Aug. 28, 1928.

1,682,673

E. M. TAYLOR

GRINDING MACHINE

Filed Jan. 25, 1926

6 Sheets-Sheet 1

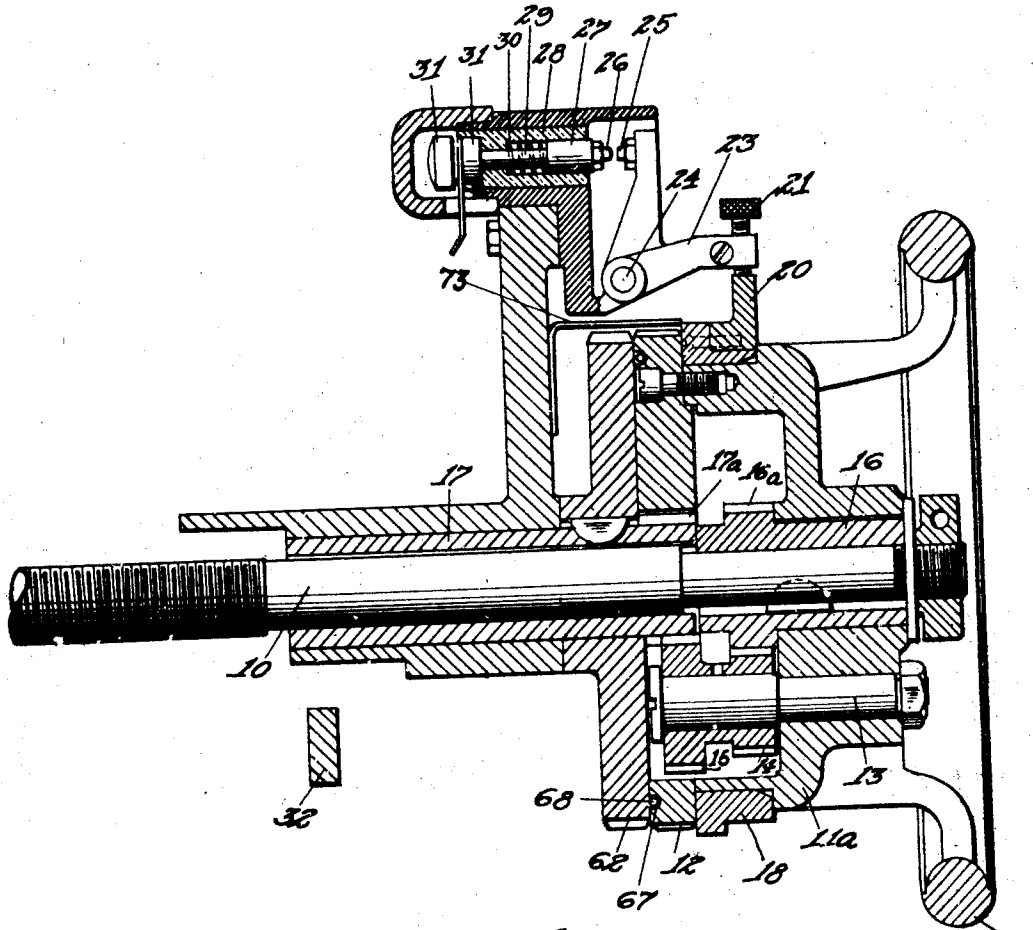


Fig. 2.

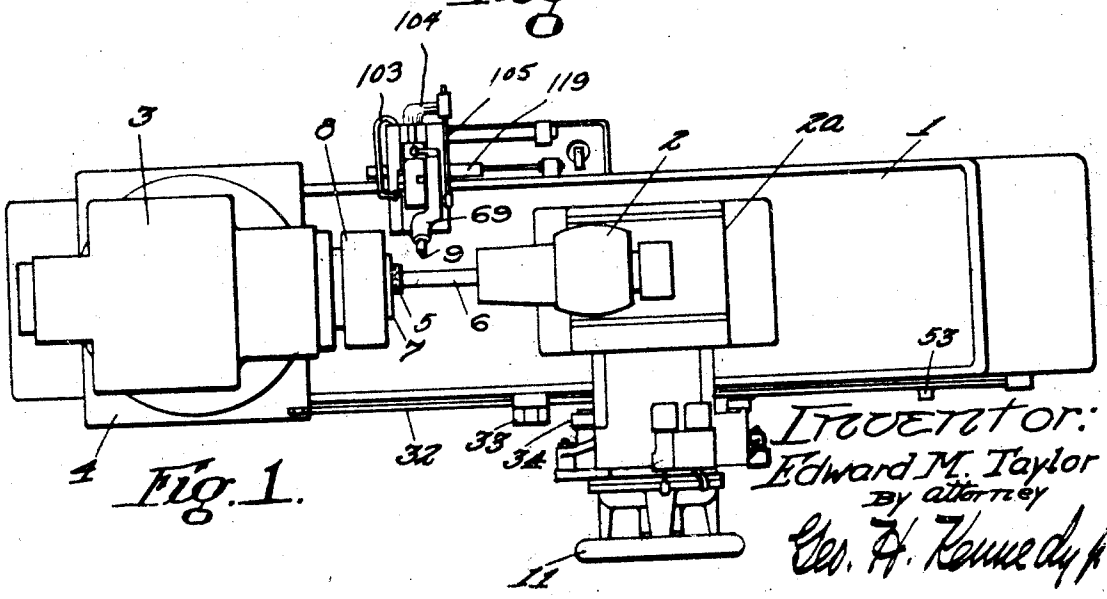


Fig. 1.

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6 Sheets-Sheet 2

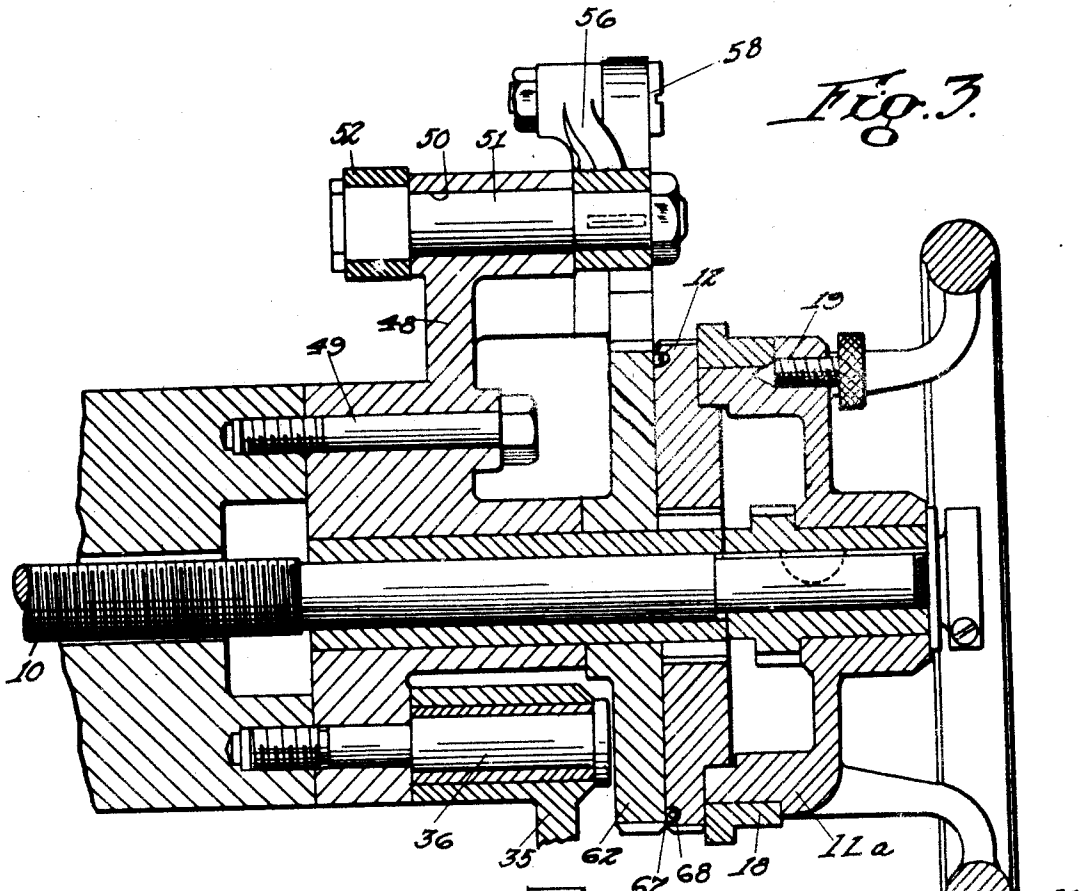


Fig. 3.

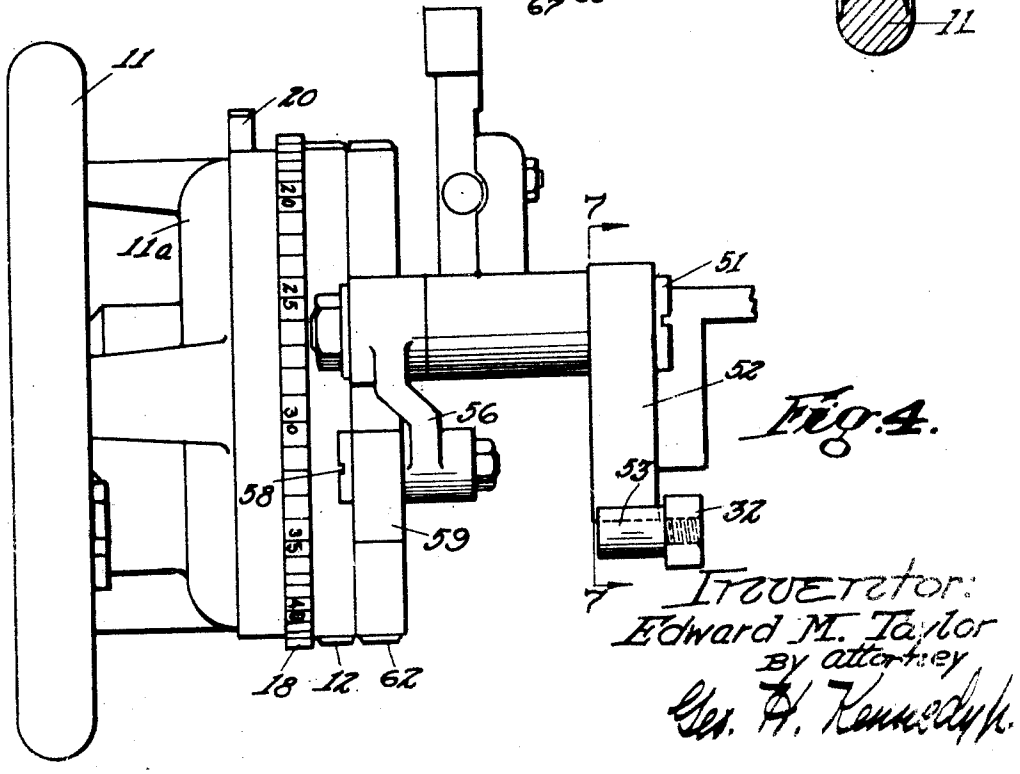


Fig. 4.

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GRINDING MACHINE

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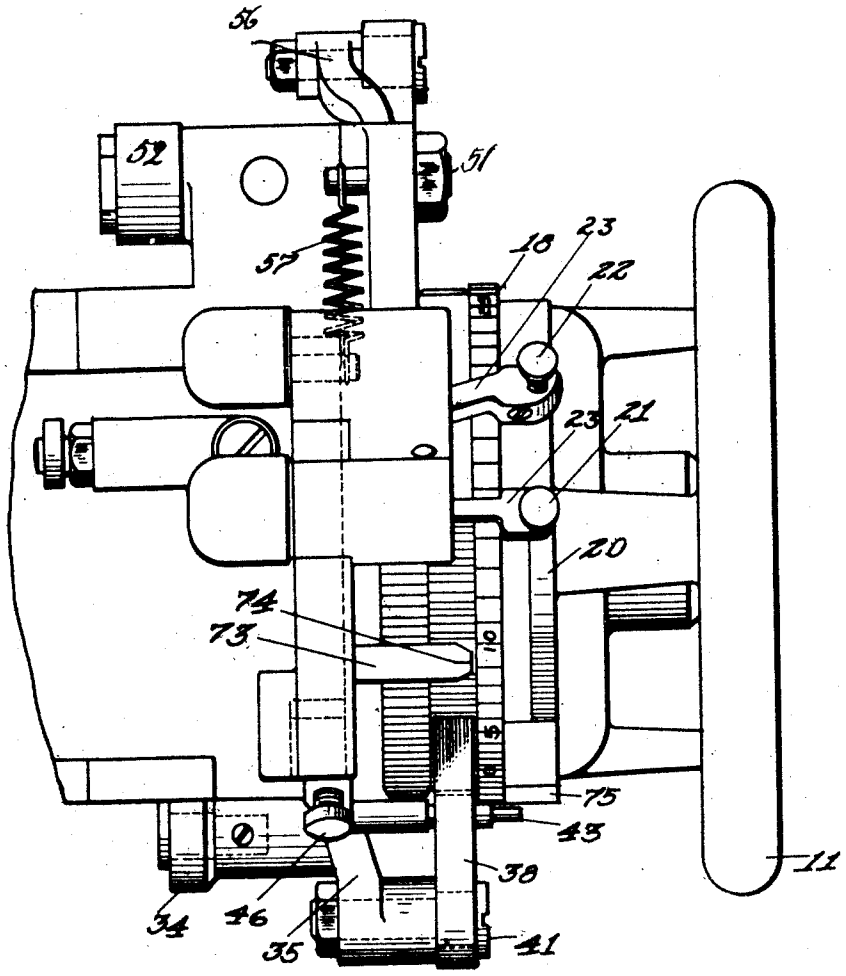


Fig. 5.

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GRINDING MACHINE

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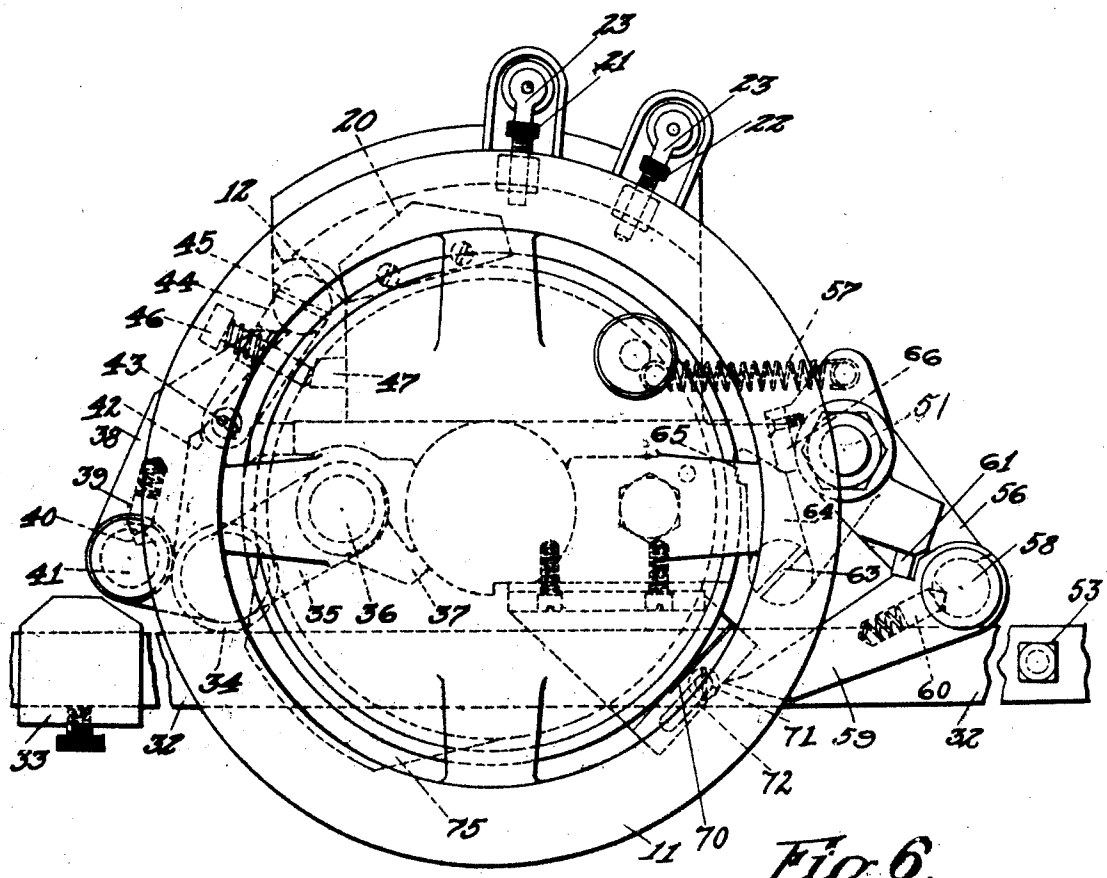


Fig. 6.

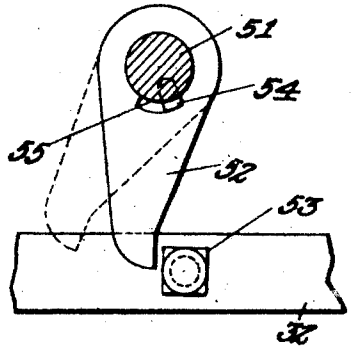


Fig. 7.

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GRINDING MACHINE

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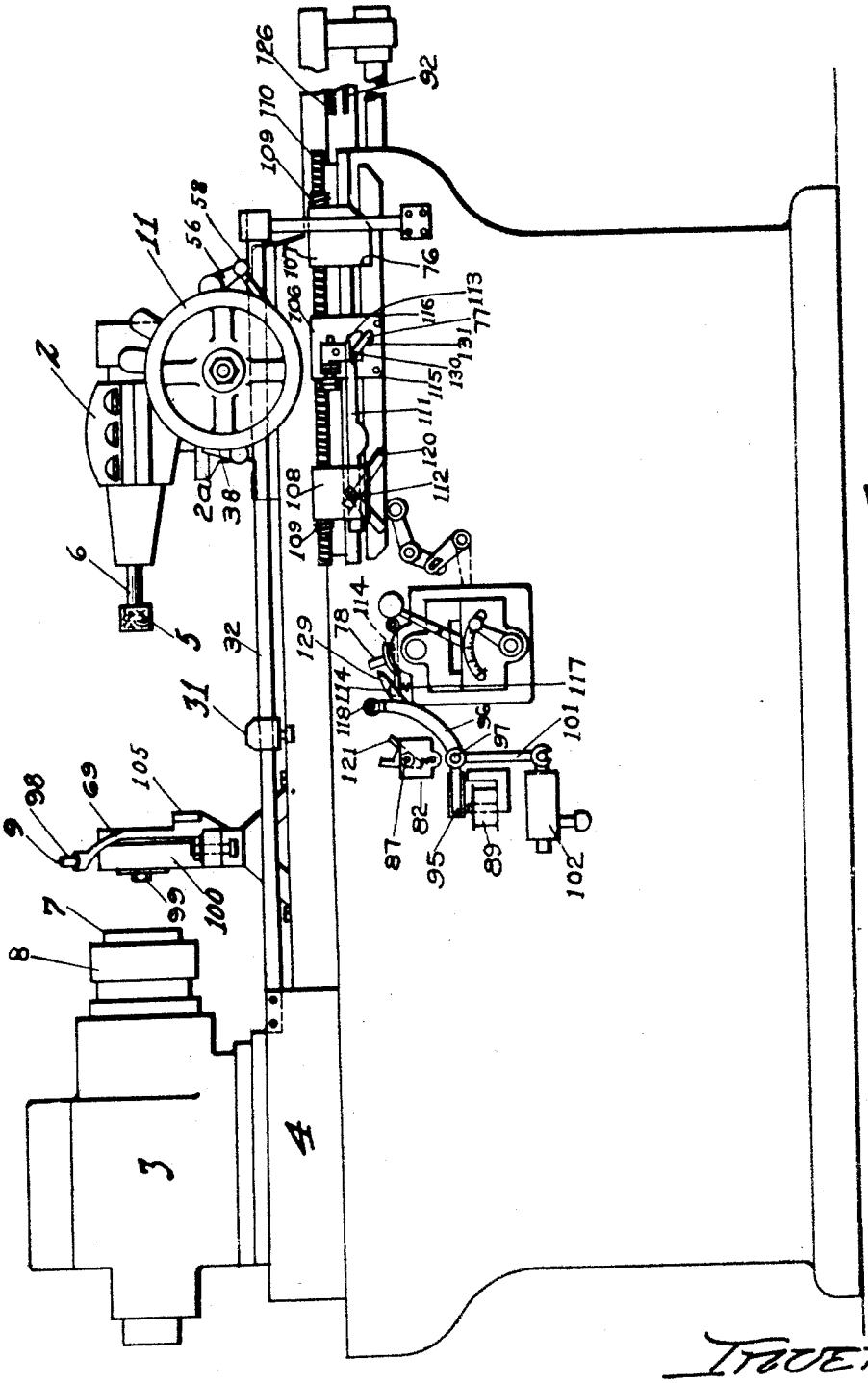


Fig. 8.

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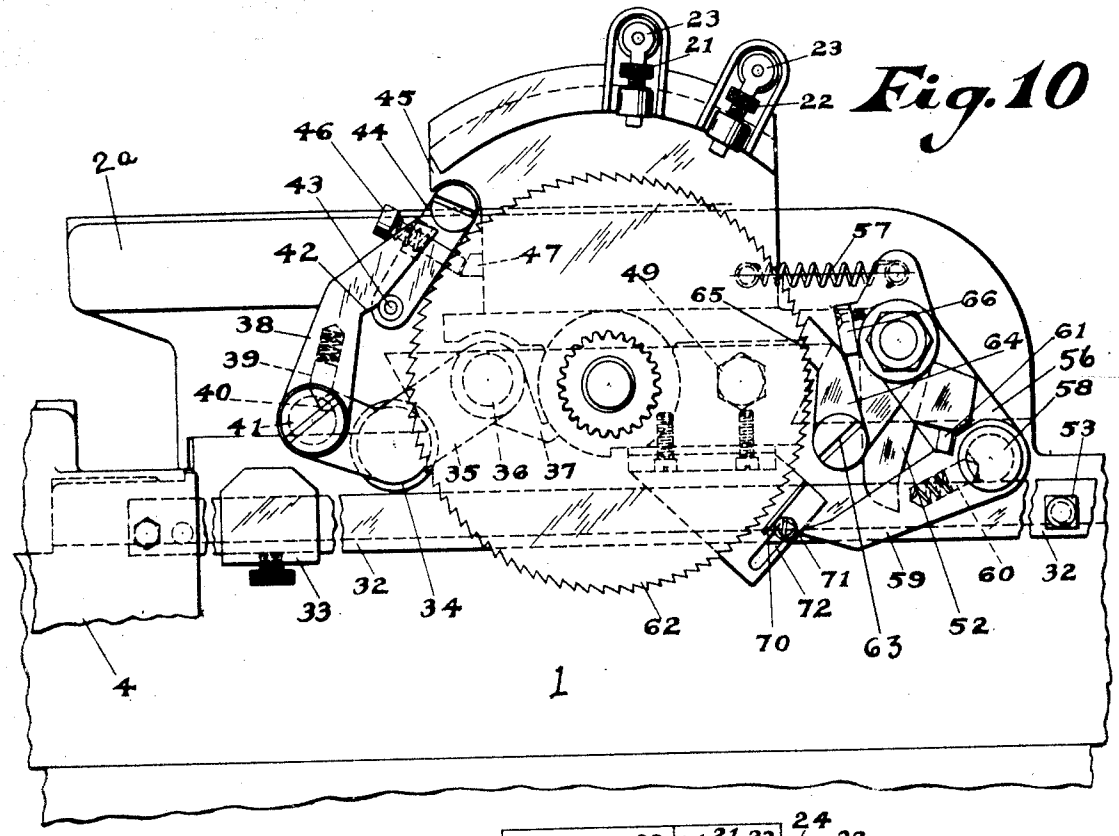
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E. M. TAYLOR

GRINDING MACHINE

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Fig. 10



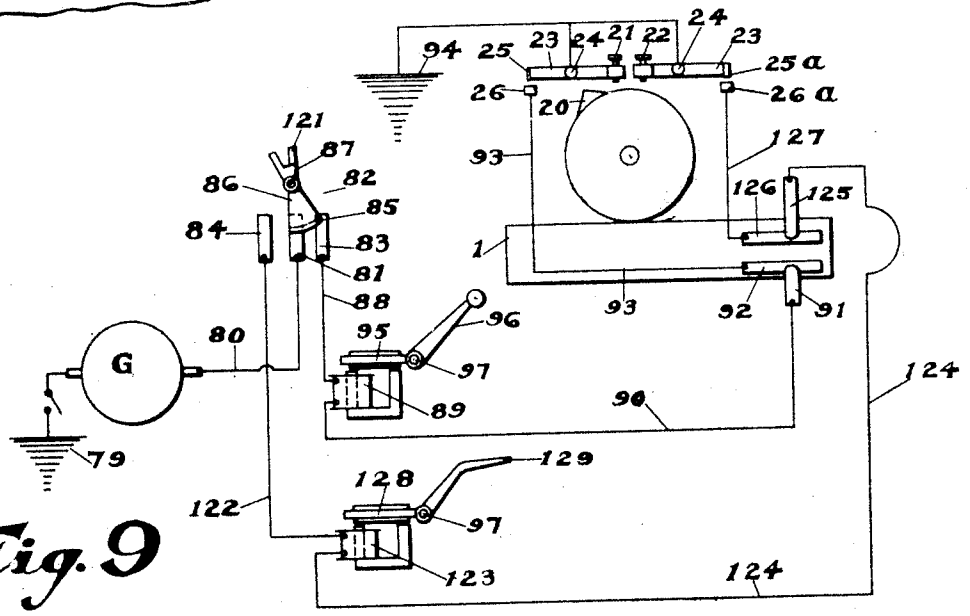


Fig. 9

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Patented Aug. 28, 1928. 1,682,673

UNITED STATES PATENT OFFICE.

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GRINDING MACHINE.

Application filed January 25, 1926. Serial No. 83,592.

The invention relates to grinding machines, particularly those adapted to automatically reduce successive workpieces to a given finished size, and the invention provides means to compensate such machines for the wear on the grinding wheel and for the reduction of said wheel by dressing and truing operations. Such compensation operates in connection with the cross-feed mechanism of the grinding machine, which progressively advances the grinding wheel or the workpiece to cause the former to cut the latter. The invention herein set forth is an improvement on that shown and described in the copending application of Waldo J. Guild, Serial No. 48,734, filed August 7, 1925.

The present improvement eliminates many of the pawl and ratchet devices employed as compensatory means in said Guild machine, and substitutes therefor a means of compensation, for wheel wear and removal of wheel material by dressing, which practically eliminates all possible sources of machine and human error. In particular, the present invention provides a wholly automatic compensating mechanism, in place of compensating mechanism actuated by manual movement of a hand wheel in the Guild machine. Thus the present mechanism prevents accidental "double" or "triple" compensation, which resulted when the operator unintentionally went through certain motions more than once.

In the drawings,

Fig. 1 is a plan view of a grinding machine embodying the invention.

Fig. 2 is a vertical sectional view of the cross-feed mechanism taken on the axis of the feed screw shaft.

Fig. 3 is a horizontal section of the same parts.

Fig. 4 is a fragmentary elevation on an enlarged scale, looking from the right hand side of Fig. 1.

Fig. 5 is a plan view of the parts shown in Figs. 2, 3 and 4.

Fig. 6 is a front elevation of these parts.

Fig. 7 is a fragmentary view, taken on the section line 7—7 of Fig. 4, through a certain shaft.

Fig. 8 is a front elevation of the grinding machine, showing the table actuating mechanism.

Fig. 9 is a wiring diagram for the machine.

Fig. 10 is an elevation of the mechanism shown in Fig. 6, with the hand wheel removed.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, an internal grinding machine is shown having a reciprocatory table or carriage 1 such as is ordinarily provided in any internal grinding machine. In such a machine, either the grinding wheel or the work to be ground may be carried on the table 1, the reciprocation of the latter being utilized in either case to produce a relative traversing movement between the grinding wheel and the work. As here shown, the table 1 supports and carries a wheel head 2, while the work which is to be operated upon is held in a work head 3, the latter being carried by a bridge 4, which spans the slideways provided by the machine frame for the back and forth movement of the table 1.

The grinding wheel 5 is carried on a spindle 6 which is suitably journalled in the wheel head 2, and any suitable means, which need not herein be described, is provided to rotate said spindle 6 and wheel 5. The workpiece 7, which is held by a suitable chuck 8, carried by the work head 3, is also rotated, but desirably at a slower speed.

The reciprocation of the table 1 to cause the rotating grinding wheel 5 to make the required interior traverse of the rotating workpiece 7 may be imparted in any well known manner, as for instance by the use of the fluid pressure controlling and reversing mechanism described in United States Letters Patent No. 1,582,468, to Heald and Guild, granted April 27, 1926. Such mechanism is now well-known in grinding machines and requires no detailed description; it is sufficient to note for present purposes, that the driving means employed for the reciprocation of the table 1, be it hydraulic drive, or gear drive, or any other type, procures the reversal of said table at each end of the latter's normal working stroke by the use of spaced adjustable dogs 76 and 77, carried by the table 1 and adapted to alternately engage and move a reversing member 78;

said member 78, during the grinding operation, when the wheel 5 is moving back and forth within the workpiece 7, is situated between the two dogs 76 and 77 in position to be struck alternately by said dogs, and said member 78, by its consequent movements, first in one way and then the other, effects the reversals in the travel of the table 1.

In this embodiment of the invention the wheel head 2 is carried by a cross slide 2^a which is mounted on ways on the table 1. Referring now to Fig. 2, a transverse feeding element for said cross slide, here shown as a screw shaft, is indicated by the numeral 10. Rotation of this shaft in a clockwise direction (in this particular embodiment of the invention) is adapted to advance the grinding wheel 5 in cutting relation to the workpiece 7. Said screw shaft 10 is adapted to be rotated manually by means of a hand wheel 11 and mechanically from a ratchet wheel 12, the latter being automatically given a step-by-step movement, as will hereinafter appear. Ratchet wheel 12 is directly fastened to an annular piece 11^a, which is herein shown as formed integral with the hand wheel 11. Fastened to the piece 11^a is a stud 13, which rotatably carries a pair of gears 14 and 15, formed out of a single piece. Keyed, or otherwise fastened to the shaft 10 is a sleeve 16. This sleeve provides a convenient bearing for the annular piece 11^a, and it also provides a gear portion 16^a which meshes with the gear 14. Another sleeve 17 surrounds the shaft 10, but is not fastened thereto. This sleeve 17 has a gear portion 17^a which meshes with the gear 15.

Considering, for the moment, that the sleeve 17 is stationary, it will be apparent that rotation of the elements 11, 11^a, and 12, will cause rotation of the screwshaft 10, but at very much reduced speed, since the gears 14 and 15 differ slightly, and only slightly, in diameter.

Referring now to all the figures, except Figs. 1 and 7, a ring 18 is carried by the element 11^a. This ring 18 desirably has suitable scale markings on it, as shown in Figs. 4 and 5. Preferably this ring is adjustable on the member 11^a, and to this end the internal front edge is bevelled, as shown in Figs. 2 and 3, and a binding screw 19 holds it in any desired position of adjustment. On the ring 18 is a cam projection 20. A pair of contact terminals is shown in section in Fig. 2; the machine provides another pair which are identical in construction, so one description will serve for both. As shown, thumbscrews 21 and 22 are carried by rock levers 23, pivoted at 24. Terminals 25 are carried by the levers 23, and when the cam 20, by engagement with the screw 21 or 22 moves a rock lever upwardly, the terminal in question, 25, engages a terminal 26. The latter are mounted on the front of plungers 27, which are slidably held by cylindrical members 28 of insulating material. The plungers have reduced portions 29 which extend through the insulating material and are threaded at the rear end. Springs 30 fit around the reduced portions 29. The threaded parts of the portions 29 serve as binding posts, nuts 31, 31 being provided for the attachment of wires and at the same time to allow the plungers 27 to be pressed into a given position by the springs 30. The above construction allows a firm contact to be made, using heavy rock levers 23 for accuracy, yet without danger of breaking any parts.

Referring now to Fig. 6, a stationary part of the machine carries a cam bar 32, and on said bar is an adjustable cam member 33. The latter is engaged at each normal working reciprocation of the table 1, by a roller 34, thus raising the latter. Said roller 34 is carried by a member 35 which is pivotally mounted at 36. A stop lug 37 holds the parts in the position of Fig. 6, this being the inactive position. A pawl 38 on member 35 is adapted to engage and move the ratchet 12, said pawl having a spring pressed plunger 39 engaging a V cut out portion 40 in the stud 41 on which said pawl is pivotally mounted, whereby the pawl tends to move in a clockwise direction to engage said ratchet 12. Normally, however, the pawl 38 is clear of the ratchet 12, the position of which in Fig. 6 is clearly indicated. Consequently the cross-feed mechanism can be manually adjusted, backwards or forwards at any time, except when the cam 33 is engaging the roller 34, by moving the hand wheel 11. The means to normally hold the pawl 38 clear of the ratchet 12 is shown as an irregular surface 42 on said pawl 38 which engages a shield pin 43 at the end of a lever 44 pivoted at 45, said lever having an adjusting screw 46 engaging a stationary lug 47.

This automatic step-by-step movement of ratchet 12 in response to the actuation of pawl 38 induced by the reciprocation of table 1 moves the annular member 11^a and consequently also the ring 18 and the cam projection 20. The thumbscrews 21 and 22 are in the path of the cam projection 20 and consequently movement of the latter successively causes contact, first of terminals 25 and 26, when the screw 21 is actuated, and subsequently of terminals 25^a and 26^a. For the relation between the two sets of similar contact mechanism, described in a single description above, see Fig. 6 and also the diagram of Fig. 9, which shows the operative relation (not the construction) of the parts. When the terminals 25 and 26 make contact, an electrical circuit is closed which, by the mechanism presently to be described, causes the table 1 to have an amplified stroke to the right, in order to withdraw the grinding wheel 5 from the work, and simultaneously causes a wheel

dressing member or diamond 9 to move into the amplified path of said grinding wheel, thereby to true the periphery of the latter as it passes the point of said diamond.

As shown by the wiring diagram of Fig. 9, electrical current may be supplied by a generator G driven continuously by any suitable means, not shown, from the same source of power that is used for the rotation of the grinding wheel or the work spindle. One terminal of this generator G is grounded, as shown at 79, and the other is connected by a supply wire 80 to the central bar or plate 81 of a two way switch,—the latter being designated as a whole by the numeral 82 and being disposed, as shown in Fig. 8, on the front of the machine. Said switch 82 provides additional contact plates or bars 83 and 84 arranged on opposite sides of the central bar 81 and adapted to be alternately connected electrically to said central bar 81 by a connector 85, which is mounted on an oscillatory member 86. The latter is pivoted at 87 and in its normal position, as shown in Fig. 9, disposes the connector 85 in contact with and across the two plates 81 and 83; in the other position of movable member 86 the connector 85 connects the two plates 81 and 84.

When the grinding wheel 5 is taking the preliminary cuts on a workpiece 7, as illustrated in Fig. 1, the oscillatory switch member 86 occupies said normal position of Fig. 9, and under these conditions the supply wire 80 from the generator G is connected to a wire 88 running from the plate or bar 83 of the switch 82. Said wire 88 runs to the coil of an electromagnet 89 disposed in the front of the machine, as shown in Figs. 8 and 9. A return wire 90 from the coil of the electromagnet 89 is connected to a finger 91 provided on any convenient stationary portion of the machine frame. A contact plate 92 is carried by the table 1, and during the normal working traverse of the table 1, when the grinding wheel 5 is moving back and forth within the workpiece, the finger 91 is in contact with the contact plate 92. The latter is connected by a wire 93 to the contact terminal 26.

When the terminals 25 and 26 are brought together as above described, by the action of cam 20, the circuit through electromagnet 89 is completed, since the terminal 25 is grounded, as shown at 94, Fig. 9. This energizes the electromagnet 89, causing attraction of an armature member 95, and the consequent elevation of its attached lever arm 96, these parts being pivoted at 97 on the front of the machine. Such movement of the lever arm 96, responsive to the engagement of cam 20 with screw 21, is made use of to automatically interrupt the grinding operation on the workpiece 7 for the dressing and truing of the grinding wheel 5, in advance of the final and finishing cuts taken by said wheel to bring the workpiece to the desired size. This involves the withdrawal of the grinding wheel 5 from the workpiece, and the disposal, in the temporarily amplified path of movement of said wheel of the dressing device or diamond 9; these two operations are effected through the medium of the lever arm 96 in the following manner:—

As fully described, in the copending application of Heald and Guild, Serial No. 25,900, filed April 25, 1925, the dressing device 9 may be moved into operative position through the medium of fluid under pressure, more especially when such fluid under pressure is employed for imparting reciprocation to the table 1. For the disclosure of the present invention it is sufficient to note that the dresser point 9, (see Figs. 1 and 8) suitably mounted on an adjustable screw plug 98, is lowered into operative position by the downward swinging movement of a carrying member 69, which turns on a trunnion 99 provided by a suitable standard 100 rising from the stationary frame of the machine. When the lever arm 96 is moved, a downward extension 101 thereof communicates said movement to a valve 102, Fig. 8, thus making the pressure fluid active, through the medium of piping 103 (Fig. 1) against a piston, not shown. Movement of said piston is communicated to a lever 104 which is connected to the carrying member 69 by means of a link 105, and thus actuation of valve 102 in response to energization of electromagnet 89, results in movement of the dresser point 9 to its dressing position in the path of the wheel 5.

As before stated, the other operation inaugurated by engagement of terminals 25 and 26 is the automatic amplification of the reciprocatory path of table 1, to carry the wheel 5 past the dresser 9. As shown in Fig. 8, the left hand table dog 77, which limits the right hand movement of table 1, is carried by a block 106, which, instead of being secured directly to the table 1, as is the case with the block 107 of dog 76, is mounted so as to be capable of sliding freely longitudinally of said table. Under normal conditions, when the table is making its usual working reciprocations to traverse the grinding wheel 5 back and forth within the workpiece, the block 106 of dog 77 is held in definite spaced relation to a block 108, which latter, the same as the block 107 of right hand dog 76, is a stationary block adapted to maintain its predetermined setting or adjustment longitudinally of the table 1, as given it by any suitable adjustment or holding devices, such for instance as the hand screw nuts 109, 109, applied to both blocks 107 and 108 and engaging with the screw rack 110 on the table 1.

The device employed to hold the slidable block 106 in spaced relation to the fixed block 108 is here shown as a latch lever 111 pivoted at 112 on block 108, and having its free end

disposed by gravity in abutting relation to a shoulder 113 on block 106, thereby holding the block 106 at a predetermined distance to the right of block 108. When the latch member 111 is lifted to free its end from the shoulder 113, the normal connection between the slidable block 106 and the fixed block 108 is broken, and when this occurs on the right hand movement of table 1, the dog 77 will bear without effect against the member 78. Thus the right hand movement of the table 1 on this particular stroke will be extended beyond the usual reciprocatory working path, and the grinding wheel 5 will be carried out of the hole in the workpiece to a point just beyond that occupied by the dressing device 9, which latter, as already described, has been moved into operative position as the right hand travel of table 1 begins.

This amplified travel of table 1 involves relative sliding movement between said table and the block 106, owing to the obstruction which the reversing member 78 imposes against the dog 77 to prevent the block 106 from moving with the table: finally the block 106 brings up against the block 108, whereupon the solid backing thus afforded for the block 106 enables the dog 77 to shift the member 78. This procures reversal of the table 1, and the left hand movement of said table thus inaugurated is caused to restore the parts automatically to normal position in the following manner:—

A member 114 pivotally mounted on the frame of the machine has a pair of inclined surfaces for cooperation with inclined surfaces 115 and 116 at the lower corners of the block 106. A spring 117 presses said member 114 upwardly. In the normal grinding operation of the machine when the blocks 106 and 108 are connected by latch 111, the inclined surfaces on member 114, although in the path of block 106, offer no effective obstruction to the back and forth travel of said block in unison with the table 1, it being obvious that when either lower corner of the block under these conditions strikes either of said bevelled surfaces, such contact will wedge the spring 117 downwardly, said spring yielding sufficiently to allow the block 106 to pass over the member 114. However, when the block 106 has been freed from the block 108 as above described, to amplify a single right hand stroke of the table 1, the ensuing reversal of said table, with the block 106 still free, finds the right hand surface of member 114 in position to contact with the bevelled corner 115 of said block, and under these conditions, the obstruction offered is sufficient to overcome whatever friction there may be tending to cause the block 106 to move to the left with the table. The block 106 being thus held stationary while the table 1 and block 108 continue to move to the left, the latch member 111 finally resumes its normal position relative to the block 106, the end of said latch member dropping behind the shoulder 113, and the parts being thus automatically restored to normal position at the conclusion of each single amplified reciprocation of the table 1.

Said single amplified reciprocation of the table 1 for wheel dressing purposes is inaugurated automatically when preliminary grinding has been carried to a predetermined point in relation to finished size on each workpiece, by the making of electrical contact through the terminals 25 and 26, as already described, thus moving the lever 96 about its pivot 97. The lever 96 has a roller 118 on the upper portion thereof, and upon movement of this lever during normal working traverse of the grinding wheel 5, the roller 118 engages and lifts the latch lever 111, thus causing the above described amplified movement of the table 1, which carries the grinding wheel 5 to the right, past the diamond 9, and then to the left, again passing said diamond before resuming the normal reciprocatory traverse of the workpiece 7. Thereupon, by any suitable means, such as by the engagement of a cam member 119, fastened to the table 1 (shown in Fig. 1) with a roller, not shown, on a forward extension of lever 104, the diamond 9 is rocked upwardly into the inoperative position that it normally occupies.

On this amplified right hand dressing stroke of the table 1, an arm 120, Fig. 8, pivoted at 112 and hanging by gravity in the position shown in Fig. 8, strikes an arm 121 of movable switch member 86, thereby rocking the connector 85 of said switch member away from bar 83 (see Fig. 9), which prevents a repetition of the dressing stroke. Thereupon the connector 85 is disposed in position to connect the switch plates or bars 81 and 84. A wire 122 runs from the switch bar 84 to the coil of a second electromagnet 123, and the other end of said coil is connected by a wire 124 to a finger 125 carried by the machine frame, preferably adjacent to the finger 91. Said finger 125 makes contact with a contact plate 126, carried by the table 1 adjacent to the plate 92, and a wire 127 connects the plate 126 with the contact 26^a.

After the wheel dressing operation above described, and with the resumption of grinding upon the workpiece 7, the inward feeding of the grinding wheel 5 involves further clockwise rotation of the ring 18, which ultimately carries the cam 20 into engagement with the screw 22. The parts are so set and adjusted that the engagement of cam 20 with screw 22 and the consequent rocking of lever 23 that carries screw 22, brings together the contacts 25^a and 26^a just as the workpiece 7 reaches the exact desired size. This contacting completes the electrical circuit through the mag-

net 123, since the contact 25ª is grounded the same as the contact 25, at 94. Thus the electromagnet 123 is energized, causing attraction of an armature member 128 pivoted on the same spindle 97 which forms the pivot for the armature member 95, the magnet 123 being directly behind the magnet 89. The armature 128 provides a lever arm 129 for cooperation with the left hand table dog 77 in the following maner:—

Said table dog 77, as shown in Fig. 8, is pivoted at 130 to its carrying block 106, and normally rests by gravity against a pin 131, thereby to maintain its free end in position to engage and move the reversing member 78 at the end of the right hand normal working stroke of the table 1. When the magnet 123 is energized, the lever arm 129 is raised into the path of dog 77, and the latter, on the right hand movement of table 1, by reason of its pivotal mounting, is free to ride on the upper surface of said lever arm; thus the striking end of said dog 77 is carried clear of the reversing member 78, and the table 1 continues its movement to the right, carrying the grinding wheel 5 out of the workpiece and well past the then inoperative dressing device 9, said table ultimately carrying the grinding wheel 5 into the position illustrated in Fig. 8, and then being brought to a full stop by any suitable means, as shown, for example, in said Patent No. 1,582,468.

Referring now to the right hand side of Figs. 6 and 10 and the corresponding parts of Figs. 3 and 5, a casting 48 is suitably attached, as by a bolt 49, and the pivot bolt 36, to the table 1. This casting 48 provides a journal 50 which receives a short shaft 51. The latter, at its rear end, carries a downwardly depending arm 52, which is shown in more detail in Fig. 7. The lower end of this arm is in the path of a lug 53 carried by the bar 32, and when the final movement of separation between the grinding wheel and the workpiece occurs, the lug 53 and arm 52 come together as shown in Fig. 7, the latter being rocked to the dotted line position of this figure. This rocks the shaft 51 in a clockwise direction, on account of a key or pin 54 in said shaft, but when contact is made between lug 53 and arm 52 in a reverse direction of travel, as the grinding wheel moves to enter a new workpiece, no movement of the shaft 51 is produced, since a slot 55 is provided in arm 52 to allow said arm to move in a counterclockwise direction of rotation without moving the pin or key 54.

Suitably fastened at the front end of shaft 51 is a member 56. Said member, of course, receives the clockwise rotation referred to, and a spring 57 returns the parts to the normal position, as shown in Figs. 6 and 10, immediately after the operative engagement of member 52 and lug 53. The member 56 pivotally carries at 58 a pawl 59. The latter contains a spring pressed plunger device 60 similar to the one already described for pawl 38, and a stop lug 61 on member 56 holds the pawl 59 in the position shown, until member 56 is moved inwardly. When this occurs, pawl 59 engages and moves a ratchet wheel 62 (see Fig. 2) which is keyed or otherwise fastened to the sleeve 17.

Conveniently pivoted at 63 on the casting 48 is a member 64, having a plurality of pawl teeth 65. When the member 56 is in its normal position of Figs. 6 and 10, a locking plate 66 carried by it engages a bevelled surface on the member 64 and, owing to the leverage effect obtained by the shortness of distance of plate 66 from the pivotal center of member 56 and the inclined plane action, the teeth 65 are firmly held against ratchet 62 by the pressure of spring 57. Also the above acts as a stop device to hold the parts 51, 52, 56, etc., normally in the position shown. Of course, when the member 56 moves inwardly, the plate 66, being attached to it, moves away from member 64, and thus the lock is released.

Between the ratchet wheel 12 and the ratchet wheel 62 is a groove 67 in one of said ratchets, and an irregular but generally circular wire 68 is inserted in said groove. Thus the wire 68 is constrained to lie in a plane, and the reacting pressure of the latter acts as a brake on ratchet 12. This prevents any retrograde motion of said ratchet from any cause, such as the dragging effect of the pawl 38.

Assuming now that an unground workpiece has been secured in the chuck 8, all necessary adjustments made and the machine set in operation; the rotating and reciprocating grinding wheel 5 gradually enlarges the hole in workpiece 7 as, at each stroke of said wheel 5 caused by the reciprocations of table 1, the cam member 33 lifts the roller 34 with the resultant movement of the cross slide 2ª on table 1. The grinding continues uninterruptedly until, by the continued movement of ratchet 12 and consequent rotation of the annular piece 11ª and ring 18, the cam projection 20 on said ring engages the screw 21, thus moving the first rock lever 23 and bringing the first set of terminals 25 and 26 together. This closes an electric circuit and, by means already fully described, causes the wheel 5 to be dressed and trued.

Subsequent to the dressing stroke first described, the grinding is again resumed, and after a determinate number of reciprocations of table 1, causing a definite advance of cross slide 2ª, the cam projection 20 comes in contact with the screw 22 and, rocking the second lever 23, brings the second set of terminals 25ª and 26ª together, thus energizing a second electric circuit. This, as likewise fully described, causes the table 1 to run out well to the right, thus giving the operator

ready access to the chuck 8. As said table 1 moves outwardly, the depending arm 52 strikes the lug 53 on bar 32, and thus the arm 52 is moved as described, which causes the lock 57 to be released, and the pawl 59 to move the ratchet wheel 62 in a clockwise direction.

This automatic movement of the ratchet 62 produces the compensation in the following manner:—When ratchet 62 is turned slightly clockwise, sleeve 17 and gear 17^a, to which said ratchet is fastened, must likewise turn. This causes a change in the geared relationship between the hand wheel 11 and the screw shaft 10. For, inasmuch as the grinding machine of the invention is intended for precision work, it is not necessary, in between the grinding of workpieces, to retract the cross slide 2^a by a greater amount than is represented by a partial rotation of the hand wheel. Consequently, so long as the sleeve 17 and gear 17^a remain stationary, each angular position of the hand wheel 11 and, consequently, of the cam 20 represents a different but definite angular position of the screw shaft 10. This is because the gear 15, which is integrally united to the gear 14, as already explained, moves on the gear 17^a when said gear is stationary, as on a track. Movement, then, of this gear 17^a produces a new relationship between the hand wheel 11 (and consequently also the cam 20) and the screw shaft 10, and the gear ratios are such (gear 14 being smaller than gear 15) that, relatively speaking, the screw shaft 10 is moved forward in relationship to the hand wheel 11 and cam 20.

The gearing 14, 15, 16^a and 17^a in fact constitutes a differential mechanism, from the fact that the axis of gears 14 and 15 is movable with the hand wheel 11, said axis being represented by the stud 13. Thus it will be seen that movement of the element comprising the parts 12, 11, 11^a and 13 results in feeding movement of the shaft 10, and movement of the element comprising parts 62, 17 and 17^a results also in feeding movement of the shaft 10, the first feed being the normal feed and the last named a compensating feed.

In the above description, the motions described are relative motions. To make the operation of the parts entirely clear, the absolute motions will now be explained, it being understood that this explanation is given only as illustrative of one way in which the mechanism operates, since the absolute motions would be varied by a change of friction of the parts, or by placing a different load on the machine. As actually observed, all the cross-feed parts rotate together during the compensating movement. Thus the hand wheel 11 and the parts thereto attached, such as the drive ratchet 12, also the sleeve 16 and the screw shaft 10 itself, all rotate clockwise for a limited distance. This action, occurring at the finish of the grinding operation, moves cam 20 on ring 18 a given angular distance beyond the contact position of thumb screw 22, shaft 10 being turned an equal angular distance. When, therefore, in repositioning the cross slide 2^a so that the wheel 5 can enter a fresh workpiece, the operator has turned the hand wheel 11 far enough in a counterclockwise direction to bring the cam 20 to that position where it had just previously caused automatic cessation of grinding by contact with screw 22, the parts 11, 11^a, 12, 18 and 20 are in the position they occupied as the wheel 5 left the last workpiece. And such repositioning has turned the shaft 10 counterclockwise, but only by a limited amount. Such limited amount is only a small fraction of the previous automatic turning, said fraction being, of course, the same as the fraction represented by the reducing action of gearing 14, 15, 16^a and 17^a.

The resultant of the above is that the cross slide 2^a is automatically advanced in relation to the hand wheel 11, ring 18 and cam 20 by an amount represented by the given angular displacement of ratchet 68 minus the fractional return motion. This compensates for the reduction of wheel 5 by grinding and by dressing, the fixed predetermined advance of the grinding wheel beyond the dressing plane being relied on to accurately and automatically bring the workpiece to a given size.

Of course, this compensation should be adjustable in amount, and to this end, a shield member 70 is provided for the pawl 59, said shield being adjustable as by a screw and slot 71, 72.

Desirably also, a suitable relatively stationary piece 73 is provided, having a mark 74 which, by cooperation with the scale markings on ring 18, indicates to the operator the stage of grinding. Usually the zero mark on the scale is set to come opposite the mark 74 when cam 20 makes the final circuit by moving screw 22. Desirably also, the ring 18 carries another cam member 75 which, by engagement with the pin 43, automatically reduces the amount of feed, but this is no part of my invention.

Having described the actual as well as the relative motion that occurs during the compensation, it will be apparent to all those skilled in the art that many reversals of parts and motions could be made. For example, instead of compensating by changing the setting of the gearing between the cam 20 and the screw shaft 10, the contact screws 21 and 22 could be moved directly. For in my invention, the distance between either contact screw and the cam 20 is a function of the position of the screw shaft 10; that is to say, each separate angular position of the shaft 10, between successive compensations, determines a given distance between, for example,

the screw 22 and the cam 20; and this would still be true of the mechanism modified as above suggested. The compensation, in effect then, alters the value of that function. Similarly, by a simple change in the mechanism illustrated in Figs. 5 and 6 the automatic compensation could be made to occur when the table 1 is moving inwardly to carry the grinding wheel 5 into workpiece 7 at the commencement of the grinding operation instead of operating, as it does, when the table runs outwardly at the finish of a grinding operation. This change would in no manner alter the function or the mode of operation of the machine and in fact the identical parts could be used some of them being arranged in reverse relation to some other parts, and therefore, in the appended claims, the phrase "extended movement" or words of similar import are to be construed as covering the return as well as the outgoing movement of the table 1 and the short extended movement as well as the long extended movement, except where the terms of a claim itself requires a different construction. These modifications above, and similar ones, being clearly within the concept of my invention fall within the spirit of the appended claims.

I claim:

1. In mechanism of the class described, a transverse feeding element, a driving member therefor, gearing connecting said feeding element to said driving member, automatic means for progressively advancing said driving member, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, and means responsive to extended movement of said table for changing the setting of the gearing connecting said feeding element to said driving member.

2. In mechanism of the class described, a transverse feeding element, a driving member therefor, gearing connecting said feeding element to said driving member, automatic means for progressively advancing said driving member, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, and means responsive to said extended movement of the table for automatically procuring a change in the setting of the gearing between said feeding element and its driving member.

3. In mechanism of the class described, a transverse feeding element, a driving member therefor, gearing connecting said feeding element to said driving member, automatic means for progressively advancing said driving member, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, and means responsive to said extended movement of the table for automatically predetermining angular displacement between said feeding element and said driving member.

4. In mechanism of the class described, a transverse feeding element, a driving member therefor rotatable in opposite directions to secure, respectively, feeding and withdrawal movements of said feeding element, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, a second member rotatable with said feeding element, means set in operation by said second member on its arrival at a predetermined point to procure said extended movement, and means responsive to said extended movement for automatically causing a movement of said feeding element independent of actuation by said driving member.

5. In mechanism of the class described, a transverse feeding element, a driving member therefor rotatable in opposite directions to secure, respectively, feeding and withdrawal movements of said feeding element, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, a second member rotatable with said driving member, means set in operation by said second member on its arrival at a predetermined point to procure said extended movement, and means responsive to said extended movement for automatically predetermining an angular displacement between said feeding element and said second member.

6. In mechanism of the class described, a transverse feeding element, a driving member therefor, automatic means for progressively advancing said driving member, a table mounted for movement on a machine frame providing for a traverse between the work and tool and an extended movement, a second member advanceable with said driving member, means set in operation by said second member on its arrival at a predetermined point to procure said extended movement, and means responsive to said extended movement for automatically causing a movement of said second member independent of the automatic means for progressively advancing said driving member.

7. In a cross-feed mechanism, a transverse feeding element, a differential gearing for actuating it, one end gear of said differential rotatable for normal feeding movements and the other end gear adjustable for compensating feeding movements.

8. In mechanism of the class described, a transverse feeding element, a driving member therefor, means to give said driving member a progressive automatic advancement, a normally stationary element, means for periodically moving said normally stationary element, and a differential gear train, one end thereof being connected to said feeding element, the other end being connected to said

normally stationary element, and said driving element being intermediately connected to said differential.

9. In mechanism of the class described, a feed screw shaft, a driving member therefor, means to give said driving member a progressive automatic advancement, a pair of rigidly attached gears carried by said driving member, a gear connected to said feed screw shaft meshing with one of said gears carried by said driving member, and a normally stationary gear meshing with the other of said pair of gears, and means to periodically move said normally stationary gear.

10. In mechanism of the class described, a transverse feeding element, a driving member therefor, gearing connecting said driving member to said feeding element, means for progressively and automatically advancing said driving member, a table mounted for movement on a machine frame, providing for a traverse between the work and tool and an extended movement, and means for producing successive changes in the setting of the gearing between said feeding element and its driving member, responsive to successive extended movements of said table.

11. In a compensating mechanism for the transverse feed for grinding machines, a table mounted for movement on a machine frame, providing for a traverse between the work and tool and an extended movement, a transverse feeding element, a pair of members one of which is movable towards the other simultaneously with the advancing action of the said transverse feeding element, mechanism brought into operation by the bringing together of said pair of members for giving said table said extended movement, a ratchet gear, means responsive to movement of said ratchet gear adapted to change the relative position between two of three members, viz, the transverse feeding element and the pair of members, means responsive to said extended movement of said table for moving said ratchet gear through a predetermined angular displacement, and means for preventing any further movement of said ratchet gear on the reverse or return movement of said table.

12. In a compensating mechanism for the transverse feed for grinding machines, a table mounted for movement on a machine frame, providing for a traverse between the work and tool and an extended movement, a transverse feeding element, a pair of members one of which is movable towards the other simultaneously with the advancing action of the said transverse feeding element, mechanism brought into operation by the bringing together of said pair of members for giving said table said extended movement, a ratchet gear, means responsive to movement of said ratchet gear adapted to change the relative position of two of three members, viz, the transverse feeding element and the pair of members, a lock mechanism normally holding said ratchet stationary, and automatic means responsive to movement of said table for releasing said lock.

13. In a compensating mechanism for the transverse feed for grinding machines, a table mounted for movement on a machine frame, providing for a traverse between the work and tool and an extended movement, a transverse feeding element, a pair of members one of which is movable towards the other simultaneously with the advancing action of the said transverse feeding element, mechanism brought into operation by the bringing together of said pair of members for giving said table said extended movement, a ratchet gear, means responsive to movement of said ratchet gear adapted to change the relative position between two of three members, viz, the transverse feeding element and the pair of members, a lock mechanism normally holding said ratchet stationary, and automatic means responsive to movement of said table for releasing said lock and moving said ratchet through a predetermined angular displacement.

Dated this eleventh day of January, 1926.

EDWARD M. TAYLOR.