July 4, 1961 A. H. TOMPKINS 2,990,656

AUTOMATICALLY OPERABLE CENTERLESS GRINDER

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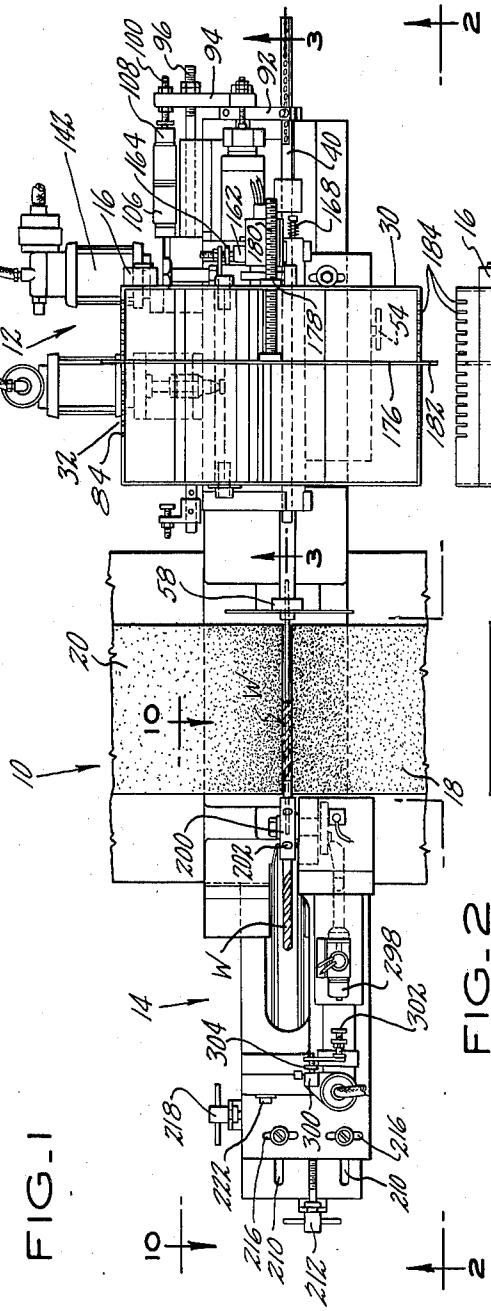


FIG. 1

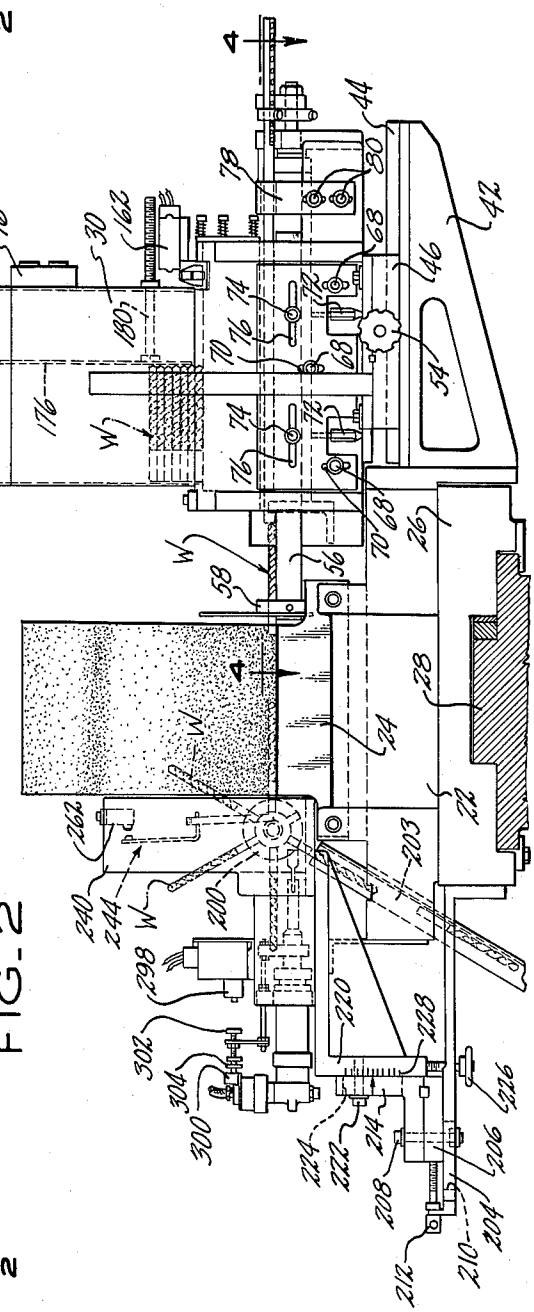


FIG. 2

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FIG. 3

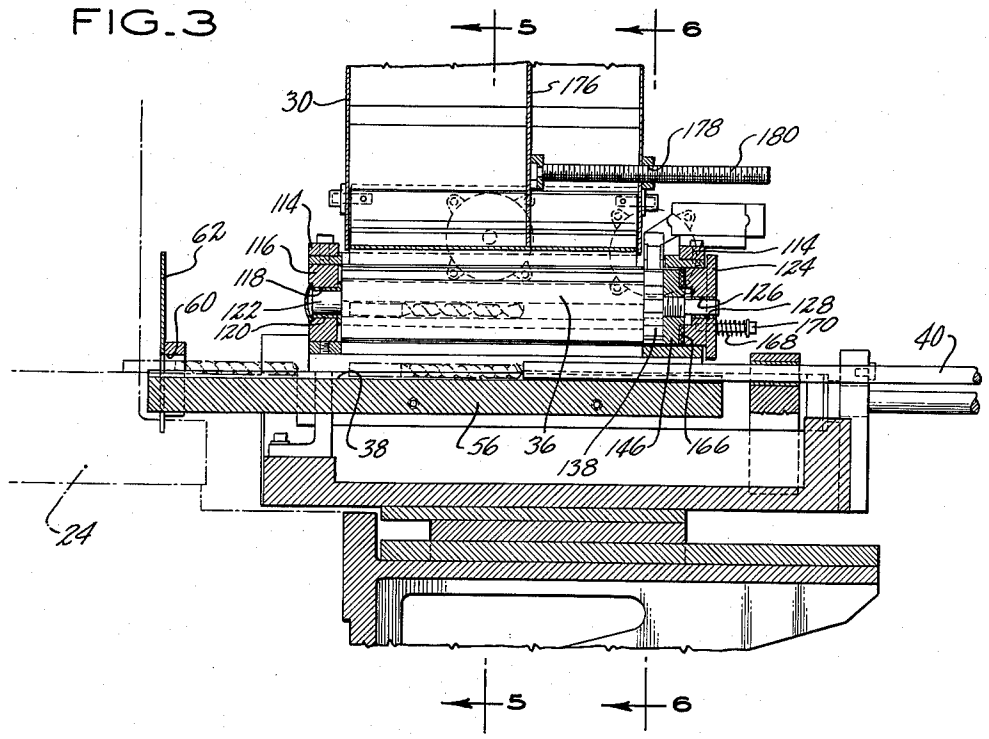


FIG. 4

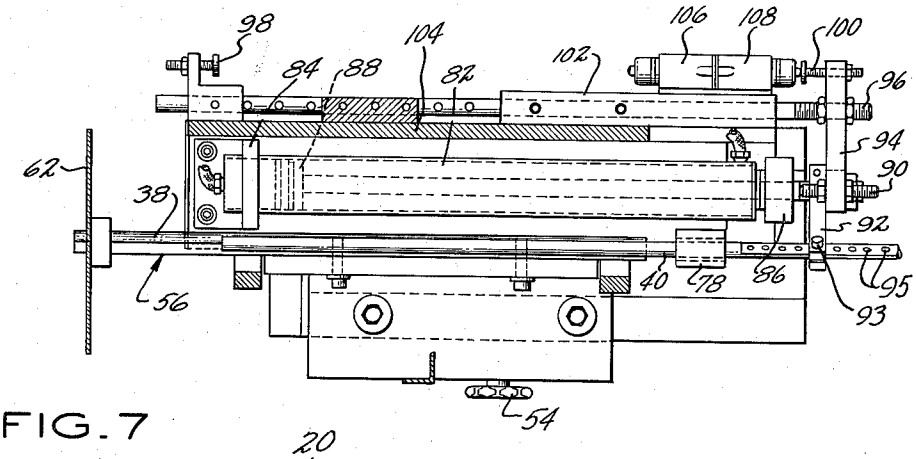
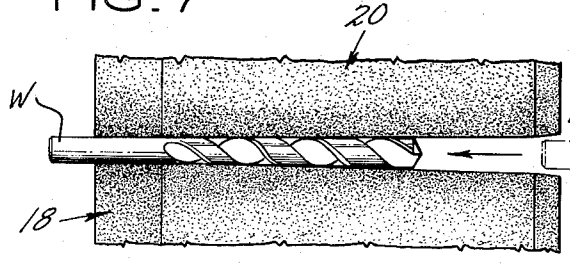


FIG. 7



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FIG. 5

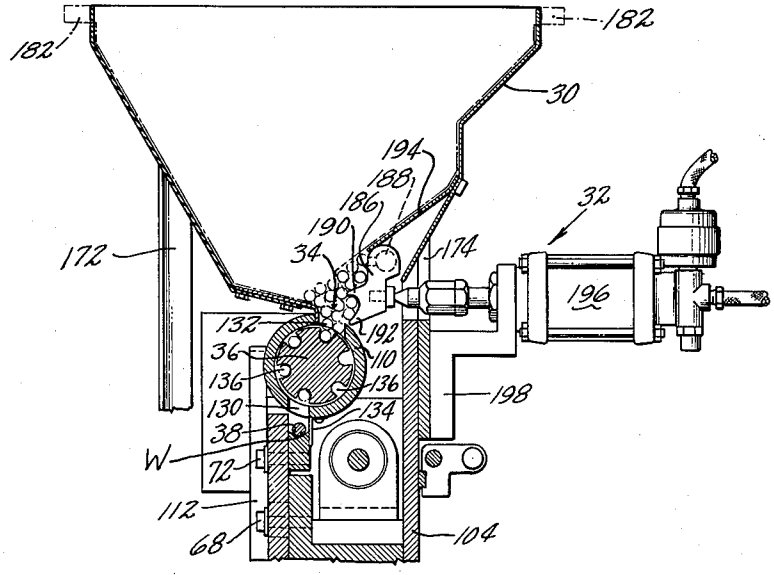
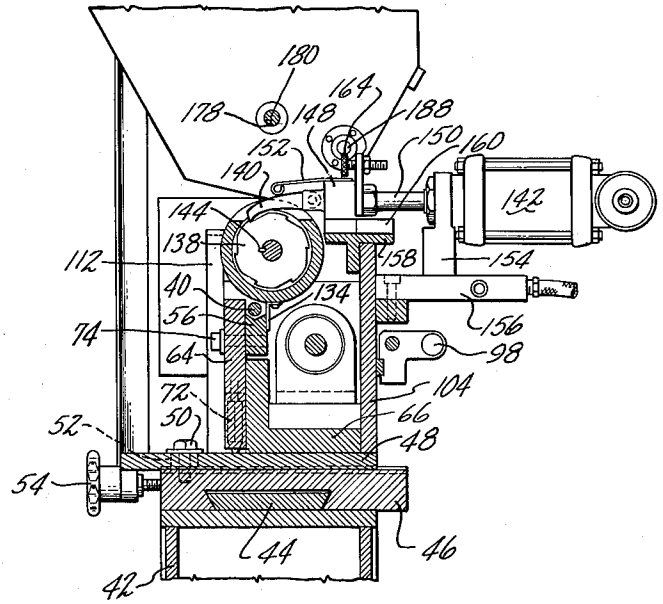


FIG. 6



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FIG_8

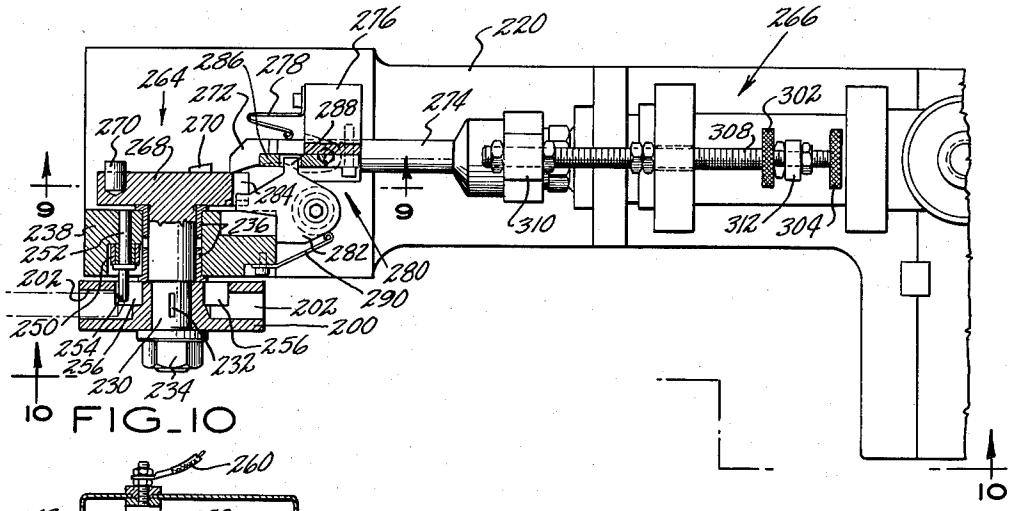


FIG_10

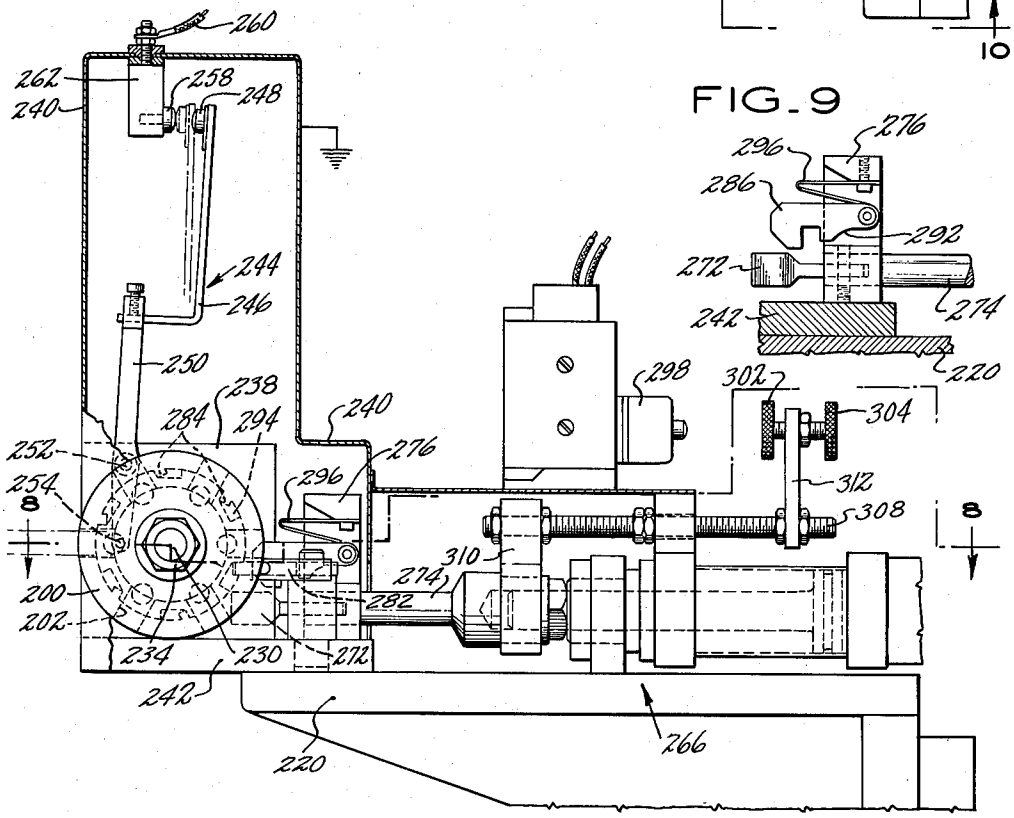


FIG_9

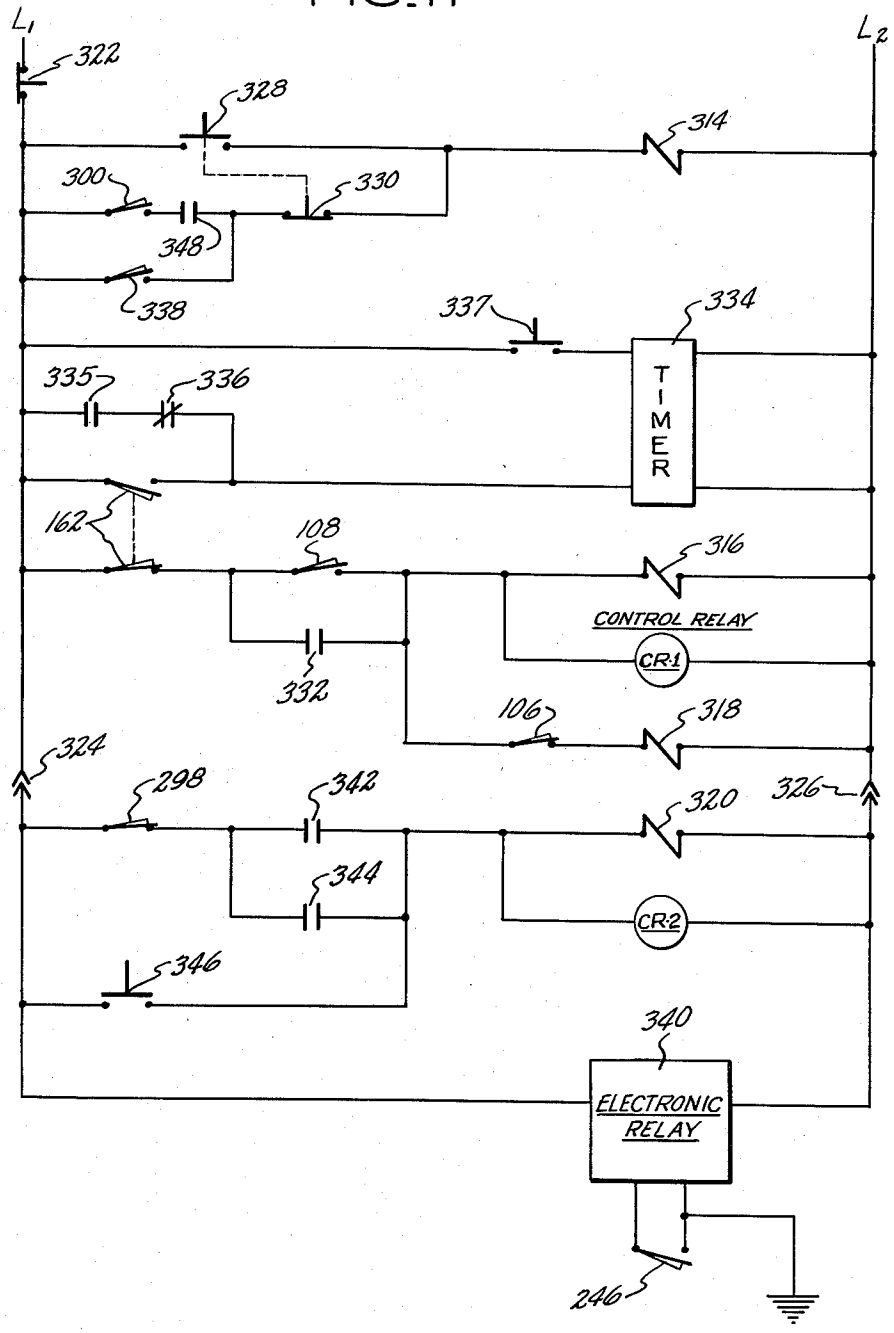
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FIG. 11



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2,990,656

AUTOMATICALLY OPERABLE CENTERLESS GRINDER

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Filed Mar. 24, 1959, Ser. No. 801,541
11 Claims. (Cl. 51—103)

This invention relates to centerless grinders and, more particularly, to a centerless grinder of the type which is adapted to be operated automatically to grind a number of like workpieces in succession.

It is the general object of the invention to provide a centerless grinder of the above-mentioned type which may be readily adapted for through-feed grinding of a wide variety of types of workpieces.

Another object of the invention is to provide an improved automatically operable loading apparatus in a centerless grinder of the type referred to, the said apparatus being adapted to handle elongated workpieces of various sizes and shapes and to feed the same to the grinding throat between the grinding and regulating wheels in succession for a through-feed grinding operation.

A further object of the invention is to provide an improved through-feed method of grinding elongated workpieces to non-uniform diameters throughout their lengths, the said method involving the delivery of the workpieces to the grinding throat for a through-feed grinding operation and the upward removal of the workpieces from the grinding throat when they have advanced to a preselected position therein.

A still further object of the invention is to provide in a centerless grinder an automatically operable unloading apparatus which is adapted to cooperate with an automatically operable loading apparatus to implement the above-mentioned improved method for grinding non-uniform workpieces.

The drawings show a preferred embodiment of the invention and such embodiment will be described, but it will be understood that various changes may be made from the construction disclosed, and that the drawings and description are not to be construed as defining or limiting the scope of the invention, the claims forming a part of this specification being relied upon for that purpose.

Of the drawings:

FIG. 1 is a fragmentary top plan view of a centerless grinding machine embodying the present invention;

FIG. 2 is a fragmentary side elevational view of the grinding machine taken generally as indicated by the line 2—2 of FIG. 1;

FIG. 3 is an enlarged longitudinal vertical section taken as indicated by the line 3—3 of FIG. 1 and showing the loading apparatus of the grinding machine;

FIG. 4 is an enlarged horizontal sectional view of the loading apparatus taken as indicated by the line 4—4 in FIG. 2;

FIG. 5 is a transverse sectional view of the loading apparatus taken as indicated by the line 5—5 in FIG. 3;

FIG. 6 is another transverse sectional view of the loading apparatus taken as indicated by the line 6—6 in FIG. 3;

FIG. 7 is an enlarged fragmentary top plan view showing portions of the grinding and regulating wheels of the grinding machine with a workpiece of non-uniform diameter located in the grinding throat;

FIG. 8 is a stepped horizontal sectional view of the unloading apparatus of the grinding machine taken as indicated by the line 8—8 in FIG. 10;

FIG. 9 is a longitudinal vertical section taken as indicated by the line 9—9 in FIG. 8 and showing a portion of the unloading apparatus;

FIG. 10 is a view of the unloading apparatus taken as indicated by the line 10—10 in FIG. 8; and

FIG. 11 is a schematic wiring diagram illustrating a portion of the electrical control system of the grinding machine.

Referring to the drawings, and more particularly to FIGS. 1 and 2 thereof, it will be observed that the centerless grinding machine embodying the invention comprises three main sections, namely, a central grinding and regulating wheel section 10, a front section 12 comprising a loading apparatus and a rear section 14 comprising an unloading apparatus. In operation of the machine, workpieces proceed from the front of the machine longitudinally toward the rear thereof (right to left in FIGS. 1 and 2). A machine operator stands at the front of the machine toward its left-hand side so as to face diagonally the rear ends of the workpieces as they pass through the machine. A control panel 16 containing the control switches and buttons for automatic operation of the machine is conveniently accessible in front of and to the right of the machine operator in this position.

The central grinding and regulating wheel section 10 of the machine may be conventional and is shown as including a grinding wheel 18 and a regulating wheel 20. The grinding wheel 18 (partially shown) is supported for rotation about a longitudinal axis at the left-hand side of the machine as viewed from the front, and the regulating wheel 20 (also partially shown) is supported for rotation about a longitudinal axis spaced transversely from the grinding wheel axis at the right-hand side of the grinding machine. Defined by and between said wheels is the usual grinding throat in which workpieces are supported by a conventional work supporting blade 24 and engaged in opposed relationship by the wheels 18 and 20. Conventional operating means drive the grinding and regulating wheels 18 and 20 and said wheels are adapted for various adjustments in accordance with conventional practice, one of said adjustments being the usual tilt adjustment of the regulating wheel spindle which is utilized in drawing workpieces through the grinding throat in through-feed grinding operations. Illustration and description of the conventional operating means and the means for accomplishing the various adjustments of the grinding and regulating wheels are not deemed necessary for an understanding of the invention and are therefore not included herein. For like reasons, other conventional elements such as wheel truing or dressing devices and coolant systems are not shown or described.

In FIG. 2 the grinding machine central section 10 is shown as also including a conventional work-rest 22 on which there is mounted the work supporting blade 24. The blade 24 is adapted to support a workpiece in the grinding throat with its axis extending generally longitudinally. The work-rest 22 is shown as being rigidly mounted on a slide or saddle 26 which is movable on a way 28 which, in turn, is pivotally supported on the grinding machine bed, not shown. Thus, adjustment of the position of the upper edge of the work supporting blade in the grinding throat may be accomplished by suitably adjusting the positions of the slide or saddle 26 and the way 28. The constructions of the work supporting blade and the support means therefor, while subject to wide variation within the scope of the invention, are preferably as shown. With such constructions, both the loading and unloading apparatus 12 and 14 may be conveniently supported for movement with the work supporting blade and it is preferred practice to so support the said apparatus for reasons which will become apparent hereinbelow.

The loading apparatus included in the front section 12 of the grinding machine operates automatically to feed workpieces in succession to the grinding throat between the grinding and regulating wheels 18 and 20 for a through-feed grinding operation. Included in the loading apparatus is a hopper 30 which is adapted to hold a number of workpieces in stacked parallel relationship with their axes extending generally longitudinally. Associated with the hopper 30 is an agitator 32 which is operable to prevent bridging and/or interlocking of the workpieces in the lower portion of said hopper and to insure that the workpieces may fall freely through a longitudinal discharge slot 34 provided at the bottom of the hopper (FIG. 5). Disposed beneath the slot 34 in the hopper is a receiver comprising a fluted cylinder or drum 36 which is rotated or indexed intermittently to accept workpieces one at a time from the hopper discharge slot and to deposit workpieces one at a time in a delivery channel 38. The delivery channel 38 extends longitudinally from beneath the receiver cylinder 36 to the front or receiving end of the grinding throat defined between the regulating and grinding wheels 18 and 20. Located in the delivery channel 38 is a longitudinally reciprocable delivery rod 40 (FIG. 4) which is power operated to intermittently thrust workpieces along the delivery channel toward the rear of the grinding machine and into said front or receiving end of the grinding throat.

As previously mentioned, the loading apparatus is preferably supported for movement with the work supporting blade 24. With the work-rest and slide constructions shown, the loading apparatus may be conveniently so supported by providing a rigid connection between the apparatus and the work-rest 22 and/or the slide 26. Such a rigid connection is provided in the embodiment of the invention shown between a base 42 of the loading apparatus and the work-rest by means of suitable screws and dowels not shown. The base 42 of the loading aparatus, as will now be described, supports all of the parts of said apparatus.

Provided on the base 42 is a longitudinally extending dovetailed way 44 which guides and supports a longitudinal slide 46. Suitable binder screws, not shown, are provided for fixing the longitudinal position of the slide 46 relative to the base 42. Mounted on said slide is a laterally or transversely movable supporting plate 48 for the loading apparatus. As best illustrated in FIG. 6, the supporting plate 48 is secured to the slide 46 by suitable binder screws 50 which extend through laterally elongated slots 52 in said plate. A handwheel for adjusting the lateral position of the supporting plate 48 is shown at 54. As will become apparent below, all of the parts of the loading apparatus are suported by and are movable with the supporting plate 48. Thus, the position of the loading apparatus may be adjusted with the work-rest 22 and slide 26 and independently of said work-rest and slide in both lateral and longitudinal directions in a horizontal plane.

As best illustrated in FIG. 6, the delivery channel 38 is preferably V-shaped in cross-section and is formed in the upper portion of a longitudinaly extending bar 56. The bar 56 extends rearwardly in the grinding machine so that the discharge end of the channel 38 formed therein is located adjacent the front or receiving end of the grinding throat. Located at the rear end of the bar 56 is a guide 58, best illustrated in FIG. 3. The said guide is provided with a suitable opening 60 through which the workpieces pass as they are delivered to the grinding throat from the channel 38 in the bar 56. In passing through the guide opening 60, the workpieces are confined to a selected entry path and are properly entered in the grinding throat and supported on the work supporting blade 24. A shield 62 secured to the guide 58 prevents cooling fluid and grinding wheel particles and the like from escaping forwardly and upwardly from the grinding throat toward the machine operator and the loading apparatus.

In accordance with the presently preferred practice, the bar 56 in which the delivery channel 38 is defined is adjustably supported by the laterally movable supporting plate 48. As best illustrated in FIG. 6, an upright longitudinally extending plate 64 carries the bar 56 and said plate is secured for vertical adjustment to an L-shaped longitudinally extending frame member 66. The member 66 is mounted on and secured to the supporting plate 48 as by suitable welding. In FIG. 2, three binder screws 68, 68 for connecting the plate 64 to the frame member 66 are shown located in vertically extended slots 70, 70 formed in the said plate. Two vertical adjustment screws 72, 72 have their heads in engagement with the supporting plate 48 and are threaded into the upright plate 64 which carries the delivery bar 56. Connection of the plate 64 with the delivery bar 56 is effected by means of two binder screws 74, 74, the said screws being entered in suitable threaded openings in said delivery bar and extend through longitudinally elongated slots 76, 76 formed in the said plate 64.

It will be apparent that the position of the bar 56 and thus the position of the delivery channel 38 may be adjusted both vertically and longitudinally independently of and relative to the supporting plate 48. The vertical and longitudinal adjustments of the delivery bar 56 which may be effected respectively by movement of the upright plate 64 relative to the supporting plate 48 and movement of the delivery bar relative to said upright plate and supporting plate are utilized for accurately positioning the discharge end of the delivery channel 38 relative to the grinding throat and the upper edge of the work supporting blade 24 after appropriate lateral and longitudinal adjustments of the loading apparatus position have been accomplished at the slide 46 and supporting plate 48. It will be apparent that when all of the required adjustments have been accomplished, the loading apparatus will be moved with the work-rest 22 and the work supporting blade 24 and the desired position of the discharge end of the delivery channel 38 relative to the grinding throat and the upper edge of the said blade will be maintained during operation of the machine.

Referring now particularly to FIG. 4, it will be observed that the afore-mentioned reciprocable delivery rod 40 which intermittently thrusts workpieces along the delivery channel 38 into the grinding throat is supported and guided in said channel by the delivery bar 56 and by a bracket 78. The bracket 78 is rigidly secured to and extends upwardly from the frame member 66, connection of the bracket with the said member being accomplished by two bolts 80, 80 (FIG. 2).

As previously mentioned, the delivery rod 40 is power operated and while any usual or preferred operating means for the rod may be utilized, the presently preferred means comprises a conventional air cylinder 82. The air cylinder 82 is supported by suitable brackets 84 and 86 mounted on the L-shaped frame member 66 and includes a pneumatically operated piston 88 and a piston rod 90 which is connected for movement with the piston 88 and which projects through the front end of the cylinder. A suitable laterally extending connecting link 92 is utilized for attaching the projecting end of the piston rod 90 to the delivery rod 40. The said link may be secured to the delivery rod 40 at selected longitudinal positions by means of a bolt 93 adapted to extend through a suitable opening in said link and through one of a longitudinal series of openings 95, 95 in said rod. A longitudinally extending rod 96 is also attached to the projecting or front end of the piston rod 90 by means of a suitable connecting link 94. The rod 96 has first and second contact buttons 98 and 100 fixedly mounted thereon at opposite ends and said rod is supported and guided for longitudinal movement by a bracket 102. The bracket 102 is rigidly secured to an upright plate 104 which extends longitudinally adjacent the air cylinder 82 and which is secured along its lower edge to the supporting plate 48 as by suitable welding. Rigidly mounted on the

bracket 102 are first and second limit switches 106 and 108 which are adapted to be actuated respectively by the contact button 98 and the contact button 100.

In Fig. 4 the delivery rod 40 is shown in the position it occupies at the end of a delivery stroke thereof. In such position, the rod delivers a workpiece to the guide 60 and to the grinding throat between the grinding and regulating wheels 18 and 20, the said workpiece being at least partially entered in the grinding throat by the rod so that it may be drawn therethrough by the grinding and regulating wheels in the usual manner for a through-feed grinding operation. It will be observed that feed strokes of the rod 40 are effected by retraction of the piston rod 90 into the air cylinder 82 and that return strokes of the said rod are effected by forward or advancing movements of the said piston rod. Exemplary control means for regulating the reciprocable movement of the piston rod 90 and thus the reciprocable movement of the delivery rod 40 are described hereinafter. It will also be observed in FIG. 4 that the limit switch 108 is actuated by the contact button 100 at the end of each feed stroke of the delivery rod 40 and that the limit switch 106 is actuated by the contact button 98 at the end of each return stroke of said delivery rod. It is to be understood that the arrangement of the limit switches 106 and 108 and the actuating means therefor is subject to wide variation, the arrangements shown and described being exemplary.

As best illustrated in FIGS. 3 and 4, the aforementioned fluted cylinder 36 which accepts workpieces from the hopper 30 and deposits the same one at a time in the delivery channel 38 has its axis extending generally longitudinally and is disposed within a suitable housing 110. The housing 110 is supported above the delivery channel 38 and beneath the hopper 30 by two similar upright bars 112, 112. The bars 112, 112 have their lower ends secured to the supporting plate 48 and are connected to said housing at opposite ends thereof as by suitable welding. Also secured to the housing 110 are two horizontally extending connecting bars 114, 114 which are rigidly connected to and which extend generally horizontally and laterally from the upright plate 104 at its upper edge. An end plug 116 at the rear end of the cylinder housing 110 is provided with a central opening 118 in which there is disposed a bushing 120 which receives the rear end of a spindle 122 formed integrally on the cylinder 36. At the forward end of the housing 110 there is provided a cap 124 which also has a central opening 126. The opening 126 is lined with a bushing 128 which receives the opposite end of the spindle 122. In a lower portion of the housing 110, there is provided a longitudinally extending slot 130 which is disposed above the delivery channel 38 and through which workpieces may fall freely by gravity to said channel. A similar longitudinally extended slot 132 is provided in an upper portion of the cylinder 110 beneath the discharge slot 34 in the hopper 30. Workpieces are entered in the flutes of the cylinder 36 from the hopper discharge slot 34 through the housing slot 132 and accordingly said slot 132 may be hereinafter referred to as a receiving slot. Similarly, workpieces are discharged from the flutes of the cylinder 36 through the lower slot 130 and said slot may be hereafter referred to as a discharge slot. Secured to the housing 110 adjacent the discharge slot 130 is a shield or guard 134 which insures that workpieces discharged through the said slot are directed into the delivery channel 38.

As shown, the cylinder 36 includes six equally spaced longitudinally extending flutes 136, 136 in which workpieces may be held, the number of flutes, however, being subject to variation. Preferably several such cylinders are provided and they are adapted to be used interchangeably for handling elongated workpieces of different sizes and shapes. In operation of the loading apparatus, the cylinder 36 is intermittently rotated or indexed through a selected angle so that one of the flutes 136, 136 registers with the receiving slot 132 in the housing 110 to allow a workpiece to be entered in said flute while a diametrically opposite flute 136 registers with the discharge slot 130 to discharge a workpiece to the delivery channel 38. When there are six equally spaced flutes provided in the cylinder 36, the indexing angle is of course 60°.

The operating means for intermittently rotating or indexing the fluted cylinder 36 through a selected angle may vary widely within the scope of the invention. In accordance with the presently preferred practice, the cylinder 36 is connected with a ratchet wheel 138 (FIG. 6). A pawl 140 operated by a conventional air cylinder rotates the said ratchet wheel and the fluted cylinder 36 as required. As best illustrated in FIG. 3, the ratchet wheel 138 is mounted on the front portion of the spindle 122 adjacent the front end of the cylinder 36 and within the cylinder housing 110. The ratchet wheel 138 is secured against rotation relative to the spindle 122 by a suitable key 144 and is secured against axial movement relative to said spindle by a nut 146 which engages a threaded portion of the spindle forwardly of said ratchet wheel. The pawl 140 is pivotally mounted on a slide 148 which is connected to and reciprocated by a piston rod 150 of the air cylinder 142. A suitable leaf spring which is secured at one end to the slide 148 has its other end in engagement with the pawl 140 to bias said pawl into engagement with the ratchet wheel 138.

The air cylinder 142 which constitutes the operating means for the pawl 140 is supported by a bracket 154 which is mounted on a platform 156 secured to the upright plate 104. Also secured to the plate 104 is a bracket 158 which has formed at its upper surface a way 160 on which the slide 148 is reciprocated at the urging of the air cylinder piston rod 150. A limit switch 162, best illustrated in FIGS. 1 and 2, is also supported on the upright plate 104 by a suitable bracket and is actuated by a contact button 164 which is carried by the slide 148. The said limit switch 162 is arranged so as to be actuated by the contact button 164 when the air cylinder 142 is operated to actuate the pawl 140 and to thereby rotate or index the cylinder 36. More specifically, the switch 162 is actuated at the completion of an indexing movement of the cylinder 36.

In accordance with presently preferred practice, a brake means is provided for preventing overtravel of the cylinder 36 when it is indexed. As shown, the said brake means comprises a disc of a suitable brake material such as cork which is rigidly secured to the front face of the nut 146 within the cylinder housing 110 and which is in axial engagement with the housing end cap 124. As best illustrated in FIG. 3, the housing end cap 124 is biased into engagement with the disc 166 by a plurality of small coil springs 168, 168 (one shown). The springs 168, 168 respectively embrace a plurality of screws 170, 170 which extend through suitable openings in the end cap 124 and which are entered in suitably threaded openings in the front end of the cylinder housing 110. It will be apparent that by suitably turning the screws 170, 170, the biasing force of the springs 168, 168 on the end cap 124 and thus the braking effectiveness of the disc 166 may be adjusted as desired.

The afore-mentioned hopper 30 which holds a stacked supply of workpieces with their axes in parallel relationship and extending generally longitudinally is preferably generally V-shaped in cross-section as best illustrated in FIG. 5. The said hopper is supported with the discharge slot 34 in its lower portion above the receiving slot 132 in the cylinder housing 110 by means of a first upright bar 172 secured at its lower end to the supporting plate 48 and a second upright bar 174 secured to the upright plate 104. In order that workpieces of different lengths and shapes may be accomplished, the hopper 30 is preferably provided with a longitudinally adjustable transverse partition 176 as best illustrated in FIG. 3. Connected to a lower portion of the adjustable partition 176 and extend-

ing through a suitably threaded opening 178 in the front wall of the hopper 30 is a threaded adjusting rod 180. A binder nut 181 is threaded on the rod 180 outwardly or forwardly of said front wall of the hopper 30 to secure the lower portion of the partition 176 in a selected longitudinal position. The upper portion of the partition 176 has wings or flanges 182, 182 formed thereon at opposite sides and a longitudinal series of notches 184, 184 is provided at the upper portion of each side wall of the hopper 30. The said upper portion of the hopper may be secured in a selected longitudinal position by entering the wings or flanges 182, 182 in the appropriate notches 184, 184. FIGS. 2 and 5 best illustrate the connection of the partition 176 with the upper portion of the hopper 30.

In preferred form, the agitator 32 which prevents bridging and interlocking of workpieces in the hopper 30 comprises a pivotally supported longitudinal agitating or lifting member 186 disposed within the hopper 30 as best illustrated in FIG. 5. A shaft 188 which has its ends journaled in the opposite end walls of said hopper supports the member 186 for pivotal movement toward and away from the center of the hopper. The member 186 has upper and lower spaced apart longitudinal lifting ribs or flanges 190 and 192 formed thereon and also has a smooth curved surface disposed between said ribs or flanges. The lip of the lower rib 192 is disposed closely adjacent the upper portion of the housing 110 of the cylinder 36 so that workpieces are prevented from passing between said housing and member when they are discharged from the hopper slot 34. A longitudinal partition 194 within the hopper 30 confines the workpieces to the zone adjacent the lifting ribs or flanges 190 and 192.

In operation of the loading apparatus, the agitating member 186 is intermittently actuated so as to be pivoted about the shaft 188 in the clockwise direction as viewed from the front of the grinding machine. When the member is so actuated, the ribs 190 and 192 thereon tend to lift the workpieces and to effect relative movement therebetween. This results in the destruction of any natural bridges which may have been formed by the workpieces and disengagement of interlocked workpieces whereupon, the said workpieces are free to fall by gravity into the receiving slot 132 in the housing 110 and be entered in the flutes 136 in the cylinder 36. The operating means for intermittently pivoting the agitating or lifting member 186 is shown as comprising an air cylinder 196 which is supported by a bracket 198 rigidly connected to the upright plate 104 but it is to be understood that other operating means may be utilized within the scope of the invention.

From the foregoing it will be apparent that the loading apparatus of the grinding machine may be operated automatically to deliver workpieces to the grinding throat of the machine at appropriate intervals. It will be further apparent that the said apparatus may be readily adapted to accommodate workpieces of various shapes and sizes. When elongated workpieces having uniform diameters are to be ground, the apparatus may be used to feed workpieces for a conventional through-feed grinding operation. In such a grinding operation, workpieces are delivered in succession at suitable intervals to the grinding throat between the grinding and regulating wheels and the workpieces are successively drawn longitudinally through the grinding throat by said wheels and are deposited at the discharge end of the throat on a suitable conveyor or the like, not shown. When, on the other hand, workpieces having non-uniform diameters throughout their lengths are to be ground, they of course cannot be permitted to pass completely through the grinding throat as in a conventional through feed grinding operation. In such event the unloading apparatus constiuting the rear section 14 of the grinding machine is utilized and is operated automatically in accordance with the improved through-feed grinding method of the present invention to lift or pivot the workpieces upwardly out of the grinding throat when they have advanced to a preselected position therein. The said improved grinding method and the unloading apparatus will be described with reference to the exemplary non-uniform workpiece illustrated in the drawings, i.e., a conventional twist drill W.

As best illustrated in FIG. 7, a conventional twist drill W has a straight shank and a gradually tapering drill portion which is of a greater diameter at its tip end than at its shank end. In accordance with the improved through-feed method of grinding workpieces such as the drill W to a non-uniform diameter throughout their length, the grinding and regulating wheels of the grinding machine are dressed to provide for minimum grinding throat width and minimum diameter of the finished workpiece adjacent the discharge end of the throat. The remaining portion of the grinding throat is shaped, by suitably dressing the said wheels, to provide for a taper as shown in FIG. 7, or to provide for other workpiece contours of larger diameter than the diameter of said throat portion adjacent the discharge end of the throat. The workpieces, such as the drills W, are fed into the grinding throat from the end opposite the discharge end as in a conventional through-feed operation and are advanced into the throat until they reach a selected position in the throat wherein a selected portion thereof (the shank of the drill W in FIG. 7) has been ground to the minimum diameter, the remaining portion thereof (drill portion of the twist drill W in FIG. 7) being concurrently ground to a desired taper or other contour of larger diameter. When the drills or other workpieces have reached the said selected position in the grinding throat, their longitudinal movement through the said throat is interrupted and they are removed upwardly from the throat with their diametral surfaces ground non-uniformly throughout their lengths as required.

It will be observed in FIG. 7 that the grinding and regulating wheels 18 and 20 are dressed so that a portion of the shank of a twist drill W projects from the discharge end of the grinding throat when the drill has reached the selected position in the throat wherein its shank and drill portion are ground as required. While the method of the present invention is not to be construed as being so limited, it is the presently preferred practice to provide for such projection of the end portion of the drill or other workpiece from the grinding throat. As will become apparent herinbelow, the upward removal of the drill or workpiece from the grinding throat is facilitated when its end portion projects from the throat discharge end.

An unloading apparatus adapted for operation in accordance with the improved method of the invention may take a variety of forms. Apparatus may be provided, for example, to effect a hammer-like blow on the end of the drill W or other workpiece which projects from the discharge end of the grinding throat whereby to pivot the said drill or other workpiece about the corner of the work supporting blade and thus remove the same from the grinding throat in an upward direction. Still other apparatus for implementing the method of the present invention may comprise means for grasping the projecting end of the drill or other workpiece and lifting the said drill or workpiece upwardly and out of the grinding throat with its axis remaining substantially longitudinal.

The unloading apparatus construction which is presently preferred and which is illustrated in the drawings includes a means whereby a non-uniform workpiece such as a twist drill is removed upwardly from the grinding throat in a pivotal movement when the workpiece reaches a selected position in said throat. The said means comprises generally an unloading turret or wheel 200 which is provided with a plurality of radial bores 202, 202, each adapted to receive the projecting end of a drill W. The unloading turret or wheel 20 is indexed or rotated through a selected angle intermittently so that the radial bores 202, 202 move upwardly into register with the discharge end of the grinding throat in succession. The pro-

jecting ends of the drills W are entered in the bores 202, 202 in succession as the drills reach the aforesaid selected position in the grinding throat and are moved upwardly and away from the said throat discharge end in an arc lying in a substantially vertical plane whereby the said drills are lifted upwardly from the grinding throat in a pivotal movement. When the drills are pivoted to a selected position, they fall by gravity from the radial bores 202, 202 into a receiving chute 203. In order that the unloading wheel 200 may be indexed at the proper instant to lift the drills out of the grinding throat when they reach the said selected position, there is provided a control means which is operable responsive to drill position to cause an operating means for the unloading wheel to index the same.

As previously mentioned, the unloading apparatus of the grinding machine is preferably supported for movement with the work-rest 22 and the slide or saddle 26 whereby the said apparatus will be moved with the work supporting blade 24. As best illustrated in FIG. 2, a base 204 of the unloading apparatus is rigidly secured to the slide or saddle of the grinding machine as by suitable welding. Mounted on the base 204 is a longiutdinally adjustable supoprting block 206. The said supporting block is secured in position by suitable binder bolts 208 which extend through longitudinally extended slots 210 formed in the base 204 and the supporting block may be conveniently moved longitudinally by a suitable handscrew 212. Supported on the block 206 for lateral movement is a generally L-shaped bracket 214. The said bracket is secured to the supporting block 206 by the binder bolts 208, 208 which extend through laterally extended slots 216 formed in the bracket. The lateral position of the bracket 214 may be conveniently adjusted by a handscrew 218. The bracket 214 supports a platform 220 for vertical movement relative thereto and the said platform has the afore-mentioned unloading wheel 200 and its operating means mounted thereon. A pair of binder bolts 222, 222 secure the platform 220 to the bracket 214 and extend through vertically extended slots 224, 224 formed in said bracket. Vertical adjustment of the position of the platform 220 may be conveniently accomplished by means of a suitable handscrew 226 and indication of the vertical position of the said platform relative to said bracket is provided by a suitably calibrated scale 228.

From the foregoing it will be apparent that a desired position of the unloading wheel 200 and its drill receiving bores 202, 202 relative to the discharge end of the grinding throat may be established by effecting suitable adjustments of the positions of the supporting block 206, the bracket 214, and the platform 220. Once established, the desired relationship between said wheel and said throat discharge end will be maintained irrespective of movement of the work supporting blade 24.

As best illustrated in FIGS. 8 and 10, in the preferred construction of the apparatus the unloading wheel 200 is provided with six radial bores 202, 202 and is fixedly supported on a stub shaft 230 for rotation therewith by means of a key 232 and a nut 234. The stub shaft 230 extends horizontally and laterally of the grinding machine and is rotatably supported in bushings 236, 236 disposed in a suitable opening in a bearing block 238. The bearing block 238 is disposed within a housing 240 and is supported on a mounting plate 242 which is secured to the platform 220 which supports the unloading apparatus. The shaft 230 projects through the side of the housing 240 and the unloading wheel 200 is mounted on the projecting end of the said shaft.

The control means which is operable responsive to the position of the drills W may take various forms within the scope of the invention. In its presently preferred form, the said means comprises a highly sensitive switch which is indicated generally at 244 and which is actuated by the projecting end of a drill within a bore 202 to complete an electrical circuit to ground. A switch armature 246 disposed within the housing 240 is provided with a contact button 248 at one end thereof and is connected at its opposite end to a pivotally supported lever 250. The lever 250 is supported intermediate its ends by a pivot pin 252 carried by the bearing block 238 and at the end of said lever 250 opposite the armature 246 there is provided a drill engaging pin 254. The pin 254 extends laterally from the lever 250 through the side of the housing 240 and into an annular groove 256 formed in the face of the unloading wheel 200. The said annular groove 256 communicates with the inner ends of the bores 202, 202 in the wheel 200 and the free end of the pin 254 is disposed in said groove so as to project into the inner end portion of each of the bores 202, 202 and thus into the path of a drill when the bores are in registry with the discharge end of the grinding throat. Thus, when a drill enters a bore 202 from the grinding throat the projecting end of the drill engages the pin 254 and causes the lever 250 to be pivoted about the pin 252. Since the distance from the contact button 248 at the end of the switch armature 246 to the pivot pin 252 is substantially greater than the distance from said pin 252 to the work engaging pin 254, only a very slight movement of the pin 254 is required to provide a substantial movement of the contact button 248.

When the contact button 248 is moved as described by engagement of the end of a drill with the pin 254, the said button engages a second contact button 258 and grounds a conductor 260 which is connected to the said button 258 within a terminal block 262 mounted on the housing 240. As will be described more fully hereinbelow, grounding of the conductor 260 results in actuation of the operating means for the unloading wheel 200 whereupon the said wheel is indexed or rotated through a selected angle to lift or pivot a drill W upwardly from the grinding throat and to move a succeeding bore 202 into registry with the discharge end of said throat.

The operating means for intermittently indexing the unloading wheel 200 preferably comprises a pawl and indexing wheel device 264 which is operated by a conventional air cylinder 266. As best illustrated in FIG. 8, there is formed integrally on the stub shaft 230 at the end opposite the unloading wheel 200 an indexing wheel 268. The indexing wheel 268 carries a plurality of pins 270 which are arranged in an annular series and which project axially from the radial surface of said wheel. When the unloading wheel 200 is provided with six radial bores, as shown, the wheel 268 is provided with a like number of pins 270. The pins 270 are adapted to be engaged by a pawl 272 which is pivotally supported at the projecting end of a piston rod 274 of the air cylinder 266. Also carried on the projecting end portion of the piston rod 274 is a mounting block 276 which in turn carries a biasing spring 278. The spring 278 maintains the pawl 272 in engagement with the radial surface of the wheel 268 from which the pins 270 project.

The operating means for the unloading wheel 200 preferably also includes a locking device 280 which is adapted to establish the indexed positions of the wheel 200 with a high degree of accuracy and to lock the said wheel in each of said positions between indexing movements thereof. As shown, the said device comprises a pivotally supported latch 282 which is adapted to be moved into and out of locking engagement with the wheel 268 in timed relation with the indexing movements of the wheel. Formed at the periphery of the wheel 268 are six locking notches 284, 284. Said notches are spaced to correspond with the six index positions of said wheel and of the unloading wheel 200. The latch 282 is entered in the notches 284 in sequence and when so entered, the said latch accurately establishes the indexed position of the wheel 268 and thus the indexed position of the unloading wheel 200 so that a radial bore 202 of the latter may receive the projecting end of a drill W. During indexing movements of the wheels 268 and 200, the latch 282 is pivotally re-

tracted from locking engagement with the notches 284, 284 by the next described means.

A pivotally supported notched member 286 (FIG. 9) which is carried by the mounting block 276 on the projecting end of the piston rod 274 moves the latch 282 into and out of engagement with the notches 284 in the wheel 268. An ear 288 formed on the latch 282 is entered in the notch of the member 286 and is engaged by the edges of said notch to pivot the said latch as the member 286 is moved with the said mounting block. That is, when the air cylinder 266 is operated to index the wheel 200, the notched member 286 is moved toward the axis of the wheels 200 and 268 by the mounting block 276 and engages the ear 288 so as to pivot the latch 282 out of engagement with the index wheel notches 284, 284 against the bias of a leaf spring 290. The pawl 272 then engages one of the pins 270 on the indexing wheel and rotates the said wheel and the unloading wheel 200 toward the next succeeding index position. During said indexing movement of the pawl 272, the ear 288 of the latch 282 is urged out of the notch of the member 286 by the rear or trailing edge of said notch and said ear slides along the face of the member 286 and then off the curved rear or trailing edge 292 of said face (FIG. 9). When this occurs, the biasing spring 290 causes the latch 282 to engage the radial face of the index wheel 268 between the notches 284, 284. As the indexing movement of the pawl 276 and the wheel 268 continues, the latch 282 is maintained in engagement with said radial face of the wheel 268 under the bias of the spring 290 until a locking notch 284 is rotated nearly into registry with the said latch. When a notch 284 is so positioned, relative to the latch 282, the said latch enters a receiving groove 294 which extends forwardly from the leading edge of said notch and further rotation of the index wheel causes the trailing edge of said notch to engaage the adjacent edge portion of the latch whereupon the said latch enters the notch with a snap movement under the bias of the spring 290. Thus a positive stop for the indexing movement of the wheel 268 is provided, the angle through which the wheels 200 and 268 are rotated is accurately determined, and the indexed position of the said wheels is accurately established. During the return movement of the piston rod 274, the ear 288 of the latch 282 engages the curved trailing edge 292 of the said member 286 whereby to momentarily pivot the said member upwardly against the bias of a spring 296 and re-enter the notch of the said member.

In addition to the above-described parts thereof, the unloading apparatus preferably includes first and second limit switches 298 and 300 (FIG. 2). The first limit switch 298 is adapted to be actuated by a contact button 302 when the piston rod 274 of the air cylinder 266 completes an indexing stroke and the second limit switch 300 is adapted to be actuated by a contact button 304 when the said piston rod completes a return stroke. The limit switch 298 is supported on a rearwardly extending portion of the housing 240 of the unloading apparatus and the limit switch 300 is supported on a suitable bracket 306 which is secured to and extends upwardly from the platform 220. The contact buttons 302 and 304 are adjustably connected with the piston rod 274 for movement therewith by means of supporting rod 308, a yoke 310 and button carrying member 312.

From the foregoing description of the grinding machine, it will be apparent that the said machine can be set up for automatic operation wherein one cycle of operation will complete the grinding of one workpiece. As will become apparent, production operation requires an operator only for the purpose of starting and stopping the machine at the control panel 16 whether the workpieces to be ground are of uniform or non-uniform diameter throughout their lengths.

When the workpieces are of uniform diameter, the unloading apparatus of the grinding machine, as stated above, is not required and the workpieces pass longitudinally through the grinding throat of the machine in a conventional through-feed operation and may be collected at the discharge end of said throat on a suitable conveyor or in a suitable receptacle. In setting up for such automatic operation, the grinding and regulating wheels are dressed and their positions are adjusted as required, a selector cylinder 36 having flutes of a suitable size for receiving the workpieces is incorporated in the loading apparatus, and the workpieces are deposited in the hopper 30 with the position of the hopper partition 176 suitably adjusted. Appropriate adjustments are made at various points in the loading apparatus to position the discharge end of the delivery channel 38 in registry with the receiving end of the grinding throat whereupon the machine is conditioned for automatic operation.

When workpieces having non-uniform diameters throughout their length, such as the twist drill W, are to be ground, the grinding and regulating wheel surfaces are dressed as described above and their positions are adjusted as required. The loading apparatus is set up as described above and the unloading apparatus is incorporated in the machine. Suitable adjustments are effected in the unloading apparatus to position the unloading wheel bores in proper relation to the discharge end of the grinding throat and the machine is then conditioned for automatic operation.

Obviously, the means for controlling the automatic operation of the grinding machine may take a variety of forms. The control means for automatically operable mechanisms and devices such as wheel dressers which may be included in the grinding and regulating wheel section 10 of the machine as well as control means for the grinding and regulating wheel operating means may be conventional and illustration and description of such means is not deemed essential for a full understanding of the invention. On the other hand, it is believed that description of exemplary means for controlling the automatic operation of the loading and unloading apparatus of the grinding machine, although said means may be partly conventional, will contribute to a full understanding of the features and operation of said apparatus.

As previously mentioned, conventional air cylinders are preferably utilized throughout the loading and unloading aparatus of the grinding machine as operating means for the various power driven mechanisms and devices of said apparatus. In further accord with conventional practice, each of the said air cylinders is preferably provided with a two-position solenoid operated control valve for selectively introducing pressurized air to opposite sides of the cylinder pistons and for selectively venting or exhausting the air chambers on opposite sides of the cylinder pistons whereby to impart the required intermittent reciprocable motion to said cylinder pistons and their respective piston rods. Such control valves are well known and it is deemed unnecessary for the purposes of the invention to show and describe their detailed construction. The manner in which the operation of the said valves is controlled by an exemplary electrical control system is, however, contributive to a full understanding of the invention and will now be described.

The position of the control valve for the air cylinder 82 which operates the delivery rod 40 is regulated by first and second solenoids which are illustrated schematically and designated respectively by the reference numerals 314 and 316 in FIG. 11. When energized the first solenoid 314 moves the said control valve to one position wherein it causes the piston and piston rod of the air cylinder 82 to be moved so as to drive the delivery rod 40 rearwardly in the grinding machine for delivery of a workpiece to the machine's grinding throat. There is no spring return provision in the said solenoid 314 or the control valve for the air cylinder 82. Thus, momentary energization of the solenoid 314 will result

in commencement of a feed stroke of the delivery rod 40 and if the solenoid 314 is thereafter de-energized, the control valve will remain in its said one position and the feed stroke of the rod 40 will be completed. Movement of the control valve for the air cylinder 82 to its other position wherein the said cylinder is caused to retract the delivery rod 40 is accomplished by energization of the second solenoid 316. Operation of the cylinder 82 responsive to energization of the solenoid 316 is similar to that which occurs when the solenoid 314 is energized. That is, momentary energization of the solenoid 316 results in commencement of a return stroke of the delivery rod 40 and subsequent de-energization of said solenoid will not terminate the said stroke, there being no spring return provision in the solenoid or the control valve for the air cylinder.

The control valves for the air cylinders 196 and 142 which respectively actuate the workpiece agitating member 186 and the pawl and ratchet wheel device which indexes the fluted receiver cylinder 36 are moved simultaneously from one position to the other by a third solenoid indicated at 318 in FIG. 11. When energized the solenoid 318 simultaneously moves the said two control valves to positions wherein they respectively cause the air cylinders 196 and 142 to actuate the agitating member 186 and to index the receiver cylinder 36. The solenoid 318 is of the spring return type and, thus, when the said solenoid is de-energized, the said two control valves are simultaneously moved to their other positions wherein they respectively cause the piston rods of the air cylinders 196 and 142 to be retracted for succeeding workpiece agitating and cylinder indexing movements.

The position of the control valve for the air cylinder 266 which actuates the pawl 272 whereby to index the unloading wheel 200 is regulated by a fourth solenoid which is designated by the reference numeral 320 in FIG. 11. When the solenoid 320 is energized, it adjusts the position of the said control valve so that the air cylinder 266 is operated to index the unloading wheel 200 and when the said solenoid is de-energized, a spring return provision causes the control valve to operate the air cylinder 266 so that its piston and piston rod are retracted for a succeeding indexing movement or stroke.

The manner in which the above-mentioned solenoids are energized and de-energized and the manner in which the automatic operation of the grinding machine is regulated and controlled by the electrical control system of FIG. 11 will now be described, it being understood that many specifically different electrical control systems can be provided within the scope of the invention. It will be observed that all of the electrical control elements of the system are supplied with energy from two lead lines L1 and L2 which may be connected with a conventional source. A normally closed switch is located in the lead line L1 and comprises an emergency stop switch which when opened will de-energize the entire electrical system. Also located in the lead line L1 is a connector 324 and located in the lead line L2 is a similar connector 326. The portion of the electrical system which appears below the connectors 324 and 326 in the wiring diagram of FIG. 11 is utilized only in controlling the operation of the unloading apparatus of the grinding machine and may be disconnected from the rest of the system when the said apparatus is not utilized as in the grinding of workpieces having uniform diameters. The electrical control system will first be considered as it relates to the control of the grinding machine in grinding operations on uniform workpieces and accordingly the portion of the system below the connectors 324 and 326 may be ignored for the present.

With the grinding machine set-up as described above for the automatic grinding of uniform workpieces, the machine operator may initiate automatic operation of the machine by pressing a push button on the control panel 16 which closes a switch 328 in circuit with the solenoid 314. The switch 328 is of the type which is spring biased toward its open position and it therefore opens the circuit de-energizing the solenoid 314 when the push button is released by the operator. Since there is, however, no spring return provision in the solenoid 314 or in the control valve which it operates, the momentary energization of said solenoid will result in movement of the control valve to a position wherein it causes the air cylinder 82 to initiate a self-sustaining feed stroke of the delivery rod 40 as described above.

In addition to the switch 328, there is also associated with the aforesaid control panel push button a switch 330 which is connected in parallel with the switch 328 and in circuit with the solenoid 314. The switch 330 is connected with the control panel push button so as to be operated by said button selectively. That is, a connection is provided between the said button and switch which permits the machine operator to close the switch 330 by pressing said button or to press said button without affecting the position of said switch at his option. As will be explained more fully hereinbelow, the electrical system is conditioned to control the automatic operation of the grinding machine when the switch 330 is closed by depression of the control panel push button. When the position of the switch 330 is unaffected by depression of the said button, the grinding machine will complete one cycle of operation and will then stop automatically as will also be explained. Description of the detailed construction of the switches 328 and 330 and connecitng means between said switches and the control panel push button is deemed unnecessary for an understanding of the invention, as switching devices adapted to be operated as described are well known. For example, one conventional switching device suitable for the purposes of the invention comprises a push button which is rotatable to two discreet positions and which is connected with first and second switches so that it momentarily closes the first switch (such as 328) and permanently closes the second switch (such as 330) when depressed in one rotated position and so that it momentarily closes the first switch (328), but does not affect the position of the second switch (330) when depressed in its other rotated position.

Irrespective of the position of the switch 330, the feed stroke of the delivery rod 40 initiated by the momentary energization of the solenoid 314 upon closing of the switch 328 will continue until the workpiece has been properly entered in the grinding throat for the reasons given above. When the feed stroke is completed, the limit switch 108 will be closed in circuit with the solenoid 316. Also connected in circuit with said solenoid and limit switch is the limit switch 162 which is associated with the air cylinder 196 which actuates the indexing means for the receiver cylinder 36. Said limit switch 162 is normally closed in circuit with the switch 108 and the solenoid 316 and said solenoid is therefore energized upon closing the limit switch 108. When the solenoid 316 is energized, it adjusts the position of the control valve for the air cylinder 82 so that said cylinder is operated to initiate a return stroke of the delivery rod 40 as stated above. Connected in parallel with the solenoid 316 is a control relay CR1 which is also energized upon closing of the limit switch 108 and which closes a normally open switch 332 when so energized. The switch 332 shunts the limit switch 108 and maintains the solenoid 316 in an energized condition upon opening of the said limit switch 108 which occurs as the return stroke of the delivery rod 40 commences.

It will be recalled that it is unnecessary to maintain energization of the solenoid 316 in order to effect a completed return stroke of the delivery rod 40. The control relay CR1 and the switch 332 operated thereby are not, however, superfluous. It will be observed that the solenoid 318 which controls operation of the agitator air cylinder 142 and the air cylinder 196 which indexes the

receiver cylinder 36 is connected in parallel with the solenoid 316 and in circuit with the switch 332. Also connected in parallel with the solenoid 316 and in circuit with the switch 332 and the solenoid 318 is the limit switch 106 actuated by the delivery rod air cylinder 82. Said limit switch 106 is closed in circuit with the switch 332 and the solenoid 318 when the delivery rod 40 completes its return stroke and the solenoid 318 is thereby energized. Energization of the solenoid 318 results in actuation of the agitator 32 and indexing of the receiver cylinder 36, as described above, a workpiece thus being deposited in the delivery channel 38 for a succeeding feed stroke of the delivery rod 40.

Referring again to the limit switch 162 associated with the air cylinder 196 which indexes the receiver cylinder 36, it will be noted that the said switch is actuated upon termination of the indexing movement of the piston rod 150 of said air cylinder. When so actuated the limit switch 162 is opened in the circuit which includes the solenoids 316 and 318 and the control relay CR1. Resulting de-energization of the solenoid 316 has no effect on the position of the delivery rod 40 for the reasons given above, but de-energization of the solenoid 318 results in the spring return movement of the control valves for the cylinders 142 and 196 and in retraction of their respective piston rods. De-energization of the control relay CR1 opens the switch 332 so that subsequent closing of the limit switch 162 upon completion of the retracting movement of the piston rod 150 of the air cylinder 196 cannot result in automatic re-energization of the solenoids 316 and 318 and said relay CR1.

The limit switch 162 is thus actuated momentarily and when so actuated during its momentary actuation, in addition to its operation described above, it sets a timer 334 in operation. Said limit switch is connected in circuit with the timer 334 and is closed to initiate timer operation when the air cylinder 196 completes an indexing stroke as described. There is also connected in circuit with the timer 334 and in parallel with the limit switch 162 a normally open switch 335 and a normally closed switch 336. The normally open switch 335 is controlled by the timer 334 and is closed thereby when the timer is set in operation. The normally closed switch 336 is controlled by the control relay CR1 and is closed when said relay is in a de-energized condition. Thus, the limit switch 162 is shunted and the timer 334, having once been set in operation, will be supplied with power through the switches 335 and 336 and will continue to operate until a predetermined period of time has elapsed. At the end of said predetermined time period, the switch 335 will be opened by the timer and its operation will be self-terminated. There is also provided in circuit with the timer 334 a control switch 337 which when closed energizes the timer for operation by the limit switch 162 and the switches 335 and 336. When the control switch 337 is opened, the timer 334 is de-energized and has no effect on the remaining elements of the control system.

During the predetermined time period of operation of the timer 334 and near the end of said period of operation, the said timer momentarily closes a normally open switch 338. The switch 338 is connected in circuit with the aforesaid push button actuated switch 330 and in circuit with the solenoid 314 which effects feed strokes of the delivery rod 40. The time period which elapses between initiation of timer operation and the momentary closing of the switch 338 is such that the desired grinding operation on a workpiece may be properly completed or, in any event, said time period is of long enough duration so that a workpiece which is being ground will have advanced far enough into the grinding throat so as not to interfere with the delivery of a succeeding workpiece to said throat. It will be apparent, that if the switch 330 is closed for automatic operation of the machine, the momentary closing of the switch 338 by the timer 334 will result in energization of the solenoid 314 and a new cycle of machine operation will be thereby initiated. If on the other hand the switch 330 is open, single cycle operation of the machine having been selected, the momentary closing of the switch 338 will have no effect.

When non-uniform workpieces are to be ground in the machine, the elements of the afore-mentioned lower portion of the wiring diagram are utilized and the switch 337 is opened to de-energize the timer 334. The control panel push button is pressed as described above to set the machine in operation for either a single cycle of operation or a series of automatically controlled cycles of operation. The electrical control system then regulates the operation of the loading apparatus as described above and a workpiece such as a drill W is delivered to the grinding throat of the machine and advances through said throat until its end projects beyond the discharge end of said throat and into a radial bore of the unloading wheel 200. When the projecting end of the drill or other workpiece engages the pin 254 in the radial bore of the unloading wheel 200 so as to pivot the lever 250 and move the switch armature 246 to close a circuit to ground, the unloading apparatus is set in operation as described hereinbelow.

Completion of a circuit to ground by the armature 246 energizes an electronic relay 340 and results in closing of a normally open switch 342 which is controlled by said relay. The switch 342 is in circuit with the solenoid 320 which controls the operation of the air cylinder 266 which indexes the unloading wheel 200 and said switch is also in circuit with the limit switch 298 which is actuated when the piston and piston rod of the said cylinder reach the end of an unloading indexing stroke. The limit switch 298 is normally closed and is opened when actuated as described. Thus, closing of the switch 342 results in energization of the solenoid 320 and operation of the air cylinder 266 to index the unloading wheel 200. A control relay CR2 which is connected in parallel with the solenoid 320 is also energized when the switch 342 is closed and said relay in turn closes a normally open switch 344 which is connected in parallel with the said switch 342. In closing, the switch 344 shunts the switch 342 so as to maintain the solenoid 320 and its relay CR2 in an energized condition after the indexing movement of the unloading wheel 200 has been initiated and the workpiece thereby moved out of engagement with the pin 254 to open the circuit to ground through the switch armature 246 and de-energize the electronic relay 340. There is also connected in parallel with the limit switch 298 and the relay control switches 342 and 344, a manually operable switch 346. The switch 346 is normally open for automatic operation of the grinding machine but may be closed by the machine operator to energize the solenoid 320 and thereby to index the unloading wheel 200.

While the wheel indexing movement of the air cylinder 266 is in progress, the limit switch 300, which is actuated when the piston and piston rod of said cylinder are in the retracted position, is closed and when said piston and piston rod are retracted the said switch is open. The switch 300 is connected in circuit with the push button operated switch 330 and the solenoid 314 which effects feed strokes of the delivery rod 40. Located between the switch 300 and the push button operated switch 330 is a normally open switch 348. The switch 348 is controlled by the control relay CR2 and is closed when the said relay is energized. Thus, it will be seen that when the solenoid 320 is energized to initiate an indexing stroke of the air cylinder 266, the switch 348 will be closed. As the indexing stroke of the piston and piston rod of the air cylinder 266 begins, the limit switch 300 will also be closed and if the push button operated switch 330 is closed for automatic operation of the machine the solenoid 314 will be energized to initiate a feed stroke of the delivery rod 40. If the push button operated switch 330 is open for single cycle operation of the machine, closing of the switches 300 and 348 will, of course, have no effect.

It will be apparent that by providing the two switches 300 and 348 in circuit with the solenoid 314, initiation of a feed stroke of the rod 40 and a new cycle of machine operation is made dependent upon the absence of a workpiece in the grinding throat which might interfere with the proper delivery of a succeeding workpiece to said throat. The solenoid 314 cannot be energized to initiate a cycle of operation unless both of said switches are closed. When both of the switches 300 and 348 are closed, it is known that the control relay CR2 and thus the solenoid 320 has been properly energizd and it is further known that an indexing movement of the air cylinder 266 has been initiated. Once such a movement of the said cylinder has been initiated, it may reasonably be expected that said movement will be completed and that the workpiece which has set the unloading apparatus in operation will be properly lifted from the grinding throat so as not to interfere with a succeeding workpiece.

The invention claimed is:

1. A work loading apparatus for a centerless grinder of the type adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, said apparatus comprising means defining a generally longitudinal delivery channel having its discharge end adjacent the entry of the grinding throat, a longitudinally reciprocable delivery rod for successively thrusting workpieces along the delivery channel toward its discharge end and at least partly entering the workpieces in said grinding throat, a hopper adapted to hold a stacked supply of workpieces with their axes generally longitudinal and having a generally longitudinal slot in a lower portion thereof for the gravity discharge of said workpieces, an agitator associated with the hopper comprising a pivotally supported agitating member engaging the workpieces in a lower portion of the hopper and operating means for intermittently actuating said member so that it is pivoted toward the workpieces to effect relative movement between them whereby to prevent bridging and interlocking of the workpieces and to insure that they may fall freely through said hopper discharge slot, a receiver disposed beneath the hopper and above the delivery channel and adapted to accept workpieces one at a time from said hopper discharge slot and to deposit said workpieces one at a time in said delivery channel for delivery to the grinding throat by said rod, and intermittent drive means for operating said receiver to deposit workpieces in the delivery channel in timed relation with the reciprocal movement of said rod.

2. A work loading apparatus as set forth in claim 1 wherein the pivotally supported agitating member extends longitudinally adjacent and in engagement with the workpieces in a lower portion of the hopper and wherein said member is provided with at least one longitudinal rib which engages and provides a lifting action on the workpieces to effect relative movement therebetween when the agitating member is pivoted by its operating means.

3. A work loading apparatus for a centerless grinder of the type adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, said apparatus comprising means defining a generally longitudinal delivery channel having its discharge end adjacent the entry of the grinding throat, a longitudinally reciprocable delivery rod for thrusting workpieces along the delivery channel toward its discharge end and at least partly entering the workpieces in said grinding throat, operating means for reciprocating said rod, adapted to hold a stacked supply of workpieces with their axes generally longitudinal and having a generally longitudinal slot in a lower portion thereof for the gravity discharge of said workpieces, an agitator associated with the hopper comprising a pivotally supported agitating member engaging the workpieces in a lower portion of the hopper and comprising operating means for actuating said member to pivot the same toward the workpieces and effect relative movement between them whereby to prevent bridging and interlocking of the workpieces and to insure that they may fall freely through said hopper discharge slot, a receiver disposed beneath the hopper and above the delivery channel and comprising a fluted cylinder supported for rotation about a longitudinal axis within a housing having longitudinal slots in upper and lower portions thereof respectively for receiving workpieces from said hopper discharge slot and for discharging workpieces to said delivery channel, a ratchet wheel and pawl device connected with said fluted cylinder and operable when actuated to rotate said cylinder through a selected angle so that one of said cylinder flutes registers with said upper housing slot to receive a workpiece from the hopper discharge slot while an opposite flute registers with said lower housing slot to discharge a workpiece to the delivery channel, operating means for actuating said ratchet wheel and pawl device, and electrical control means for intermittently actuating said delivery rod operating means and said ratchet wheel and pawl operating means and said agitator operating means in timed relation with each other.

4. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having at least one generally radial passage adapted to receive the projecting end portion of a workpiece, and means operable when a workpiece has reached said preselected position in the grinding throat and when its projecting end portion has entered said passage to rotate the wheel so that said workpiece is lifted upwardly from the grinding throat.

5. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, and intermittent drive means for rotating the unloading wheel so that said passages move upwardly into longitudinal registry with the discharge end of the grinding throat in succession and so that the projecting ends of successive workpieces are entered in said radial passages as they register with said throat discharge end, the said workpieces being thereby lifted upwardly from the grinding throat in succession as they reach said preselected position in the throat.

6. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the marhine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, intermittent drive means for rotating the unloading wheel so that said passages move upwardly into longitudinal registry with

the discharge end of the grinding throat in succession to receive the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession, and electrical control means operable to cause said intermittent drive means to rotate said unloading wheel when a workpiece reaches said preselected position in the grinding throat wherein its projecting end portion is entered in an unloading wheel passage.

7. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, intermittent drive means for rotating the unloading wheel so that said passages move upwardly into longitudinal registry with the discharge end of the grinding throat in succession to receive the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession, and automatically operable locking means for positively preventing rotation of said unloading wheel when said intermittent drive means is not operable to rotate same.

8. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotating about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, an indexing wheel connected in driving relationship with the unloading wheel and adapted to be rotated through a selected angle by a pawl whereby to rotate said unloading wheel through a similar angle and cause adjacent radial passages in said wheel to move upwardly out of longitudinal registry with the discharge end of the grinding throat and to move into registry with said throat discharge end, a pawl for rotating the indexing wheel, and operating means for intermittently actuating said pawl to rotate the indexing and unloading wheels whereby said unloading wheel passages are caused to register with the discharge end of the grinding throat in succession for receiving the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession.

9. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove work pieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, an indexing wheel connected in driving relationship with the unloading wheel and adapted to be rotated through a selected angle by a pawl whereby to rotate said unloading wheel through a similar angle and cause adjacent radial passages in said wheel to move upwardly out of longitudinal registry with the discharge end of the grinding throat and to move into registry with said throat discharge end, a pawl for rotating the indexing wheel, operating means for intermittently actuating said pawl to rotate the indexing and unloading wheels whereby said unloading wheel passages are caused to register with the discharge end of the grinding throat in succession for receiving the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession, and locking means actuated by the pawl and operable to determine positively the angle through which the indexing and unloading wheels are rotated when said pawl is actuated by its operating means and operable also to prevent rotation of said indexing and unloading wheels when said pawl is not actuated to rotate the same.

10. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece, intermittent drive means for rotating the unloading wheel so that said passages move upwardly into longitudinal registry with the discharge end of the grinding throat in succession to receive the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession, electrical control means operable to cause said intermittent drive means to rotate said unloading wheel, and switch means adapted to be operated by a workpiece when the workpiece reaches said preselected position in the grinding throat to actuate said electrical control means whereby to cause said wheel to be rotated.

11. In a centerless grinding machine of the type which is adapted for through-feed operation by longitudinal movement of workpieces in the grinding throat of the machine, a work unloading apparatus adapted to remove workpieces successively from the grinding throat of the machine when the workpieces have reached a preselected position in the throat and project from the discharge end thereof during a through-feed grinding operation, said apparatus comprising a work unloading wheel supported for rotation about a substantially horizontal axis adjacent the discharge end of the grinding throat and having a plurality of generally radial passages each adapted to receive the projecting end portion of a workpiece and also having an annular groove in one of its faces which communicates with each of said generally radial passages, intermittent drive means for rotating the unloading wheel so that said passages move upwardly into longitudinal registry with the discharge end of the grinding throat in succession to receive the projecting end portions of successive workpieces as they are advanced to said preselected position in said throat, the said workpieces thus being lifted upwardly from said grinding throat in succession, electrical control means operable to cause said intermittent drive means to rotate said unloading wheel, and switch means for operating said electrical control means to cause said wheel to be rotated and comprising an armature movable to one position wherein said electrical control means is

so operated and also comprising a member connected with the armature and adapted to be engaged by a workpiece to move the said armature to its said one position, said member being disposed in said annular groove in the unloading wheel so as to project into each of the radial passages in said wheel and into the path of the projecting ends of the workpieces as said passages register in succession with the discharge end of the grinding throat.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,990,656 July 4, 1961

Albert H. Tompkins

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 17, line 67, after "rod," insert -- a hopper --.

Signed and sealed this 21st day of November 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

USCOMM-DC