

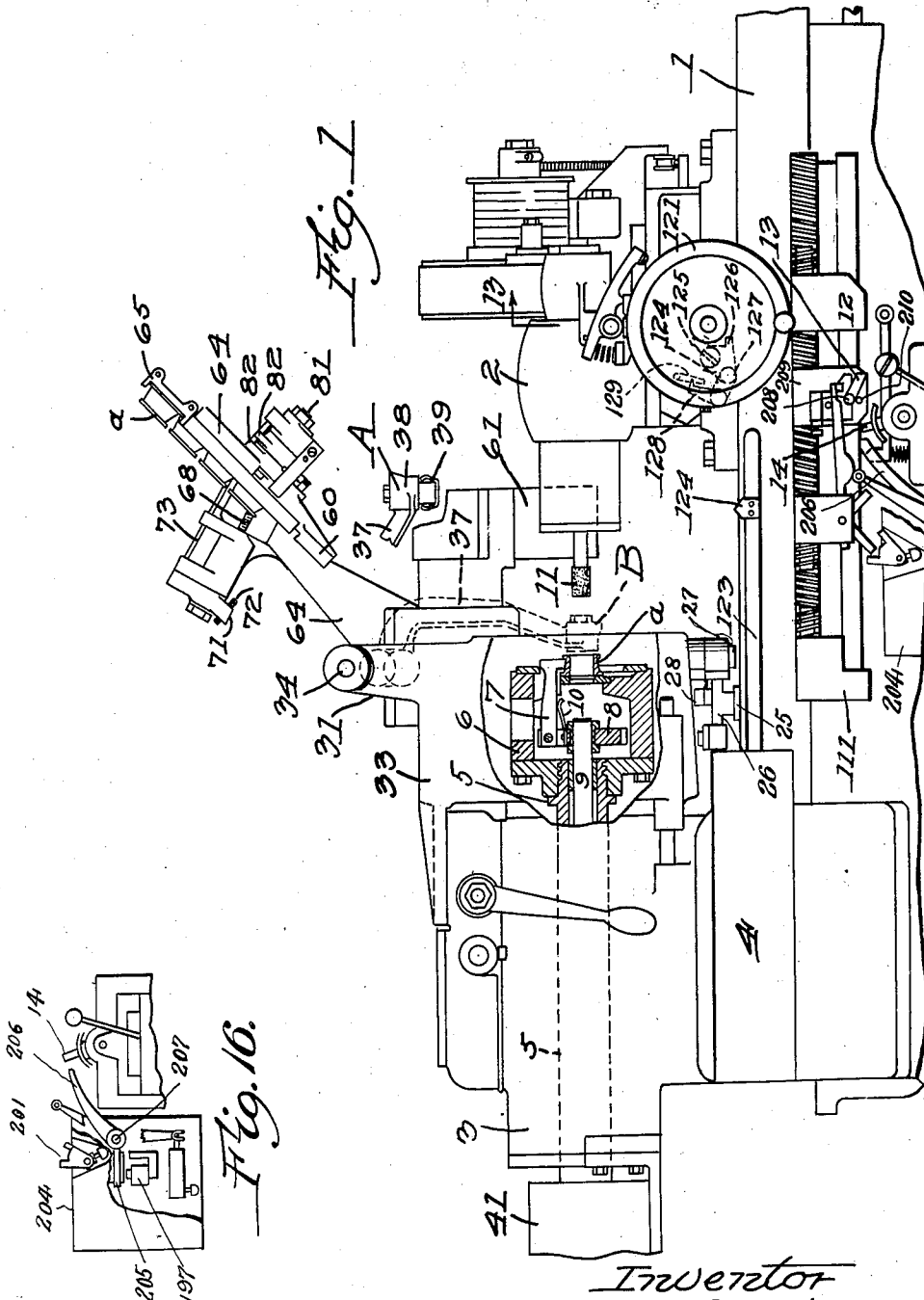
Jan. 12, 1932.

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1,840,841

WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

Original Filed April 2, 1926 9 Sheets-Sheet 1



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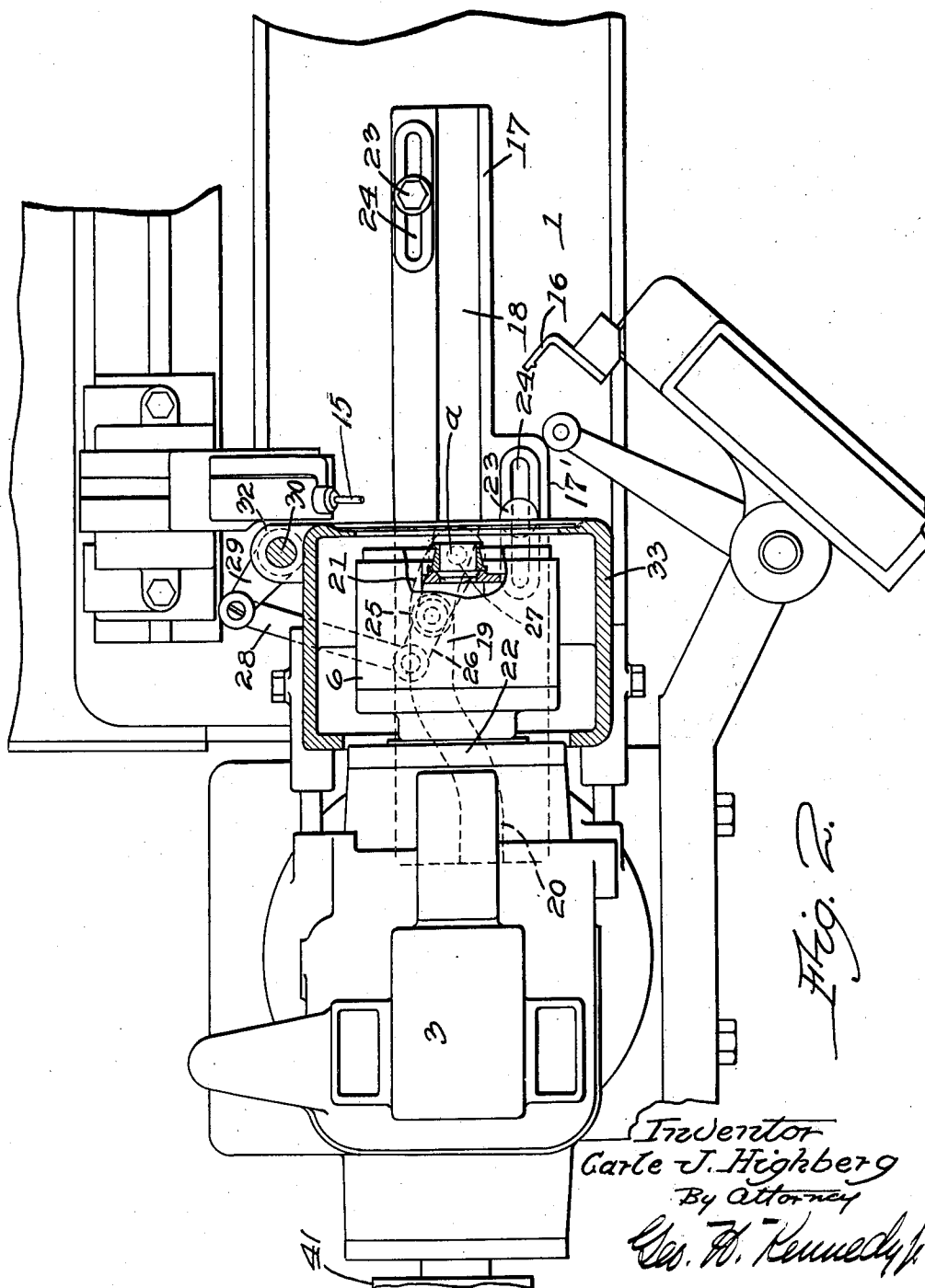
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WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

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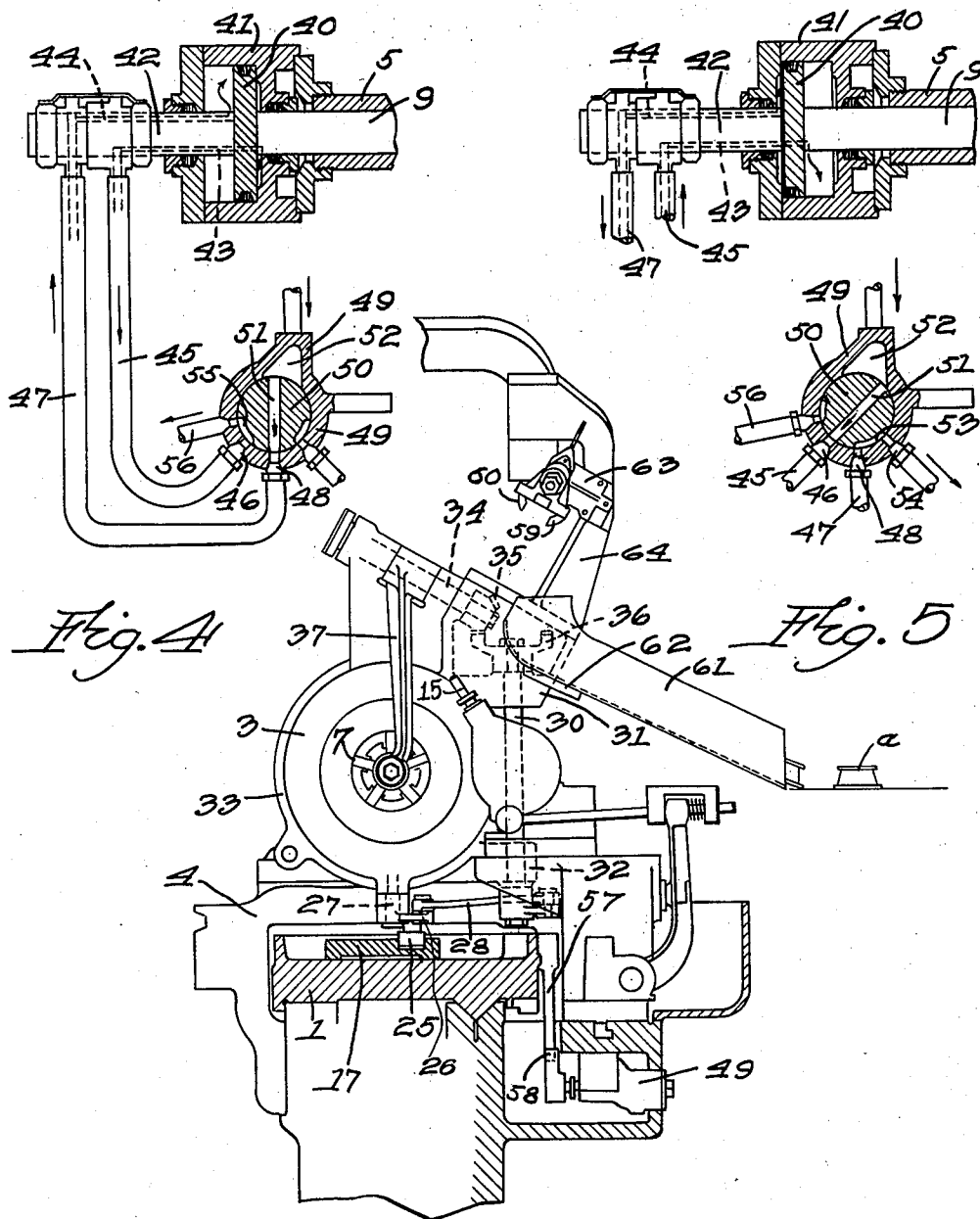
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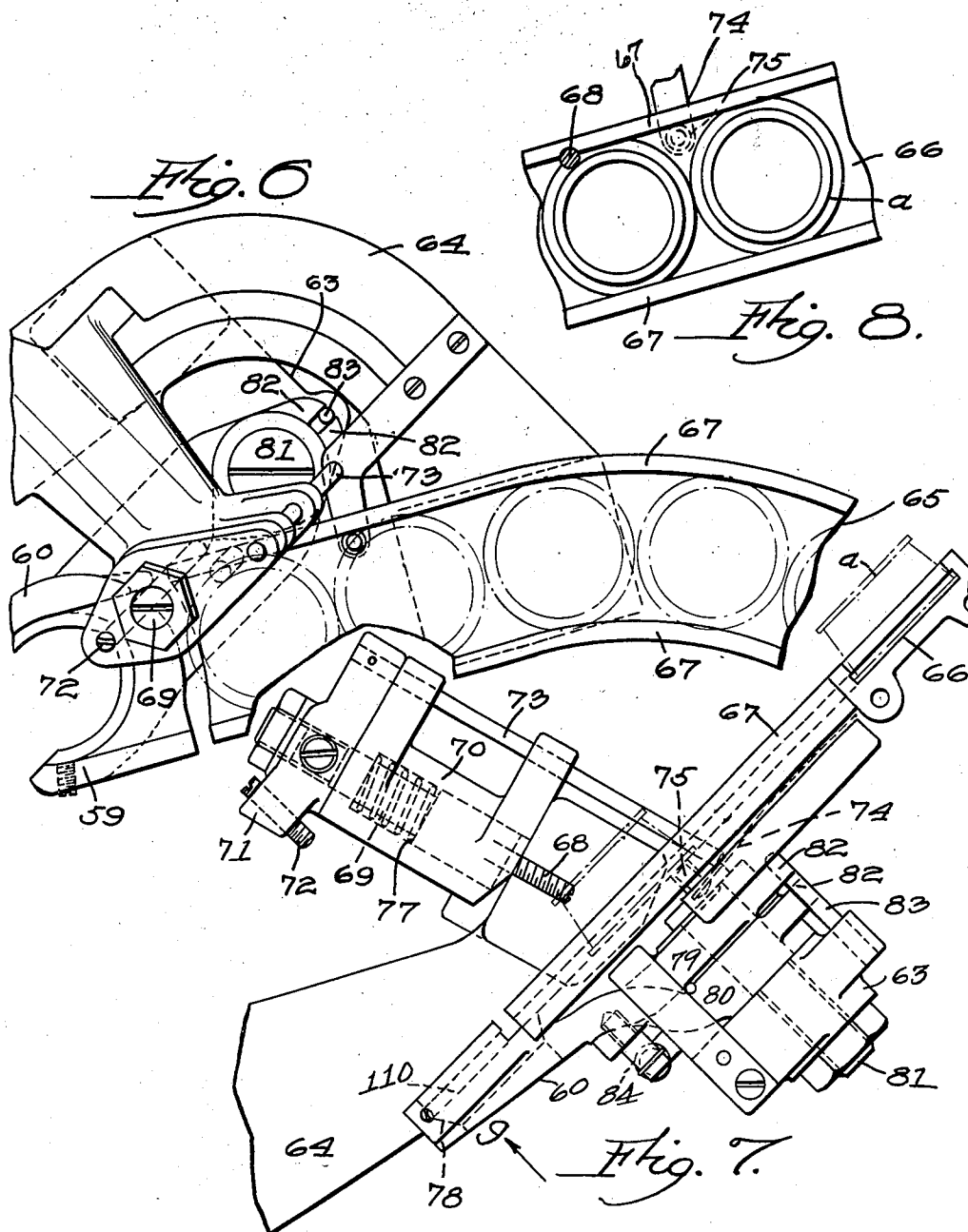
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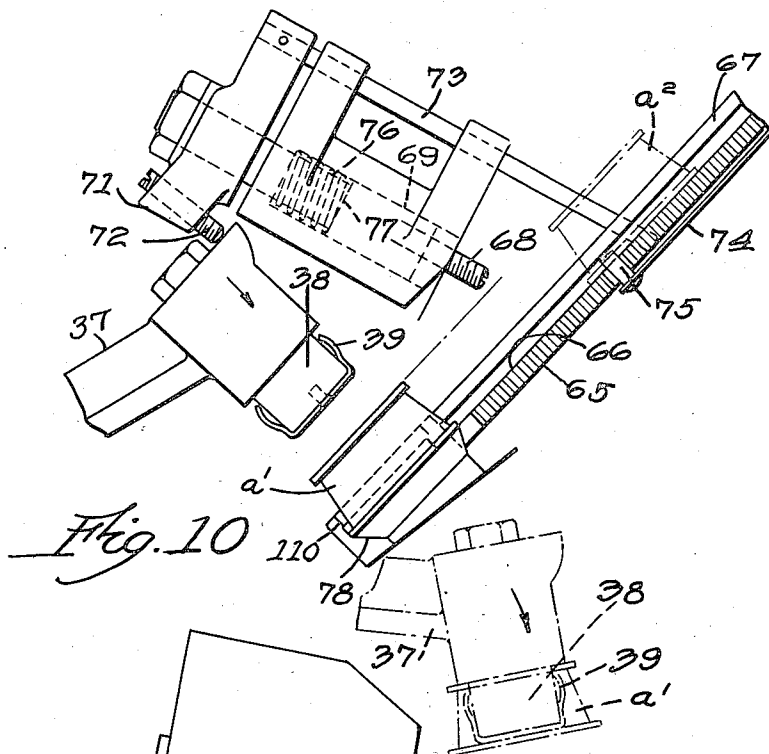
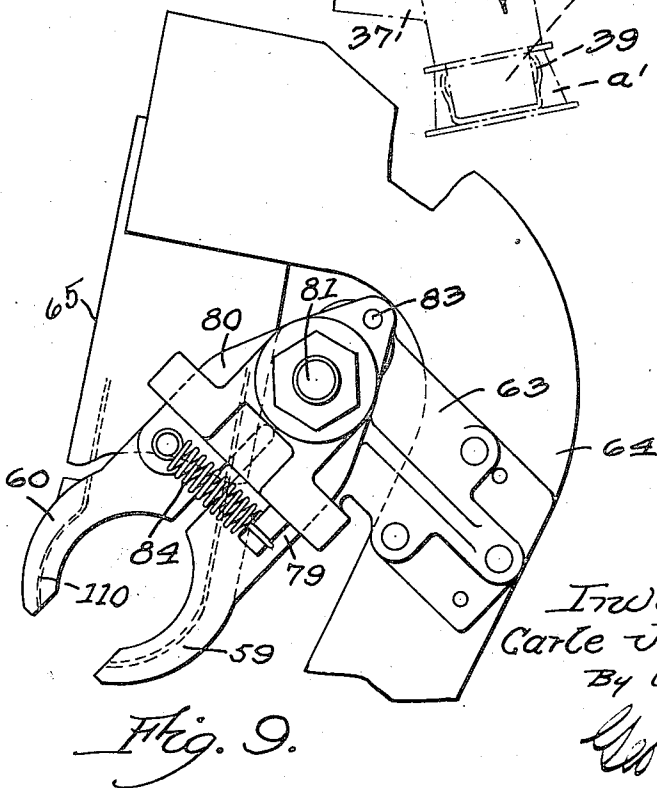
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WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

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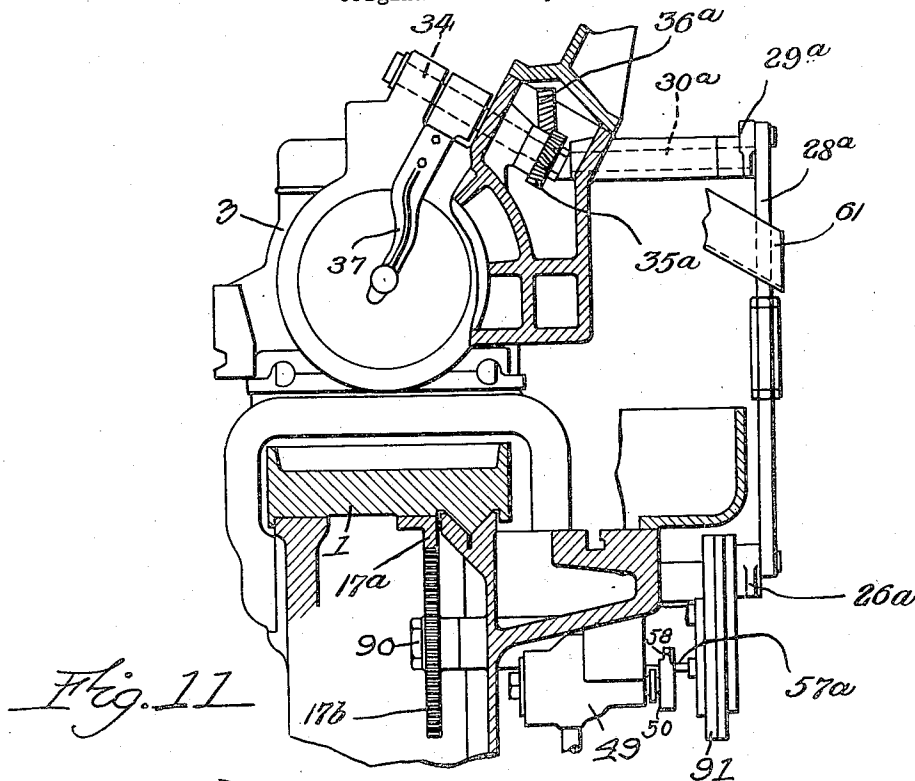
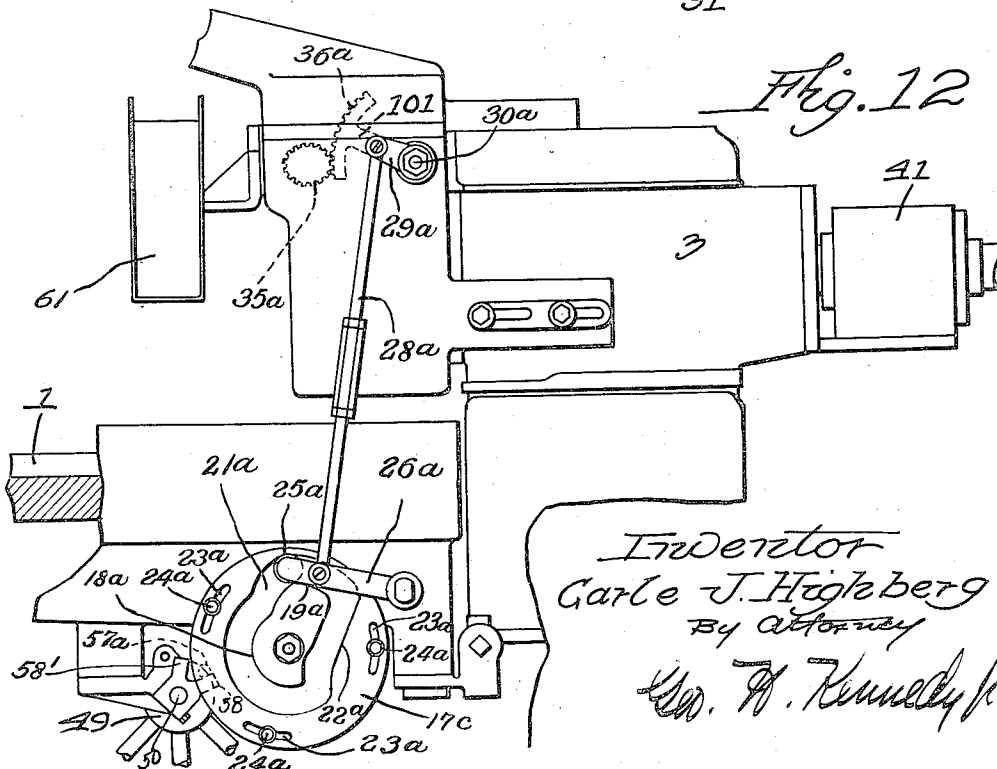
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WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

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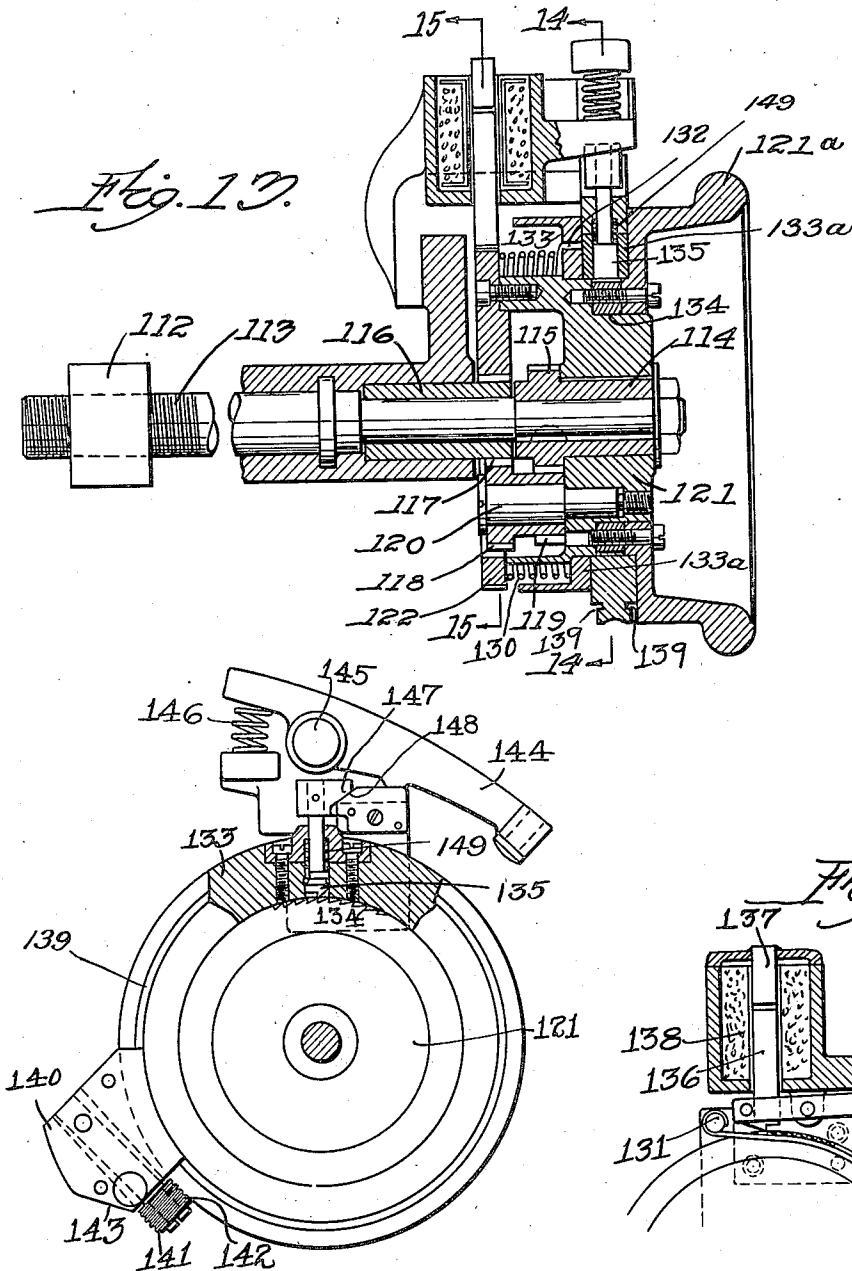
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WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

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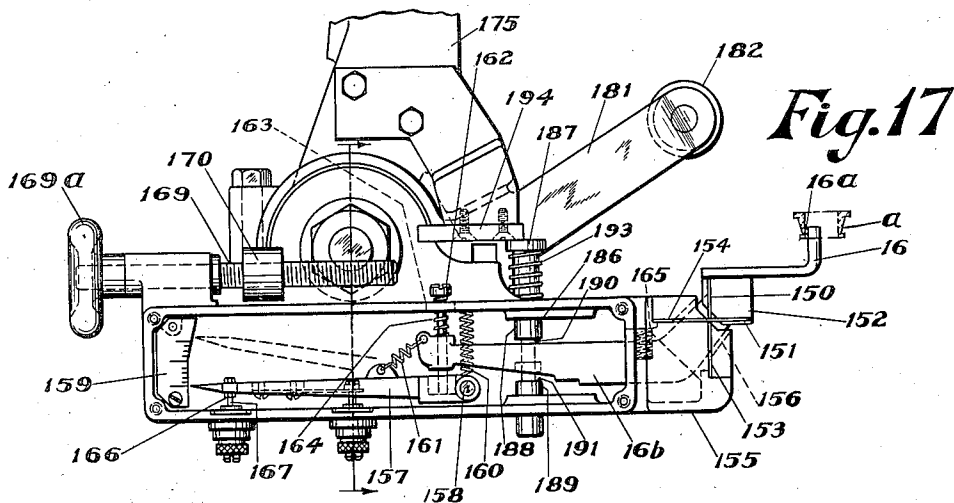


Fig. 17

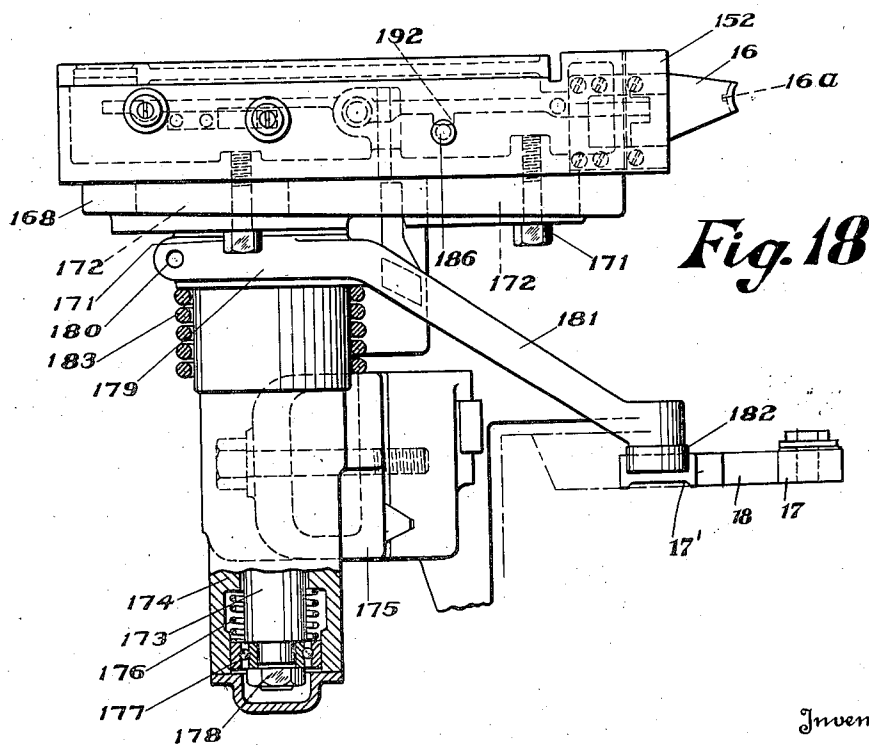


Fig. 18

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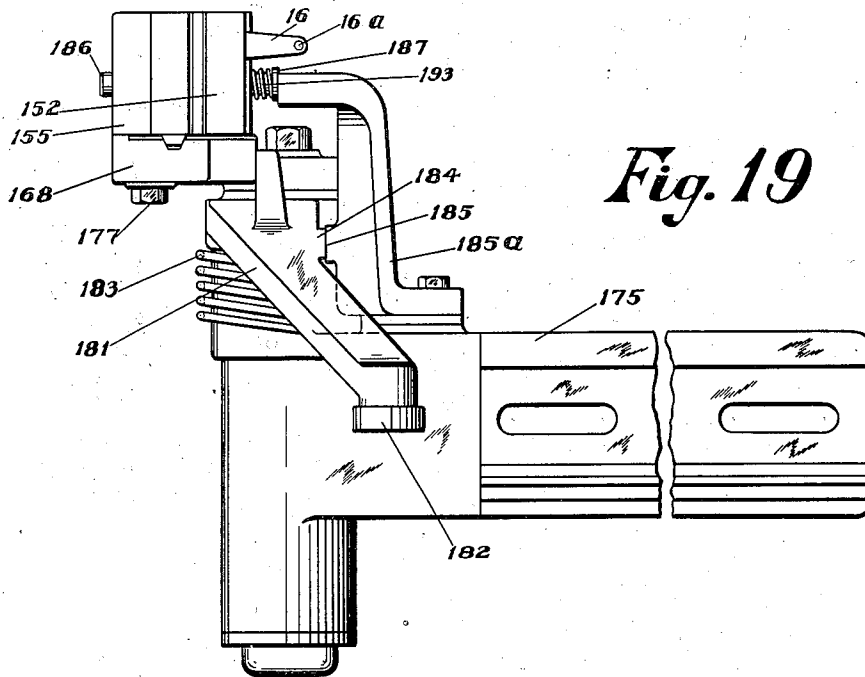
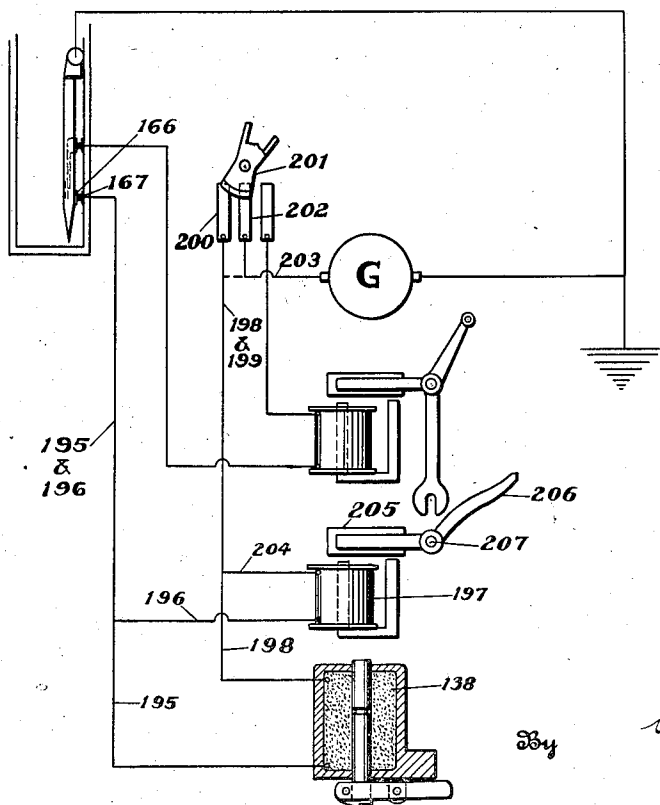
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UNITED STATES PATENT OFFICE

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WORK HANDLING MECHANISM FOR GRINDING MACHINES AND THE LIKE

Application filed April 2, 1926, Serial No. 99,287. Renewed October 24, 1929.

The present invention relates to apparatus, applicable to automatic grinding machines and the like, for mechanically handling the successive workpieces that are subjected to the operation of such a machine.

The invention is here shown in connection with an automatic internal grinding machine having the general construction and the capabilities of operation of machines such as are shown and described in the patents of Heald, Guild, Burns and Garno, #1,751,202, dated March 18, 1930, and Kempton and Gallimore, #1,731,719, dated October 15, 1929. With such machines it is possible to accurately grind successive similar workpieces to exactly the same predetermined internal diameter, without intervention by an operator except to remove each finished piece upon withdrawal of the grinding wheel therefrom and to present a new unground piece to the chuck or work holder of the machine, preparatory to the next grinding operation. According to the present invention, this handling of the workpieces both for the loading and unloading of the chuck or work holder is performed mechanically, in timed and responsive relation to the usual movements of the grinding wheel carriage in the intervals between successive grinding operations,—thus measurably increasing the productive capacity of the machine by making its operation in every way continuous, and by eliminating the necessity for any interruption or intervention by an operator, once the machine has been adjusted and set up for the grinding of workpieces of a given type and size. The above and other objects are attained by the instrumentalities which are set forth in detail in the following description, reference being had in this connection to the accompanying drawings, wherein—

Fig. 1 is a side elevation, partly in section, showing the elements of an internal grinding machine, with the invention applied thereto.

Fig. 2 is a top plan view, partly in section, showing certain of the mechanism of Fig. 1 on a larger scale.

Fig. 3 shows the loading and unloading instrumentalities as viewed from the end of

the machine, the latter being shown partly in transverse section.

Figs. 4 and 5 are detail sectional views showing two different positions of the operating mechanism for the chuck or work holder of the machine.

Fig. 6 is a fragmentary plan view, on an enlarged scale, of the magazine or hopper for the unground workpieces which are to be operated upon, successively, by the machine.

Fig. 7 is a side view of the parts shown in Fig. 6.

Fig. 8 is a fragmentary detail view of a portion of the magazine.

Fig. 9 is a fragmentary plan view of mechanism situated at the lower end of said magazine.

Fig. 10 is a side view, partly in section, showing the operation of the loading and unloading elements in relation to the lower end of said magazine.

Fig. 11 is a view similar to Fig. 3, showing a modified form of the invention.

Fig. 12 shows the parts disclosed by Fig. 11 as viewed from the rear of the machine.

Fig. 13 is a sectional view on the line 13—13 of Fig. 1, showing the transverse feeding mechanism with automatic repositioning means.

Fig. 14 is a sectional view on the line 14—14 of Fig. 13.

Fig. 15 is a fragmentary sectional view on the line 15—15 of Fig. 13.

Fig. 16 is a fragmentary view of the front of the machine, showing the location of a certain magnet and the lever it operates.

Fig. 17 is a plan view of the work caliper mechanism.

Fig. 18 is an elevation of the right hand side of said mechanism.

Fig. 19 is a view of the caliper mechanism detached from the machine.

Fig. 20 is a wiring diagram.

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

Referring to the drawings, particularly to Figs. 1, 2 and 3, the machine provides the usual reciprocating table or carriage 1 which is ordinarily provided in internal grinding machines. In such a machine, either the

grinding wheel or the work to be ground may be carried on the table 1, the reciprocations 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 of the usual construction, 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 work head 3 provides the usual instrumentalities for supporting and rotating the workpiece that is to be ground. As shown in Fig. 1, a hollow rotary work spindle 5, journaled in the work head 3, has secured to its end the usual chuck-encircling fixture 6, the latter providing, interiorly, a plurality of slidable work engaging jaws 7, 7. These jaws are pivotally secured to a member 8 carried by a rod 9, which is slidably mounted in the bore of the spindle 5; as is usual in the operation of such a work holding device, the retraction of rod 9 causes the jaws to seize and center the workpiece *a*, thereby procuring its rotation with the spindle 5, while the opposite movement of rod 9 to the right, Fig. 1, causes the jaws 7 to open, under the influence of a set of springs, one of which is shown at 10, thereby releasing the workpiece *a* and allowing it to be withdrawn from the chuck.

The back and forth movement of the table 1, to cause the rotating grinding wheel 11 to make the required interior traverse of the rotating workpiece *a*, may be imparted in any well known manner; in the present instance, a fluid pressure controlling and reversing mechanism is employed, the same as illustrated and described in United States Letters Patent No. 1,582,468 to Heald and Guild, granted April 27, 1926; it being noted that the valve and associated mechanism of said patent for stopping the table at the outward end of its long stroke is not employed in the present machine, since the table 1 is automatically reversed at its outer limit of extended travel, as will hereinafter appear. Such mechanism procures the reversal of the table 1 at each end of the latter's normal working stroke, by the alternate engagement of spaced adjustable dogs 12 and 13 with a suitable reversing member 14. Also, as described in an application of Heald and Guild, Serial No. 25,900, filed April 25, 1925, I desirably utilize mechanism adapted, at an intermediate point in the grinding of each workpiece *a*, to move a wheel dressing device 15, Figs. 2 and 3, into the path of grinding wheel 11,—the latter, for the purpose of being dressed and trued by said device 15, undergoing, automatically, a single amplification of its normal working stroke; in the

manner set forth in said Heald, Guild, Burns and Garno patent.

The above described instrumentalities, of themselves, form no part of the present invention, and hence a detailed description of the construction and operation of the same is unnecessary; it is sufficient to note, for present purposes, that in common with the machine of said Heald, Guild, Burns and Garno patent, the present machine may be equipped with a work calipering member 16, Fig. 2, whose movement to a predetermined position, in response to the progressive enlargement of the hole in the workpiece *a*, procures, automatically, the above described single amplification of the stroke of table 1, simultaneously with the disposal of dressing device 15 in operative position,—thus to subject the grinding wheel 11 to a dressing and truing operation in advance of the final and finishing cuts taken on the workpiece *a* to bring it to the required predetermined size. Following this dressing operation, the dressing device 15 automatically returns to inoperative position, and the grinding wheel 11 automatically resumes its normal working stroke in the hole of workpiece *a*, as a result of which the calipering member 16, in response to further progressive enlargement of said hole, arrives at a position which signifies the completion of the grinding operation on said workpiece, through the latter having reached the desired predetermined internal diameter. When the calipering member 16 reaches this position, it automatically procures, through the completion of an electric circuit and the instrumentalities described in said Heald, Guild, Burns and Garno patent, the full withdrawal movement of table 1, to carry the grinding wheel 11 out of the workpiece *a* and well beyond the dressing position, and simultaneously the withdrawal of the calipering member 16 from said workpiece so that the latter can be removed from the chuck. As hereinafter described, the completion of this electric circuit automatically procures, in the present machine, the lateral repositioning of the grinding wheel, so as to let it enter the new unground workpiece which is next automatically disposed in the chuck.

The mechanism to automatically dress and true the grinding wheel 11 could be entirely omitted if desired, so it will not be further described, but as a completely automatic machine, such as the present embodiment of my invention is, must provide for the substitution, at the proper moment, of a fresh unground workpiece for the one that has been ground to the desired size, and since this action is responsive, in the present instance, to a caliper 16 which makes contact with successive workpieces, it is necessary to describe so much of the said invention of Heald, Guild, Burns and Garno as will describe how the caliper 16 is brought into position and then

removed, so that each successively finished workpiece *a* can be automatically removed from the chuck.

As shown in Figs. 2, 17 and 18, the member 16 is to all intents and purposes a lever, said member, for the movement required of it to maintain a point 16*a* in constant contact with the interior of a workpiece *a*, being supported by a pair of flexible U-shaped flat springs 150 and 151, which springs cross each other, as shown in Fig. 17, and are attached to two adjacent sides of a rectangular block portion 152 of member 16. At their other ends, the crossed springs 150 and 151 are attached to two inner surfaces 153 and 154 of a box 155, these surfaces 153 and 154 being at right angles to each other, and the box 155 providing an opening 156 of sufficient size to permit the inward extension 16*b*, of member 16, to move freely about the pivotal axis which is afforded by the intersection of the planes of the U-shaped springs 150 and 151. This pivotal movement is accomplished by the flexing of these two springs, and takes place in the entire absence of lost motion since there is no bearing or pivot pin. Consequently, any movement of the extension 16*b* of member 16 within the box 155 is invariably in exact accordance with the movement of calipering point 16*a*, in maintaining contact with the surface of the gradually enlarging hole in the workpiece.

Such motion of the member 16 is adapted to be transmitted to an indicator lever 157, pivoted at 158 within the box 155, with its free end adapted to move across the graduations of a suitable scale 159. Lost motion may be eliminated at bearing 158 by a spring 160. The connection between extension 16*b* and indicator lever 157 is made by a spring 161, which draws the parts together and maintains the lever 157 in contact with the end of a screw 162, said screw being adjustably threaded in extension 16*b* and passing at its head end through a suitably enlarged slot or hole 163 in box 155, so as to permit adjustment from the exterior of said box. By turning the screw 162, the indicator lever 157 can be made to assume any desired position relative to the member 16, and said screw 162 is maintained in any given setting, and displacement thereof prevented by any suitable friction device, such as a spring 164. With the arrangement above described, a very slight movement of the calipering point 16*a* is multiplied many times in being transmitted to the indicator lever 157, as will be readily understood.

In the operation of the mechanism, the calipering point 16*a* maintains contact with a given workpiece *a*, the movement of member 16 for this purpose being obtained by the pressure of a spring 165, and such movement being transmitted through the above described connections to the indicator lever 157.

The multiplied movement of the latter is made use of, at a predetermined point in the grinding of each workpiece, to cause cessation of the grinding when each workpiece reaches a predetermined and desired size. To this end the lever 157 carries an electrical contact 166 for closing an electric circuit that controls the operations involved in cessation of grinding. In the path of this contact, the box 155 provides a stationary terminal contact 167. Before describing the electrical circuits which contain the contact points 166 and 167, the further construction and operation of the work calipering mechanism will be set forth.

The box 155 which carries the member 16 and indicator lever 157, as above described, is adjustable longitudinally on a supporting bracket 168, such adjustment being effected by a screw 169, turned by a hand wheel 169*a*, said screw passing through a threaded lug 170 of bracket 168; after the box 155 has been adjusted as above described, it is firmly fastened in position by tightening the bolts 171, 171, which are threaded into the bottom of the box and pass through elongated slots 172, 172 of bracket 168, see Figs. 17 and 18. Said bracket 168, which carries box 155, is rigidly attached to the upper end of a spindle 173; the latter being journaled in a bearing sleeve 174 provided by a bracket 175 which, as best shown in Fig. 2, is bolted to the bridge 4. Preferably the upper part of spindle 173 (not shown) is frusto-conical in shape, and seats against a correspondingly formed portion in the bearing sleeve 174, the spindle being drawn tightly against said frusto-conical seat by a spring 176 (Fig. 18) which thrusts against the outer race of a ball bearing 177, the inner race being clamped between a shoulder on the spindle and a nut 178. This construction is adopted, of course, to keep the axis of oscillation of the box 155 accurately fixed or determinable upon the machine frame.

This swinging or oscillating movement of the box 155 takes place in response to movement by the table 1 as follows:—A split collar 179 surrounds that portion of the bracket 168 that is secured to the spindle 173, said collar being drawn into tight engagement with said bracket by a bolt 180. Extending from said collar is an arm 181 carrying a roller 182 which, in the normal work engaging position of the calipering point 16*a*, lies in the path of, but spaced at some distance from, a cam bar 17' attached to the table 1. In this normal work engaging position, a strong coil spring 183, surrounding the sleeve 174 and attached thereto, exerts its force against arm 181 to rotate the latter counterclockwise. Said arm is firmly attached to the bracket 175 by collar 179 and bolt 180, and thus the force of spring 183, exerted on said arm, maintains the calipering

and indicating mechanism as a unit in the position shown in Fig. 17, where a lug 184, on arm 181, brings up against a fixed stop 185 formed on a bracket 185a which is attached to the casting 175. See Fig. 19. At the end of each grinding operation, when the table 1, as hereinafter described, is automatically given an extended movement to the right, the cam bar 17', carried by said table, strikes roller 182 and rocks the arm 181 in a clockwise direction against the force of spring 183, thereby swinging the entire calipering and indicating mechanism as a unit from the position shown in Fig. 17 to the position shown in Fig. 2, thus allowing the finished workpiece *a* to be withdrawn and a new workpiece to be inserted in the jaws 7 of the chuck 6, as will be described.

In connection with the above described swinging movement of the calipering and indicating mechanism, the work calipering point 16a, desirably a diamond, is automatically disposed in a position which prevents it, or the member 16, from forcibly engaging the mouth of a workpiece in the act of entering the same. If some such means were not provided, the member 16 might be entirely prevented from entering a fresh workpiece *a*, or, in the act of entering, the calipering point 16a might be chipped or broken off.

To prevent such occurrences, a rod 186 having a head 187 provides bearing portions 188 and 189 for sliding movement in bearing holes provided by opposite sides of the box 155. Between the bearing portions 188 and 189, the rod has a reduced neck 190, forming a shoulder 191 for cooperation with a downward projection 192 of the extension 16b. A spring 193, encircling the rod 186 and thrusting outwardly against the head 187 thereof, draws the shoulder 191 against projection 192 and, in the inoperative position of the calipering and indicating mechanism shown in Fig. 2, this action of spring 193, being stronger than the action of spring 165, rocks the member 16 in a clockwise direction, thus to hold the calipering point 16a in an inoperative position, so that it can enter, without striking, an unground workpiece *a*. However, when the member 16 and the calipering point 16a have entered the said unground workpiece, the head 187 of rod 186 strikes a hardened steel stop plate 194 which is secured to the bracket 185a, and this action forces the rod 186 inwardly of the box 155 and relieves the member 16 of the influence of spring 165. It will be readily understood that head 187 and plate 194 come together just before the lug 184 strikes the stop 185, and that the coil spring 183 is stronger than the spring 193 around rod 187, so that the latter spring cannot prevent the proper positioning of the box 155 as determined by the stops 184-185. See Fig. 19.

The above action releases the member 16

so that the caliper point springs toward the internal surface of the workpiece it has entered, and from that time till the box 155 is again swung outwardly by the cam bar 17' on the table, (which only happens when the grinding of the said workpiece is finished), the point 16a is in engagement with the work, and the indicating and contact making lever 157 moves in accordance with the enlargement of the bore of the workpiece.

When said lever 157 has moved far enough to make contacts between points 166 and 167, an electric circuit is formed which causes the table 1 to undergo an extended movement to the right, carrying the grinding wheel 11 out of the workpiece, well past the now inoperative dressing device 15 and moving the cam bar 17' into contact with the roller 182 to swing the box 155 outwardly, as set forth. As shown in the wiring diagram of Fig. 20, electric current may be supplied by a generator G driven continuously by any suitable means. One terminal of this generator is grounded, as clearly shown, and the contact point 166 is also grounded, by reason of not being insulated from the lever 157. The stationary terminal 167 is connected by conductors 195 and 196 to the coils of a solenoid 138 and an electromagnet 197, respectively. The return leads from said solenoid and electromagnet, numbered 198 and 199, go to the left hand bar 200 of a three-way switch 201. Bar 200 is, when contacts 166 and 167 come together, electrically connected to a central bar 202 of said switch 201, by reason of certain instrumentalities brought into operation coincident with the automatic dressing action referred to, and as bar 202 is connected by a conductor or lead 203 to the generator, the circuit through the solenoid 138 and the electromagnet 197 is complete, and said electric devices are energized. However since, for the purposes of the present invention the dressing instrumentalities could be entirely dispensed with, and since it is not proposed to describe them further, it may be considered that the conductors 198 and 199 are directly and at all times connected to the conductor 203, and as indicated by the dotted line in Fig. 20, and that the switch 201 is non-existent.

The electromagnet 197 is located, as shown in Fig. 16, on the front of the grinding machine, being preferably inclosed in a casing 204 to keep out dirt. Above the magnet 197 is an armature 205 having attached thereto a lever arm 206, these parts being pivotally mounted for movement on a pin 207. The upward movement of arm 206, due to the energizing of electromagnet 197 and the consequent attraction of armature 205, interposes the free end of said arm in the path of table dog 13, see Fig. 1, which latter, as heretofore pointed out, normally, on the right hand

working stroke of the table, strikes and moves the reversing member 14 to cause a reversal in the direction of table travel. Said dog 13, unlike dog 12, is a pivotally mounted dog, being pivoted at 208 to a carrying block 209, and hanging by gravity against a pin 210. When the arm 206, as above described, moves upwardly into the path of dog 13, the free end of said dog, on the right hand movement of the table, engages with and rides upon the upwardly inclined surface of arm 206. Such elevation of the dog 13 carries it clear of reversing member 14, and thus when the contacts 166 and 167 come together to energize the magnet 197, the table 1 is automatically prevented from reversing its travel at the right hand limit of its usual working stroke; instead said table, through the disposal of dog 13 in a wholly inoperative position, continues its movement to the right, carrying the grinding wheel out of the work and well past the dressing device 15, said table finally being reversed by a remotely positioned dog 111, whereupon the table 1 returns, carrying the grinding wheel 11 into a new workpiece *a*, the dog 13 lifting and dropping behind the member 14, thus again placing said reversing member between the dogs 12 and 13 that control the normal work traverse.

The present invention is concerned with instrumentalities brought into operation by said full withdrawal movement of table 1 for mechanically effecting the removal of said finished workpiece from the chuck and for mechanically disposing an unground workpiece in said chuck, preparatory to the next grinding operation of the machine. To this end, as shown in Figs. 2 and 3, the table 1 has secured thereto a member 17, the latter providing an elongated cam groove or slot having a straight longitudinal portion 18 and two offset portions 19 and 20, the former being connected to portion 18 by a portion 21 of relatively slight deviation, and the portion 20 being connected to portion 19 by a portion 22 of sharper deviation. The cam member 17 is adjustable longitudinally of the table 1, this adjustment being secured by the passage of the retaining bolts 23, 23 through elongated slots 24, 24 provided by said member. Working in the cam of member 17 is a roller 25, the latter being carried by a lever 26 which is pivoted at 27 to the under side of a casting 33 attached to the work head 3. The lever 26 is connected by a link 28 to a rocker arm 29 extending from a vertically disposed rock shaft 30. Said rock shaft 30 is journaled in suitable bearings provided by upper and lower extensions 31 and 32 of the casting 33 which is the usual water guard casting that surrounds the work holder or chuck.

The upward extension 31 of said casting provides suitable bearings for another rock

shaft 34, whose axis, lying in a plane at right angles to the axis of work spindle 5, has a decided inclination from the vertical, as best shown in Fig. 3. The shaft 34 carries a bevel pinion 35, in mesh with a bevel gear 36 on the shaft 30, whereby the rocking of said last named shaft, brought about by the engagement of roller 25 with cam portions 21 and 22, will be communicated, with multiplied angular movement, to the shaft 34.

Said shaft 34 has secured thereto an arm 37, whose free end is adapted for the reception and retention of a work engaging plug 38, said plug being somewhat smaller than the holes of the workpieces *a*, *a* and providing a spring, or other suitable friction gripping device 39, Figs. 1 and 10, which is adapted to frictionally support a workpiece *a* on the plug when the latter is entered into the hole of said workpiece. In the normal grinding operation of the machine, when the rotating grinding wheel 11 is making its usual reciprocatory working traverse within the rotating workpiece *a*, the roller 25 is engaged wholly by the longitudinal cam portion 18, in consequence of which no movement is imparted to the shafts 30 and 34,—said shafts remaining stationary and holding the arm 37 in the position illustrated by full lines at A in Fig. 1. This position is also maintained by said arm during the single amplified dressing stroke of grinding wheel 11, which may occur, as above stated, at an intermediate point in the grinding of each workpiece,—the longitudinal cam portion 18 being of sufficient length to permit such amplification of the stroke of table 1 without having the roller 25 engaged by the cam portion 21.

However, on the full withdrawal movement of table 1, brought about as above described at the completion of the grinding operation, the roller 25 is engaged by the cam portion 21, this causing initially the movement of arm 37 from the position A to the dotted line position B, Fig. 1, wherein the plug 38 and spring 39 are thrust into the hole of the finished workpiece *a*, the latter, as will now be described, being released by the chuck jaws 7 to permit its removal by the ensuing reverse movement of arm 37.

As shown in Figs. 4 and 5, suitable fluid pressure devices may be employed, if desired, for the movement of rod 9 which, as described above, renders the chuck jaws 7 operative and inoperative. Said rod 9, extending through the hollow work spindle 5, is secured at its outer end to a piston 40, the latter working in a cylinder 41. The piston rod or extension 42 of said piston provides a pair of passages 43 and 44, terminating, respectively, on opposite sides of said piston within the cylinder 41. The passage 43 is connected by flexible piping 45 to a valve casing port 46, and the passage 44 is connected by flexible piping 47 to a valve casing port 48.

The valve casing 49, which provides these ports 46 and 48, is preferably mounted, as shown in Fig. 3, on the frame of the machine below the table 1, and a cylindrical valve 50, contained in said casing 49, occupies, during the grinding operation, the position illustrated in Fig. 5, where a passage 51 of said valve connects the port 46 with a source 52 of fluid pressure supply, thus admitting the pressure fluid through passage 43 to the right hand side of piston 40, and retaining said piston in its left hand position, as shown in Fig. 5; drawing back rod 9 until the fingers 7 grip the workpiece *a*; in this position, the pressure fluid exhausted from the other side of piston 40 through passage 44 passes out by an exhaust recess 53 of valve 50 to an exhaust port 54 of the valve casing. When the valve 50 is rocked from the position shown in Fig. 5 into the position shown in Fig. 4, the pressure fluid flows to port 48, and thence through the passage 44 to the left hand side of piston 40, thus moving rod 9 to the right, to release the jaws 7, 7 from their grip on the workpiece *a*. The pressure fluid which is displaced by this right hand movement of piston 40 returns to the valve by passage 43 and is exhausted through a valve recess 55 connecting the port 46 with an exhaust port 56.

Substantially coincident with impalement of the workpiece *a* on the plug 38 on the above described down swing of arm 37, the rotation of work spindle 5 is stopped,—this stoppage being brought about in a manner well known in machines of this class, namely by a cam, not shown, on the table 1 which unclutches said spindle from its operating means, not shown, and simultaneously applies a brake, not shown, to said spindle. The arm 37 remains stationary during the brief engagement of cam portion 19 with roller 25, and in this period of dwell an arm 57, Fig. 3, depending from table 1, strikes a projection 58 on the shaft of valve 50, to rock said valve from the position shown in Fig. 5 into the position shown in Fig. 4, thereby releasing the work-piece *a* from the grip of the chuck jaws 7, 7, as above described. Following this, on the continued withdrawal movement of table 1, the roller 25 is engaged by the cam portion 22, this engagement procuring a reverse rotation of the rock shafts 30 and 34 and a consequent upward swinging of the arm 37, whose plug 38 carries with it the finished workpiece *a* which has just been released from the chuck. The cam portion 22 being considerably longer than the cam portion 21, the upward swing of arm 37 continues beyond the position A and carries the plug 38 between a pair of spaced jaws 59 and 60, to be hereinafter more fully described. The spacing of these jaws is sufficient to permit the passage of the plug 38 between them, but is not sufficient to permit the passage of the workpiece *a* which is fric-

tionally held, by spring 39, on said plug. Consequently, the jaws 59 and 60, by the engagement of their under surfaces with the face of workpiece *a*, are effective to strip said workpiece from the plug 38, as a result of which the finished workpiece drops into an inclined chute 61, Fig. 3, which is supported in any suitable manner, as by a lug 62 on the upper extension 31 of water guard casting 33. Each finished workpiece, as thus mechanically removed from the machine, is thus discharged into the chute 61, which serves for the conveyance of said workpieces, by gravity, to any suitable receptacle, not shown.

As shown in Figs. 3, 6, 7 and 9, the jaws 59 and 60 above referred to, are supported by a member 63 which is secured to the under side of an inclined bracket 64 rising from the extension 31. On its other side, said bracket 64 supports a suitable chute or hopper 65 into which the unground workpieces *a*, *a* are loaded, the floor 66 of said hopper being inclined, and having suitable side walls 67, 67 for the guidance and confinement of said workpieces in their gravity descent towards the lower end of said hopper, contiguous to said jaws 59 and 60. The jaws 59 and 60 are so shaped as to form a continuation of and a partly closed end for the chute 65. As best shown in Figs. 7 and 8, a stop 68 normally occupies a position wherein it is engaged by the upper edge of the lowermost workpiece in the hopper 65, thus interposing an obstruction to the movement of all the workpieces in said hopper, and at the same time preventing said lowermost workpiece from reaching the lower end of the hopper where its presence would interfere with the free passage of the arm 37 and plug 38 through the jaws 59 and 60 on the above described upward swing of said arm.

The stop 68 is carried by a rod 69, the latter being slidable in an extension 70 of the bracket 64. Said rod 69 has secured thereto a head 71, which provides an adjustable screw 72 adapted to be engaged by the arm 37, Fig. 10, just before the arm 37 reaches the limit of its upward movement, as the roller 25 passes out of the cam portion 22 and into the cam portion 20. The engagement of arm 37 with screw 72 moves the rod 69 from its normal position, illustrated in Fig. 7, into the position shown in Fig. 10, and this movement carries the stop 68 away from contact with the lowermost workpiece *a* in the hopper 65, thus freeing said lowermost workpiece and allowing it to slide by gravity down into the position illustrated at *a* in Fig. 10, supported now by the jaws 59 and 60. At the same time, a rod 73 carried by the head 71, undergoes the same retraction as the stop 68; normally this rod 73 presses against a spring 74 beneath the floor 66 of the hopper and holds a stop 75 carried by said spring in inoperative position, 13

as shown in Fig. 7. However, when rod 73 is retracted, as shown in Fig. 10, the spring 74 thrusts the stop 75 above the plane of the floor 66 of the hopper and in front of the next lowest workpiece a^2 , and thus prevents said workpiece and the workpiece above it from moving past the retracted stop 68.

The table 1 now having reached the limit of its outward movement, with the cam portion 20 engaging the roller 25, the aforementioned dog 111 on table 1 strikes the member 14, thereby initiating the return movement of said table to carry the grinding wheel 11 back into position for operation on the next workpiece. On this return movement, as soon as the left hand end of cam portion 22 reaches roller 25, the down swing of arm 37 begins, and the initial downward movement of said arm, carrying said arm away from screw 72, allows rod 69 to return to its normal position under the influence of a spring 76 encircling said rod and bearing against a shoulder 77 thereof. This movement of rod 69 simultaneously lowers the stop 75 into inoperative position and lowers the stop 68 into operative position, whereupon the workpiece a^2 slides down against stop 68 in position to be released by said stop on the next cycle of operations of the mechanism. As the arm 37 continues to swing downwardly, the plug 38 is thrust into the hole of workpiece a^1 , Fig. 10, the latter, as above described, having descended to the lower end of the hopper which is constituted, as shown in Fig. 7, by the two jaws 59 and 60. These jaws provide side ledges or flanges 110 constituting a continuation of the side walls 67 of hopper 65, and as shown in Fig. 9, the ledges 110 are curved inwardly at the tips of the jaws so as to arrest the workpiece a^1 in its descent and hold it in position to be impaled on the descending plug 38. The inner curved surfaces of the jaws 59 and 60 support the workpiece a^1 with its bottom substantially flush with the floor 66 of hopper 65, this support being afforded by the inward taper of said surfaces, as shown at 78, Figs. 7 and 10, in consequence of which the space between said jaws, in their normal positions, is not sufficient for the workpiece a^1 to pass through. The jaws 59 and 60 constitute the terminal portions of two members 79 and 80 respectively, which are pivoted on a stud 81 carried by member 63, said members 79 and 80 having tailpieces 82, 82, which engage on opposite sides of a fixed pin 83, forming a limit stop for the approach, toward each other, of the jaws 59 and 60. A spring 84 connects the two members 79 and 80 and draws the two jaws yieldingly toward each other, so that the workpiece a^1 is held by said jaws in the path of the descending plug 38, as shown in Fig. 10.

As the descending arm 37 thrusts the plug 38 into the workpiece a^1 , the downward pressure of said arm is transmitted through said

workpiece onto the inwardly tapered surfaces 78 of the jaws 59 and 60, producing a wedging action which, as the downward swing of arm 37 continues, distends said jaws and permits the workpiece to pass between them,—the resistance of spring 84 to this distention, however, being sufficient to insure the complete entry of plug 38 into the workpiece, so that the spring 39 of said plug secures a firm grip which prevents the workpiece from falling off the plug after being carried clear of the jaws. The latter then automatically return, under the influence of spring 84, to normal position, in readiness to serve as a means for stripping the workpiece after its grinding, from said plug, on the upward swing of arm 37, as heretofore described.

With the table 1 still moving to the left, the down swing of arm 37 continues until the roller 25 reaches the right hand end of cam portion 22, at which time said arm 37, carrying the unground workpiece a^1 , comes to rest in the position marked B, Fig. 1, the workpiece being thus disposed between the distended chuck jaws 7, 7. In the brief dwell provided by the cam portion 19, the arm 57 of table 1 strikes another projection 58' on the shaft of valve 50, see Fig. 12, rocking said valve from the position illustrated in Fig. 4 into the position illustrated in Fig. 5, and thereby moving the rod 9 to the left, so as to procure the engagement and retention of the workpiece by the chuck jaws 7, 7. Following this, as the cam portion 21 becomes operative on the roller 25, the arm 37 swings upwardly, the plug 38 withdrawing from its frictional engagement with the workpiece, since the latter is held firmly by the chuck jaws 7, 7; this upward swing of arm 37 returns it to the position indicated at A, Fig. 1, at which time the roller 25 is once more engaged by the longitudinal cam portion 18, which prevents any further movement of said arm 37 until the grinding operation on said workpiece has been completed. Substantially coincident with the return of arm 37 to the position indicated at A, Fig. 1, the clutch or work spindle 5 is again made operative to cause rotation of said spindle, and the calipering member 16, as described automatically enters the hole in the workpiece; thereupon the grinding wheel 11 enters said hole and begins the operation which brings the workpiece to the desired finished size, following which the above described cycle of operations is repeated.

Referring to Figs. 11 and 12, a modification therein shown involves a swinging loading and unloading arm 37 of substantially the same form and disposition as the arm 37 heretofore described, said arm 37 cooperating in the same way with an overhead hopper, not shown, into which the unground workpieces are loaded, and with a stripping de-

vice in the form of the jaws 59 and 60 for discharging each finished workpiece removed by said arm into a suitable trough or chute 61. The arm 37 is mounted on a rock shaft 34, and the movements of said shaft, to secure the same cycle of operations for the arm 37 as are above described, are obtained in the following manner:—

The reciprocatory table 1 is formed on its under side with a rack 17a, the latter having in mesh therewith a gear 17b secured to a shaft 90, which is suitably journaled in the stationary framework of the machine. At its other end the shaft 90 carries a plate 91, to which is secured a cam disk 17c, the latter being angularly adjustable with respect to the plate 91 through the medium of elongated slots 23a, 23a provided for the passage of the retaining screws or bolts 24a, 24a. Said cam disk 17c has formed thereon an irregular cam track 18a, in which rides a roller 25a, carried by the end of a pivoted arm 26a. The latter is connected by a link 28a to an arm 29a on a rock shaft 30a, whose other end provides an arm 101 formed with a gear segment 36a that meshes with a suitable pinion 35a on the rock shaft 34.

In the normal grinding operation of the machine, and also during the automatic dressing of the grinding wheel, the roller 25a rides in the concentric portion 18a of cam groove 18a, in consequence of which no rotation is imparted to the rock shaft 30a, and the arm 37 remains stationary in a position corresponding to that marked A, in Fig. 1. The full outward movement of table 1, initiated by the completion of the grinding operation on a given workpiece, secures a single counterclockwise rotation of the cam disk 17c, and in this rotation, the engagement of cam portion 21a with roller 25a, secures the down swing of arm 37 into position for its plug to impale the finished workpiece. Then, in the dwell provided by cam portion 19a, a pin 57a, carried by plate 91 and operating in timed relation to cam plate 17c, strikes one of the projections 58 of the oscillatory valve 50, to rock said valve from the position illustrated in Fig. 5 into the position illustrated in Fig. 4, thereby releasing the workpiece from the chuck jaws 7, 7. Continued counterclockwise rotation brings the cam portion 22a into engagement with the roller 25a, this causing the upward swing of arm 37 on which the impaled finished workpiece is stripped from said arm, as heretofore described, and on which the lowermost unground workpiece in the hopper is separated from the other workpieces in the hopper and allowed to descend into position to be seized by said arm. At this time, the table 1 reverses its movement, causing clockwise rotation of cam disk 17c, and cam portion 22a being then in engagement with roller 25a, secures the down swing of arm 37, on which said arm picks up the

segregated workpiece from the hopper and carries it into chucking position. Then, during the engagement of cam portion 19a with roller 25a, the chuck jaws are again made operative, following which, on the engagement of cam portion 21a with roller 25a, the arm 37 moves back up into the position marked A in Fig. 1.

In both embodiments of the invention, some means must be provided to retract the wheel 11 laterally prior to its movement into a fresh and unground workpiece a. Such means, including also the normal and usual lateral feeding mechanism, will now be described. I do not claim such wheel retracting mechanism per se, but only in combination with the other instrumentalities herein shown and described.

Referring now to Figs. 1, 13, 14 and 15, the wheel head 2 is mounted to move transversely of the table 1, the said table 1 for that purpose providing ways, not shown, as such is the usual and ordinary construction of these parts. The wheel head 2 carries a nut or other equivalent device 112 which is internally threaded, see Fig. 13, and passing there-through is a screw shaft 113 which is carried by the table 1. Rotation of this shaft 113 is adapted to feed the wheel head 2 laterally of the table 1, the direction of travel being, of course, determined by the direction of rotation. In this particular mechanism, a sleeve 114 surrounds the front portion of shaft 113 and is fastened to it, said sleeve 114 providing a spur gear portion 115. A second sleeve 116 surrounds shaft 113 and provides a gear portion 117, but these parts are stationary. A pair of integral gears 118 and 119 mounted to turn on a stud 120, provide, with the other parts, a convenient differential reduction gearing so that rotation of the annular hand wheel member 121 to which said stud 120 is attached will result in rotation of said screw shaft 113, but at a very much reduced rate. A ratchet wheel 122 is also attached to the hand wheel member 121, and automatic rotation of said ratchet to feed the wheel head 2 to carry the wheel 11 into engagement with the workpiece is effected as follows:—

The bridge 4, or any other convenient stationary part of the machine, carries a bar 123 on which is adjustably mounted a cam piece 124. Pivotaly mounted at 125 (see Fig. 1, dotted lines) is a member 126. Said member 126 carries a roller 127 and also a pawl 128 which is spring pressed towards the ratchet 122, but in the position shown in Fig. 1, with the roller 127 not engaging the cam 124, said pawl 128 is prevented from engaging said ratchet 122 by a shield device 129.

From the foregoing brief description of parts, it will be apparent that longitudinal reciprocation of table 1 results in lateral feeding of the wheel 11, said feed at the left hand extreme travel of table 1, the cam 124

being adjustable for the purpose of causing the feed to occur at this point regardless of the size or depth of the particular workpiece. Also, it will be noted that except at the instant of feed, the ratchet 122 is capable of undergoing a retrograde movement, so far as the pawl 128 is concerned.

Referring now to Fig. 13, a coil spring 130 is provided to automatically reposition the wheel head 2. Said coil spring 130 is fastened at 131 (see Fig. 15) to a non-rotatable part of the table 1. The other end 132 of said spring is fastened to an annular member 133, rotatably mounted on the hand wheel casting 121. As shown in Fig. 14, the latter carries a ratchet gear 134, while a rotatably mounted member 133a fastened to the member 133 carries a pawl 135. These face in such a way that when the spring 130 is allowed to unwind, the member 133a, which then turns in a counterclockwise direction, carries with it the hand wheel 121a and ratchet 122.

During the grinding operation, the ratchet 122 is held from any retrograde motion in response to the means just described, by a pawl 136, see Fig. 15. Said pawl 136 is formed on the end of a core piece 137 inside a solenoid 138. When the workpiece has been ground to the finished size, the solenoid 138 is energized, as already set forth, so that as the table 1 moves outwardly or more accurately, when the electric circuit is made which will cause it to move outwardly, the pawl 136 is lifted. This allows the wound up spring 130 to come into action, and the hand wheel 121a and associated parts are moved in a retrograde direction, so that the wheel 11 can enter a subsequent unground workpiece.

As the spring 130 builds up quite a momentum in the hand wheel 121a and member 121, bumper means is provided to bring the parts to a stop without damage. To this end the member 133a has track grooves 139 thereon, extending partially around it, and a stop 140 is mounted in said track 139, being adjustably fastened at any position by means of a hand screw device 141 cooperating with worm wheel teeth 142 in the outer periphery of member 133a. The stop 140 has an inclined plane surface 143 adapted to strike a bumper lever 144, pivoted at 145 on the table 1. The impact compresses a spring 146 which takes the shock.

Assuming the machine to be put in operation with a fresh grinding wheel 11 and the cross-feed mechanism just described to be set so that when the first workpiece reaches finished size, the parts will be in the position shown by Fig. 14, and it is obvious that in the case of the second workpiece, the cross-feed mechanism will have to be advanced slightly beyond the said position of the hand wheel member 121 in said figure, because of

the reduction of the grinding wheel 11 on account of wear and dressing. But the members 133 and 133a cannot be moved past said position of Fig. 14, for at that point a cam surface 147 on the upper end of pawl 135 engages a stationary cam surface 148 to lift said pawl 135, until the edge of pawl 135 is lifted to clear tooth of ratchet 134. This releases the rings 133 and 133a which will then turn back counterclockwise under the influence of the wound-up spring 130. This retraction is limited to one tooth of ratchet 134 by the spring 149, which forces pawl 135 to follow the inclined back of ratchet tooth 134 and being allowed to do so by the inclined cam surfaces 147 and 148 as the ring 133a retracts. Thus the spring 130 is always wound to an even tension at said finished size. The spring 149 presses the pawl 135 into engagement with the ratchet 134, providing enough resistance to hold the hand wheel 121a and casting 121 when the members 133 and 133a are stopped by the bumper described.

Within the contemplation of my invention, the new automatic work-loading means may be used in combination with the wheel repositioning means just described, or with any other suitable to the purpose, a particular repositioning means being shown and described as my invention consists not only in the work loading mechanism, but also in the latter combined with other mechanism necessary to make a completely automatic machine.

I claim:

1. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of means for determining when a workpiece has been ground to the desired size, a work carrier, and means set in operation by said last named means and brought into operation during said movement of separation for causing said work carrier to move into engagement with the work in said chuck and disengage the work from the chuck and move out of the way of the grinding instrumentality.
2. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, and means directly actuated by said movement of separation for causing said work carrier to move into engagement with

the work in said chuck, and disengage the work from the chuck and move out of the way of the grinding instrumentality.

3. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, means actuated by said movement of separation for moving said work carrier to said chuck where it receives a ground workpiece from said chuck, and for moving said carrier away from said chuck, and stripping means for removing the ground workpiece.

4. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of means for determining when a workpiece has been ground to the desired size, a work carrier, means set in operation by said last-named means and functioning during said movement of separation for moving said work carrier to said chuck, where it receives a ground workpiece from said chuck, and for subsequently moving said carrier away from said chuck, and stripping means for removing the ground workpiece from said carrier.

5. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a work carrier, means set in operation by said last-named means for moving said work carrier to said chuck, where it receives a ground workpiece from said chuck, and for subsequently moving said carrier away from said chuck, and stripping means for removing the ground workpiece from said carrier.

6. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a magazine, a work carrier, means actuated by said movement of separation for moving said work carrier to said chuck and then past said magazine, a ground workpiece being

thereby removed from said chuck and discharged from the machine, and means actuated by the return motion for moving said carrier past said magazine, then to said chuck, and finally out of the proximity of said chuck, whereby a fresh workpiece is transferred to said chuck, and the carrier is removed from the relative path of travel of said grinding instrumentality.

7. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a magazine, a work carrier, means actuated during said movement of separation and return for moving said work carrier to said chuck and then past said magazine, a ground workpiece being thereby removed from said chuck and discharged from the machine, and further means actuated during said movement of separation and return for moving said carrier past said magazine, then to said chuck, and finally out of the proximity of said chuck, whereby a fresh workpiece is transferred to said chuck, and the carrier is removed from the relative path of travel of said grinding instrumentality.

8. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a magazine, a work carrier, means set in operation by said last named means for moving said work carrier to said chuck and then past said magazine, a ground workpiece being thereby removed from said chuck and discharged from the machine, and further means for moving said carrier past said magazine from the other direction, then to said chuck, and finally out of the proximity of said chuck, whereby a fresh workpiece is transferred to said chuck.

9. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a magazine, a work carrier, means set in operation by said movement of separation for moving said work carrier to said chuck and then past said magazine, a ground workpiece being thereby discharged from the machine, and for moving said carrier past said magazine from the other direction, then to said

chuck a second time, and finally out of the proximity of said chuck, whereby a fresh workpiece is transferred to said chuck and the carrier is removed from the relative path of travel of said grinding instrumentality.

10. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, means set in operation by said movement of separation for moving said work carrier to said chuck, for thereafter moving said work carrier to discharge a workpiece from said chuck, and further means set in operation by said movement for opening said chuck between said movements of the work carrier.

11. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, means set in operation during said movement of separation for moving said work carrier to said chuck, for thereafter moving said work carrier to discharge a workpiece from said chuck, and further means for opening said chuck between said movements of the work carrier.

12. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a work carrier, means set in operation by said last named means for moving said work carrier to said chuck, and means for thereafter moving said work carrier to discharge a workpiece from said chuck, and further means for opening said chuck between said movements of the work carrier.

13. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a work-holding magazine, a work carrier, means set in operation by said last named means for first moving said work carrier to said chuck and then past said magazine to remove a ground work piece and to pick up an unground workpiece, and for lastly moving said carrier to said chuck, and further means for opening said chuck after

the first movement of the carrier and for closing said chuck on the unground workpiece after the third movement of said carrier.

14. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, means set in operation by said movement of separation for moving said work carrier to said chuck, further means set in operation by said movement for opening said chuck, a magazine, means for moving said carrier to discharge the ground workpiece from said chuck, and means set in operation by the return movement between said chuck and grinding instrumentality for moving said work carrier by said magazine, picking up an unground workpiece and moving it to said chuck, and further means set in operation by said return movement for closing said chuck on said unground workpiece.

15. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a work carrier, means set in operation by said movement of separation for moving said work carrier into engagement with said chuck, where it receives a ground workpiece from said chuck, and then away from said chuck, and for moving said carrier a second time into engagement with said chuck before the completion of the return movement between said chuck and grinding instrumentality, a magazine, and means for placing an unground workpiece from said magazine in the path of said carrier.

16. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a work carrier, means set in operation by said last named means for moving said work carrier to said chuck, where it receives a ground workpiece from said chuck and moves away from said chuck, for then moving said carrier a second time to said chuck, a magazine, and means for placing an unground workpiece from said magazine in the path of said carrier.

17. The combination with a grinding in-

strumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, a work carrier having a single work holding means, means set in operation during said movement of separation for moving said work carrier to said chuck, where it receives a ground workpiece from said chuck, said means then moving said carrier away from said chuck, a magazine, means for placing an unground workpiece from said magazine in the path of said carrier, and means for then moving said carrier a second time into engagement with said chuck before the completion of the return movement between said chuck and grinding instrumentality, whereby said carrier with a single work-holding means may load and unload the chuck, thus facilitating accurate adjustment in automatic work loaders.

18. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has reached the desired size, and means brought into operation by said last-named means for opening said chuck.

19. The combination with a grinding instrumentality, a work-holding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has reached the desired size, and means set in operation by said last-named means for first opening said chuck and for subsequently closing it.

20. In a machine of the class described, a work carrier, said carrier being formed so that it can impale an annular workpiece, a chuck, a magazine, means to move said carrier to said chuck to cause it to impale a workpiece then located in said chuck and to then move said carrier away from said chuck carrying the impaled workpiece with it, stripping means to then remove said impaled workpiece, the means to move said carrier then causing said carrier to move past said magazine impaling a fresh workpiece there, and then moving said carrier back to said chuck, inserting the fresh workpiece in said chuck, whereby a single carrier device positively removes a finished workpiece from the chuck and replace it with a new one.

21. In a machine of the class described, a magazine, a chuck, a work carrier, means on said carrier to grip a workpiece, said carrier being normally between said magazine and said chuck, a pivotal mounting for said car-

rier whereby it is adapted to swing in a definite arc, a cam and means connecting said carrier to said cam, whereby upon movement of said cam said carrier is moved through substantially a half oscillation to said chuck, and then through a full oscillation past said magazine, and upon reverse movement of said cam said movements of said carrier are exactly reversed, said carrier moving first through a full oscillation to said chuck, and then through substantially a half oscillation back to its original position, and a reciprocatory grinding table actuating said cam, thus to load and unload the chuck responsive to movement of said table by a plurality of oscillations permitting a single carrier part to convey both the finished and the new workpieces in order to secure accuracy and sureness of operation.

22. The combination with a grinding instrumentality, a workholding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, of means for determining when a workpiece has been ground to the desired size, a single plug for holding annular workpieces and mounted for oscillation, means to move said plug to said chuck to impale a ground annular workpiece and to subsequently move said plug away from said chuck and to thereafter move it again to said chuck and finally out of the way thereof, a pair of spaced jaws, resilient means holding said jaws a given distance apart, said jaws being located in the path of movement of said plug and acting to strip a ground workpiece therefrom, and feeding means to place an unground workpiece between said jaws just after the first movement of said plug therethrough whereby the said workpiece is impaled by said plug and moved to said chuck, the foregoing constituting an automatic loading mechanism and being set in operation by the aforesaid means for determining when a workpiece has been ground to the desired size.

23. The combination with a grinding instrumentality, a workholding chuck, and means for causing a relative reciprocatory motion between said grinding instrumentality and said chuck, including means for causing a substantial separation between said instrumentality and chuck followed by a return motion to bring said parts together again for further relative reciprocatory motion, of a single plug for holding annular workpieces and mounted for oscillation, means to move said plug to said chuck to impale a ground annular workpiece and to subsequently move said plug away from said chuck and to thereafter move it again to said chuck and finally out of the way thereof, a pair of spaced jaws, resilient means holding said jaws a given distance apart, said jaws being located in the path of movement of said plug and acting to

strip a ground workpiece therefrom, and feeding means to place an unground workpiece between said jaws just after the first movement of said plug therethrough, whereby the said workpiece is impaled by said plug and moved to said chuck, the foregoing constituting an automatic loading mechanism and operating during the aforesaid substantial separation between the grinding instrumentality and chuck.

24. In a grinding machine, the combination with the apparatus set forth in claim 22, and operating as therein specified, of means for opening and closing the chuck, said means being set in operation by the means for determining when a workpiece has been ground to the desired size to allow the plug to remove the ground workpiece from the chuck and to cause the chuck to firmly hold the unground workpiece subsequently presented to it by said plug.

25. In a grinding machine, the combination with the apparatus set forth in claim 23, and operating as therein specified, of means for opening and closing the chuck, said means being set in operation during the movement of substantial separation and return to allow the plug to remove the ground workpiece from the chuck and to cause the chuck to firmly hold the unground workpiece subsequently presented to it by said plug.

26. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, means for separating the grinding wheel and the work holder at the completion of a grinding operation, means for then moving the work transferring carrier to engage the ground workpiece in said holder to discharge it from the machine, said discharge movement engaging the carrier with a fresh workpiece, and the operating means therefor then moving it back to the work holder to place the fresh workpiece therein.

27. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, means for separating the grinding wheel and the work holder at the completion of a grinding operation, means for then moving the work transferring carrier to engage a ground workpiece in said holder to discharge it from the machine, said discharge movement engaging the carrier with a fresh unground workpiece, and the operating means therefor then moving said carrier back to the work holder to place the fresh workpiece therein, and the

work holder and carrier being then separated to allow the grinding wheel to grind the workpiece.

28. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided both by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, means for separating the grinding wheel and the work holder at the completion of a grinding operation, a discharging device to remove workpieces from the carrier, carrier operating means brought into operation during the separation of the grinding wheel and work holder for moving said carrier to engage a ground workpiece in said holder and to deliver it to said discharging device, said operating means then engaging the carrier with an unground workpiece and moving said carrier to transfer said ground workpiece to said holder.

29. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided both by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, means for separating the grinding wheel and the work holder at the completion of a grinding operation, a discharging device to discharge workpieces from the carrier, carrier operating means brought into operation during the separation of the grinding wheel and work holder for engaging said carrier with a ground workpiece in said holder and delivering said workpiece to said discharging device, said carrier operating means moving said carrier to engage a new workpiece, and then moving the carrier to the work holder, and the carrier and work holder being then separated to allow the grinding wheel and work holder to come together again.

30. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided both by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, a workpiece supplying magazine, a discharging device to take workpieces from said carrier for discharge from the machine, means for separating the grinding wheel and the work holder at the completion of a grinding operation, carrier operating means brought into operation at that time for effecting said carrier's transfer of a ground workpiece from the work holder to the discharging device, the discharging device then operating to remove said workpiece from said carrier, and means for then transferring a workpiece from the magazine to the work carrier, the

carrier operating means then shifting said carrier back to the work holder to place the last-named workpiece therein.

31. In a grinding machine, a grinding wheel, a rotatable work holder, a work transferring carrier, work gripping means provided both by said carrier and by said work holder, one of said gripping means being adapted to impale a workpiece and the other being adapted to hold it by the outside, a workpiece supplying magazine, a discharging device to take workpieces from said carrier for discharge from the machine, means for separating the grinding wheel and the work holder at the completion of a grinding operation, carrier operating means brought into operation at that time for effecting said carrier's transfer of a ground workpiece from the work holder to said discharging device, and means operable on said transfer movement of said carrier for engaging a fresh workpiece from the magazine with said carrier, the carrier operating means then moving said carrier to the work holder to place the fresh workpiece therein, and the work holder and carrier being finally separated to allow the grinding wheel and work holder to come together again.

32. In a grinding machine, a grinding wheel, a chuck, a work carrier for transferring successive unground workpieces to said chuck, means to bring the chuck and wheel together for grinding and for thereafter separating them, means for bringing the carrier and chuck together and for thereafter separating them to remove each ground workpiece from said chuck, and work impaling means and outside work engaging means provided by said carrier and said chuck, whereby one of these parts grips the work from the inside and the other one of these parts grips it from the outside, the said means being adapted to operate without interference with each other.

CARLE J. HIGHBERG.

CERTIFICATE OF CORRECTION.**Patent No. 1,840,841.****Granted January 12, 1932, to****CARLE J. HIGHBERG.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, line 129, after the word "feed" insert the word occurring; page 11, line 47, claim 12, strike out the word "means"; page 12, line 60, claim 20, for "replace" read replaces; page 13, line 98, claim 29, for "discharge" read remove; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of March, A. D. 1932.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.