

Filed July 5, 1943 2 Sheets-Sheet 1

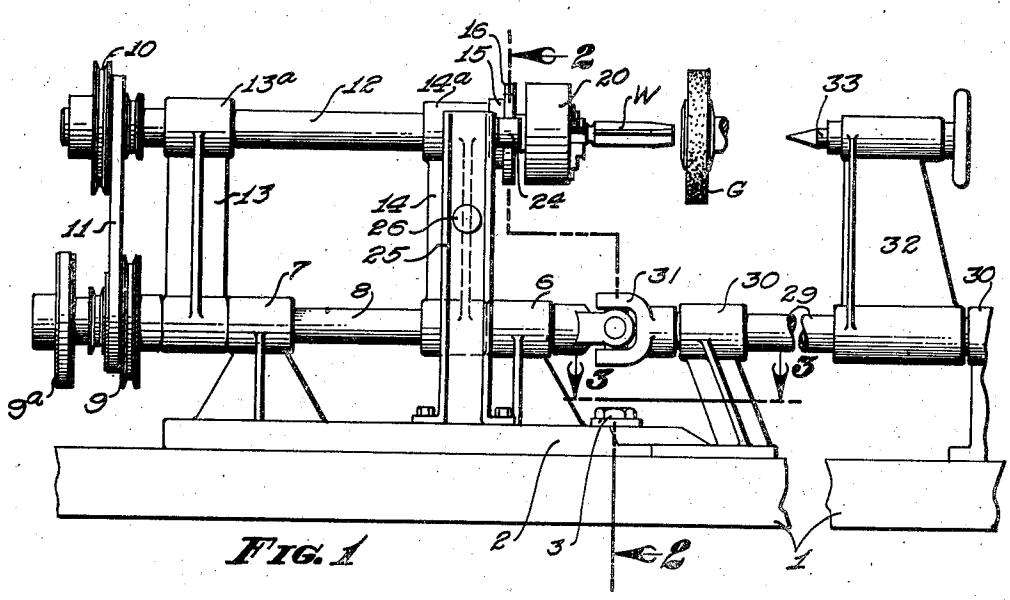


FIG. 1

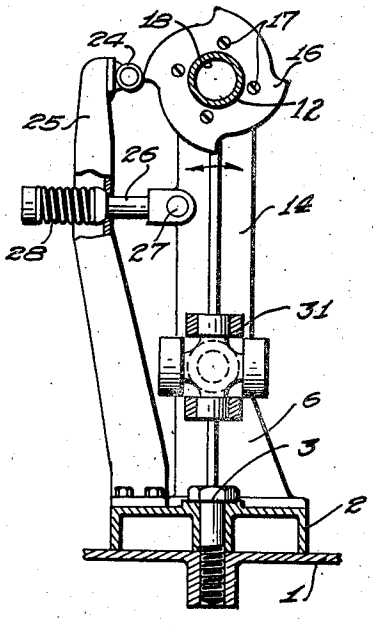


FIG. 2

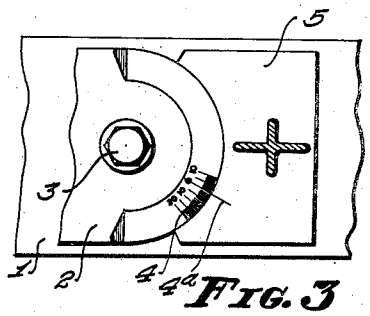


FIG. 3

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TOOL GRINDING MACHINE

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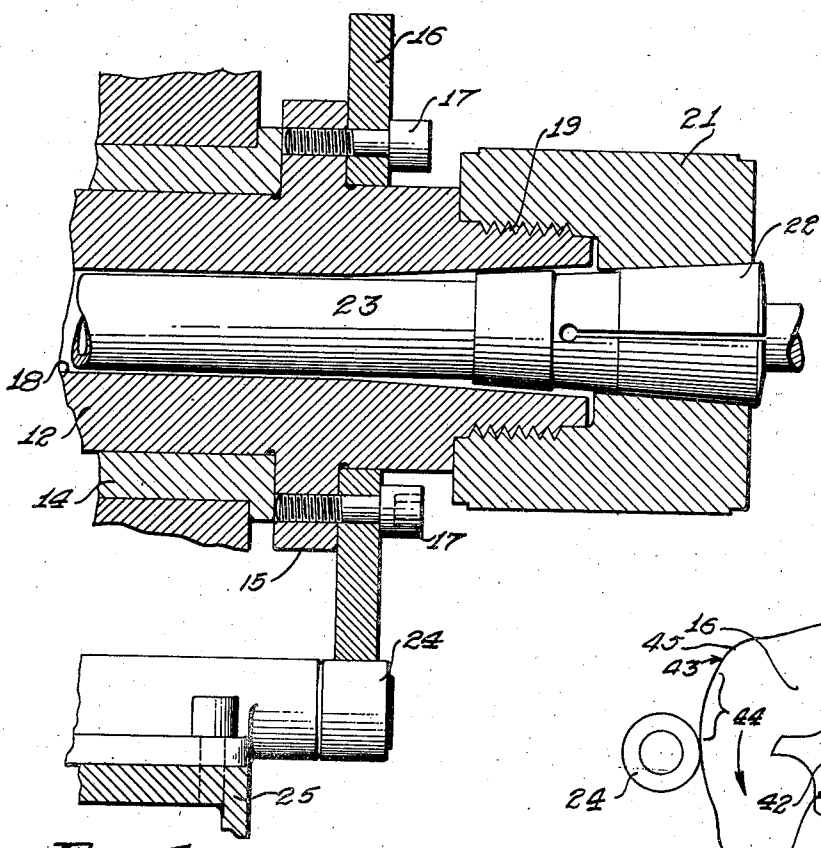


FIG. 4

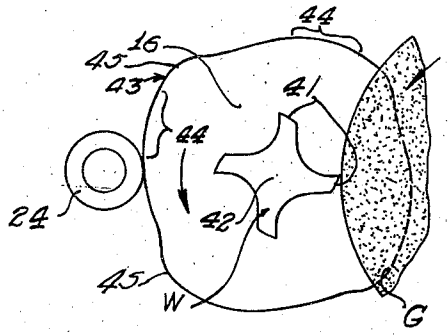


FIG. 5

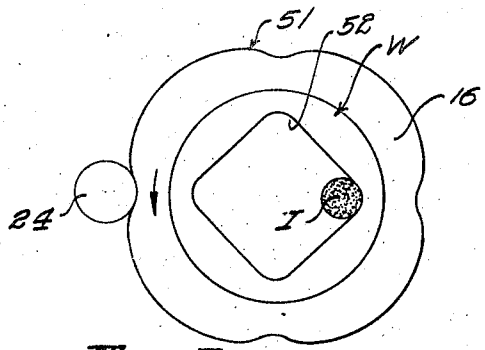


FIG. 7

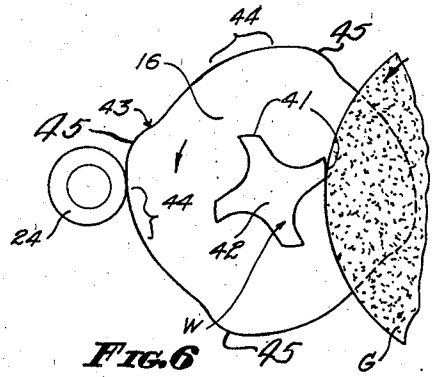


FIG. 6

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UNITED STATES PATENT OFFICE

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TOOL GRINDING MACHINE

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Application July 5, 1943, Serial No. 493,550

1 Claim. (Cl. 51—101)

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This invention has to do with grinding machines, and more particularly with grinding machines for grinding surfaces which depart from a circular cross section.

Grinding machines of various designs for grinding cylindrical surfaces are in common use, while other known grinding machines are designed to grind solids of specific generation such as the surfaces of gear teeth or cam shapes. Such machines, however, are limited to the configuration of the surface which may be ground, or require major and time consuming changes to adapt them to the grinding of a different surface.

It is a general object of the present invention to provide a grinding machine which is capable of grinding not only cylindrical surfaces but to grind a wide variety of eccentric and irregular surfaces with a minimum of unproductive time and effort in changing from one job to another.

It is another object of the invention to provide a grinding machine which is capable of grinding surfaces, the axes of which are either parallel to or at an angle with the axis of the grinding wheel.

A further object of my invention is to provide a grinding means which may be arranged either as an attachment or addition to a conventional grinding machine, or as an independent grinding machine.

A still further object of my invention is to provide a grinding machine which is capable of both internal and external grinding operations.

A still further object of my invention is to provide a grinding machine which is simple of construction, economical of manufacture, durable and efficient in its action.

The grinding machine of the present invention employs a control cam to effect a movement of the rotating workpiece toward and from the grinding wheel during the grinding operation. By this means, contours of various kinds may easily be provided merely by choice or design of proper cams. Preferably, and in accordance with a present illustrative embodiment of the invention, the control cam is secured to a rotatable headstock spindle and the workpiece to be ground is secured in a suitable chuck of conventional design such as a three or four jaw chuck or collet chuck of the type used in engine lathes. The control cam and workpiece are then rotated at a suitable speed and the workpiece is caused to move laterally to and from the grinding wheel during the course of each revolution in accordance with the configuration of the control cam.

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The various features and accomplishments of my invention, as well as other objects and features which are preliminarily mentioned, will be set forth in the following detailed description of a present preferred illustrative embodiment of the invention, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevational view of my grinding machine showing the workpiece being held by a jaw chuck;

Fig. 2 is a transverse sectional view thereof taken through 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view in plan taken along the line 3—3 of Fig. 1;

Fig. 4 is an enlarged sectional view through the workpiece and control cam receiving end of the headstock spindle, showing a collet chuck positioned thereon;

Fig. 5 is a diagrammatical view showing the angular relationship of workpiece cam and grind wheel for grinding the clearance angle required for a tap, end mill, router or the like;

Fig. 6 is a view similar to Fig. 5, but showing a different position of the parts; and

Fig. 7 is another diagrammatic view showing the angular relationship of the control cam, cam follower, workpiece and grind wheel for grinding a square opening in the workpiece.

The grinding machine is mounted on a work bed or bed frame 1 which may be of conventional design and may be supported and arranged by means not shown, but which may be of any conventional type, for movement both longitudinally and transversely or merely longitudinally with respect to a grinding wheel G, and also for pivotal movement on a vertical axis with respect to the grinding wheel. The grinding wheel is supported and driven in a suitable conventional manner, not shown. The grinding wheel may be so mounted as to move lengthwise of the bed frame or transversely thereto or in both directions much in the manner of the cross feed of a lathe. Since supporting arrangements for the indicated relative movements of the work bed 1 and grinding wheel G are well known in the art, and may be of a conventional nature, no illustration thereof is deemed necessary in the present drawings.

A headstock base structure 2 is mounted on the work bed 1. This base structure may be a member of inverted channel cross section and is secured near one end to the midportion of the work bed 1 by a pivot pin 3. The pivot pin may be in the form of a bolt adapted, when loosened, to permit angular adjustment of the base structure

with respect to the bed frame 1 about a vertical axis; and, when tightened, to secure the base structure 2 in its adjusted position. While a bolt is shown for simplicity, it is of course obvious that more elaborate securing and adjusting means may be provided to facilitate accurate angular adjustment of the base structure 2.

The pivoted end of the base structure may be rounded and bear scale markings 4 which co-act with a reference line 4a scribed on a contiguous complementary plate 5. Bracket bearings 6 and 7 extend upwardly from the base structure 2 and support a rockable shaft 8.

Journaled freely rotatable on the end portion of the rockable shaft remote from the pivot pin 3 is a pulley unit 9 comprising a plurality of pulley wheels of different diameters which may also include a suitable drive pulley 9a also freely rotatable on said shaft 8. The pulley unit 9 is connected by a belt 11 to a corresponding pulley unit 10 mounted on a headstock spindle 12. The headstock spindle 12 is supported above and parallel to the rockable shaft 8 by a pair of headstock arms 13 and 14. The headstock arms are fixedly secured at their lower ends to the rockable shaft 8 and their upper ends form coaxial bearings 13a and 14a which receive and support rotatably the headstock spindle 12.

The end of the headstock spindle 12 above the pivoted end of the base frame 2 is provided with a control cam collar 15 which is adapted to carry the control cam 16. The control cam is in the form of disc secured to collar 15 by screws 17, and the periphery of the cam is shaped to cause movement of the workpiece to and from the grinding wheel during the course of revolution, as will be described in more detail hereinafter. The cam may have any outline, depending upon the characteristics desired to be given the workpiece. A cam outline specifically designed to grind certain cutting tools or workpieces with a clearance angle appears in Figs. 6 and 7.

The headstock spindle 12 is provided with a bore 18 therethrough, and its end portion beyond the flange 15 is threaded as indicated at 19 (see Figure 4) to accommodate various conventional work holding devices such as a jaw chuck 20 shown in Fig. 1, or a collet chuck 21 as shown in Fig. 4. In the latter case, the collet chuck receives collets 22 adapted to be tightened by a suitable tension tube 23. Other work holding devices and jigs may of course be employed depending upon the nature of the workpiece W (see Figures 1, 5, 6 and 7).

A cam roller 24 bears on the periphery of the control cam 16 at a point substantially tangential to an arc having its center originating at the rockable shaft 8. The cam roller is mounted at the upper end of a rigid post 25 which extends along the side of the headstock arm 14 and is secured at its lower end to the base frame 2 so that the roller 24 occupies a fixed position with respect to the base structure 2. A horizontal stem 26 is pivotally connected at 27 to the headstock arm 14 and extends outwardly therefrom through an opening in the post. The extended end of the stem is provided with a head and between the head and post 25 is a heavy spring 28 which, acting against the post 25, draws the entire headstock assembly comprising headstock arms 13 and 14 and headstock spindle 12 toward the post and causes the periphery of the cam 16 to bear against the roller 24. As a consequence, the headstock spindle and the workpiece W carried thereby are moved laterally to and from the grinding wheel G.

Sometimes it is desired to mount a relatively long workpiece between the headstock spindle and a tailstock spindle and to move such workpiece bodily to and from the grinding wheel. This is accomplished by means of an extension 29 of the rockable shaft 8 which is supported by bracket bearing 30. Normally the extension 29 is in coaxial relation with the rockable shaft 8; however, to permit pivotal movement of the base frame 2 about the pivot pin 3, a universal joint 31 connects the rockable shaft 8 and its extension 29. If desired, the two shafts may be merely capable of disconnection at this point for the tailstock is not employed in conjunction with the headstock except when the two shafts 8 and 29 are coaxial.

The extension 29 of the rockable shaft 8 has secured thereon a tailstock arm 32 which carries a tailstock spindle 33 or other conventional work supporting tool or fixture.

Operation of my grinding machine is as follows:

1. *Grinding cylindrical objects.*—The headstock and tailstock spindles are disposed in alignment; that is, the base structure 2 is in its "0" or neutral straight line position. A plain circular disc concentric with respect to the workpiece is employed in place of the control cam 16. The workpiece is then rotated while the grinding wheel is moved into engagement with the workpiece and either the grinding wheel or work bed is moved longitudinally within the region of the work to be ground. If the workpiece be long, it is supported between both the headstock and tailstock spindles; otherwise it need be held only by the headstock spindle.

2. *Grinding noncylindrical objects.*—If the surface to be ground is parallel to the axis of rotation, the workpiece is mounted as in the first mode of operation described above, with the exception that a cam 16 having a predetermined variation in radius is substituted. For example, in order to grind the lands 41 of a tap or an end mill 42, indicated diagrammatically in Figs. 5 and 6, a control cam 16 having a periphery of the general shape indicated at 43 may be used. In such operation the object is to give the lands a proper clearance angle. The portions 44 of the cam, subtended by the same central angles as the lands 41, are of gradually increasing radius in the direction of rotation, the difference in radii at the beginning and end points of said portions being of course equal to the depth to which the trailing edges of the lands are to be ground as compared with the forward edges thereof to provide the desired clearance angle. Figs. 5 and 6 show the clearance angle of the lands 41 and the corresponding shaping of the cam 43 with some exaggeration for clarity of illustration. In Fig. 5, the parts are shown just before one of the lands 41 engages the grind wheel, and just before the cam portion 44 engages the roller 24. At a position just beyond that of Fig. 5, the leading portion of the land 41 engages the grind wheel, and the cam portion 44 reaches the roller 24. As the portion 44 of the cam then moves across the roller 24, the entire working assembly including headstock spindle 12, arms 13 and 14, and the workpiece moves gradually towards the grind wheel, thus grinding the land 41 with the clearance angle desired. Fig. 6 shows the parts with the trailing edge portions or heels of the land being ground, and just about to sepa-

rate from the grind wheel. The portions **45** of the cam between portions **44** merely connect the latter and serve to return the workpiece to the proper position for the beginning engagement of the next land with the wheel G.

3. *Grinding a tapered surface.*—A tapered surface is ground in the manner of the first or second mode of operation described above with the exception that the base plate **2** is set horizontally at an angle. This may be at a slant in either one direction or the other so that the workpiece may diverge or converge toward its extremity. Thus, the end of a tap may be ground with a taper towards its extremity; whereas, an end mill or router may be ground so that it diverges towards its extremity. In such a mode of operation, the tailstock is not employed. If the workpiece is relatively long, however, it may be desired to support it by the tailstock. In this type of operation the base plate **2** is placed on a centered position on the work bed **1**, and the latter is pivoted as a whole to the necessary angle relative to the grinding wheel on the previously-mentioned vertical pivot **3** with which the work beds of grinding machines are conventionally provided.

4. *Grinding internal surfaces.*—For such operations, the grinding machine may be set up as for any of the operations 1, 2 or 3 described above. In place of the grinding wheel G, an internal grinding wheel or spindle I, represented diagrammatically in Fig. 7 is employed. The internal grinding wheel or spindle is, of course, small in diameter to fit within the socket or bore to be ground and is supported by any suitable conventional means, not shown. In Fig. 7, for purposes of illustration, a control cam **16** having a special surface **51** is shown shaped to cause the grinding of a square opening **52** in a workpiece W. Other internal shapes may be as readily ground by proper shape of the control cam.

By reason of the fact that the control cam **16** is mounted coaxially with respect to the workpiece and is adjacent thereto and rotates therewith, it is a simple matter to adjust the phase relation or angular position of the workpiece with respect to the control cam.

As indicated in the foregoing description, the work bed proper and grinding wheel G themselves together with their directly associated elements may be conventional, in which case my frame structure **2** and its associated parts are, in effect, an attachment. However, it is of course obvious that the work bed and grinding wheel together with their associated elements may be specially designed so that the whole may constitute a complete machine entity, as distinguished from an accessory or attachment.

While I have now described a preferred specific illustrative embodiment of the invention, it is to be understood that the invention is not limited to the exact illustrative machine as shown and specifically described, but that various changes in design, structure and arrangement may be made without departing from the spirit of the present invention or the scope of the appended claim.

I claim:

A grinding machine, comprising a headstock base structure pivotally mounted near one of its ends about a vertical axis, means for releasably securing said base structure in its angularly adjusted positions about its pivotal axis, a rockable shaft carried by said base structure and projected at one end over said pivoted base structure end, a headstock unit swingably secured to said rockable shaft above said headstock base structure whereby to be swung laterally of the axis of said rockable shaft upon a forced rocking movement of said shaft, a rotatable spindle journaled on said headstock unit with its axis parallel to the axis of said rockable shaft, a control cam carried by and rotated with said spindle, a roller abutment positioned peripherally opposite said control cam and fixed stationarily with respect to the headstock base structure, spring means interposed between said roller abutment and said headstock unit for maintaining the control cam forcibly but yieldably in engagement with said roller abutment whereby said headstock unit is caused to swing in accordance with the peripheral configuration of said control cam, means on said headstock spindle for supporting and rotating a workpiece about the axis of said spindle, a grinding element cooperatively positioned and arranged and adapted for peripheral grinding engagement with the workpiece as supported on the spindle of said headstock unit in whatever angular position the headstock base structure may be adjusted about its pivotal axis, a laterally swingable tailstock unit, said tailstock unit being mounted on a rockable shaft supported and arranged as a continuation of the first-mentioned rockable shaft and normally in axial alignment therewith, and a universal coupling between said first-mentioned and said last-mentioned rockable shafts, said coupling having its center in alignment with the pivotal axis of the headstock base structure.

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