Sept. 12, 1933. R. A. QUIMBY 1,926,959

WORK HANDLING APPARATUS FOR GRINDING MACHINES AND THE LIKE

Filed May 1, 1929 5 Sheets-Sheet 1

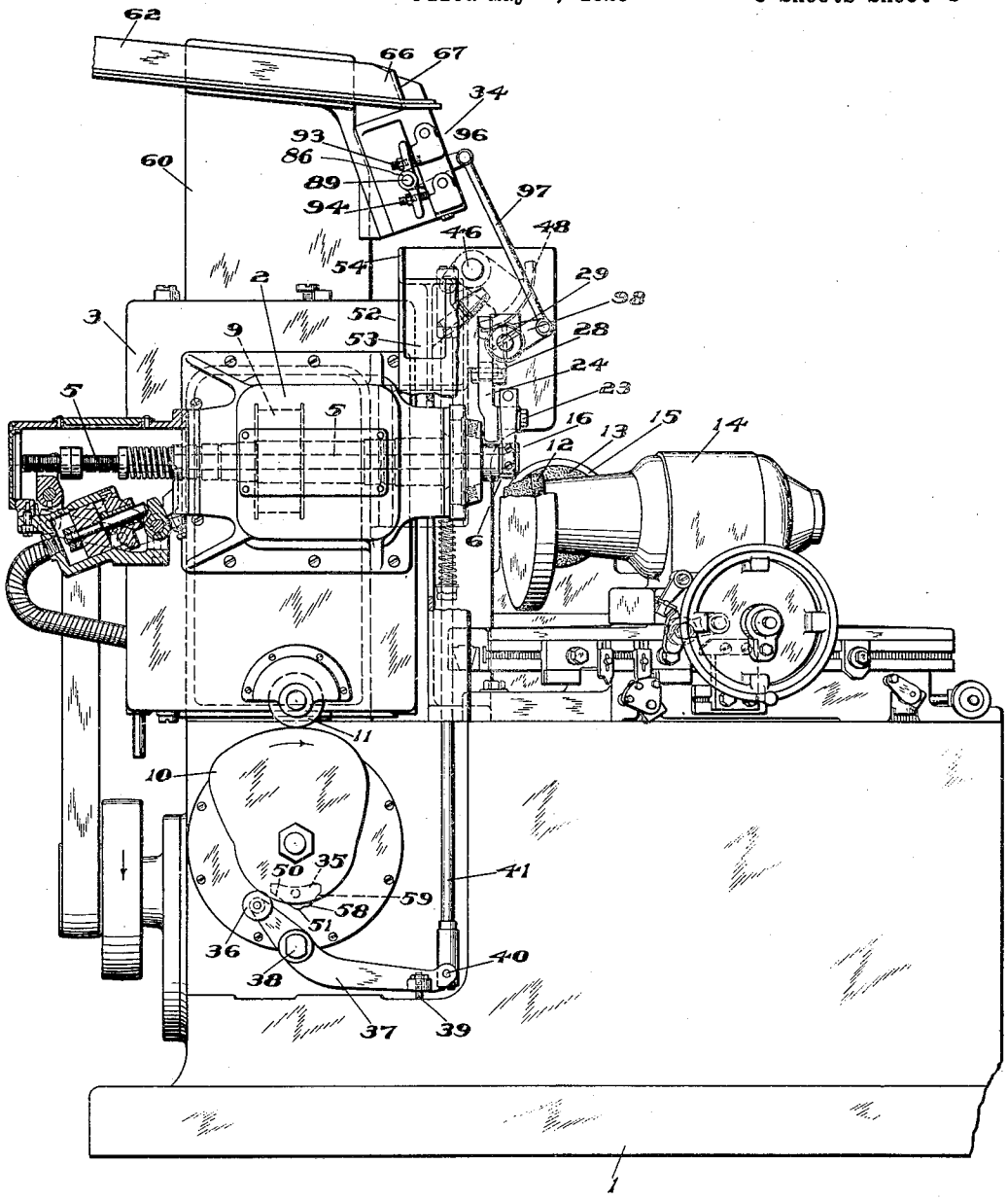


Fig. 1

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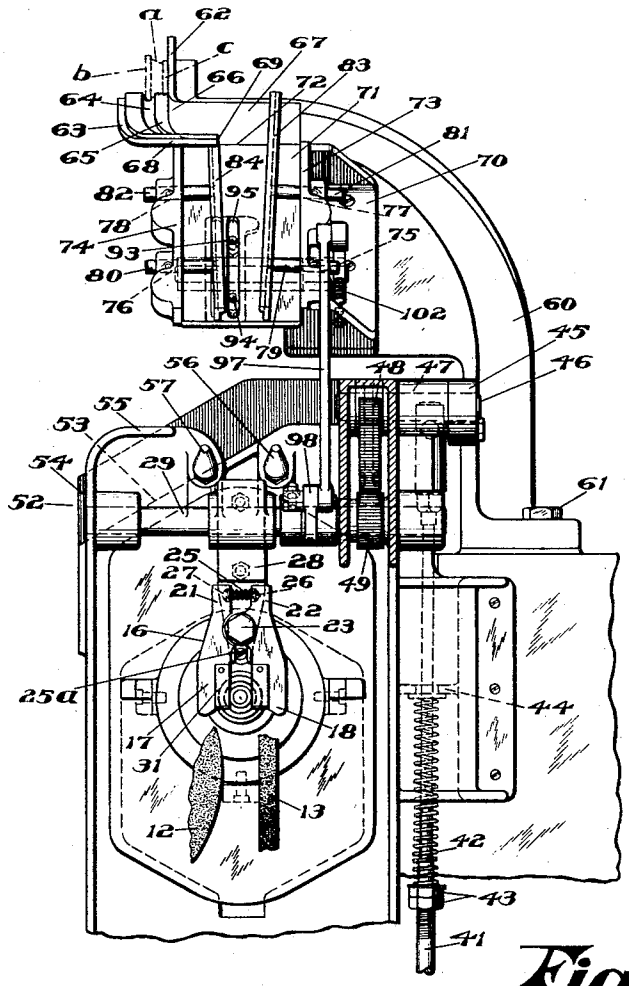


Fig. 2

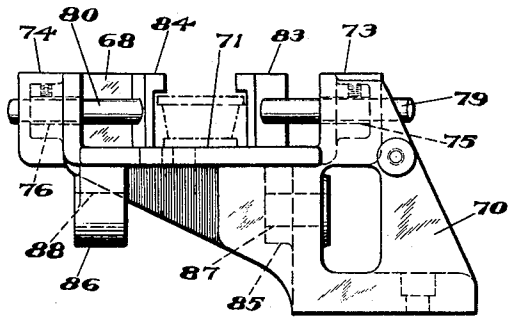


Fig. 10.

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WORK HANDLING APPARATUS FOR GRINDING MACHINES AND THE LIKE

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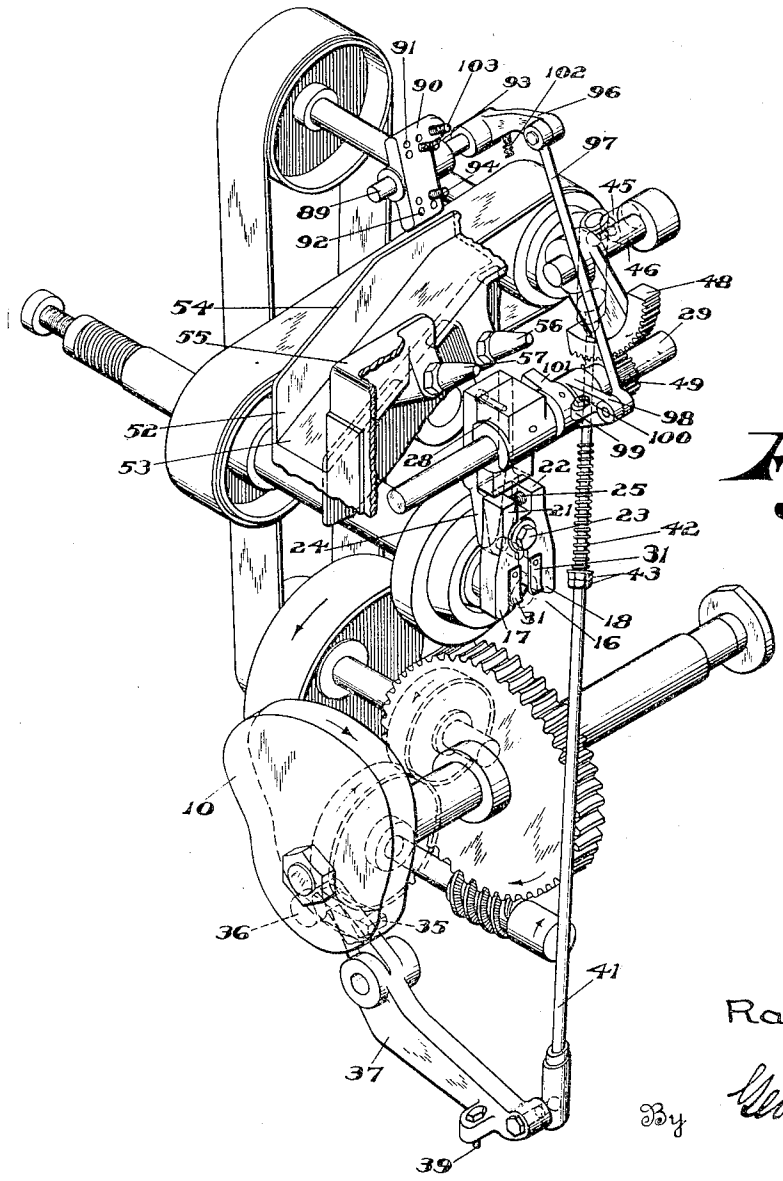


Fig. 3

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WORK HANDLING APPARATUS FOR GRINDING MACHINES AND THE LIKE

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Fig. 4

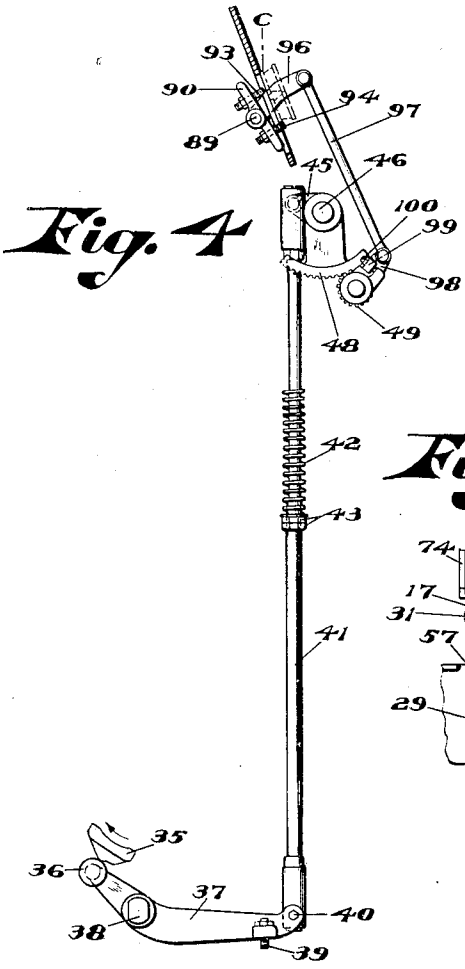


Fig. 5

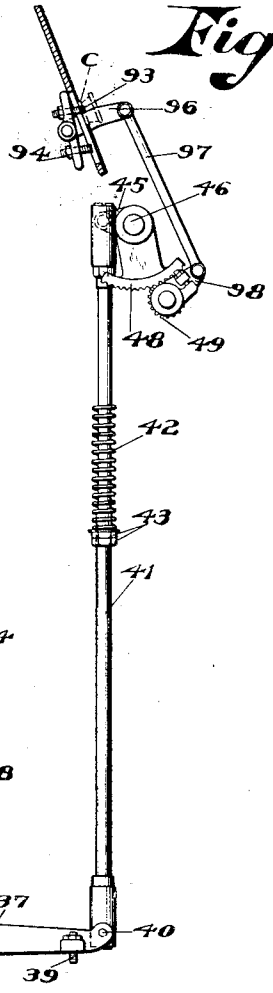
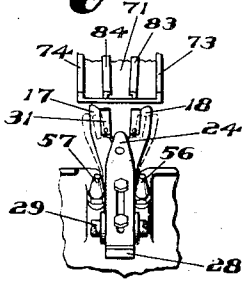


Fig. 6.



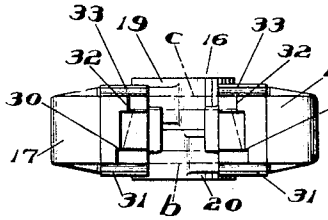


Fig. 7.

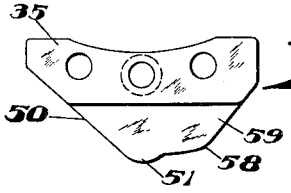


Fig. 8.

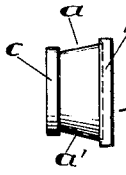


Fig. 9.

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WORK HANDLING APPARATUS FOR GRINDING MACHINES AND THE LIKE

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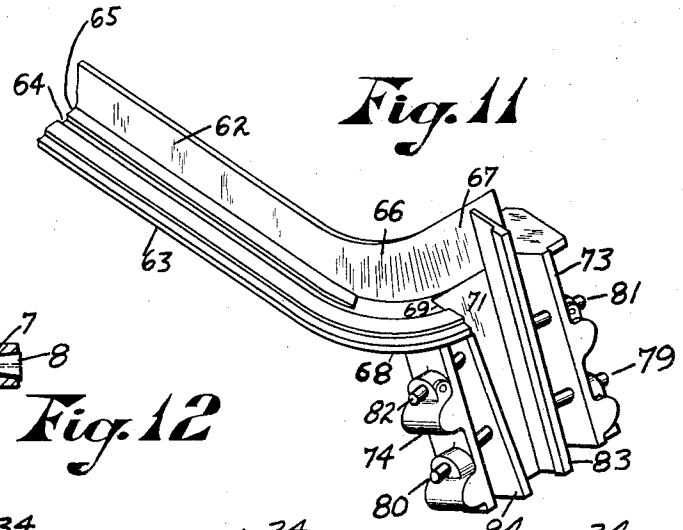


Fig. 11

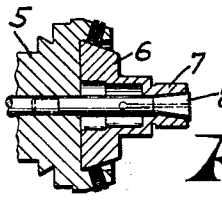


Fig. 12

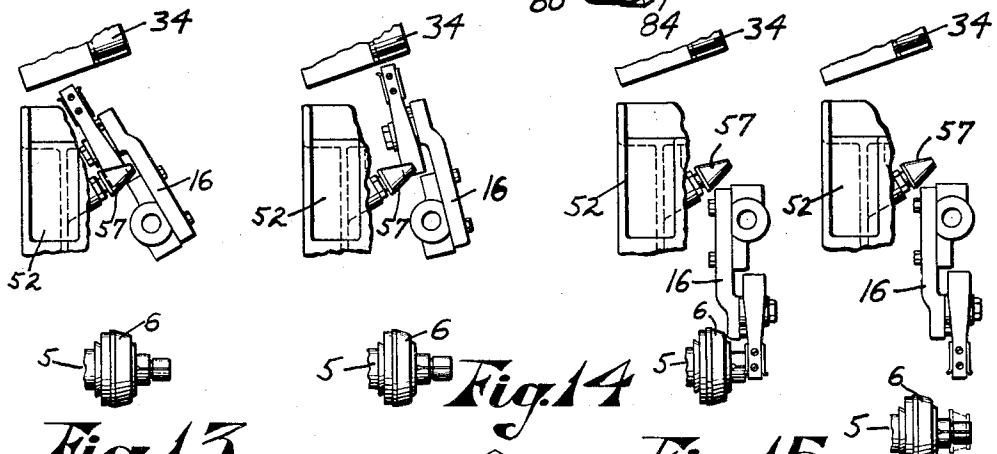


Fig. 13

Fig. 14

Fig. 15

Fig. 16

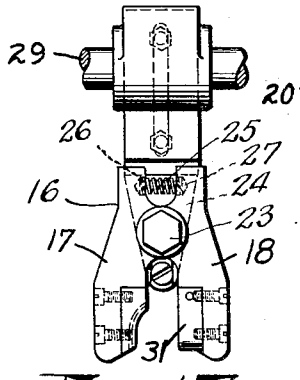


Fig. 17

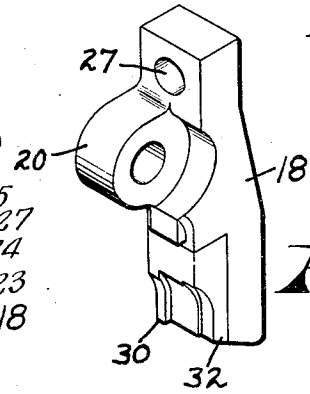


Fig. 18

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UNITED STATES PATENT OFFICE

1,926,959

WORK - HANDLING APPARATUS FOR GRINDING MACHINES AND THE LIKE

Ralph A. Quimby, Worcester, Mass., assignor to The Heald Machine Company, Worcester, Mass., a corporation of Massachusetts

Application May 1, 1929. Serial No. 359,617

16 Claims. (Cl. 51—215)

The present invention relates to the mechanical handling of separate similar workpieces that are operated upon successively in a grinding machine or the like. The invention does away with any need for an operator's attention or intervention, either in presenting the successive workpieces to the work holding devices of the machine, or in removing each finished workpiece from the machine, these respective loading and unloading functions being performed wholly automatically.

According to the invention, an oscillatory workpiece carrier or gripper is so arranged as to procure, by its movement in one direction, the removal of a finished workpiece from the rotary work holding spindle of the machine, such movement ultimately discharging said workpiece in a convenient receptacle; and on the reverse movement of said carrier or gripper, a fresh workpiece is taken from the mouth of a magazine or the like, and is substituted, on said spindle, for the removed workpiece. This apparatus is preferably applied to a grinding machine of the type disclosed in the copending application of Heald, Taylor, Quimby and Highberg, Serial No. 281,888, filed May 31, 1928, now Patent No. 1,841,809, granted January 19, 1932, in which each successive workpiece is carried into contact with the grinding wheel by a rectilinear movement of the work-holding spindle; by the present invention, advantage is taken of this motion, in one direction, to strip an unground workpiece from the carrier or gripper, and in the other direction, to engage a ground workpiece with said carrier or gripper, preparatory to the movement of the latter which strips said workpiece from the spindle.

The above and other novel and advantageous features of the invention will appear more fully hereinafter from the following detailed description of the invention, taken in connection with the accompanying drawings, in which—

Fig. 1 is a view in side elevation of a grinding machine to which the invention is applied.

Fig. 2 illustrates parts of the machine as viewed from the right hand side of Fig. 1.

Fig. 3 is an isometric view of the operating parts shown in Figs. 1 and 2, with the machine frame and workpiece magazine omitted.

Figs. 4 and 5 are fragmentary views of the actuating mechanism for the work carrier, illustrating particularly the magazine escapement mechanism in two different positions.

Fig. 6 is a fragmentary elevational view of the work carrier and magazine, as viewed from the right hand side of Fig. 1.

Fig. 7 is a view looking into the work carrier jaws, which are shown on a somewhat enlarged scale.

Fig. 8 is an enlarged view of the actuating cam which operates the work carrier and escapement mechanism.

Fig. 9 is an enlarged view of one of the workpieces adapted to be handled by the mechanism of the invention.

Fig. 10 is a view on an enlarged scale of the lower portion of the magazine, as viewed from the bottom of the magazine shown in Fig. 2.

Fig. 11 is an isometric view of the work magazine, on a somewhat larger scale than that of Figs. 1 and 2.

Fig. 12 is a fragmentary sectional view of the work holding end of the spindle.

Figs. 13 to 16 inclusive are fragmentary views illustrating different positions of the work spindle and work carrier, in the cycle of operations of the invention.

Fig. 17 is a view in elevation of the work carrier, on a larger scale than that of Fig. 2.

Fig. 18 is an isometric view of one of the jaws of said work carrier.

Like reference characters refer to like parts throughout the drawings.

The machine to which the present invention is herein applied, for purposes of illustration, is a grinding machine of the type disclosed in the aforesaid Patent No. 1,841,809, adapted for the simultaneous performance of two grinding operations on a workpiece *a* such as is shown in Fig. 9 hereof. Said workpiece *a* is the inner cone member of a roller bearing assembly, and requires the grinding of its exterior conical surface *a'*, between the end flanges *b* and *c*, and also the grinding of the inner face of its flange *b*, to provide the undercut surface indicated by the broken lines in Fig. 9.

The grinding machine for this purpose provides a suitable supporting base or frame 1, the latter, as disclosed in the aforesaid Patent No. 1,841,809, having vertical slideways, not shown herein, for the movement of a slide 3, which carries a workhead 2. Suitably journalled in the workhead 2 is a rotary spindle 5 whose projecting end 6, as shown in Fig. 12, is so constructed as to receive and retain one of the workpieces *a*, the bore of the latter being impaled upon the expansible end portions 7, 7 of spindle 5, following which said portions are distended by a member 8, thereby firmly gripping the work-

piece internally, and securing its rotation with the shaft 5 for the above described grinding operations.

The rotation of the work spindle 5 may be effected in any suitable way, as by a belt drive for the pulley 9 secured to said spindle, as fully described in the aforesaid Patent No. 1,841,809, and also in the copending application of Waldo J. Guild, Serial No. 331,833, filed January 11, 1929, now Patent No. 1,901,236, granted March 14, 1933. The slide 3 carries a roller 11 in contact with a cam 10 whose rotation procures the up and down motion of said slide; as fully set forth in the aforesaid Patent No. 1,841,809, the slide 3 has a pronounced dwell at the upper limit of its movement to permit the removal of a ground workpiece *a* from the end of spindle 5 and the placing of an unground workpiece on said spindle. Thereupon, by rotation of cam 10, the slide 3 moves downwardly, carrying the surface *a'* of the unground workpiece into contact with a grinding wheel 12, and at the same time subjecting the inner face of the workpiece flange *b* to the action of a grinding wheel 13. The two rotating grinding wheels 12 and 13, carried respectively by the wheel heads 14 and 15 of the machine, may be operated and controlled, and periodically subjected to dressing or truing in the manner disclosed in the aforesaid Patent No. 1,841,809, these functions, of themselves, forming no part of the present invention. The latter is concerned with instrumentalities, brought into operation on the rise of slide 3 that carries a finished workpiece *a* away from grinding position, for mechanically removing said finished workpiece from the spindle 5 and for placing on said spindle another workpiece to be ground. According to the invention, these operations are performed by a swinging workpiece carrier designated generally by the numeral 16. This carrier 16 rests normally in the lowermost position of its swing, as shown by Figs. 1 and 2, and in this position it receives and engages a finished workpiece *a* as a result of the upward movement of slide 3 that carries the work spindle 5 away from the grinding wheels 12 and 13. As hereinafter described, the upward swing of carrier 16 strips the ground workpiece from the spindle and discharges said workpiece into a suitable receptacle; on the return swing of said carrier, an unground workpiece is picked up from a magazine or other supply means, designated at 34, and by the arrival of said carrier at its rest position is impaled on the spindle 5 while the latter dwells in its non-grinding position; thereupon the downward movement of said spindle under the influence of cam 10 strips the newly received workpiece from the carrier 16 and subjects said workpiece to grinding by the wheels 12 and 13. The construction of the carrier 16 is as follows:—

Referring particularly to Figs. 2, 9, 17 and 18, the work carrier 16 comprises a pair of jaws 17 and 18 having hub portions 19 and 20 offset from each other and tail pieces 21 and 22. The hub portions 19 and 20 provide alined holes, through which a pivot bolt 23 extends, said pivot bolt being attached to an arm 24. A spring 25, the ends of which rest in depressions 26 and 27, forces the tail pieces normally apart, while a stop screw 25*a* carried by the arm 24, holds the jaws in the position shown in Fig. 2. The arm 24 is adjustably attached to a member 28, which is keyed or pinned to a shaft 29. Oscillation of this shaft procures the above described upward and return swings of the carrier 16.

As shown in Fig. 7, the jaws 17 and 18 are adapted, when allowed to come together, to grip and firmly hold a workpiece *a*. The jaws provide shoulders or ledges 30, 30 at one side which, together with a pair of flat springs 31, 31 on said jaws hold the large flange *b* of the workpiece and prevent it from turning side ways. At the other side the jaws provide ledge portions 32, 32 which engage the smaller flange *c*, while flat springs 33, 33 on said jaws help to hold the workpiece in position. The flat springs 31, 31 and 33, 33 are bent outwardly at the ends and assist in guiding the workpiece into position as it falls out of the magazine 34.

The shaft 29 is oscillated in timed relation to the rest of the machine, particularly to the rising and falling of the slide 3, and the means for doing this will now be described.

It will be seen from Fig. 1 and the shape of the cam shown thereon, that slide 3 has a fairly quick movement to substantially its lowermost position, where it has a comparatively long dwell, involving substantially 180 degrees of cam revolution, followed by a fairly rapid movement to the upper position where it again dwells. This cycle of operation is characteristic of the grinding machines of the aforesaid copending applications, and as will be understood, so far as the present invention is concerned, it could be varied within wide limits. Assuming, therefore, a vertical reciprocation of the slide 3, with a substantial dwell at the upper position, the carrier 16 oscillates to remove the ground workpiece from the spindle, discharges it, receives a fresh ground workpiece from the magazine, 34, and moves downward to place this unground workpiece on the spindle 5, all during the dwell of the slide 3 in its upper position. Upon the downward movement of the slide 3, the unground workpiece is withdrawn from the carrier jaws, and upon resuming upward movement of said slide, after the grinding of the workpiece, the latter is reengaged with said jaws.

These being the general conditions, it is apparent that a mechanism timed in relation to the motion of the slide 3, and operating fairly quickly in relation to the motion of this slide, is necessary for carrying the foregoing into effect. As shown in the accompanying drawings and as one way of carrying this into effect, a cam piece 35 is attached to the side of the cam 10 so as to move in unison with it. A roller 36 lies in the path of this cam piece 35 but not in the path of the periphery of the cam 10. The roller 36 is on one end of the lever 37, which is fulcrumed at 38 on the machine frame, said lever having an adjustable stop device or set screw 39 for cooperation with the stationary machine base 1 to limit the clockwise movement of the lever 37. Said lever 37 is pivotally connected at 40 to a link rod 41 which, as best shown in Fig. 3, extends substantially vertically in the machine. A spring 42 surrounds the link rod and abuts adjustable nuts 43 provided by said link rod and by the reacting thrust of the spring against a stationary portion 44 (Fig. 2) of the machine frame, the parts are held in the positions shown by Fig. 1 except when moved by the cam 35.

Referring now to Figs. 3, 4 and 5, the link rod 41 is pivotally attached to a short arm 45 which is in turn fastened to a shaft 46 that, as best shown in Fig. 2, is journalled at 47 in the frame of the machine. The shaft 46 has likewise fastened to it a rack segment 48 which meshes with a

gear 49 that is fastened to the shaft 29. It will thus be seen that when the cam piece 35 strikes the roller 36, and moves the lever 37 counterclockwise, the link rod 41 will be raised, thus oscillating the segment rack 48 in a clockwise direction, Fig. 1, and thus oscillating the shaft 29 in a counterclockwise direction.

Referring to Fig. 1, when the cam piece 35 strikes the roller 36, the slide 3 is in its uppermost position, and therefore the ground workpiece *a* has, by vertical movement, entered between the jaws 17 and 18. Consequently this counterclockwise movement of the work carrier 16 removes the finished workpiece from the spindle 5.

Referring now to Fig. 8, the cam 35 therein depicted provides a surface 50 of sharp pitch, terminating in a high spot 51. Thus the carrier swings immediately to the limit of its movement in a counterclockwise direction. The roller 36 is on the shorter arm of lever 37; the arm 45 is much shorter than the radius of the segment 48, and the radius of said segment is greater than the radius of the gear 49, in consequence of all of which a very slight movement of the roller 36, due to contact therewith by the inclined surface 50 of the cam 35, produces a large angular movement of the carrier 16.

In the present illustrative embodiment of the invention, the carrier arm 16 moves through an arc substantially greater than 180 degrees. At all events, the motion is great enough to carry the workpiece well away from the spindle 5 and into the proximity of a discharge chute herein illustrated at 52. As shown in Figs. 1, 2 and 3, the discharge chute 52 comprises an inclined bottom plate 53 and side walls 54 and 55, the latter being broken away at the point where the carrier 16 swings over it. Means are provided to separate the jaws 17 and 18 when the carrier 16 comes into the proximity of the discharge chute 52 in order that the workpiece may be released, whereupon its velocity and gravity carry it into the chute. This means will now be described.

As heretofore set forth, the jaws 17 and 18 are in the form of levers pivotally mounted on the bolt 23 and provide tail pieces 21 and 22 held apart by a spring 25. It is obvious that if the portions 21 and 22 are forced together, the jaws will be opened. In the present embodiment of the invention, the jaws are opened by their own motion which impinges the tail pieces 21 and 22 upon stationary wedge means. The latter takes the form of a pair of conical pins 56 and 57, projecting from the machine frame in the vicinity of discharge chute 52 as shown in Figs. 1, 2, 3, 6 and 13 to 16 inclusive, said cones being spaced apart by such a distance that their apexes just allow the ends of the tail pieces 21 and 22 to enter between them, but as the tail pieces travel toward the bases of the cones, they are forced together. Thus when the carrier 16 arrives at its most extreme counterclockwise position, which is illustrated in Fig. 6, the tail pieces 21 and 22 are adjacent the bases of the cones 56 and 57 and the jaws 17 and 18 are spread apart. A front view of the jaws in this condition is shown in dotted lines in Fig. 6, and it will be obvious that the ground workpiece is now free to fall into the chute 52.

Referring now to Figs. 1 and 8, it will be seen that the cam piece 35 provides a dwell portion 58 just beyond the apex 51, this dwell portion being of shorter radius than the said apex. This represents simply one means of moving the carrier 16 from the discharging position shown in Fig. 4 to the position to which it receives the next workpiece, which is shown in full lines in Fig. 6, and holding it there. The carrier is in this position just long enough to receive a new workpiece, and while doing so the cones 56 and 57 are in contact with the tail pieces 21 and 22, holding the jaws 17 and 18 slightly spread apart. At this time a workpiece drops between said jaws 17 and 18 and then roller 36 moves onto an incline 59 which returns the carrier to its lowermost position and places the unground workpiece on the spindle 5. To provide a continuous stream of unground workpieces, and to cause them to drop into the carrier jaws 17 and 18 at exactly the right time, a magazine and escapement means are necessary, and this will now be described.

Referring to Figs. 1, 2 and 11, a standard 60 is fastened to the machine frame 1 by means of bolt 61. Suitably fastened to or formed integral with the standard 60 is a back plate 62 whose front surface is vertical, and whose lower edge joins an inclined ledge 63. The ledge 63 provides a depression 64 which constitutes a track for the large flanges *b* of the work pieces *a*, the flanges *c* being thus adapted to rest vertically on a more elevated portion 65 of the ledge, while the radial end face of the flanges *c* rest horizontally against the back plate 62. It will readily be seen that a large number of workpieces can be placed along the ledge 63, which thus constitutes a magazine.

The back plate 62 merges into a curved surface 66 which merges into an inclined surface 67. This surface 67 is inclined to the vertical but any horizontal line in said surface is perpendicular to an adjoining horizontal line in a surface of the back plate 62. The ledge 63 likewise curves around forming a portion 68 in front of part of the inclined surface 67, and the track groove 64 curves and maintains the same distance from the surface 67 that it maintains from the surface of the back plate 62. Thus if a number of workpieces are placed along the inclined ledge 63 with the flanges *b* in the groove 64, the weight of the ones furthest up the track will force the front workpieces around the corner and along the ledge portion 68. The ledge portion 68 terminates abruptly at 69, and the workpieces are at this point unsupported.

Referring now to Figs. 2, 10 and 11, a bracket 70 is suitably fastened to a portion of the standard 60. This bracket 70 provides a flat portion 71 which forms substantially a continuation of the inclined portion 67, or may form a slight dihedral angle with it. If any dihedral angle is formed, the vertex thereof will be substantially horizontal and represented by the line 72. The portion 71 is bounded by two side portions 73 and 74 which rise substantially perpendicularly from the plane of the flat portion 72. Holes 75, 76, 77 and 78 are formed in the sides 73 and 74, and in these holes are located rods 79, 80, 81 and 82 respectively. The rods are of smaller diameter than the holes, and are attached in any convenient way to long L-shaped guides 83 and 84. The guide 83 is somewhat longer than the guide 84 and extends over the inclined portion 67, while the guide 84 is arranged just below the edge of the ledge or trough 69. Because of the looseness of the rods 79 to 82 in the holes 75 to 78, the guides 83 and 84 may be adjusted angularly as well as across the surface of the ledge 72. They are preferably adjusted so that the guides 83 and 84 converge towards the bottom of the surface 71. It will now be seen that individual workpieces *a* will continue

to drop off the end of the ledge at 69 until the space between the guides 83 and 84 is full of workpieces. The workpieces can not fall outwardly due to the inclination of the plate 71 and the fact that the guides 83 and 84 have overhanging portions as stated and as clearly shown. The guides 83 and 84 and the flat portion 71 form a magazine chute for the workpieces.

In order to prevent workpieces from dropping out of the magazine chute, except as the carrier 16 passes the mouth of said chute on its return swing, and in order to release at such time the bottom workpiece while holding those above it, I have provided an escapement mechanism which will now be described.

Referring to Figs. 1 and 10, the bracket 70 provides a pair of hub portions 85 and 86 in which are a pair of alined holes 87 and 88. A shaft 89, Figs. 1, 3, 4 and 5 is journalled in these holes 87 and 88, and fastened to the shaft is a member 90 having a plurality of holes 91 in its upper portion and a plurality of holes 92 in its lower portion. Screws or stops 93 and 94 are located respectively in these holes, and project through a slot 95 provided in the member 72. The screw 93 is above the axis of the shaft 89 while the screw 94 is below it, and it follows that oscillation of said shaft 89 will result in projecting one screw and withdrawing the other. Normally, except when the transferring mechanism is operating, the upper screw 93 projects through the slot 95, and thus holds the bottom workpiece and all others above it. When the carrier 16, in the course of its upward movement to discharge a workpiece, passes the position shown in Fig. 14, the member 90 starts to oscillate counterclockwise from the position shown in Fig. 5 to the position shown in Fig. 4, reaching said position as the carrier 16 discharges the workpiece. This removes the stop pin or pins 93 from under the lowest workpiece *a*, and permits the workpiece to drop down where it is prevented from falling further by the stop 94, which is moved into position simultaneously with the withdrawal of the stop 93. The return of the carrier 16, to the position shown in Fig. 14, where it dwells for an instant, is accompanied by gradual withdrawal of the stop 94 and replacement of the stop 93, and this results in allowing the bottom workpiece to drop into the carrier and holding the one next above it, which in turn holds the remaining workpieces in the magazine.

The size of the workpiece in relation to the position of the stops 93 and 94 are such that, although when the magazine is originally loaded, the bottom workpiece *a* is held by contact of the exterior of the flange *c* with the stop 93; once a workpiece has been transferred, succeeding workpieces are held by contact of the stop 93 with the inside of the hole in the workpiece *c*. It is obvious that instead of dropping a workpiece down onto the lower stop 94, and then releasing it, the action of the mechanism might be reversed so as to hold the pieces with the bottom one normally in engagement with the lower stop and move this inward upon the motion of the carriage into work receiving position.

The mechanism for oscillating the escapement member 90 operates in timed relation with the carrier mechanism, and is directly associated therewith. As shown in Figs. 2, 4 and 5, the shaft 89, to which the member 90 is fastened, has at one end an arm 96 fastened to it also. A link 97 connects this arm to an arm 98 which is journalled on the shaft 29. A lug 99 projects from the side of the arm 98 and a set screw 100 is located therein. An arm 101 is fastened to the shaft 29 in such an angular position that it will strike the screw 100 when the carrier 16, moving counterclockwise, reaches the position of Fig. 14, this forces the arm 98 to oscillate and in turn oscillates the member 90. When the carrier 16 starts back, the arm 96 is urged in a clockwise direction by means of a spring 102 and thus the escapement member 90 with escapement stops 93 and 94 are oscillated in timed relation to the movement of the carrier 16. A stop pin 103 may be provided to limit the movement of the member 90 under the influence of the spring 102.

It is believed that the operation of the machine has been made apparent from the foregoing description, but it will be briefly reviewed in order that the cycle of motions may be made clear. After making all adjustments of the grinding wheels 12 and 13, the manner of doing which is no part of the present invention, the operator fills the magazine with workpieces, placing them along the ledge 63 with the small flange *c* against the back plate 62. Each workpiece so placed immediately rolls down, the large flange *b* being guided by the track 64, the space between the guides 83 and 84 filling up with workpieces, the bottom one resting against the stop screw 93. As more workpieces are added, they gradually back up the track 64, and when the operator deems that sufficient workpieces are in the magazine to keep the machine going until he has time to place more therein, he starts the machine in operation, as by throwing the switch to the main driving motor, not shown. Assuming the machine to have been stopped substantially in the position shown in Fig. 1, the portion 50 of the cam piece 35 would very presently engage the roller 36, and by rocking the lever 37 and raising the link 41, cause the carrier 16 to be moved counterclockwise to the position shown in Fig. 13. The position of the escapement mechanism corresponding to the foregoing is shown in Fig. 4, the apex 51 of the cam piece 35 being in engagement with the roller 36, and in this position of parts the stop pin 93 has been withdrawn and the stop pin 94 projected into the path of the lower flange *c* of the bottom workpiece *a*, and consequently all of the workpieces drop down in the magazine.

As the apex 51 of the cam member 35 gradually leaves the roller 36, the carrier member 16 is moved to the position shown in Fig. 14, where it dwells owing to the dwell portion 53 provided by the cam piece 35. This action, resulting in lowering of the link 41 and counterclockwise movement of the segment rack 48, turns the gear 49 in a clockwise direction, and lowers the link 97, which causes the withdrawal of the pin 94 and projects the pin 93 into the interior of a workpiece. The bottom workpiece thereupon drops into the carrier, while the balance of the workpieces are retained in the magazine by engagement of the stop pin 93 with the interior of the now lowest workpiece in the magazine.

The workpiece that is released drops by gravity between the jaws 17 and 18 of the carrier, which are held slightly apart at this instant, the flange *b* and *c* of the workpiece being guided by the flat springs 31 and 33, as well as by the shoulder 30. The shoulder 30 in connection with the flanges 31 serve effectively to prevent the workpiece from assuming a wrong position between the carrier jaws. Immediately after the workpiece reaches its lowest position between the carrier jaws, said

jaws come together with considerable pressure, since the tail pieces 21 and 22 are immediately moved away from the cones 56 and 57, and the spring 25 comes into action.

The carrier is now undergoing its clockwise oscillation, as viewed in Fig. 1, since the roller 36 has reached the inclined portion 59 of the cam piece 35. The link 41 moves rapidly down under the influence of the springs 42 until such time as the stop screw 39 strikes the frame of the machine, at which time the workpiece, as shown in Fig. 15, has been placed on the spindle 5 with the large flange *b* on the inside and resting against the projection 6 provided by said spindle.

The carrier 16 does not move again until the workpiece has been ground, the workpiece being removed from between the jaws of the carrier by downward movement of the slide 3, which carries the spindle head 2 and the spindle 5 with it, as shown in Fig. 16. The workpiece *a* is thus moved into proximity of the grinding wheels 12 and 13, where it is ground in a manner described in the aforesaid copending application, Serial No. 281,883, heretofore referred to. The details of the grinding operation form no part of the present invention and are therefore not herein described.

The grinding operation is finished when the smallest radius of the cam 10 is in contact with the roller 11, carried by the slide 3, after which point the slide is moved rapidly upward where it finally dwells for the removal of the now ground workpiece and the placing of an unground one on the spindle 5. The resultant upward movement of the spindle 5, which carries it to exactly the same position that it occupied when the workpiece was first placed on it, carries said workpiece again between the jaws 17 and 18, the forcible entry and the shape of the workpieces serving to spread the jaws so that the workpieces are firmly gripped thereby. It will be readily perceived that there is no possibility of faulty placement of a workpiece between carrier jaws at any time, since each workpiece is firmly held by the engagement of the spindle 5 with the interior of the hole therethrough.

As soon as the cam piece 35 strikes the roller 36 a second time the carrier 16 is moved counterclockwise again to the position shown in Fig. 13, and in dotted lines in Fig. 6. This motion is in reality a very rapid one, and carries the tail pieces 21 and 22 between the conical members 56 and 57, right down to the bases thereof, which results in spreading the jaw portions 17 and 18 wide apart. The workpiece is practically thrown into the chute 52, where it rolls down into any convenient receptacle, not shown. The carrier 16 then moves back to the position shown in Fig. 14, where it receives the next workpiece in the manner already described, and the cycle of operations is repeated so long as any workpieces are left in the magazine.

It will be seen that a very effective transferring mechanism for placing workpieces on a spindle from a magazine has been devised by the present invention, said mechanism involving a simple cycle of operation and no very complicated movement of the parts. It will be readily perceived that many variations may be made in the mechanism without departing from the scope of the invention, as set forth in the following claims.

I claim:

1. Work-handling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which a workpiece is mounted during the operation of a tool thereon, means operable in the treating of each workpiece for moving said spindle, with the workpiece mounted thereon, first into tooling position and then away from tooling position, a workpiece carrier having workholding means secured thereto and movable therewith, means for supporting said carrier with the workholding means thereon in position for engagement with the workpiece on the spindle at the end of the movement of said spindle out of tooling position, and means for imparting movement to said carrier when said workpiece has been placed in engagement with said workholding means to remove said workpiece from said spindle, and to release said workpiece from the work holding means on said carrier, said work holding means being released in response to said carrier movement.

2. Workhandling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which a workpiece is mounted during the operation of a tool thereon, means operable in the treating of each workpiece for moving said spindle, with the workpiece mounted thereon, first into tooling position and then away from tooling position, a workpiece carrier having work holding means secured thereto and movable therewith, means for supporting said carrier with the work holding means thereon in a position for engagement with the workpiece on the spindle at the end of the movement of said spindle out of tooling position, means for imparting movement to said carrier when the workpiece on the spindle has been carried into engagement with said work holding means by movement of said spindle, to strip said workpiece from said spindle and thereafter to release it from said work holding means, and means operable by the return movement of said carrier to dispose an untreated workpiece on said spindle, said workpiece being supported by said work holding means on the carrier during said return movement of said carrier.

3. Work-handling mechanism for grinding machines and the like, comprising a rotary spindle on which a workpiece is mounted during the operation of a tool thereon, means operable in the treating of each workpiece for moving said spindle, with the workpiece mounted thereon, first into operative position relative to the tool and then away from operative position, said spindle having a temporary dwell in inoperative position, a workpiece carrier having work holding means thereon with which said workpiece mounted on the spindle is engaged by movement of said spindle away from operative position and into inoperative position, means operable during the dwell of said spindle in inoperative position for moving said carrier first in one direction, to strip the treated workpiece from said spindle and to release it from the work holding means, and then in the other direction to impale an untreated workpiece on said spindle, said untreated workpiece being supported in said work holding means during the movement of said carrier in said other direction, and means for holding said carrier stationary when the spindle is moved into operative position thereby to strip said untreated workpiece so impaled on said spindle from said work holding means.

4. Work-handling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which a workpiece is mounted

during the operation of a tool thereon, means operable after the treating of each workpiece for moving said spindle with the workpiece mounted thereon away from operative position, a workpiece carrier having work holding means thereon with which the treated workpiece mounted on the spindle is engaged by said spindle movement, means for moving said carrier, when said work holding means are so engaged by said treated workpiece, to strip said treated workpiece from said spindle and to release it from the work holding means, means operative on the return movement of said carrier to deliver an untreated workpiece to said work holding means, said work holding means supporting said untreated workpiece in position on said carrier for impalement on said spindle at the termination of said return movement, and means for moving said spindle into operative position while said work holding means is in impaling position, thereby to strip said untreated workpiece from said work holding means.

5. Work-handling mechanism for grinding machines and the like, comprising a rotary spindle on which the workpiece is mounted during the operation of a tool thereon, means operable on said spindle after the treating of each workpiece to move said spindle away from operative position, a workpiece carrier having work holding means thereon with which the treated workpiece on said spindle is engaged by said spindle movement, means for moving said carrier, when said work holding means are so engaged by said treated workpiece, to strip said workpiece from said spindle and to discharge it from the work holding means, a workpiece magazine in the path of said carrier, and means operative on the return movement of said carrier for delivering an untreated workpiece from said magazine to said work holding means, said work holding means supporting said untreated workpiece in position for impalement on said spindle at the end of said return movement.

6. Work-handling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which a workpiece is mounted during the operation of a tool thereon, means for moving said spindle into and for maintaining said spindle in inoperative position at the completion of each tooling operation of said machine, a workpiece magazine, a movable carrier, work holding means on said carrier which receive a workpiece from said magazine and at the termination of the movement of said carrier impale said workpiece, supported by said work holding means, on said spindle in the inoperative position of the latter, and means for moving said spindle, with the workpiece impaled thereon, and while the carrier is in work-impaling position, into tooling position thereby to strip said workpiece from said work holding means.

7. Work-handling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which the workpiece is mounted during the operation of a tool thereon, means operable in the treating of each workpiece for moving said spindle, with the workpiece mounted thereon first into tooling position and then away from tooling position, a workpiece carrier having work holding means secured thereto and movable therewith, means for supporting said carrier with the work holding means thereon in a position for engagement with the workpiece on the spindle at the end of the movement of said spindle out of tooling position, means for imparting movement to said carrier, when the work holding means thereon are so engaged by the workpiece on said spindle, to remove said workpiece from said spindle, and, at the end of said removal movement of the carrier, to release the workpiece from said work holding means, a workpiece magazine which said carrier passes on said removal movement, and means operable on the return movement of said carrier to feed an untreated workpiece from said magazine into the work holding means on said carrier, said carrier on its return movement transferring said untreated workpiece to said spindle.

8. Work-handling mechanism for grinding machines and the like, comprising a rotary work holding spindle on which a workpiece is mounted during the operation of a tool thereon, means operable on said spindle after the treating of each workpiece mounted on said spindle to move said spindle away from tooling position, a workpiece carrier having work holding means secured thereto and movable therewith, means for supporting said carrier with the work holding means thereon in a position for engagement with the workpiece on the spindle at the end of the movement of said spindle out of tooling position, means for imparting movement to said carrier, when said spindle has carried the workpiece into engagement with said work holding means, to remove said workpiece from said spindle and to release said workpiece from the work holding means, a workpiece magazine in the path of said carrier, means for restraining the delivery of a workpiece from said magazine during the aforesaid releasing movement of said carrier, and means for rendering said restraining means inoperative on the return movement of said carrier.

9. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable in the grinding of each workpiece for moving said spindle, with a workpiece mounted thereon, first into grinding position and then away from grinding position, a workpiece carrier having work holding means secured thereto and movable therewith, means for supporting said carrier with the work holding means thereon in a position for engagement with the workpiece on the spindle at the end of the movement of said spindle out of grinding position, and means for imparting movement to said carrier, when said work holding means are so engaged by the workpiece on said spindle, to remove said workpiece from said spindle and to release said workpiece from the work holding means, said work holding means being released in response to said carrier movement.

10. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable in the grinding of each workpiece for moving said spindle with a workpiece mounted thereon first into grinding position and then away from grinding position, a workpiece carrier having work holding means thereon, means for supporting said carrier with the work holding means thereon in a position for engagement with the workpiece on said spindle at the end of the movement of said spindle away from grinding position, means for moving said carrier, when said work holding means are so engaged by the workpiece on said spindle, to strip said workpiece from said spindle and thereafter to release said workpiece from said work holding means, and means operable by the return movement of said carrier to dispose an un-

ground workpiece on said spindle, said workpiece being supported by said work holding means during said return movement of said carrier.

11. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable in the grinding of each workpiece for first moving said spindle with a workpiece mounted thereon into grinding position and then away from grinding position, said spindle having a temporary dwell in non-grinding position, a workpiece carrier having work holding means thereon with which a ground workpiece on said spindle is engaged by the movement of said spindle away from grinding position, means operable during the dwell of said spindle in non-grinding position for moving said carrier first in one direction, to strip said ground workpiece from said spindle and to release it from the work holding means, and then in the other direction to impale an unground workpiece, supported in said work holding means, on said spindle, and means for holding said carrier stationary in workpiece impaling position when the spindle moves into grinding position thereby to strip said unground workpiece, impaled on said spindle, from said work holding means.

12. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable after the grinding of each workpiece for moving said spindle with a workpiece mounted thereon away from grinding position, a workpiece carrier having work holding means thereon with which the ground workpiece mounted on the spindle is engaged by said spindle movement, means for moving said carrier, when said work holding means are engaged by said ground workpiece, to strip said ground workpiece from said spindle and release said workpiece from said work holding means, means operative on the return movement of said carrier to deliver an unground workpiece to said work holding means for impalement on said spindle at the termination of said return movement and means for moving said spindle into grinding position, while said work holding means on said carrier are in work impaling position, to strip said ground workpiece from said work holding means.

13. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable on said spindle after the grinding of each workpiece to move said spindle with a workpiece mounted thereon away from grinding position, a workpiece carrier having work holding means thereon with which the ground workpiece on said spindle is engaged by said spindle movement, means for moving said carrier, when the work holding means thereon are engaged by said workpiece, to strip said workpiece from said spindle and to release said workpiece from the work holding means, a workpiece magazine in the path of said carrier, and means operative on the return movement of said carrier for delivering an unground workpiece from said magazine to said work holding means, the latter supporting said unground workpiece in position for impalement on said spindle at the end of said return movement.

14. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means for moving said spindle into and for maintaining said spindle in inoperative or non-grinding position at the completion of each grinding operation, a workpiece magazine, a movable carrier having work holding means thereon which recieve a workpiece from said magazine and which at the termination of the carrier movement impale said workpiece on said spindle in the non-grinding position of the latter, and means for moving said spindle, with the workpiece impaled thereon, into grinding position to strip said workpiece from said work holding means.

15. In a grinding machine, the combination with a grinding wheel, of a rotary work holding spindle, means operable in the grinding of each workpiece for moving said spindle with a workpiece mounted thereon first into grinding position and then away from grinding position, a workpiece carrier having work holding means thereon with which a ground workpiece on said spindle is engaged by the movement of said spindle away from grinding position, means for imparting movement to said carrier, when said work holding means are so engaged by the workpiece on said spindle, to remove said workpiece from said spindle and at the end of said removal movement of the carrier, to release the workpiece from said work holding means, a workpiece magazine which said carrier passes on said removal movement, and means operable on the return movement of said carrier to feed an unground workpiece from said magazine into said work holding means, the latter supporting said unground workpiece to transfer said workpiece from said magazine to said spindle.

16. In a grinding machine, the combination with a grinding wheel, of a rotary spindle, means operable on said spindle after the grinding of each workpiece to move said spindle with a ground workpiece mounted thereon away from grinding position, a workpiece carrier having work holding means thereon with which said workpiece is engaged by said spindle movement, means for moving said carrier, when said work holding means are so engaged by said workpiece, to strip said workpiece from said spindle and to release it from the work holding means, a workpiece magazine in the path of said carrier, means for restraining the delivery of a workpiece from said magazine during the aforesaid discharging movement of said carrier, and means for rendering said restraining means inoperative on the return movement of said carrier.

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