Sept. 2, 1947. J. C. WILSON 2,426,807

APPARATUS FOR SHAPING WORKPIECES BY GRINDING

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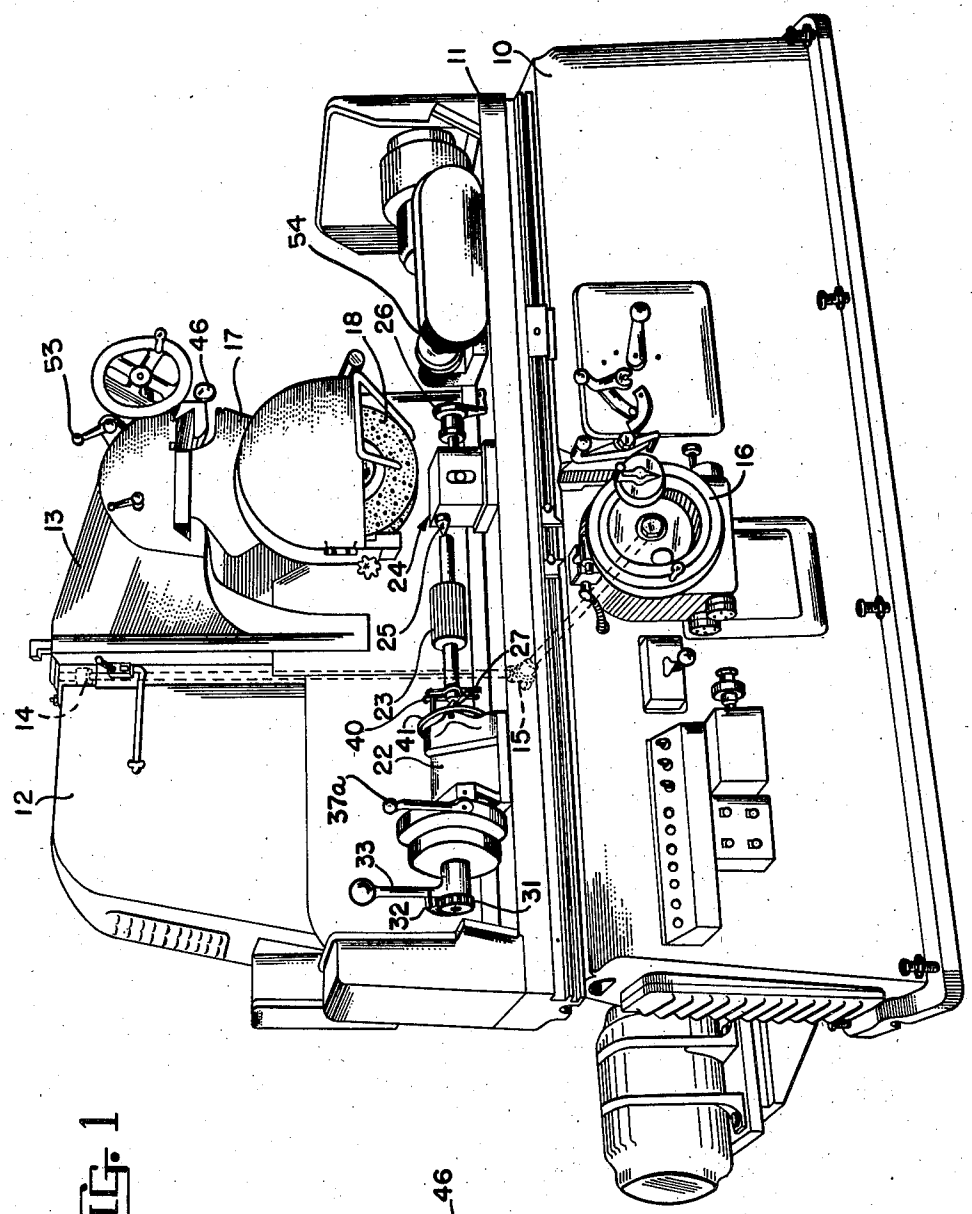


FIG. 1

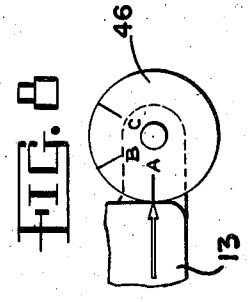


FIG. 2

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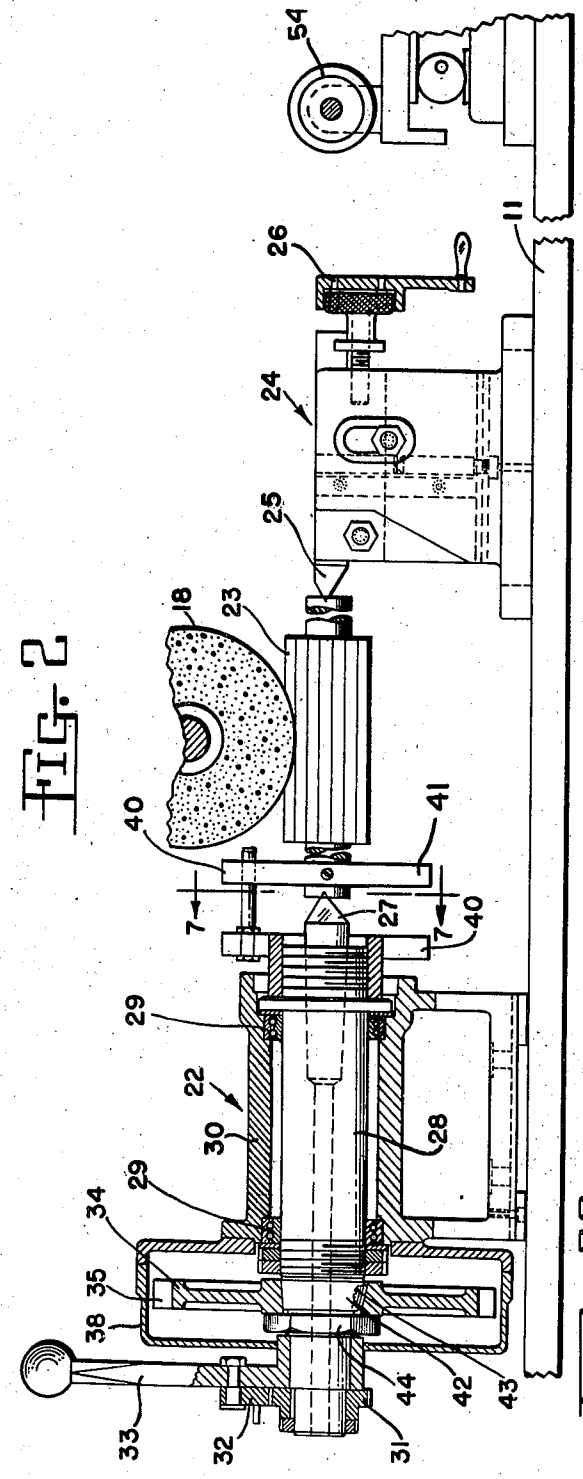


FIG. 2

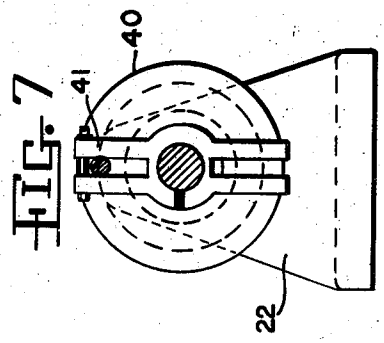


FIG. 7

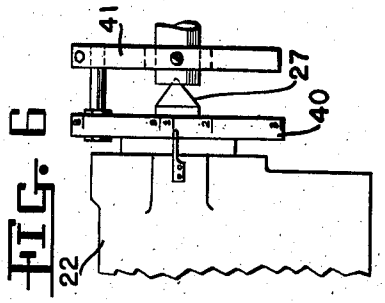


FIG. 6

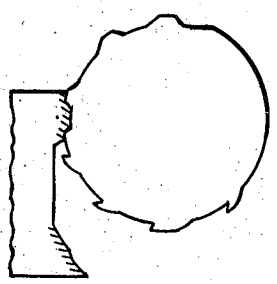


FIG. 20

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APPARATUS FOR SHAPING WORKPIECES BY GRINDING

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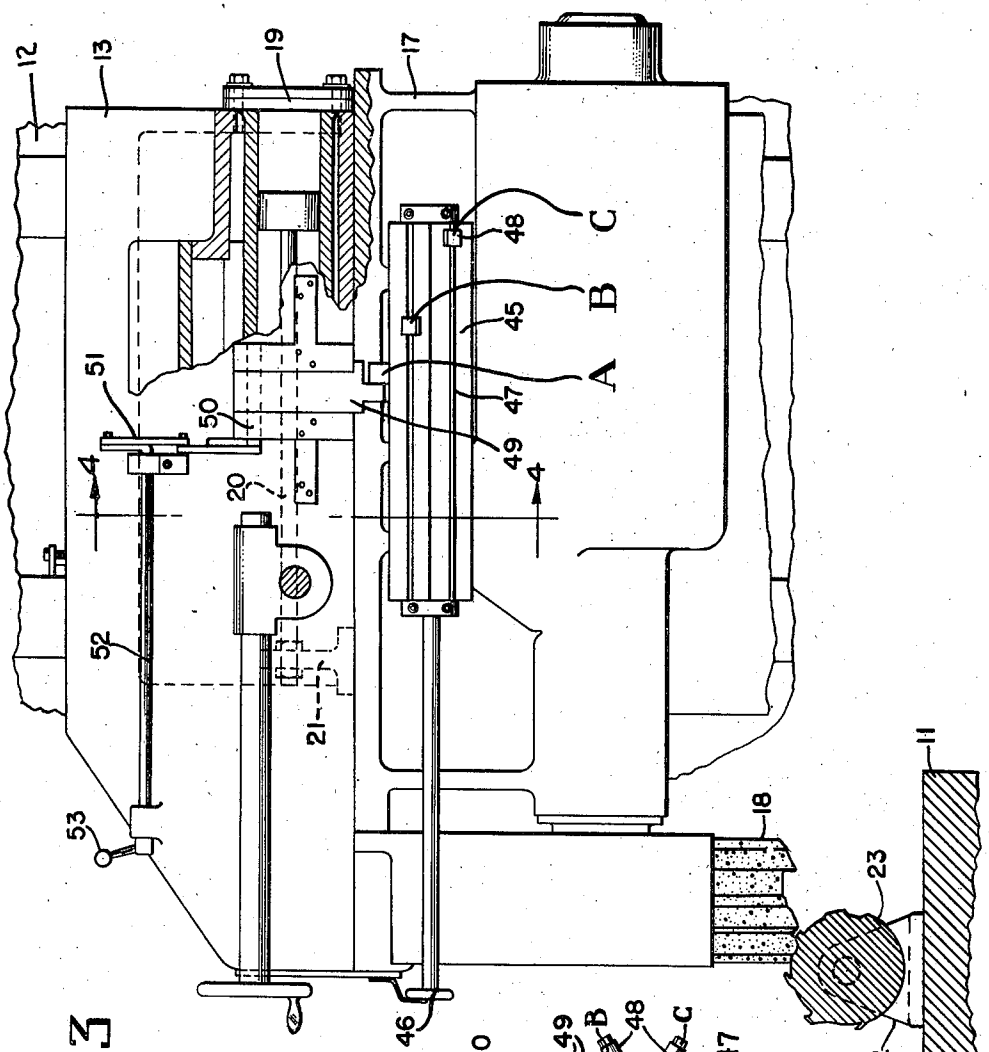


FIG. 3

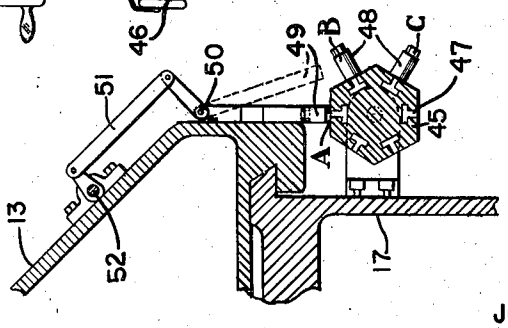


FIG. 4

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APPARATUS FOR SHAPING WORKPIECES BY GRINDING

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FIG. 5

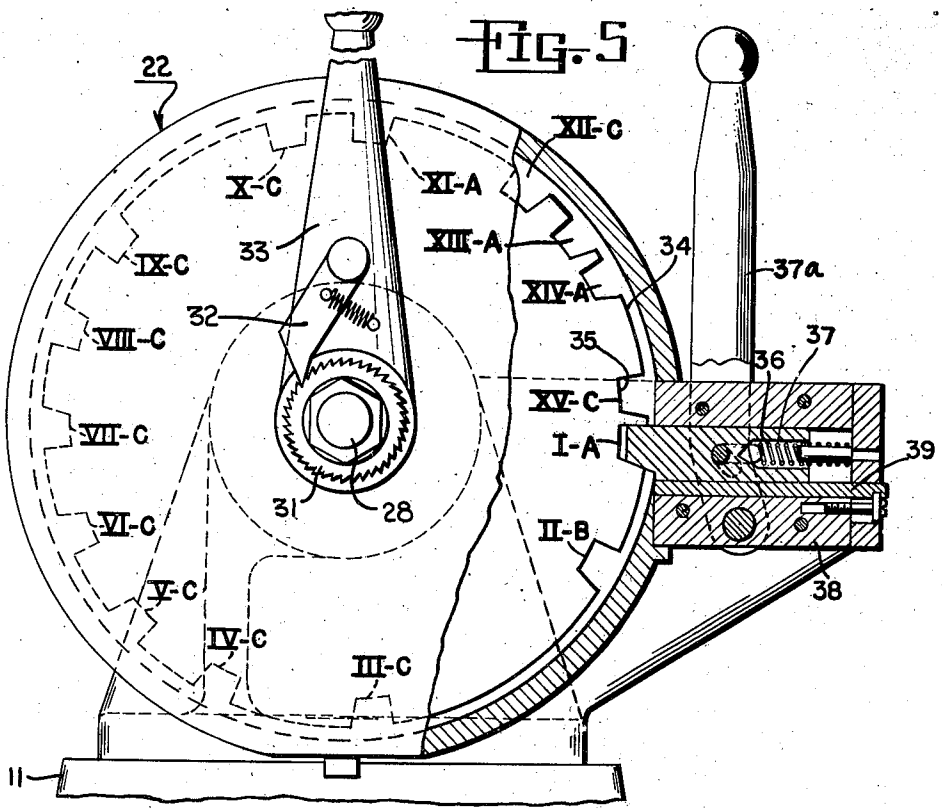


FIG. 9

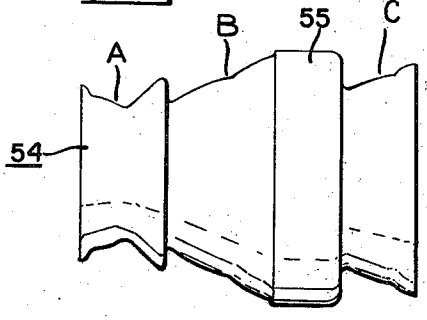


FIG. 10

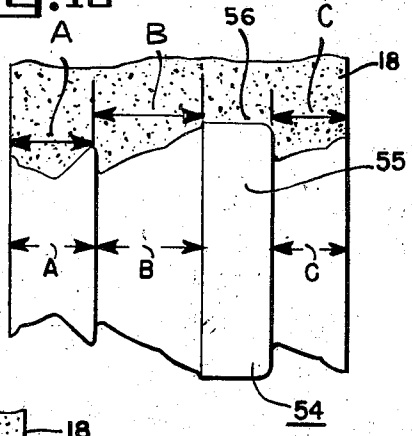
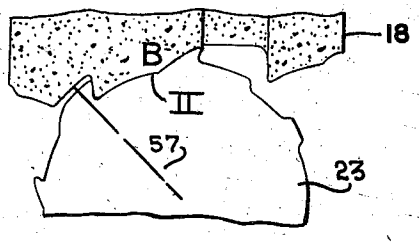


FIG. 12



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APPARATUS FOR SHAPING WORKPIECES BY GRINDING

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FIG. 11

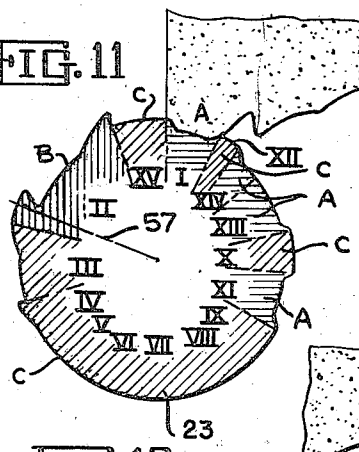


FIG. 13

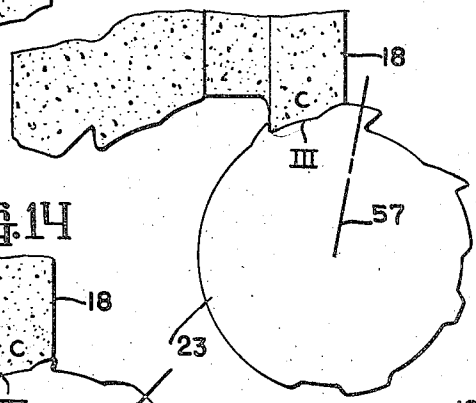


FIG. 14

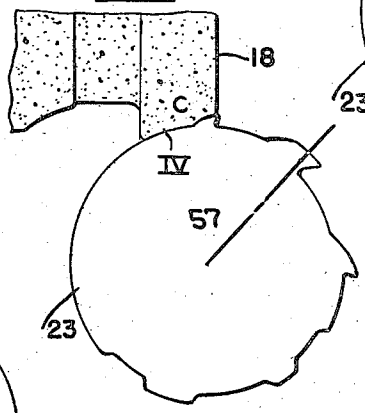


FIG. 15

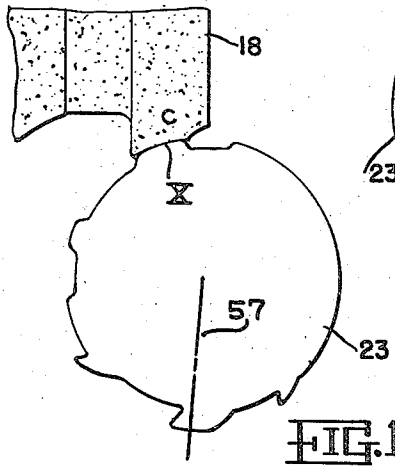


FIG. 16

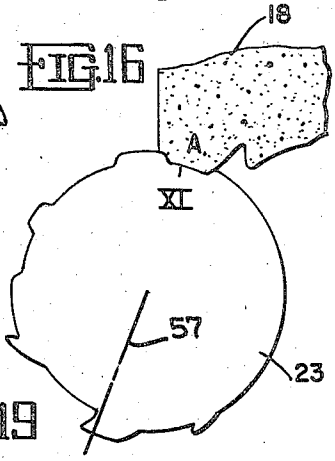


FIG. 17

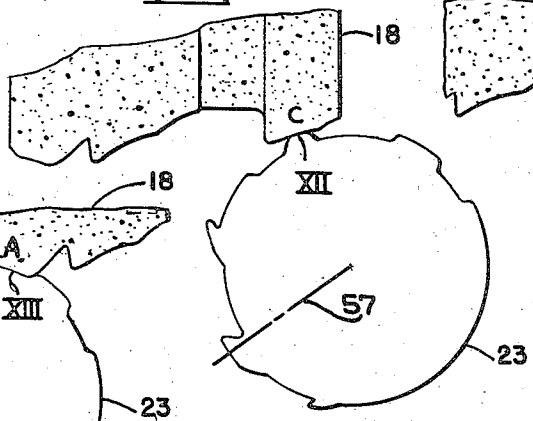


FIG. 18

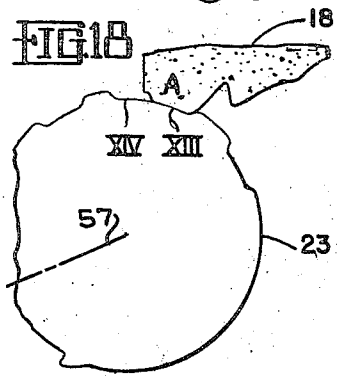
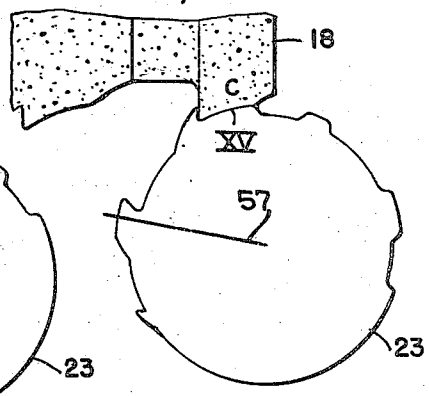


FIG. 19



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Patented Sept. 2, 1947

2,426,807

UNITED STATES PATENT OFFICE

2,426,807

APPARATUS FOR SHAPING WORKPIECES BY GRINDING

John C. Wilson, Springfield, Ohio, assignor to The Thompson Grinder Company, Springfield, Ohio, a corporation of Ohio

Application November 9, 1945, Serial No. 627,603

14 Claims. (Cl. 51—92)

1

This invention relates to grinding methods and apparatus and is particularly concerned with the forming of cams by grinding.

In certain machines, such as business machines, there are required circular cams of relatively long length which have a plurality of differently shaped surfaces therearound, these surfaces running the length of the cam. Such cams must be accurately sized in order properly to control the machine with which they are associated and, for reasons of economy, must be manufactured relatively inexpensively.

Accordingly, it is a primary object of this invention to provide a method and apparatus for grinding cams having a plurality of different configurations.

Another object is to provide a method of forming cylindrical cams having a plurality of configurations by grinding.

Still another object is to provide, in a grinding machine, a grinding wheel and mechanism selectively operable for grinding the various portions of a cylindrical cam to produce a completed workpiece in one cycle of operation.

Still another object of this invention is to provide means for shaping a grinding wheel so that various portions thereof may be utilized for grinding the various portions of a cylindrical cam.

Another object is to provide an apparatus including a grinding wheel and a support for a cam in which the wheel and a cam support are selectively adjustable for bringing various portions of the wheel into working contact with correspondingly shaped portions of the cam for grinding the complete surface of the said cam.

These and other objects and advantages become more apparent upon reference to the following specification taken together with the accompanying drawings in which:

Figure 1 is a perspective view of a grinding machine adapted for grinding cams according to the method of this invention;

Figure 2 is a sectional view, somewhat enlarged, showing the workpiece supporting means more in detail;

Figure 3 is a somewhat enlarged view showing more in detail the grinding wheel supporting mechanism;

Figure 4 is a view taken substantially along the line 4—4 on Figure 3 showing the selective cross slide stop mechanism for the grinding wheel;

Figure 5 is an enlarged view showing the indexing mechanism associated with the workpiece supporting means;

Figures 6, 7 and 8 are fragmentary views showing details in connection with the wheelhead stop and the indexing mechanism;

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Figure 9 is an elevational view of one type crushing member for the grinding wheel;

Figure 10 is a view showing the configuration of the dressing member being transferred to the periphery of the grinding wheel;

Figures 11 through 19 show a representative cam in the several stages of the grinding thereof; and

Figure 20 is a fragmentary view showing another type of cam adapted for being formed according to this invention.

General arrangement

According to this invention, there is provided a grinding wheel and a workpiece support which are relatively reciprocable. The workpiece which is to be ground is a cam, which may be cylindrical, and which comprises a variety of configurations around the periphery of its active surface.

The wheel which is to be employed for grinding the cam surface has its periphery shaped to match the configurations of the cam. Then, in order to grind the cam, it is positioned so that a portion of its surface is engaged by the correspondingly shaped portion of the wheel, and the wheel and workpiece are reciprocated relatively at grinding speeds.

To grind other portions of the cam, it is indexed and moved into engagement with the proper portion of the wheel and another grinding operation is accomplished. In this manner, the entire cam surface is ground within relatively precise limits.

Any suitable dressing means may be employed for shaping the wheel but it is preferred to use a crushing roller which is properly shaped and which transfers its configuration to the periphery of the wheel when brought together therewith, under pressure, and rotated against the wheel at the same surface speed.

Usually, the cam to be ground will be found to have two or more segments having identical configurational characteristics. In such a case, it is necessary to provide only one portion of the wheel for grinding these segments. Thus, a cam may be divided into similar segments or zones and a wheel provided which has one shaped portion for each of the groups of similar segments or zones.

Structural arrangement

Referring to the drawings, 10 indicates the bed

of a grinding machine upon which is reciprocably mounted a table 11. The table 11 is reciprocated on the bed by any suitable means such as a fluid motor.

Mounted adjacent the bed, or affixed thereto, is a column 12 which supports a saddle 13 for reciprocation vertically. The vertical reciprocation of the saddle may be accomplished through the lead screw and nut indicated at 14, the gearing 15 and the handwheel 16.

Transversely reciprocable in the saddle 13 is a wheelhead 17 which carries a motor on the shaft of which is secured a grinding wheel 18. Suitable means for transversely reciprocating the wheelhead 17 in the saddle 13 are provided, such as the fluid motor 19 which comprises a plunger 20 secured by the lug 21 to the said wheelhead. Fluid may be conducted to and from the motor 19 from a fluid source by any standard valve means and may be accomplished manually or automatically as desired.

Mounted on the table 11 is a fixture 22 adapted for supporting one end of a workpiece 23 and for driving the said workpiece through predetermined angles of rotation. The other end of the workpiece is supported in a second fixture 24 which comprises a center 25 that is adjustable by a handwheel 26. The center 25 is vertically movable in order exactly to align it with the center 27 of the fixture 22.

Referring more particularly to the fixture 22 this will be seen, in Figures 2 and 5, to comprise a spindle 28 for supporting the center 27 and which is journalled in the anti-friction bearings 29 at each end of the spindle housing 30.

The left end of the spindle 28 has attached thereto a ratchet wheel 31 which is engaged by the spring pressed pawl 32 pivoted on the arm 33. Between the arm 33 and the spindle housing 30 is an index plate 34 having a plurality of notches 35 about its periphery adapted for being engaged selectively by a plunger 36. A spring 37 continuously urges the plunger against the periphery of the index plate 34 or into one of the notches thereof and a lever 37*a* is provided for withdrawing the plunger when desired. The plunger is slidable within a housing 38 which comprises the tapered gib 39 which is adjustable for taking up for any wear or lost motion around the said plunger.

The right end of the spindle 28 screw threadedly receives a plate 40 which rigidly receives a dog mechanism 41 that is, in turn, rigidly connected with the workpiece 23. Thus, when the latching plunger 36 is withdrawn from one of the notches of the index plates 34, and the lever 33 is actuated to rotate the spindle 28, the workpiece 23 will turn through exactly the same angle as the spindle and index plate. In order to insure a rigid connection between the index plate and the spindle, the said spindle and plate comprise the cooperating conical shaped portions at 42, the key at 43 and the clamping nut 44.

In engaging various portions of the workpiece, the wheel and wheelhead must be moved transversely of the table. In order precisely to position the wheel in its several transverse positions, there is secured to the wheelhead the multi-sided stop bar 45 which is rotatable by a shaft and hand wheel 46 and which carries in the T slots 47, a plurality of stops 48. Pivotally, mounted on the saddle 13 is a plate 49 which, when in its Figure 4 position, lies in the path of the stop carried in the uppermost face of the rod 45. Each stop, in cooperation with the plate 49, thus provides for a predetermined position of the wheel across the width of the machine table.

In order to move the plate 49 out of alignment with the stops 48, the said plate may be pivoted on a shaft 50 which is connected by a linkage 51 with a shaft 52 that is rotatable by the lever 53. In this manner, the wheelhead may be reciprocated freely for regular grinding work or may be arranged to stop at predetermined positions.

Referring to Figure 11 one type of cam which it is contemplated forming by this invention is shown. The cam of Figure 11 may be divided into a plurality of sectors as indicated by the dot dash lines. Upon inspection, it will be observed that the several segments may be divided into three groups, the segments in each group having identical configurational characteristics. For example, there is one segment, shaded with horizontal lines and indicated at A having a first configuration consisting of end portions and an intermediate arcuate portion. A second group, indicated by the vertical shade lines and the letter B have other characteristics and also comprises end portions and an arcuate intermediate portion of a different radius than the intermediate portion of the group A. Still a third group is indicated by the letter C and the diagonal shade lines and is characterized by different shaped end portions and an arcuate intermediate portion which may be formed at still another radius.

Referring to Figure 9, it will be noted that the dressing member 54 comprises the portions marked A, B, and C which correspond in configuration with the portions A, B, and C respectively, of the cam 23. The roll 54 is formed with the portions A, B and C thereof disposed in as nearly a horizontal plane as is possible in order that the wheel may be properly dressed by the said roll and also in order that the surface speed of the wheel when grinding may be as uniform as possible.

In Figure 10, the grinding wheel 18 is illustrated having its periphery crush formed by engagement with the roll 54. It will be seen that the wheel is shaped to have the configurations A, B, and C which are complementary, respectively, to the configurations A, B, and C of the roller 54. In order to provide for adequate clearance as various portions of the workpiece are ground, the roller 54 and, therefore, the grinding wheel 18 comprise the idle portions 55 and 56, respectively.

Figures 11 through 19 show the workpiece 23 in its various grinding stages. In order to facilitate the reading of these diagrams, there is indicated a radius vector 57 which occupies the same position on the workpiece in every view.

Referring to Figures 5 and 11, the notches in the index plate 34 have been identified with Roman numerals from I through XV. Each of these numerals has associated with it a letter indicating the type zone of the cam which is to be ground when the latching plunger is engaged with that notch. In Figure 11 the cam is divided into zones which are marked A, B or C according to their type and which are further identified by a Roman numeral which corresponds with the numeral on the index plate notch which is active when that portion of the cam is ground.

The wheel and cam occupy the same relative position during the grinding of all of the A zones, a second position when grinding the B zones, and a third position when the C zones are being ground. To this end, the handwheel 46 has the index marks A, B, and C which are moved into register with a stationary index mark when a cam

zone identified by the corresponded letter is to be ground.

In Figure 11 the A zone marked I is being ground and the index plate has the notch I—A engaged by the latch plunger 36 while the handwheel 46 is set with its index mark A in alignment with the stationary index mark. These positions are illustrated, respectively, in Figures 11, 5, and 8.

After the zone A—I of the cam has been ground, the latch plunger 36 is withdrawn from the notch I—A and the plate 34 is rotated until the plunger falls into the notch II—B. Inasmuch as a B zone is to be ground, the handwheel 46 is turned until its B mark registers with the stationary index mark. The wheelhead is then moved over until the B stop (Figure 3) abuts the stop plate 49. Then, the zone marked II—B on the cam may be ground by the portion B of the wheel. The grinding of this new zone may or may not require an adjustment in the elevation of the wheel. If such an adjustment is required, it may be made by suitable means bearing indicia identified in the same manner as the zones to be ground. The grinding of the cam proceeds as illustrated in Figures 11 through 19 until a completely ground workpiece results. Thereafter, the cam may be removed and a new workpiece placed in the machine.

Figure 20 illustrates another type cam adapted for being ground by the method of this invention and which has only two configurations. Accordingly, the wheel has a first configuration at the left side, and a second configuration at the right side, and an idle space therebetween.

It will be evident that this invention is not limited in practice to the forming of cylindrical cams, but may be employed equally well in connection with cam members which are only a portion of a cylinder, or which have variously shaped cam surfaces thereon which do not lie in a common plane.

In any event, the method of this invention which comprises subdividing the member to be ground into groups of zones, the zones in each group having identical configurational characteristics, and providing a wheel having portions adapted for grinding each group is employed.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel.

2. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for

adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table; means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel.

3. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table; means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said means for adjusting said wheelhead to said series of predetermined positions including a plurality of stops and means for continuously urging said wheelhead against one of said stops.

4. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table; means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said means for continuously adjusting said wheelhead transversely including a plurality of stops, a turret, and means for mounting said stops on said turret.

5. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predeter-

mined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, said indexing means including a wheel and means engaging said wheel for holding the same in predetermined positions.

6. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table; means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said indexing means including a wheel and means engaging said wheel for holding the same in predetermined positions.

7. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, said indexing means including a notched wheel, said notched wheel being rigid with said workpiece supporting means, and a tapered latch pin mounted on said table and engageable with the notches in said notched wheel.

8. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table; means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said indexing means including a notched wheel, said notched wheel being rigid with said workpiece supporting means, and a tapered latch pin mounted on said table and engageable with the notches in said notched wheel.

9. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, said workpiece supporting means including means for rigidly mounting said workpiece relative to said indexing means.

10. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table, means for indexing the workpiece through predetermined and precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said workpiece supporting means including means for rigidly mounting said workpiece relative to said indexing means.

11. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the perpihery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, said workpiece supporting means including means for rigidly mounting said workpiece relative to said indexing means, said means for rigidly mounting the workpiece relative to the indexing means including a face plate and a dog for engaging said face plate.

12. In a grinding machine for grinding workpieces; a grinding wheel; a shaft for said wheel, said wheel having a plurality of differently shaped grinding portions arranged axially of said shaft; a wheelhead supporting said wheel; means for adjusting said wheel and wheelhead transversely to a series of predetermined positions to present one only of said differently shaped grinding portions to the work at each transversely adjusted position of said wheel; a table reciprocable relative to said wheelhead; a workpiece supporting means mounted on said table, means for indexing the workpiece through predetermined and

precise angles corresponding to said differently shaped grinding portions of said wheel whereby to enable the operator of said machine to effect wheel and work movements in a predetermined sequential relationship so a separate portion of the workpiece can be ground with a differently shaped grinding portion of said wheel, said workpiece supporting means including means for rigidly mounting said workpiece relative to said indexing means, said means for rigidly mounting the workpiece relative to the indexing means including a face plate and a dog for engaging said face plate.

13. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, said indexing means and said wheelhead each being provided with indicia whereby an operator can be apprised at any time concerning the proper correlation of said indexing means and wheelhead stop.

14. In a grinding machine; a grinding wheel rotatable on an axis, said wheel having a plurality of differently shaped grinding portions arranged axially on the periphery thereof; a table reciprocable relative to said wheel; a workpiece supporting means mounted on said table; means for indexing a workpiece supported by said supporting means through predetermined angles for presenting different parts of said workpiece to said wheel; and means for indexing said wheel and workpiece relatively in the direction of said wheel axis whereby the operator of said machine can effect wheel and work movements in a predetermined sequential relationship so that separate portions of the workpiece can be ground with separate parts of the wheel, the grinding portions of said wheel being arranged substantially in a plane whereby to grind a generally cylindrical workpiece.

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