Feb. 12, 1935. W. J. BRYANT ET AL 1,990,469

MULTIPLE SPINDLE MACHINE

Filed Nov. 11, 1932 4 Sheets-Sheet 1

Fig. 1.

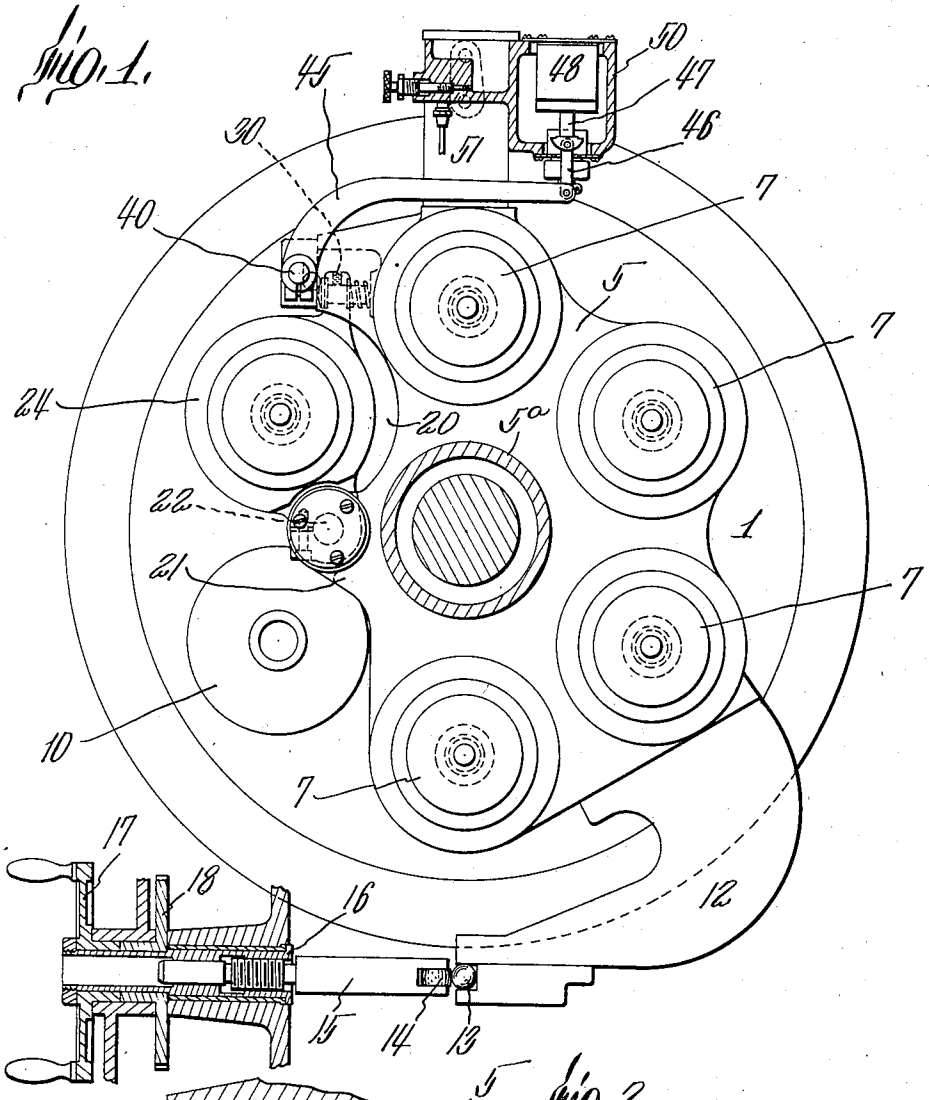
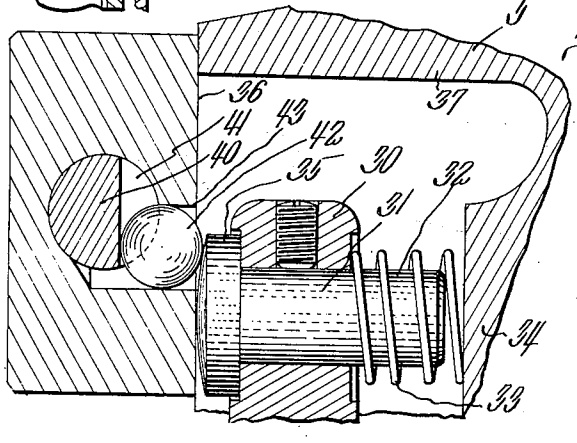


Fig. 2.



Inventors
William J. Bryant
Merton H. Arms
by
Wright Brown Quinby & May
Attys

Feb. 12, 1935. W. J. BRYANT ET AL 1,990,469

MULTIPLE SPINDLE MACHINE

Filed Nov. 11, 1932 4 Sheets-Sheet 2

Fig. 3.

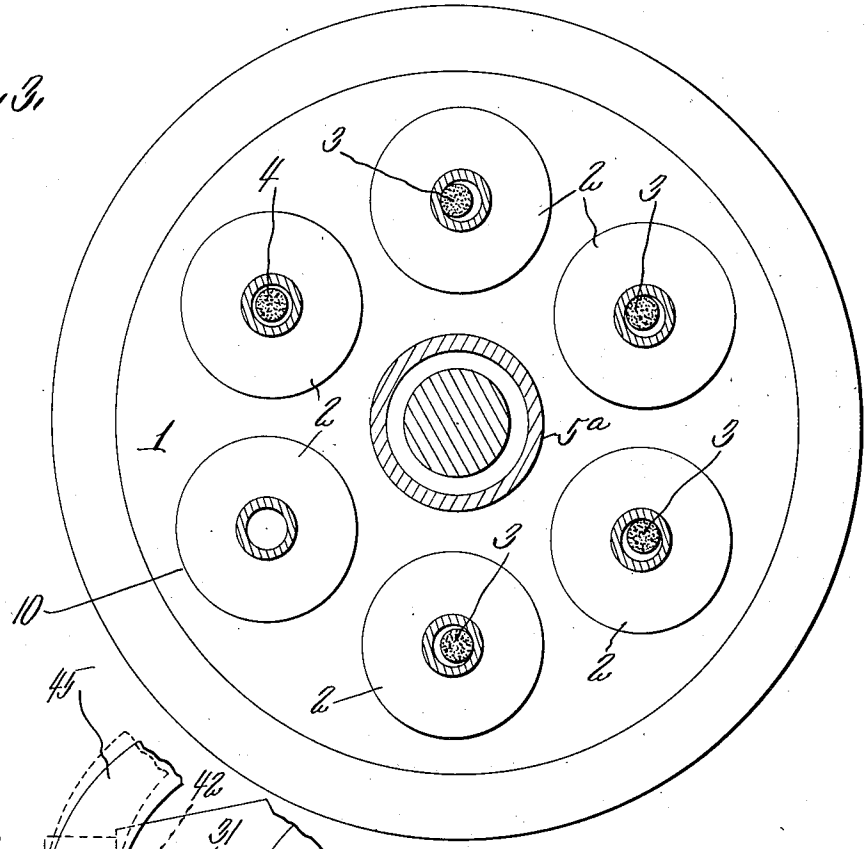
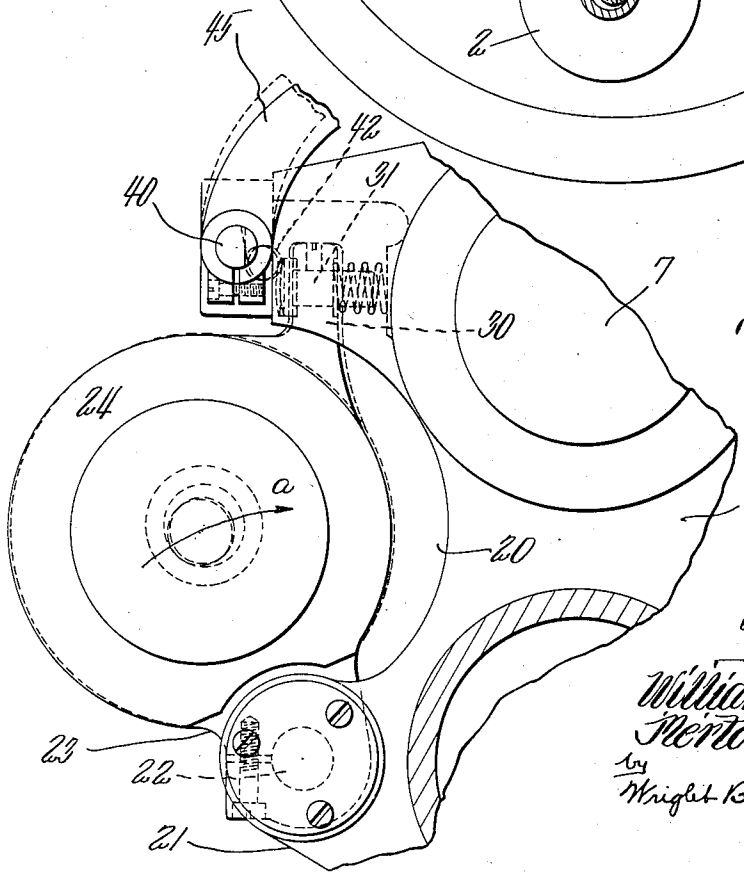


Fig. 4.



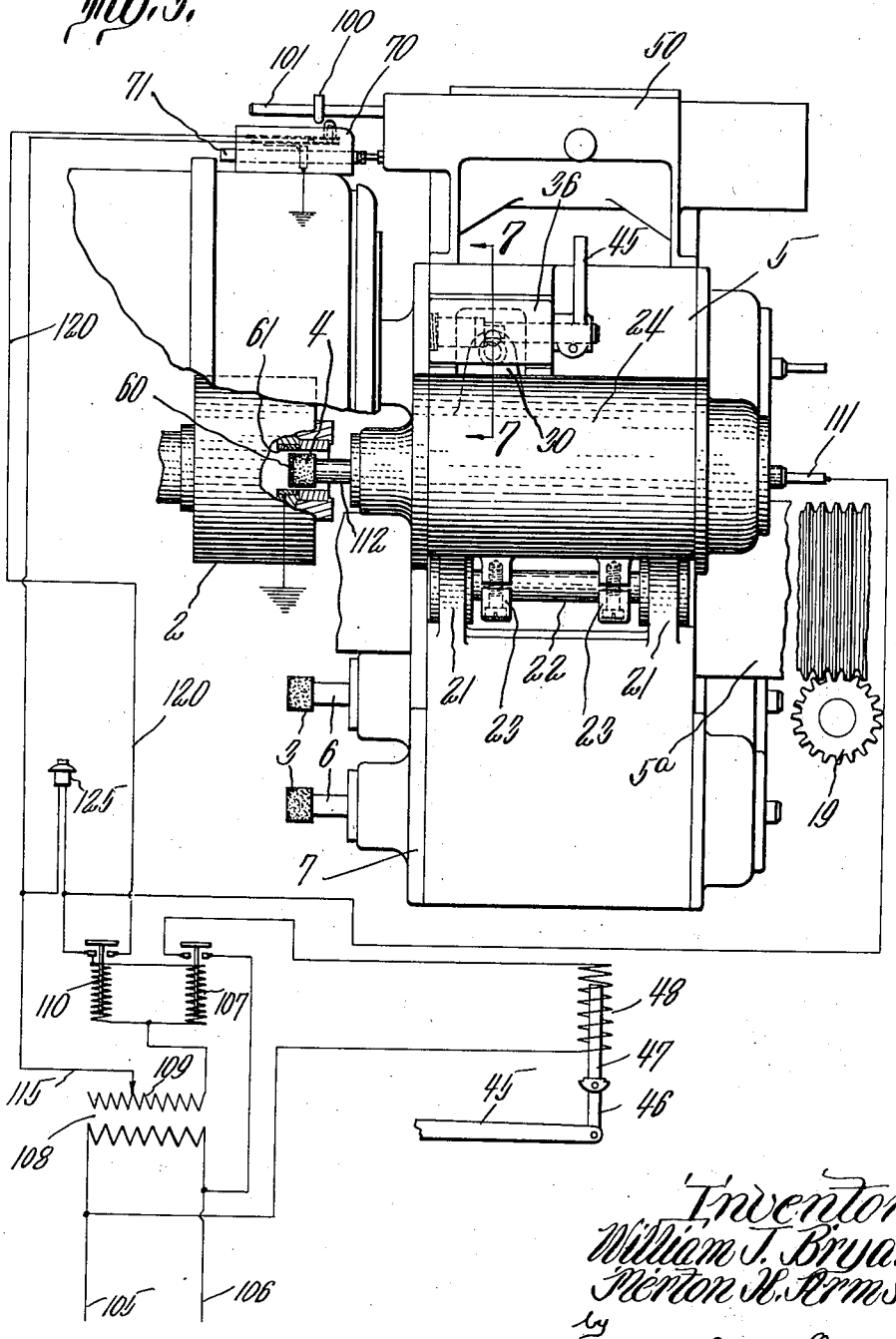
Inventors
William J. Bryant
Merton H. Arms
by
Wright Brown Quinby & Clay
Attys

Feb. 12, 1935. W. J. BRYANT ET AL 1,990,469

MULTIPLE SPINDLE MACHINE

Filed Nov. 11, 1932 4 Sheets-Sheet 3

Fig. 5.



Inventors
William J. Bryant
Merton K. Terms
by Wright Brown Quinby & May
Attys

Feb. 12, 1935. W. J. BRYANT ET AL 1,990,469

MULTIPLE SPINDLE MACHINE

Filed Nov. 11, 1932 4 Sheets-Sheet 4

Fig. 6.

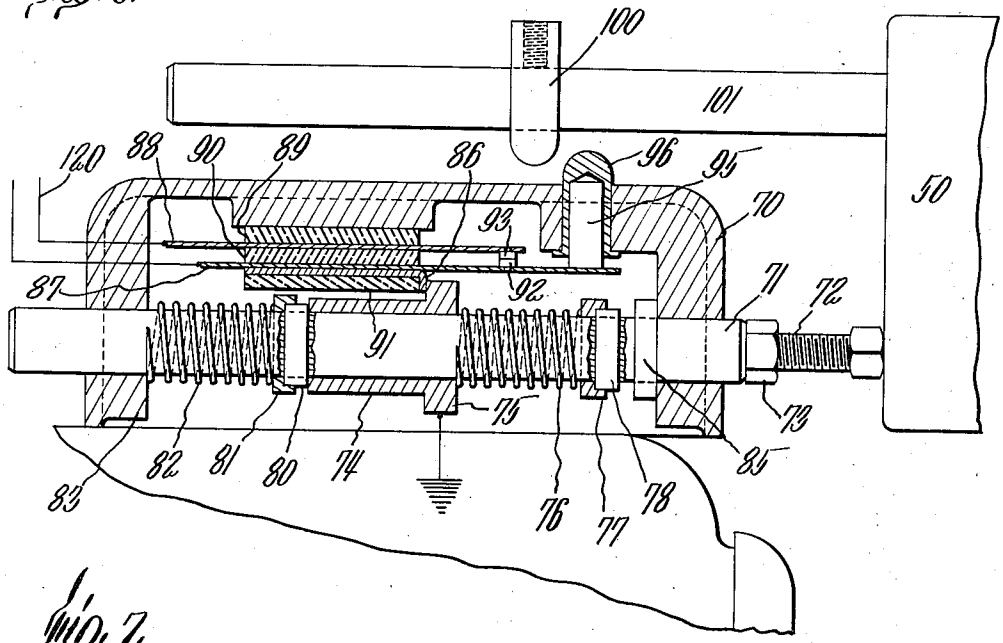
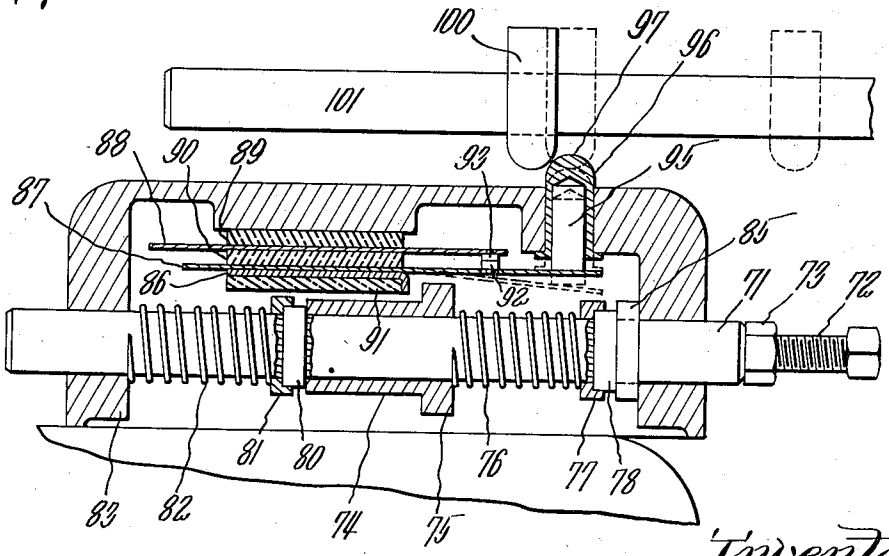


Fig. 7.



Inventors
William J. Bryant
Merton R. Arms
by Wright Brown Quinby & May
Attys

Patented Feb. 12, 1935 1,990,469

UNITED STATES PATENT OFFICE

1,990,469

MULTIPLE SPINDLE MACHINE

William J. Bryant and Merton H. Arms, Springfield, Vt., assignors to Bryant Chucking Grinder Company, Springfield, Vt., a corporation of Vermont

Application November 11, 1932, Serial No. 642,235

21 Claims. (Cl. 51—53)

This invention relates to machines of the multiple spindle type and while in its broadest aspect it is not limited thereto, it is particularly applicable to grinding machines where a plurality of work pieces are ground simultaneously at a plurality of stations in which each work piece is successively positioned and it will be described with more particular relation to such machines. In a machine of this type the work pieces in the earlier stations are being rough ground in successive stages, while the final grinding is a finishing cut. It is desirable that the rough grinding shall be effected with reasonable accuracy to a predetermined work size so that it is quite practicable to feed the rough grinding tools simultaneously by an amount determined by the setting of the roughing wheel last to act on the work so that it produces the desired final rough dimension and each of the roughing wheels takes a part only of the entire roughing cut. It is often desirable to use a different type of wheel for the finished grinding and its grinding operation should terminate when the work has been ground to accurate finished size. Where the feed motion of all the grinding wheels is the same, the end of the feed would then, of course, be determined by the proper feed for the finish grinding wheel and the rough grinding feed limit would be controlled thereby. It is often not desirable, however, to determine the limit of rough grinding of the several rough grinding wheels by the limitation of the finish grinding.

According to the present invention, therefore, the feed limits for rough and finish cutting are made independent of each other, in the case of a grinding machine the finish grinding wheel and the rough grinding wheels feeding together until finished size of a piece in the finishing station is reached, whereupon the feed of one of the wheels, i. e., finishing grinding wheel, stops while the feed of the others or rough grinding wheels continues until the final rough grinding wheel has reduced its work to the desired rough ground size. In a grinding machine where the work holders are carried by a turret which is indexed to bring the successive pieces in succession to the various grinding stations, this makes possible accurate finish grinding of the work where the several rough grinding wheels are given a constant feed motion at each indexed position, allowing for any slight inaccuracy in the indexing movement of the work supporting turret which would vary somewhat the final rough ground size for work held in the different work holders.

In order to accomplish these purposes in accordance with this invention, the finishing tool or grinding wheel is movably carried by the carrier which supports all the tools or grinding wheels and when the finish size is reached the final tool or wheel is moved relative to the carrier in retractive direction while the feed motion of the carrier continues until the rough size for the last rough work piece is reached, or until a uniform amount of feed motion for the roughing tools or grinding wheels has been completed after each indexing operation of the work holding turret.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a fragmentary cross section through a multiple spindle grinding machine of the type shown in the Bryant Patent No. 1,794,440 granted March 31, 1931, but equipped according to this invention and omitting the wheel truing mechanism.

Figure 2 is a sectional detail to a larger scale showing a portion of the finishing grinding wheel relieving means.

Figure 3 is a somewhat diagrammatic transverse section of the machine through the work pieces, showing the the relative positions of the work pieces and the grinding wheels after the feed of the final or finishing grinding wheel has been relieved.

Figure 4 is similar to a portion of Figure 1, but to a larger scale.

Figure 5 is a fragmentary front elevation of the machine, parts being broken away and in section, this figure including a diagram of the electrical system.

Figures 6 and 7 are sections through a switch mechanism showing certain of the parts in different positions.

Referring to the drawings, more particularly Figures 1 to 5, at 1 is shown a horizontally arranged turret within which are positioned in circular series about the axis of the turret a plurality of work holders 2 and arranged to cooperate with these work holders is a plurality of tools, shown as grinding wheels 3 and 4, supported by a carrier 5; these parts being arranged in general as shown in the Bryant Patent No. 1,794,440 to which reference has heretofore been made. As shown in this patent, also, these work holders are rotated and the wheels 3 and 4 are carried by shafts 6 which form continuations of the armatures of motors 7 supported by the carrier 5 in corresponding positions about the axis of the turret 1 to the work holders, except that there is one less wheel than work holder in order to provide a loading and unloading station for the work where no wheel is positioned. This station is shown at 10 in Figures 1 and 3.

As disclosed also in the Bryant patent, the turret is arranged to be indexed so as to bring the rotary work holders successively into positions to be operated upon by each of the grinding wheels. Thus starting from the loading and unloading station 10, each work holder is moved downward-

ly and then rearwardly and then upwardly and forwardly to the final finishing station at which is positioned the finish grinding wheel 4. The finish grinding wheel unit, as will be more fully explained later, is not supported rigidly in the carrier 5 as are the remainder of the grinding wheel units. Each of the wheel units comprises a wheel and its shaft and a driving motor, the wheel shaft being an extension of or coupled to the armature of the motor so that each of the wheels is independently rotated by its own motor as is more fully disclosed in the Bryant patent to which reference has been made.

The carrier 5 is arranged to be rocked about the axis of the turret to produce relative feeding and retraction between the several grinding wheels and the work, and for this purpose it is shown as provided with an actuating arm 12 having a follower 13 against which rides a carrier 14 on a feed screw 15. This feed screw is supported for axial adjustment in the frame of the machine and may be moved axially by rotation of a nut member 16 threaded thereon to which may be operatively secured any suitable actuating mechanism such, for example, as the hand wheel 17 and any usual type of automatic feeding mechanism of which the toothed wheel 18 may form a part. At each indexed station of the turret, when a wheel is presented opposite to all but one of the pieces of work in the work holders 2, the carrier 5 is rocked a predetermined amount to advance the several wheels against the work and thus feed the wheels to the work. Likewise provision is made for moving the wheels axially relative to the work, a portion of this axial movement providing for a relative operative traversing motion while the wheels are in contact with the work, and a further axial movement in one direction serving to separate the wheels from the work while they are retained in the same axial relation therewith, this withdrawing motion being effected prior to each indexing movement of the turret 1. Means for producing these relative motions are also shown in the Bryant patent to which reference has been made, this motion, as shown being imparted to the carrier. A portion of this is shown in Figure 5 in which a pinion 19 meshes with teeth in a sleeve 5a to which the carrier 5 is secured.

As previously mentioned the finishing wheel 4 and its driving motor are mounted on the carrier 5 for movement relative thereto, this movement being in the general direction of feed and retraction and being for the purpose of permitting the finishing wheel to be moved back from contact with the work while the rocking feed motion of the carrier 5 continues. To this end the carrier 5 is shown as provided with a recess or cut away portion 20 and at the lower edge of this recess it is provided with upstanding ears 21 for supporting bearings for a pivot shaft 22. To this shaft are fixed ears 23 of a casing 24 which carries the driving motor for the finishing wheel 4. This casing 24 is of sufficiently smaller diameter than the recess 20 so as to permit the desired extent of rocking movement of the casing 24 so as to permit the finishing wheel 4 to be rocked backwardly in the feed direction and be held out of contact with the work in the work holder to which it is presented after this work has reached the finished size and during any further motion of the carrier 5 which produces feed between the other or rough grinding wheels and their respective work pieces. Thus the finishing wheel may be given a knock-off movement to prevent further grinding of its work while the feed motion of the wheels earlier to act on the work is continued, these earlier wheels being the roughing wheels. These several roughing wheels are arranged each to take a portion only of the roughing cut, the motion of the carrier 5 determining by the last of these roughing wheels 3 the roughed size of the work. This knock-off for the finishing wheel is shown as controlled by a sizing device, which, as illustrated, is of the type disclosed in the Bryant Patent No. 1,872,667 dated August 23, 1932, for Work sizing.

This sizing device is operatively connected to mechanism for changing the angular position of the finish grinding wheel unit from its normal relation to the carrier 5. As shown the casing 24 of this unit is extended upwardly to form an ear 30 through which passes a headed pin 31, shown best in Figure 2. Surrounding the projecting end 32 of this pin is a coil spring 33 which reacts between the ear 30 and an abutment portion 34 on the carrier 5. This spring, therefore, acts to yieldingly hold the ear 30 pressed away from the abutment 34 and with the head 35 of the pin 31 against a plate 36 which is secured in any suitable manner to the portion 5 and forms the cover of a recess 37 within which the ear 30 extends, the abutment portion 34 being at the base of this recess. Journaled in the member 36 is a rock shaft 40 which has a cut away portion 41 within which is positioned a ball 42, this ball riding in an opening 43 in the member 40, and bearing against the head 35 of the pin 31. By rocking this shaft 40 counterclockwise as viewed in Figure 2, the ball 43 is moved outwardly against the head 35 and forces the ear 30 toward the abutment 34, this swinging the casing 24 in a direction to move the finishing wheel 4 in a direction opposed to the feed direction between the several grinding wheels and their work pieces. To the outer end of the rock shaft 40 is shown clamped an arm 45 (see Figures 1, 4 and 5). The free end of this arm is connected through a link 46 with the core 47 of a solenoid 48, which is shown as carried within a casing 50 supported by suitable brackets 51 from the carrier 5. By energization of the solenoid 48 the arm 45 is rocked upwardly and the casing 24 is rocked backwardly or in the direction of the arrow *a* (Figure 4) to withdraw the finishing wheel from contact with the work. When this occurs the relative positions of the several grinding wheels and the work is shown in Figure 3, the grinding wheel 4 being out of contact with its work piece while the grinding wheels 3 are still in operation on their respective work pieces.

The particular sizing device herein illustrated comprises a disk or ring of electro-conductive material such as carbon at 60 secured to and concentric with the grinding wheel 4 so that its surface is subject to the wear and truing as is the surface of this grinding wheel. Cooperating with this disk or washer 60 when the work is reduced to finished size is a contact element 61, one of these contact elements being carried by each work holder and in such relation to the work carried thereby that when electrical contact is made between the washer 60 and a contact 61 the work in the corresponding work holder has been reduced to the desired finished size. Since the finishing wheel only is provided with the sizing device, no contact elements are carried by the wheels 3, but since each of the work holders brings work thereon successively into the finishing station, each of these work holders must be provided with

a contact 61. As shown this contact is in the form of a ring as is illustrated in the William J. Bryant Patent No. 1,872,667 to which reference has heretofore been made.

As shown each of these contacts 61 is grounded, as, for example, to the frame of the machine through its work holder. With this arrangement, however, it is important to prevent closing of the circuit which includes the washer 60 through contact thereof with the work which is also carried by and grounded through each work holder. Provision is therefore made by which the circuit including the wheel contact 60 is open whenever the wheel is in such axial position that it may engage the work being ground, except that after this circuit has once been closed through the contacts 60 and 61, it will remain closed until such time as the carrier 5 and the work holding turret have been moved relatively axially out of cooperative relation to permit indexing of the turret. To this end a switch mechanism shown more in detail in Figures 6 and 7 is carried on the machine frame at 70.

As shown best in Figures 6 and 7, this casing carries an axially movable bar 71 provided with an extension 72 which is axially adjustable and which may be contacted by a portion of the casing 50 carried by the carrier 5. For the purpose of such adjustment the portion 72 is shown as comprising a bolt threaded into the end of the bar 71 and secured in adjusted position by means of a check nut 73. Within the casing this bar 71 carries loosely thereon a contact sleeve 74 having a head 75. This contact sleeve is suitably grounded. It is normally held in one axial position on the bar 71 by means of a spring 76 reacting between the head end of the sleeve 74 and a collar 77 on the bar which is held against axial motion away from the sleeve 74 as by means of the abutment pin 78 extended through the bar 71. The limit of motion of the sleeve 74, due to the pressure of the spring 76 thereon, is determined by means such as a transverse pin 80 which in turn holds a collar 81 which is pressed upon by a coil spring 82 surrounding the bar 71 and reacting between the collar 81 and the wall 83 of the casing 70. This spring 82 acts therefore to project the bar 71 toward the carrier 5 as far as is permitted by the position of the casing 50 on this carrier or the impingement of the pin 78 against an abutment collar 85 through which the bar 71 passes as in the position shown in Figure 7. When the collar 74 is in this position its head 75 is out of engagement with an electrical strip contact element 86. This strip element is mounted in contact with a spring strip 87 and this is spaced and insulated from a second strip spring element 88. These elements 86, 87 and 88 are spaced from the casing 70 and from the collar 74 by suitable insulating pieces 89, 90 and 91. In the position shown in Figure 6 and in Figure 7 in full lines contacts 92 and 93 carried by the strips 87 and 88, respectively, are in engagement with each other, thus closing electrical connection therebetween. The spring strip 87, however, is extended beyond the spring strip 88 and is provided at its extended portion with an upwardly projecting pin 95 of insulating material surrounded by a sleeve 96 with a closed rounded end 97. The resiliency of the spring strip 87 normally holds the sleeve 96 upwardly projected and into the path of a dog 100 adjustably secured to a bar 101 projecting laterally from the casing 50. When the carrier 5 and the work-carrying turret are sufficiently close together to bring the contact 60 into alinement transverse to the wheel axis with the contact 61 in the work piece being finish ground, the casing 50 has engaged the extension 72 and pressed the bar 71 inwardly so as to make electrical connection between the sleeve 74 and the contact 86, thus grounding the spring contact element 87. In this position, it will be noted also, that the dog 100 is positioned to the left of the sleeve 96.

The strip contacts 87 and 88 are arranged in the circuit shown diagrammatically in Figure 5. This circuit is shown as deriving energy from the alternating current line wires 105 and 106 from which is tapped off a circuit including the solenoid 48 and normally open contacts of the relay 107 so that until this relay 107 is closed the solenoid 48 remains unenergized. At 108 is shown a transformer from the secondary of which at 109 is tapped off low voltage connections to the energizing coil of the relay 107 and also to the energizing coil of another relay 110, which is also normally open. One of the contacts of the relay 110 is in series with its energizing coil and is connected through a brush 111 with the shaft 112 of the finish grinding wheel 4 and is thus in series with the grinding wheel contact 60. The other side of the secondary 109 is connected through the lead wire 115 to the spring contact 87 so that when the parts within the switch casing 70 are in the position shown in Figure 6, this side of the transformer secondary is grounded. Thus when the work is reduced to such dimension that electrical contact is made between the contact washer 60 and the contact 61, circuit is completed through the relays 110 and 107, the relay 107 being closed, energizing the solenoid 48, thus rocking the casing 24 in a direction to remove the finish grinding wheel from contact with the work. The energization of the relay 110 also closes a connection through the lead 120 with the spring contact 88 which through its connecting contacts 92 and 93 retains the electrical connection through the spring contact 87 even after the circuit has been broken between the wheel and work contacts 60 and 61 so that the relay 107 remains closed and the solenoid 48 energized. Thus the relay 110 controls a holding circuit to retain the solenoid 48 energized after the circuit has once been closed between the wheel and work contacts, even though these contacts are immediately separated by the action of the solenoid 48 in relieving the finish grinding wheel at the inner end of the grinding stroke.

During the further cycle of operations of the machine and after the feed motion of the carrier 5 has continued to complete the rough grinding, the carrier 5 is retracted and the carrier and turret are moved relatively axially to separate the grinding wheels from the work, all as disclosed in the Bryant Patent No. 1,794,440. When this axial separation between the several wheels and the work has been effected sufficiently to withdraw the wheels from the work, the dog 100 strikes against the sleeve 96 and depresses the end of the spring contact 87, breaking the holding circuit at the contacts 92 and 93 which are separated by this action. This immediately de-energizes the relays 107 and 110, causing the solenoid 48 to be de-energized, whereupon the spring 33 rocks the finishing wheel casing 24 back to its normal position. After the dog 100 passes to the right of the sleeve 96, as shown in dotted lines in Figure 7, the spring 96 snaps back into its original position, closing the contacts 92 and 93, but in this position of the parts the casing 50 no longer engages the end of the rod 71 so that the

spring 82 has broken the contact between the head 75 of the sleeve 74 and the contact 86 so that even though the wheel contact 60 might be grounded by contact between it and the work, the circuit would not be completed through the coil of the relay 107, and thus the solenoid 48 would remain de-energized. It is only after the grinding wheels and work have been returned to their operative relation axially and at the inner end of the grinding stroke that grounding of the wheel contact 60 can cause the solenoid 48 to be energized, and in this position of the parts this can only occur through grounding connection with the sizing contact 61 at the work holder. A push button at 125 may be actuated to close the circuit through the relays 107 and 110 at any time, thus to energize the solenoid 48 and move the finishing wheel casing to its retracted position.

From the foregoing description of an embodiment of this invention, it will be seen that the finishing grinding wheel is removed from contact with the work when the work has been reduced to its final finished dimension and while the feed of the roughing wheels is continued. This permits the feed of the roughing wheels to be effected by a predetermined feeding movement and even though there may be inaccuracies in the indexing motion of the drum, which would result in slight differences in the rough grinding size produced by such a predetermined feed motion, the final finished size may be unaffected, provided of course these indexing inaccuracies are not greater than the depth of finish grinding. It will also be understood that it may be applied to other than grinding machines and that various changes and modifications might be made without departing from the spirit or scope of this invention as defined by the appended claims.

We claim:

1. In combination, a turret, a plurality of work holders arranged in circular series in said turret, a tool carrier, a plurality of tools supported by said carrier each in position to operate on work in one of said holders, means supporting one of said tools on said tool carrier for movement in the direction of feed relative to said carrier, means for indexing said drum to present each work holder successively into operative relation to each tool, means imparting relative feed motions between said carrier and turret, and means for retracting said one tool relative to said carrier when the work operated on by said tool has reached a predetermined dimension and while the feed motion between said turret and carrier is continued.

2. In combination, a turret, a plurality of work holders arranged in circular series in said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier in circular series to correspond with certain of said work holders, means for relatively moving said turret and carrier to effect feed of the wheels relative to work carried by said holders, one of said grinding wheels being supported by said carrier movable relative thereto in the general direction of feed between said wheels and work, a work sizing device for the work at said one grinding wheel, and means responsive to said device for retracting said one wheel relative to said carrier when the work operated thereon reaches a predetermined dimension and during the relative feed motion between said turret and carrier.

3. In combination, a turret, a plurality of work holders arranged in circular series in said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier in circular series to correspond with certain of said work holders, means for producing relative feed motion between said turret and carrier, one of said grinding wheels being pivotally secured to said carrier for movement about said pivot in the general direction of feed, means for normally retaining said one grinding wheel in one angular position about its pivot, and means acting when the work operated upon by said one grinding wheel reaches a predetermined dimension for swinging said one grinding wheel about its pivot in a direction opposite to the feed.

4. In combination, a turret, a plurality of work holders arranged in circular series in said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier in circular series to correspond with certain of said work holders, means for producing relative feed motion between said turret and carrier, one of said grinding wheels being pivotally secured to said carrier for movement about said pivot in the general direction of feed, yielding means for normally retaining said one grinding wheel in one angular position about its pivot, and means acting when the work operated upon by said one grinding wheel reaches a predetermined dimension for swinging said one grinding wheel about its pivot against said yielding means away from the work.

5. In combination, a turret, a plurality of work holders arranged in circular series in said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier in circular series to correspond with certain of said work holders, means for producing relative feed motion between said turret and carrier, one of said grinding wheels being pivotally secured to said carrier for movement about said pivot in the general direction of feed, yielding means for normally retaining said one grinding wheel in one angular position about its pivot, a rock shaft on said carrier, means actuated by rocking of said shaft from a normal position to swing said one grinding wheel about its pivot against said yielding means away from the work, and means acting when the work operated on by said one wheel reaches a predetermined dimension to rock said shaft from said normal position.

6. In combination, a rotatable turret, a plurality of work holders arranged in circular series about the axis of rotation of said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier and arranged to correspond with certain of said work holders, means for relatively moving said turret and carrier axially of said turret to produce relative traverse between said wheels and the work and to separate said wheels from the work, means to relatively rock said turret and carrier to produce feed and retractive motions between said wheels and the work, means for carrying one of said wheels for movement in the general direction of feed relative to said carrier, means normally holding said one wheel against motion relative to said carrier, a sizing mechanism for the work operated on at any one time by said one wheel, and means controlled by said sizing mechanism for moving said wheel relative to said carrier in retractive direction to free said one wheel from its work when its work has reached a predetermined dimension, regardless of said feed motion between said turret and said carrier.

7. In combination, a rotatable turret, a plurality of work holders arranged in circular series

about the axis of rotation of said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier and arranged to correspond with certain of said work holders, means for relatively moving said turret and carrier axially of said turret to produce relative traverse between said wheels and the work and to separate said wheels from the work, means to relatively rock said turret and carrier to produce feed and retractive motions between said wheels and the work, means for carrying one of said weels for movement in the general direction of feed relative to said carrier, means normally holding said one wheel against motion relative to said carrier, a sizing contact associated with each work holder, a mating contact movable with said one wheel, an electric circuit closed by said contacts when the work operated upon by said one wheel reaches a predetermined dimension, and means energized by the closing of said circuit for moving said one wheel relative to said carrier backward in the line of feed.

8. In combination, a rotatable turret, a plurality of work holders arranged in circular series about the axis of rotation of said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier and arranged to correspond with certain of said work holders, means for relatively moving said turret and carrier axially of said turret to produce relative traverse between said wheels and the work and to separate said wheels from the work, means to relatively rock said turret and carrier to produce feed and retractive motions between said wheels and the work, means for carrying one of said wheels for movement in the general direction of feed relative to said carrier, means normally holding said one wheel against motion relative to said carrier, a sizing contact associated with each work holder, a mating cantact movable with said one wheel, an electric circuit closed by said contacts when the work operated upon by said one wheel reaches a predetermined dimension, means energized by the closing of said circuit for moving said one wheel relative to said carrier backward in the line of feed, and means for preventing contact between the work and said wheel contact from closing said circuit.

9. In combination, a rotatable turret, a plurality of work holders arranged in circular series about the axis of rotation of said turret, a grinding wheel carrier, a plurality of grinding wheels supported by said carrier and arranged to correspond with certain of said work holders, means for relatively moving said turret and carrier axially of said turret to produce relative traverse between said wheels and the work and to separate said wheels from the work, means to relatively rock said turret and carrier to produce feed and retractive motions between said wheels and the work, means for carrying one of said wheels for movement in the general direction of feed relative to said carrier, means normally holding said one wheel against motion relative to said carrier, a sizing contact associated with each work holder, a mating contact movable with said one wheel, an electric circuit closed by said contacts when the work operated upon by said one wheel reaches a predetermined dimension, means energized by the closing of said circuit for moving said one wheel relative to said carrier backward in the line of feed, and means for retaining said wheel in its backward position until said turret and carrier have been moved into wheel and work separated position.

10. In combination, a work holder, a wheel carrier, a grinding wheel mounted on said carrier, means for moving said holder and carrier relatively in the direction of the wheel axis to produce relative traverse between said wheel and work and to bring said wheel into and out of operative relation to the work, means for moving said holder and carrier relatively transverse to their relative traverse direction to feed and retract the wheel relative to the work, said grinding wheel being movable relative to said carrier in feed direction, yielding means for normally holding said grinding wheel in one position relative to said carrier, a sizing contact adjacent to the work, a sizing contact carried by said wheel, an electrical circuit closed by said contacts when said wheel is in operative position and the work has been reduced to a predetermined dimension, electromagnetic means actuated by the closing of said circuit for retracting and holding retracted said grinding wheel from its normal position relative to said carrier, a holding circuit closed by closing of said first mentioned circuit for holding said first mentioned circuit closed when said contacts are separated, and means for breaking said holding circuit to cause breaking of said first mentioned circuit and return of said wheel to said normal position after said holder and carrier have been moved relatively to bring said wheel into inoperative position.

11. In combination, a work holder, a wheel carrier, a grinding wheel mounted on said carrier, means for moving said holder and carrier relatively in the direction of the wheel axis to produce relative traverse between said wheel and work and to bring said wheel into and out of operative relation to the work, means for moving said holder and carrier relatively transverse to their relative traverse direction to feed and retract the wheel relative to the work, said grinding wheel being movable relative to carrier in feed direction, yielding means for normally holding said grinding wheel in one position relative to said carrier, a sizing contact adjacent to the work, a sizing contact carried by said wheel, an electrical circuit closed by said contacts when said wheel is in operative position and the work has been reduced to a predetermined dimension, electromagnetic means actuated by the closing of said circuit for retracting and holding retracted said grinding wheel from its normal position relative to said carrier, a holding circuit closed by closing of said first mentioned circuit for holding said first mentioned circuit closed when said contacts are separated, means for breaking said holding circuit to cause breaking of said first mentioned circuit and return of said wheel to said normal position after said holder and carrier have been moved relatively to bring said wheel into inoperative position, and means actuable to close said first mentioned circuit independently of said contacts.

12. In combination, a work holder, a grinding wheel, means for moving said holder and wheel relatively in the direction of the wheel axis to produce relative traverse between said wheel and work and to bring said wheel into and out of operative relation to the work, a sizing contact adjacent to the work, a sizing contact carried by said wheel, an electrical circuit closed by said contacts when said wheel is in operative position and the work has been reduced to a predetermined dimension, electromagnetic means actuated by the closing of said circuit for retract-

ing and holding retracted said grinding wheel from its normal position, a holding circuit closed by closing of said first mentioned circuit for holding said first mentioned circuit closed when said contacts are separated, and means actuated automatically when said wheel and work holder have been moved relatively axially of said wheel to a position where said wheel is out of operative relation to the work for opening said holding circuit to cause breaking of said first mentioned circuit and the return of said wheel to said normal position.

13. In combination, a work holder, a grinding wheel, means for moving said holder and wheel relatively in the direction of the wheel axis to produce relative traverse between said wheel and work and to bring said wheel into and out of operative relation to the work, a sizing contact adjacent to the work, a sizing contact carried by said wheel, an electrical circuit closed by said contacts when said wheel is in operative position and the work has been reduced to a predetermined dimension, electromagnetic means actuated by the closing of said circuit for retracting and holding retracted said grinding wheel from its normal position, a holding circuit closed by closing of said first mentioned circuit for holding said first mentioned circuit closed when said contacts are separated, means actuated automatically when said wheel and work holder have been moved relatively axially of said wheel to a position where said wheel is out of operative relation to the work for opening said holding circuit to cause breaking of said first mentioned circuit and the return of said wheel to said normal position, and manually operative means for effecting retraction of said wheel transverse to its axis independently of said contacts.

14. In combination, a pair of carriers, a plurality of work holder members carried by one carrier, a plurality of tool members carried by the other carrier, means for providing relative traverse between said tool and holder members, means for moving said carriers relatively to feed said tool members relative to work held by said work holder members, means for mounting one of said members on its carrier for movement in the feed direction relative thereto, and means actuated when the work at said one member reaches a predetermined dimension for retracting said one member relative to its carrier to stop the tooling of said work while the relative feed of said carriers continues.

15. In combination, a pair of carriers, a plurality of work holder members carried by one carrier, a plurality of tool members carried by the other carrier, means for moving said carriers relatively to present each work holder member in succession into cooperative relation to each tool member, means for moving said carriers relatively to feed said tool members relative to work held by said work holder members, means for mounting one of said members on its carrier for movement in the feed direction relative thereto, and means actuated when the work at said one member reaches a predetermined dimension for retracting said one member relative to its carrier to stop the tooling of said work while the relative feed of said carriers continues.

16. In combination, a work carrier, a plurality of work holders carried by said carrier, a tool carrier, a plurality of tools carried by said tool carrier, means for providing relative traverse between said tool and holder members, each in position to operate on work carried by one of said work holders, means for moving said carriers relatively to feed the tools relative to the work, means for supporting one of said tools for movement in the general direction of feed relative to said tool carrier, and means actuated when the work operated on by said one tool has reached a predetermined dimension to retract said one tool relative to its carrier to stop its feed while the feed motion between said carriers continues.

17. In combination, a plurality of work holders, a plurality of tools, means for relatively moving said tools and holding to cause said tools to operate successively on work held by said work holders, means for simultaneously feeding said tools relative to work held by said holders, and means for interrupting the feed of one of said tools while the feed of the remainder of said tools continues.

18. In combination, a plurality of work holders, a plurality of tools, means for relatively moving said tools and holders to cause said tools to operate successively on work held by said work holders, one of said tools being a finishing tool, means for simultaneously feeding said tools relative to work held by said holders, and means for interrupting the feed of said finishing tool while the feed of the remainder of said tools continues.

19. In combination, a pair of carriers, a plurality of work holder members carried by one carrier, a plurality of tool members carried by the other carrier, means for producing relative traverse between said tools and work holder members, means for moving said carriers relatively to present each work holder member in succession into cooperative relation to each tool member, means for moving said carriers relatively to feed said tool members relative to work held by said work holder members, means for mounting one of said members on its carrier for movement in the feed direction relative thereto, and means actuated when the work at said one member reaches a predetermined dimension for retracting said one member relative to its carrier to stop the tooling of said work while the relative feed of said carriers continues.

20. In combination, a plurality of work holders, a plurality of tools, means for relatively moving said tools and holders to cause said tools to operate successively on work held by said work holders, means for producing relative traverse between said tools and work holders, means for simultaneously feeding said tools relative to work held by said holders, and means for interrupting the feed of one of said tools while the feed of the remainder of said tools continues.

21. In combination, a plurality of work holders, a plurality of tools, means for relatively moving said tools and holders to cause said tools to operate successively on work held by said work holders, one of said tools being a finishing tool, means for producing relative traverse between said tools and work holders, means for simultaneously feeding said tools relative to work held by said holders, and means for interrupting the feed of said finishing tool while the feed of the remainder of said tools continues.

WILLIAM J. BRYANT.
MERTON H. ARMS.

CERTIFICATE OF CORRECTION.

Patent No. 1,990,469.

February 12, 1935.

WILLIAM J. BRYANT, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, second column, line 15, claim 17, for "holding" read holders; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of March, A. D. 1935.

(Seal)

Leslie Frazer

Acting Commissioner of Patents.