

July 21, 1942.

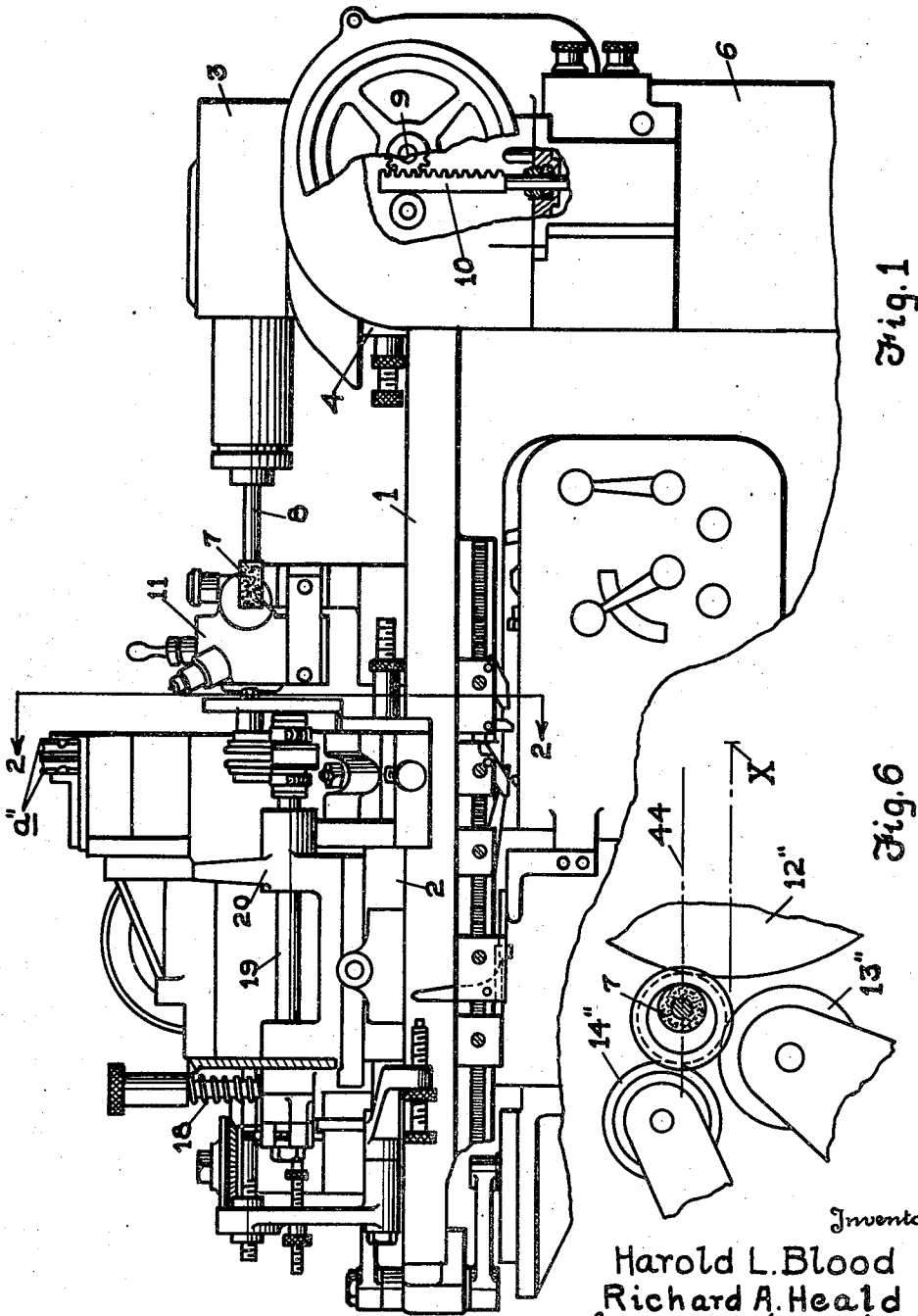
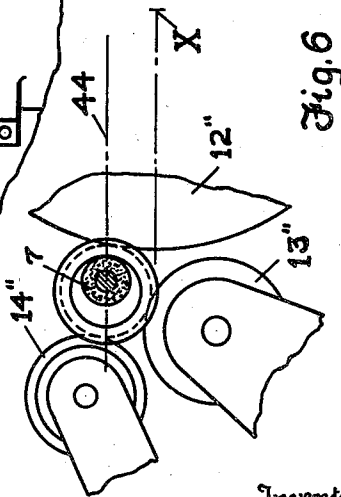
H. L. BLOOD ET AL

2,290,269

INTERNAL GRINDING MACHINE

Filed April 5, 1939

2 Sheets-Sheet 1



Inventor

Harold L. Blood
Richard A. Heald

Richard A. Heald

Geo. D. Kennedy Jr.

Attorney

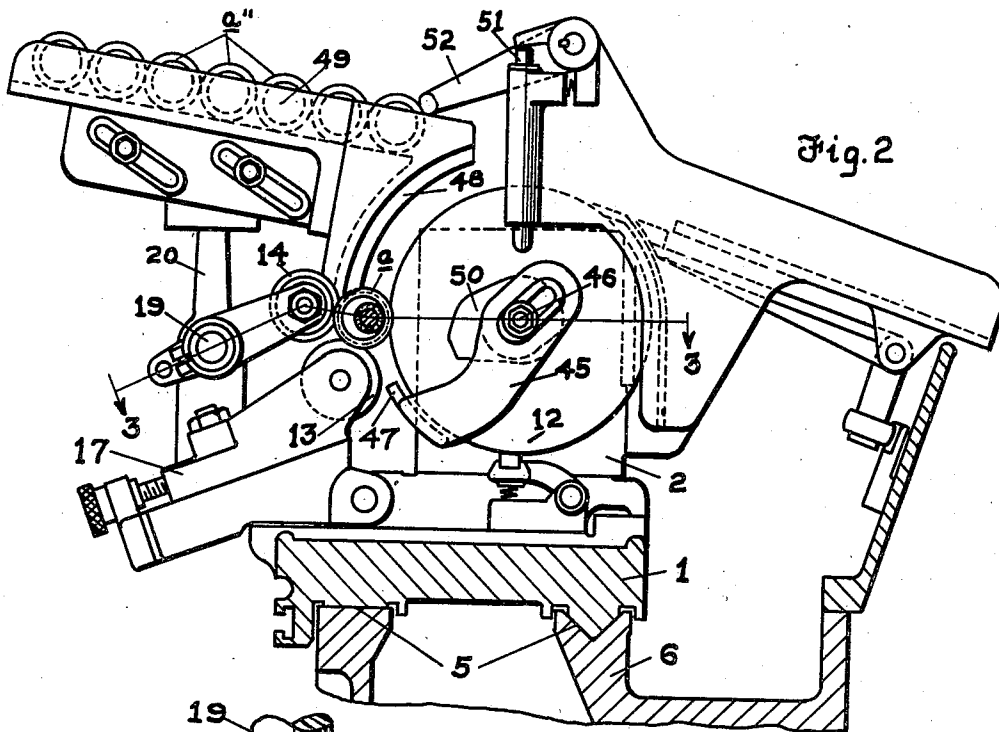
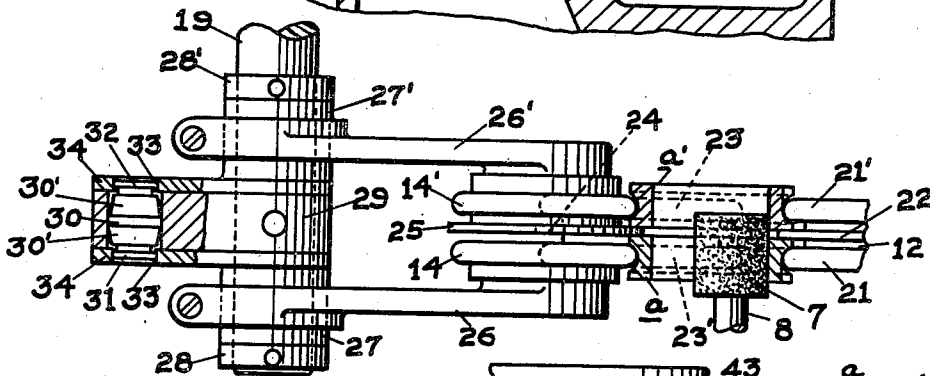
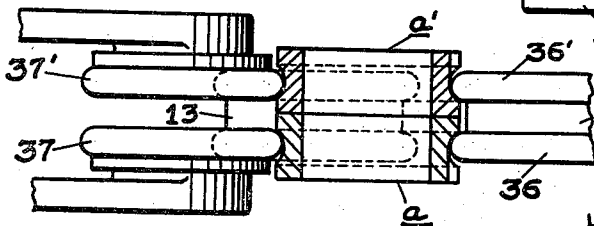
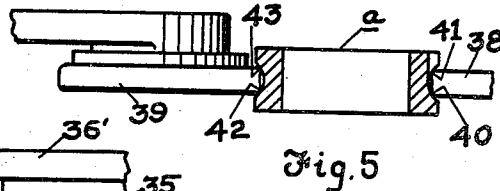
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2 Sheets-Sheet 2



Inventor

Harold L. Blood
Richard A. Heald

334

Geo. W. Kennedy
Attorney

UNITED STATES PATENT OFFICE

2,290,269

INTERNAL GRINDING MACHINE

Harold L. Blood and Richard A. Heald, Worcester, Mass., assignors to The Heald Machine Company, Worcester, Mass., a corporation of Massachusetts

Application April 5, 1939, Serial No. 266,164

7 Claims. (Cl. 51—103)

The present invention relates to internal or bore grinding by the so-called chuckless or centerless method, involving the support and rotation of hollow workpieces by rolling contact with their outer peripheral surfaces, so that the internal grinding operation generates a bore or bores in truly concentric relation to said outer surfaces. More particularly, our invention is concerned with the simultaneous internal grinding in a machine organization of this centerless type of a multiplicity of aligned similarly-dimensioned workpieces having tapered or contoured (non-cylindric) outer peripheral surfaces.

Heretofore in such simultaneous or multiple centerless internal grinding of aligned hollow workpieces presenting truly cylindrical external surfaces, it has been the practice, as disclosed for example in Blood and Burns Patent No. 2,027,627, dated January 14, 1936, to provide in the machine a suitable thrust-resisting member for the end workpiece of the group to bear against. According to our invention, as hereinafter described, advantage is taken of the contoured or non-cylindric character of the workpieces themselves, to eliminate the need for such a thrust-resisting element.

Other and further objects and advantages of the invention will appear from the following detailed description taken in connection with the accompanying drawings, in which—

Fig. 1 is a front elevation of a machine embodying the invention, with parts broken away.

Fig. 2 is a larger scale sectional view substantially along the line 2—2 of Fig. 1.

Fig. 3 is a sectional view substantially along the line 3—3 of Fig. 2.

Fig. 4 is a sectional view similar to Fig. 3, showing a modification.

Fig. 5 is a view similar to Fig. 3, showing a further modification.

Fig. 6 is a diagrammatic view showing an arrangement of parts used in "above-center" grinding.

With reference first to Fig. 1, the machine incorporating the invention may be any conventional type of internal grinding machine. The machine shown has the usual reciprocatory table 1 on which either the grinding wheel or the work to be ground is carried, the reciprocations of the table serving in either case to produce a relative translatory movement between the wheel and the workpiece. In the embodiment illustrated, the table supports and carries a workhead 2 while the wheelhead 3 is mounted on a bridge 4 which spans the guideways 5, Fig. 2, provided by the

machine base 6 for the movements of the table. The grinding wheel 7 is carried on a spindle 8 journaled in the wheelhead and is suitably rotated at a high rate of speed. The workhead 2 provides a centerless or chuckless means for the support and rotation of a plurality of aligned workpieces, as will hereinafter appear.

The reciprocations of the table 1 which cause the rotating grinding wheel to make the desired traverse longitudinally of the workpiece bores, and which provide for an axial separation between the wheel and workpiece, are imparted in any well known manner, as by the use of the table controlling and reversing mechanism described in detail in the Blood and Burns Patent No. 2,027,627, above mentioned. This mechanism is not a feature of the invention and need not be described in detail.

The crossfeed movement between the workpiece and the grinding wheel may be obtained by a transverse movement of the wheel head on the bridge 4 and may be procured by any well known mechanism, as for example, the fluid pressure actuated crossfeed mechanism of the Blood and Burns Patent No. 2,027,627, above referred to. It is sufficient to note for the purpose of the present invention that a cross slide, not shown, is horizontally movable on the bridge 4 and the wheelhead 3 is mounted on the cross slide. A crossfeed screw 9, by its rotation, provides for transverse movement of the cross slide on the bridge, the rotation of the crossfeed screw being procured through a rack 10 suitably connected to a fluid pressure actuating mechanism. The transverse movement of the cross slide, carrying therewith the wheelhead 3, provides for a horizontal movement of the grinding wheel relative to the aligned workpieces in the centerless work-supporting means.

The table 1 also carries a suitable truing or dressing tool 11 for the grinding wheel; the operation of this tool is conventional in character and need not be described in detail.

The general arrangement above described is all old and well known and represents a machine in which the particular work-supporting means of our invention is adapted to be used.

As shown in Figs. 2 and 3, our centerless work-supporting means for a pair of workpieces *a* and *a'* comprises a backing roll 12, a supporting element 13 in the form of a roll, and a pressure member which, as will hereinafter appear, consists of two relatively movable rolls 14 and 14', Fig. 3. All of the rolls, or elements are engageable with the peripheries of the workpieces *a*

and *a'* mounted in the supporting means and thus provide for the simultaneous rotation of the pair of workpieces. The backing roll 12 engages the periphery of the workpieces substantially along a horizontal line which includes the axis of the grinding wheel, and thus this roll acts to take the lateral thrust of the grinding wheel exerted on the workpieces as a result of the transverse or crossfeed movement between the wheel and the workpieces.

The supporting element 13 is positioned below the workpieces and slightly offset from the vertical plane containing the axis thereof, as shown, being preferably supported by an angularly adjustable slide 17.

The pressure rolls 14 and 14' which engage the workpieces from above are yieldingly held against the workpieces by any well known means, as for example, the spring arrangement of the above referred to Blood and Burns Patent No. 2,027,627. It is sufficient to note that a suitable spring 18, Fig. 1, provides, through mechanism not shown, for turning of a shaft 19, Figs. 2 and 3, journaled in an upright 20 forming a part of the workhead. The spring 18 tends to turn the shaft 19 clockwise, Fig. 2, and thereby hold the pressure rolls 14 and 14' against the workpieces.

Any of the rolls engageable with the workpieces may be positively rotated for a rotation of the workpieces, and since the axis of the backing roll 12 is fixed, the drive is preferably applied to this roll. The particular drive is not material; it is sufficient to note that the roll 12 is rotated at such a rate as to assure a proper rotation of the workpieces.

With reference now to Fig. 3, the work-supporting structure is adapted for the support and rotation of a pair of workpieces *a* and *a'* simultaneously, the peripheries of the workpieces being non-cylindrical. In the arrangement shown, each of these workpieces has an arcuate groove in its periphery and the backing roll 12 has peripheral flanges 21 and 21' presenting outer arcuate surfaces corresponding approximately in contour to the arcuate grooves in the workpieces. Between the two peripheral flanges 21 and 21' is another peripheral flange 22 having its opposite surfaces parallel and substantially radial of the roll for engagement with the end surfaces of the workpieces *a* and *a'* in the work-supporting means. As shown, the spacing of each of the flanges 21 and 21' from the flange 22 is slightly less than the spacing of the arcuate groove in the corresponding workpiece from the end surface thereof. Thus, the arcuate flanges 21 and 21' engage portions of the grooves where elements of the outer surfaces of the workpieces are convergent, so that the action of the flanges is to urge each of the workpieces individually against the flange 22.

The supporting element or roll 13 has similar peripheral flanges 23 and 23' which are arcuate on their outer surfaces and also a flange 24 corresponding to the flange 22, these flanges 23, 23' and 24 functioning in a manner similar to the flanges 21 and 21'.

As shown in Fig. 3, the pressure imparting means is so arranged that each workpiece is engaged by an independent roll. These rolls 14 and 14' have arcuate outer surfaces which are arranged to engage the groove in the periphery of the workpiece in the same manner as the flanges 21 and 21' and one of the rolls (the roll 14' in the drawings) has, in parallel relation to the arcuate surface, a flange 25 engageable with the

end surfaces of the workpieces. It will be noted that the flange 25 is spaced from the arcuate surfaces or rolls 14 and 14' in the same manner as the spacing of the flange 22 from the flanges 21 and 21'.

In order that the rolls 14 and 14' may be separately urged against the workpieces to hold each of the workpieces separately in engagement with the backing and supporting rolls, these pressure rolls 14 and 14' are separately carried by individual arms 26 and 26' respectively. These arms are clamped on sleeves 27 and 27' turnable on the shaft 19, endwise movement of the sleeves being limited by fixed collars 28 and 28'. The shaft 19 has an arm 29 pinned thereto between the sleeves 27 and 27', the outer end of the arm carrying a member 30, the opposite ends 31 and 32 of which extend into openings 33 and 33' in arms 34 and 34' integral with the sleeves 27 and 27' respectively.

The member 30 has a central substantially cylindrical section and frustoconical surfaces 30' on opposite sides of the central portion and is thus capable of limited rocking movement in the end of the arm 29. Thus, as the shaft 19 is urged clockwise, Fig. 2, the pressure rolls 14 and 14' are urged separately against the workpieces. The rolls 14 and 14' thus are capable of a slight relative movement to compensate for slight variations in diameters of the two workpieces.

In the above described arrangement each workpiece of the pair is so engaged by the backing, pressure, and supporting rolls as to urge the piece of work slightly endwise and thereby hold both workpieces against a common thrust-resisting means which, in the present arrangement, comprises the flanges 22, 24 and 25 on the several rolls. By having the pair of workpieces opposed to each other, only a single thrust-resisting element for preventing endwise movement of the pair of workpieces is necessary, this element being positioned between the workpieces.

Although the work-supporting rolls have been described as all having flanges having outer surfaces shaped to correspond approximately to the part of the outer surface of the workpieces engaged thereby, it may be possible, in certain instances, to omit these flanges on one or more of the rolls, where a part of the outer periphery of the workpiece is cylindrical and could be supported on one or more of the rolls in the conventional manner.

Fig. 4 shows the several rolls without such thrust-resisting flanges, the two workpieces *a* and *a'* being arranged back to back so that the pieces of work provide a mutual backing for each other. As shown in this figure, the backing roll 35 has the spaced peripheral flanges 36 and 36', the outer edges of which correspond approximately in shape to the grooves in the peripheries of the workpieces. With the workpieces back to back and engaging each other, as shown, the spacing of the flanges 36 and 36' is slightly less than the spacing of the arcuate grooves in the workpieces and thus the peripheries of these flanges engage portions of the workpieces which are approximately frustoconical. The tendency of these flanges is therefore to urge the pieces of work against each other and they are thus held against axial movement during a grinding or other machining operation performed simultaneously on their aligned bores.

The supporting roll of this arrangement has spaced peripheral flanges which correspond in

spacing to the spacing of the flanges 36 and 36' of the backing roll.

As in the arrangement of Figs. 1 to 3 inclusive, it is not essential that both the backing and supporting rolls have these peripheral flanges, provided that a part of the outer surface of each workpiece is cylindrical so that the conventional cylindrical roll could engage and support this part of the outer surface.

In the arrangement of Fig. 4 the pressure rolls 37 and 37' are separately held against the individual workpieces by a structure corresponding to that shown in Figs. 2 and 3 and the spacing of the peripheral flanges of these rolls is, as stated in connection with the backing roll 35, slightly less than the spacing of the arcuate grooves in the two workpieces which are in end to end engagement. By the arrangement shown in this figure it is possible to internally grind a pair of similar workpieces having non-cylindrical outer surfaces in a single operation, since the two workpieces are rotated simultaneously on their external surfaces.

The invention above described for the support of a pair of workpieces having non-cylindrical outer surfaces is equally applicable to the support of a single workpiece *a*. As shown in Fig. 5, the backing roll 38 is shaped to engage with a non-cylindrical portion of the periphery of the workpiece and the pressure roll 39 is similarly shaped. In this arrangement the periphery of the backing roll 38 has spaced rounded corners 40 and 41 spaced apart so that each arcuate corner engages with a portion of the periphery of a workpiece which is approximately frustoconical. Thus, either of the corners 40 or 41 of the backing roll tends to urge the workpiece endwise and the other corner acts as a backing member to resist the end thrust on the workpiece so that the latter is held against endwise movement. The provision of spaced points of contact between the backing roll and the workpiece periphery has been found to prevent any tendency of the workpiece to rotate out of alignment with the predetermined axis upon which it is intended to rotate.

The pressure roll 39 has corresponding small arcuate peripheral corners 42 and 43 which act in the same way as the corners 40 and 41 on the backing roll. In this arrangement the pressure roll may be held resiliently against the workpiece by the resilient means described above in connection with Figs. 2 and 3, or by any of the well known means by which the pressure roll is resiliently held. The supporting roll, not shown, of this modification is similarly shaped to assure a support of the workpiece against endwise movement at each of the three points which provide for the support and rotation of the workpiece.

It will be apparent that the present invention is applicable to the support and rotation of workpieces having non-cylindrical outer surfaces so long as a portion of the periphery of each workpiece has a portion which is approximately frustoconical, or in which the elements of the surface converge to some extent so that the action of the backing supporting and pressure rolls tends to urge the workpiece endwise and thereby holds it against some thrust-resisting means to limit the endwise movement.

In the several arrangements shown the axis of the backing roll 12 lies, as stated, approximately in the same horizontal plane as the axis of the grinding wheel, and thus the backing roll engages the periphery of the workpiece in the same radial plane as the line of engagement between the

workpieces and grinding wheel. This arrangement is entirely satisfactory where all of the workpieces are accurately finished to the same predetermined outside dimension. In order to compensate for any diversities in external dimension between workpieces *a* and *a'*, the arrangement herein disclosed can readily incorporate the expedient disclosed in the Blood Patent No. 2,047,055, dated July 7, 1936. The arrangement described in this patent is intended to compensate for slight variations in the outside diameters of simultaneously ground workpieces, and this is accomplished by having the axis of the backing roll somewhat above or below the horizontal plane of the grinding wheel during its crossfeed movement relative to the workpiece. By this so-called "above-center" grinding, the slight variation in outside diameter is minimized when grinding the bores of the workpieces, as fully described in said patent.

The "above-center" arrangement of parts incorporating the present invention is shown in Fig. 6, in which the backing roll 12' has its axis of rotation X positioned below the horizontal plane (represented by the dot-dash line 44) of the grinding wheel axis. The backing roll 12' may have its periphery shaped to conform to the backing roll of any of Figs. 3, 4 or 5, and the supporting roll 13' is conventionally positioned and preferably has a periphery corresponding to that of the backing roll. The pressure roll 14' is also mounted in the same manner as the pressure roll or rolls of Figs. 3, 4 or 5, and may correspond to the pressure roll constructions of any of said figures, dependent upon the type of the backing roll 12', as will be understood.

The machine as illustrated provides a loading mechanism by which workpieces are automatically positioned in the work-supporting means to be supported and rotated during the internal grinding operation and removed therefrom when the grinding is completed. This loading mechanism is fully described in the above cited Blood and Burns Patent No. 2,027,627, and is not, of itself, a feature of the present invention. It is sufficient to note for the purpose of the present invention that a loading arm 45 is carried on the end of a rod 46 concentric to the axis of the backing roll 12. This loading arm has a laterally extending flange 47 projecting over the peripheral surface of the backing roll and normally positioned below the workpieces in the centerless work-supporting means. At the completion of a grinding operation the loading arm is swung clockwise, Fig. 2, by any suitable mechanism, and the workpieces *a* and *a'* are thereby carried upwardly between the periphery of the backing roll and a guide flange 48 on a work hopper 49, so that the workpieces are discharged toward the back of the machine.

When the loading arm reaches a position such that the flange 47 is adjacent to the top of the backing roll, a cam 50 carried by the rod 46 operates through a plunger 51 to raise an arm 52 out of alignment with the unground workpieces *a'* positioned in the hopper, thus allowing the foremost pair of workpieces to drop onto the flange 47 and be guided thereby into grinding position. During this unloading and loading of the work-supporting means, the pressure roll 14 is moved away from engagement with the workpieces by any suitable mechanism, preferably controlled by the same means that actuates the work-loading arm. It will be un-

derstood that where the workhead is adapted for the simultaneous support and rotation of a pair of workpieces, as in Figs. 2 and 3, or Fig. 4, the workpieces are arranged in pairs in the hopper, as shown in Fig. 1, the width of the hopper being such that the workpieces may be placed side-by-side and be guided thereby.

Although the machine, as an entirety, has been described as an internal grinding machine, and the particular work-supporting means has been described in relation to a grinding machine cycle, it will be understood that this work-supporting means may as readily be utilized for an internal honing operation on the work, or for other types of internal finishing operations, as, for example, a boring operation.

We claim:

1. In apparatus of the class described, a centerless or chuckless means for the support and rotation of a hollow workpiece having a grooved periphery, for a finishing operation on the bore of said workpiece, said means comprising a plurality of spaced elements engageable with the outer surface of the workpiece, at least one of said elements being rotated for a rotation of the workpiece and at least one of said elements having a portion engageable with one wall only of the groove in the periphery of the workpiece, and a flange on said last element in spaced relation to said portion and engageable with an end surface of the workpiece for supporting the latter against endwise movement.

2. In an internal grinding machine, a centerless or chuckless means for the support and rotation of a pair of workpieces having non-cylindric external surfaces, and arranged in alignment for simultaneous grinding of their bores, said means comprising a plurality of circumferentially-spaced elements engageable with the peripheries of the workpieces, at least one of said elements being rotated to impart rotation to the workpieces, and at least one of said elements having spaced portions engageable with oppositely-positioned non-cylindric surfaces of said workpieces, to urge the latter toward each other, and a flange on one of said elements between the workpieces and engageable with the adjacent end surfaces thereof for supporting the workpieces against endwise movement.

3. In apparatus of the class described, a centerless or chuckless means for the support and rotation of a pair of hollow workpieces having non-cylindric outer surfaces, for a simultaneous finishing operation on the bores of said workpieces, said means comprising a plurality of spaced elements engageable with the peripheries of the workpieces, at least one of said elements being rotated for a rotation of the workpieces and at least one of said elements having spaced portions engageable with the non-cylindrical surfaces of the workpieces in such a manner as to urge the workpieces endwise toward each other, whereby the workpieces, by engagement with each other, are supported against endwise movement.

4. In apparatus of the class described a cen-

terless or chuckless means for the support and rotation of hollow workpieces having non-cylindric outer surfaces, for finishing operations on the bores thereof, said means comprising a plurality of spaced elements engageable with the periphery of a workpiece, one of said elements being resiliently urged toward the other elements, at least one of said elements having a portion engageable with a part of the outer surface of the workpiece where the elements of the outer surface of the workpiece are convergent, and means for preventing endwise movement of the workpiece resulting from the action of the elements, said means comprising a flange on one of said elements, said flange being engageable with an end surface of the workpiece.

5. In a work-supporting structure for the simultaneous support and rotation of a pair of similar workpieces having non-cylindrical outer surfaces, a backing or regulating roll, a supporting member and a pressure roll, each of said rolls having a pair of relatively narrow annular flanges having their outer surfaces shaped to engage a portion of the peripheries of the workpieces where the elements thereof are convergent, said flanges engaging with the workpieces to urge each of the workpieces endwise toward the other.

6. In an internal grinding machine, a centerless or chuckless means for the support and rotation of a pair of hollow workpieces having non-cylindric peripheries and arranged in alignment for simultaneous internal grinding, said means comprising a regulating roll, a supporting member and a pressure roll, each of said rolls providing spaced relatively narrow annular portions rotatable on a common axis, each annular portion having a substantially toric outer surface engaging with a non-cylindric surface on the outer periphery of a workpiece, with adjacent annular portions having their substantially toric work-engaging surfaces in opposed relation to each other to urge the pair of workpieces toward each other, each workpiece being engaged by one annular portion of each roll, and means for urging the rolls toward each other to hold their annular portions in contact with the workpieces.

7. In an internal grinding machine, a centerless or chuckless means for the support and rotation of a pair of hollow workpieces having non-cylindric peripheries and arranged in alignment for simultaneous internal grinding, said means comprising a plurality of circumferentially spaced members at least one of which is rotary, each of said members having a pair of annular flanges, spaced apart for rolling contact each with one of said workpieces at a non-cylindric portion of its periphery, the contacting surfaces of each workpiece and its associated flange being convex in the case of one of said parts and concave in the case of the other and said contact surfaces on said flanges being in opposed relation to urge each of the workpieces endwise toward each other.

HAROLD L. BLOOD.
RICHARD A. HEALD.