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W. W. GLEESON

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CENTERLESS GRINDING PROCESS

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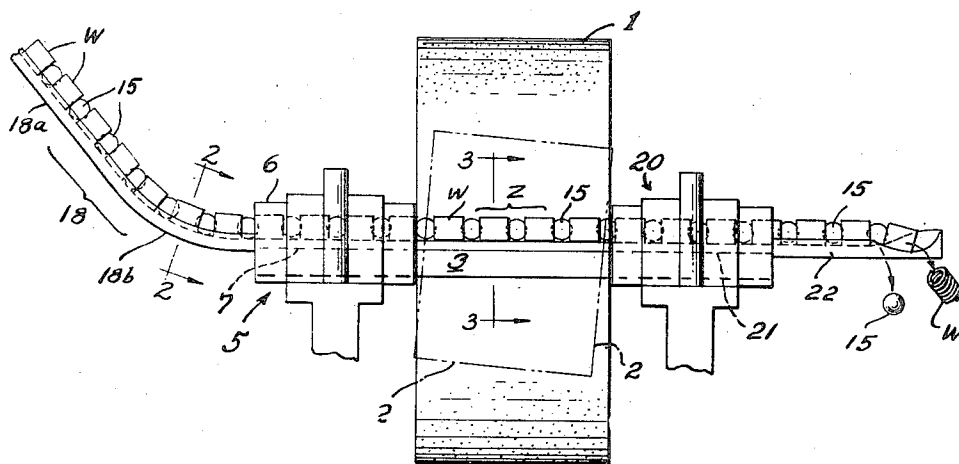


FIG. 1

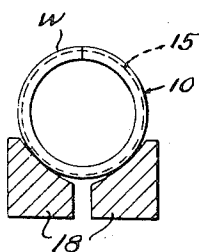


FIG. 2

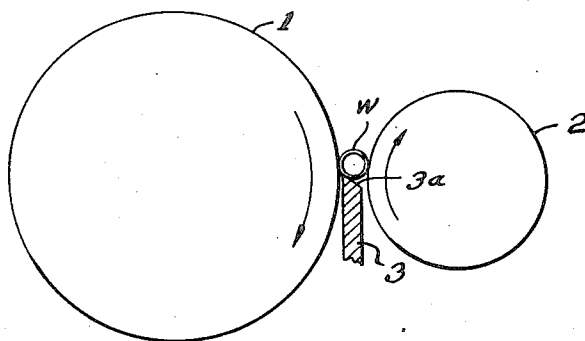


FIG. 3

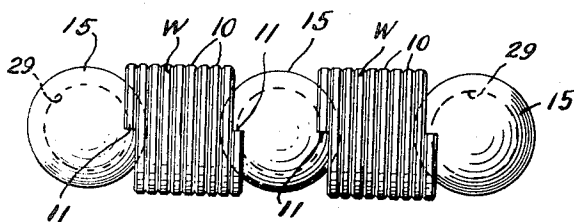


FIG. 4

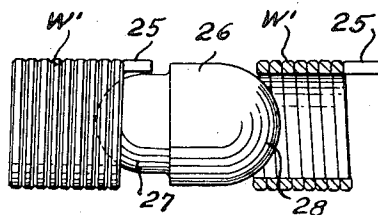


FIG. 5

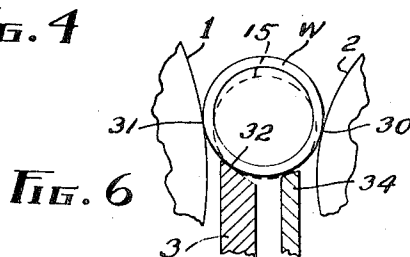


FIG. 6

INVENTOR

WILLIAM W. GLEESON

By George M. Louie
ATTORNEY

UNITED STATES PATENT OFFICE

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CENTERLESS GRINDING PROCESS

William W. Gleeson, Indianapolis, Ind., assignor
to L. G. S. Spring Clutch Corporation, Indian-
apolis, Ind., a corporation of Indiana

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In centerless grinding, when the work pieces are coaxially arranged and presented to working position in readily separable relationship serially along a guide generally parallel to the grinding wheel axis, the method is called "through-feeding" as against "spot feeding" and other types of work placement which are slower, hence less expeditious and economical. The term "through feeding" as used herein is intended to exclude mounting of the work pieces as on rods or apertured bars in fixed positions in order to introduce them to working position.

The present invention relates primarily to a method or process of through-feeding of work pieces (e. g.) during centerless grinding operations, the principal object being so to through-feed certain shapes of work pieces that they will not snag or catch each other and become misaligned or jammed while being formed or finished or while being introduced into or ejected from forming or finishing positions.

Another object is to provide a new and efficient method of exteriorly finishing, e. g. grinding, work pieces of generally cylindrical form having end portions which because of likelihood of interference with each other during the finishing process preclude feeding of the pieces in end-to-end abutment relationship.

A further object is to provide, in connection with centerless grinding and similar processing of generally cylindrical work pieces, through-feeding of the pieces, wherein the pieces are maintained spaced apart and guided for free universal relative angular movement without restraint against free floating lateral movement and free rotation, particularly when in the processing position or positions.

Another object is to provide for presenting generally cylindrical tubular or terminally socketed work pieces endwise and serially into association with forming or finishing tools and in such manner that the work pieces are maintained in approximately aligned spaced relationship without substantial restraint against individual lateral and other necessary movement and free separating relative movement.

A specific object is to provide, in metal processing such as centerless grinding, a method and means for spacing apart generally cylindrical work pieces, particularly coiled clutch springs of various types and sizes for coaxial presentation endwise and serially into processing position, which spacing means tends to hold the pieces aligned while requiring no mechanical or manual operation in order to separate the spacing means

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from the work pieces after the work on the latter has been accomplished, and which spacing means will not, ordinarily at least, come into contact with the processing tools.

Other objects of the invention will be made apparent in the following description of the procedure by which the method is preferably practiced.

In the drawing,

Fig. 1 is a diagrammatic illustration of a typical arrangement of tools and work guides adapted for centerless grinding, said view also illustrating diagrammatically the present improvement.

Figs. 2 and 3 are transverse sectional views taken as indicated on Fig. 1.

Fig. 4 is a relatively enlarged view showing a plurality of work blanks and spherical separators.

Fig. 5 is a similar view showing a modified work piece and appropriately modified separator, and

Fig. 6 is a fragmentary relatively enlarged sectional view on the order of Fig. 3, showing a modified guide for the separators at the working position.

Referring to Figs. 1 and 3, a typical grinding wheel 1 and feed wheel 2, diagrammatically shown in Fig. 1, are illustrated in relation to a conventional rigid work rest blade 3 (see Fig. 3) in the usual arrangement of those parts for centerless grinding when through-feeding is employed. The feed wheel is inclined slightly to cause progressive movement of the work pieces or blanks W (as to the right) at the principal grinding zone Z, Fig. 1, and the top face 3a of the rest blade slopes away from the grinding wheel as usual.

The blanks or work pieces W to be formed or finished by the centerless grinding tools mentioned are supported prior to introduction to the wheels 1 and 2 in a conventional work guide assembly 5 which includes adjustable vertical, parallel side plates 6, one shown, and a bottom support 7 which may be simply an extension of the work blade or rest 3.

The work blanks W may comprise, for example, generally cylindrical coil springs such as shown in Figs. 2 and 4. These have closely wound spiral turns of suitable wire or rod stock, but the coils or part of them may be openly wound. When such blanks are to be used as spring clutch elements, as for gripping an internal cylindrical drum, the exterior surfaces 10 must be finished within narrow dimensional limits as truly cylindrical as possible. The ends 11 of the wire or rod stock as shown in Fig. 4 present abrupt

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shoulders which, were the springs to be fed to the centerless grinder tools end-to-end, would frequently catch upon each other due, for example, to the fact that as each spring reaches the grinding position Z it starts to turn rapidly whereas the relatively trailing spring, not yet in forceful working contact with the wheels 1 and 2, is either not turning or is turning at relatively slow speed. Experience proved that when the abrupt shoulders or ends such as 11 of two endwise adjacent springs were brought into relative abutment, due to their relative speed of rotation, it resulted in bending outwardly of one end of one of the springs, thus destroying that spring and gouging a deep channel in the grinding face of the wheel. That necessitated the stopping of the grinding operation, removal of all work from the grinder, and a careful truing up of the grinder wheel. The bend in the spring end was such that the truing operation required removal of an eighth of an inch from the face of the wheel. Finally the entire machine had to be very carefully checked and adjusted before resumption of operation would produce accurately ground springs.

Gouging of the grinding wheel, in the case of left hand wound springs such as shown by Fig. 4 (assuming there are no separators 15) occurs as the leading one of two endwise adjacent springs in process of being ground is being advanced beyond the grinding zone Z (Fig. 1), whereby its speed of rotation (counter-clockwise as viewed in Fig. 3) becomes gradually reduced relative to the rotational speed of the trailing spring which is still in maximum pressure contact with the grinding wheel and feed wheel. In that case, assuming the adjacent spring ends 11 are at the time a short distance apart circumferentially of the springs, and with the end coils in face-to-face contact or nearly so, the trailing spring will overrun the leading spring. Then, if abutment of the spring ends 11 occurs while the decelerating leading spring is still somewhat in friction-driven contact with the wheels 1 and 2, there will usually be enough relative-rotation-restraining effect on the leading spring, coupled with the inertia of that spring, to enable the leading end 11 of the trailing spring to act as an energizer or teaser in initiating an uncoiling effort (analogous to energization of such spring in a clutch pocket) on part of the leading spring. Once such uncoiling is initiated the expanded spring immediately wedges itself in the nip or bight of the wheels 1 and 2; and if at that instant the trailing end of the leading spring comes into contact with the rapidly moving grinding wheel face it will be bent outwardly by snubbing contact therewith and will gouge the grinding wheel.

Approximately the same destructive spring-uncoiling action occurs under analogous conditions in the case of a right hand wound spring but at the opposite (receiving end) of the grinding zone Z. The difference in location arises from the fact that, in case of a right hand wound spring, the trailing end 11 of a relatively leading spring in the grinding zone overruns or catches up with the leading end 11 of the trailing spring which latter is not yet in sufficient pressure contact with the wheels 1 and 2 to cause it to rotate as rapidly as the leading spring. Thus such leading spring is energized in the direction tending to uncoil or expand its diameter into locking or wedging relationship to the bight or nip of the wheels and the trailing end of the leading spring gouges the grinding wheel.

Heretofore, so far as I know, there was no

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method by which such springs as shown in Fig. 4 or 5 could be successfully introduced by through or end-to-end feeding in centerless grinding. Accordingly, "spot" feeding was used wherein the springs were mounted, well spaced apart, loosely on a rod and the rod was carefully placed into working position to bring the work into proper relationship to the two wheels and the work rest blade. Usually the wheels are separated for placement of work so held and are brought together into processing relation to the springs after such placement of the work. Obviously that requires a great deal more time and care than through-feeding wherein the work progresses continuously and the wheels remain in working relationship continuously.

To prevent end-to-end contact of the work pieces while enabling through-feeding thereof in row arrangement to the grinding tools, I provide separators 15 between each pair of adjacent pieces, which separators, in their simplest form, are spherical balls of metal or other reasonably hard and/or wear-resisting material. Steel bearing balls of approximately uniform diameter are highly suitable. The separators present opposite convex surfaces non-wedgingly entering the ends of the springs in approximately centered relation thereto. Thus the springs are connected in pairs as though by universal joints, yet the balls and springs readily disassociate themselves from each other without requiring any special or time-taking separating operation after the springs have been ground.

In an operating installation, according to Fig. 1, each of the balls 15 has a diametrical cross section somewhat smaller than the external diameters but larger than the internal diameters of the springs both before and after grinding so that as the row of springs and balls is advanced along the work rest 3, the balls are maintained out of contact with the wheels 1 and 2 by the approximately centering but non-wedging contact with the springs. The feed wheel 2 is usually of friction material such as hard rubber which may or may not include a small amount of embedded abrasives. Contact of the feed wheel with the separators therefore does no harm to the separators or feed wheel, and accordingly, if the work pieces tend to separate and allow the balls to drop down from their normal positions between the work pieces, they will, because of the slope of the work rest surface 3a, Fig. 3, gravitate toward the feed wheel rather than toward the grinding wheel.

In order progressively to advance the row of alternately arranged work pieces and separators toward processing position, a trough-like chute 18, for example, (Figs. 1 and 2) is provided, having an inclined portion 18a and curved portion 18b. The curved portion terminates in operative alignment with the guide 7 and side plates 6. The inclined portion 18a of the chute is of sufficient height so that the separators may be readily assembled with the work pieces therein by hand much faster than the work is caused to progress through the grinder by the relative inclination of wheels 1 and 2. Thus the necessary through-feeding force to the processing zone is supplied by gravity. The universal connection between the work pieces afforded by the spherical separators assists in causing the pieces to move smoothly along the curve at 18b. In the processing zone Z (assuming the feeding force is sufficient to maintain a supply of work pieces and separators thereto) the separators allow free individual

lateral floating movement as well as free relative turning movement of the work pieces so that the location of the work is determined solely by the processing tools (e. g. grinding wheel, feed wheel and work rest bar).

The row of finished work pieces W and their separators (e. g. 15), after completion of the centerless grinding operation, moves further to the right into a finished work guide assembly 20, having an arrangement of side plates and bottom guide 21 similar to the receiving guide assembly described above. The bottom guide 21 is shown as extended beyond the assembly 20 to provide a work ejection trough or guide 22 which is arranged to separate the work pieces W and separators 15 into two groups. A finished clutch spring is shown in perspective at the far right Fig. 1 as being ejected from one side of the ejector guide 22 and a separator ball 15 as being discharged from the opposite side of the guide. Any other suitable means for segregating the springs and separators may be used.

In many clutch springs, one or the other of the end coils is or are diverted out of helical form to provide (e. g.) anchoring toes or lugs—an example of such being illustrated at 25 in Fig. 5. The toes may extend radially of the springs or generally parallel to the spring axes and they may be bent or curled into eye formations and many others. Ordinarily if the lugs, toes, etc. are relatively short, the spherical separators serve adequately to space the springs apart and prevent engagement between the toes and end coil shoulders 11 or additional toes of adjacent springs. When the toes are of considerable length as in the case of the toes 25, Fig. 5, the separators may be at least partly of other than spherical shape. As a suggestion, the elongated or generally cylindrical shape of separator shown at 26, Fig. 5, has one reduced partially spherical end as at 27 small enough to clear the toes and allow free relative rotation and lateral floating movement of the work at the grinding zone. One end only of each spring W has the toe 25, hence the end of the separator opposite the reduced portion 27 is made suitably convex as at 28 so as to be similar in operative effects to the balls 15.

When the springs are relatively large, solid metal (e. g. steel) balls are apt to be heavy enough to spread the springs apart notwithstanding such feeding force as provided by the inclined trackway 18; and in that event, hollow separators or separators made from light weight material such, for example, as aluminum or hard plastic may be used. In Fig. 4, hollow spaces 29 in the balls 15 are indicated by way of example.

In centerless grinding, the work pieces as shown, for example, in Fig. 6 are located solely by three point contact as at 30, 31 and 32, with the feed wheel, grinding wheel and work blade respectively. If it is desired more definitely to prevent contact of the separators with the feed wheel, means such as a supplemental rest 34 may be provided, at the grinding zone and therebeyond in either direction, terminating upwardly in such position as to contact only with the separators but not with the work. The top face of the supplemental rest slopes toward the grinding wheel so that the separators 15 or 26 gravitate on both the work rest and supplemental rest away from respective wheels.

I claim:

1. The method of grinding generally cylindrical

workpieces having hollow end portions in a centerless grinding machine having a grinding tool and a smooth, upwardly facing work guiding surface adjacent the tool, which comprises: placing separators of generally circular section and of a smaller diameter than the diameter of the workpieces in abutting relationship with the hollow ends of adjacent workpieces so that the separators are approximately centered with respect to the axes of the workpieces, advancing the workpieces and separators along the work guiding surface past the grinding tool while rotating the workpieces on their axes in contact with the tool to grind the peripheries of the workpieces.

2. In centerless grinding, the method of through-feeding and externally grinding generally cylindrical workpieces having hollow end portions and associated axially projecting surfaces which would be apt to catch or snag each other if the pieces were permitted to be in mutual contact as in through-feeding of pieces end-to-end; said method comprising placing separators loosely between adjacent workpieces, approximately centering the separators with the axes of the workpieces through non-rotation-restraining contact of the separators with said hollow ends while advancing the workpieces and separators along an upwardly facing guide disposed adjacent the grinding tool and rotating the workpieces on their axes in contact with the tool.

3. The method of externally grinding generally cylindrical helical springs in a centerless grinding machine having a rotary grinding tool and an upwardly facing, work-guiding surface adjacent the tool, which method comprises placing separators between adjacent spring ends, which separators have generally circular surface portions designed to enter the separated spring ends without wedging therein or restraining free relative rotary movement of the springs and so as to be piloted or generally centered by and with the springs, advancing the springs and separators along the work guiding surface past the grinding tool while rotating the springs on their axes in contact with the tool to grind the peripheries of the springs.

4. The method of grinding the external peripheries of generally cylindrical helical springs in a centerless grinding machine having a rotary grinding tool and an upwardly facing work guiding surface adjacent the tool, said method comprising alternating the springs with generally spherical separators capable of being maintained approximately centered along the axes of the springs by non-wedgingly entering the hollow ends of the springs, advancing the springs and separators along the guiding surface past the tool while rotating the springs on their axes in peripheral contact with the tool.

WILLIAM W. GLEESON.

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