

Nov. 22, 1938.

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2,137,644

GRINDING MACHINE

Filed March 26, 1936

4 Sheets-Sheet 1

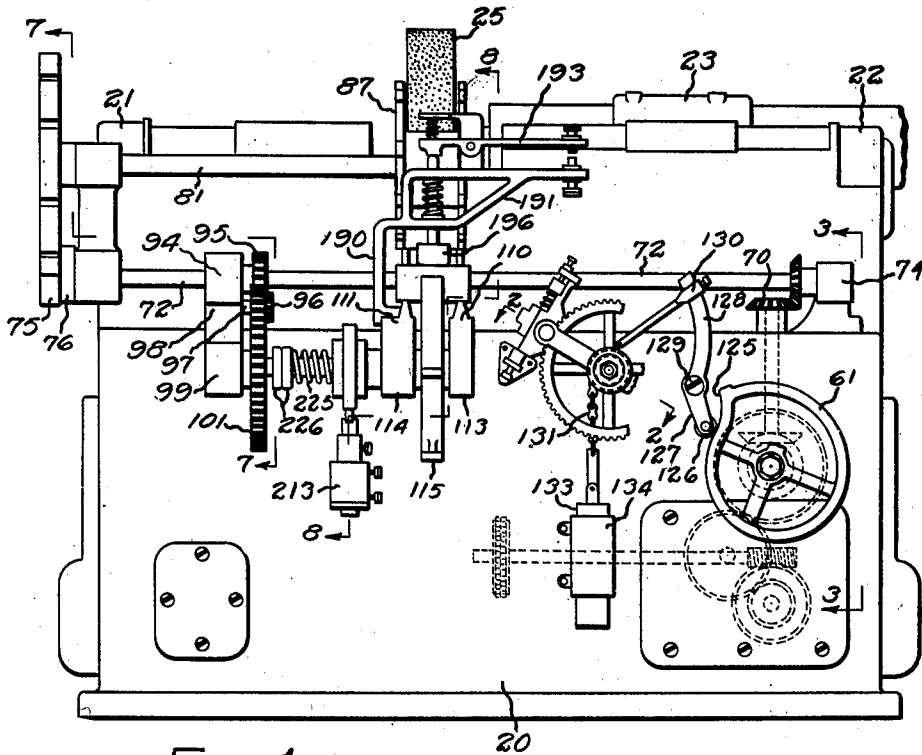


FIG. 1

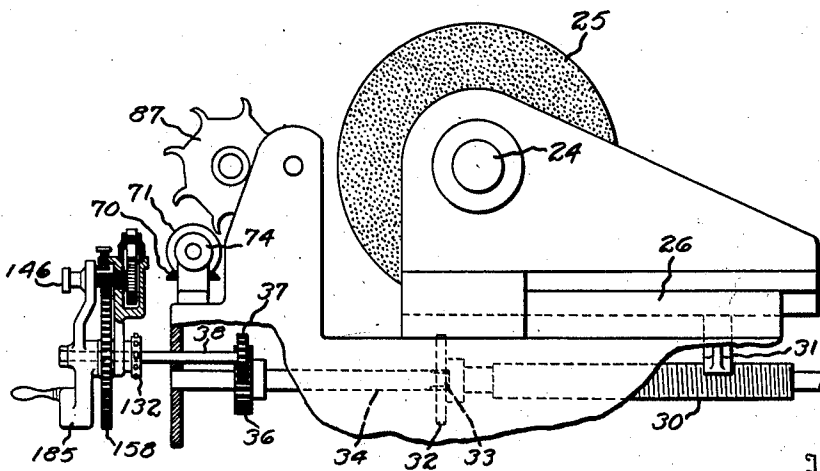


FIG. 2

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4 Sheets-Sheet 2

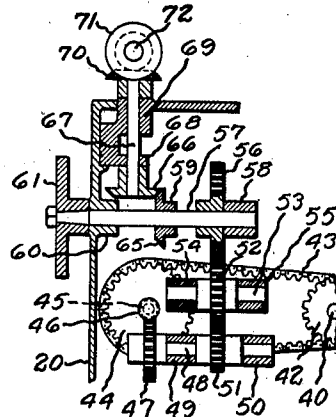
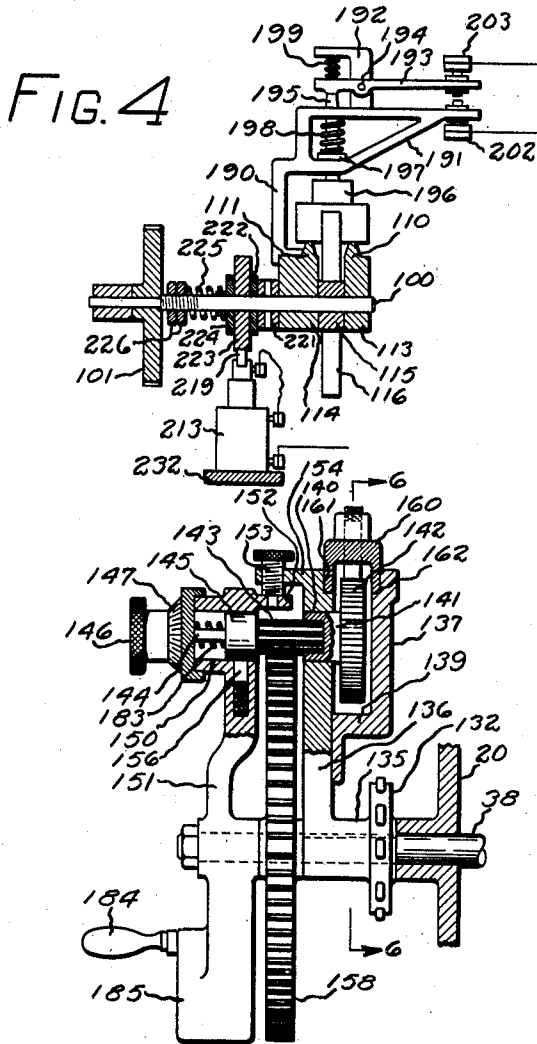


FIG. 5

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4 Sheets-Sheet 3

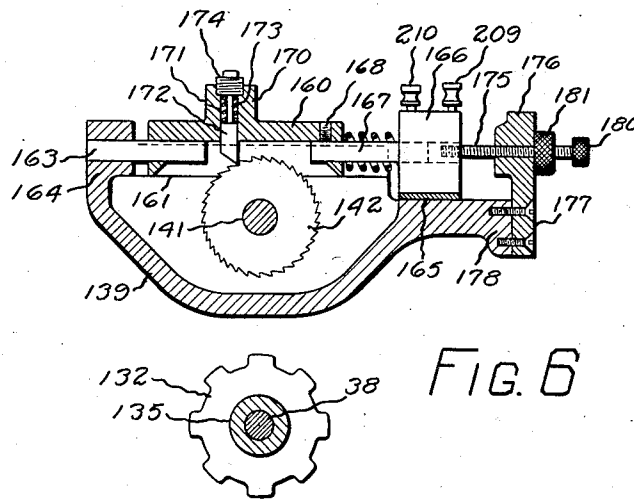
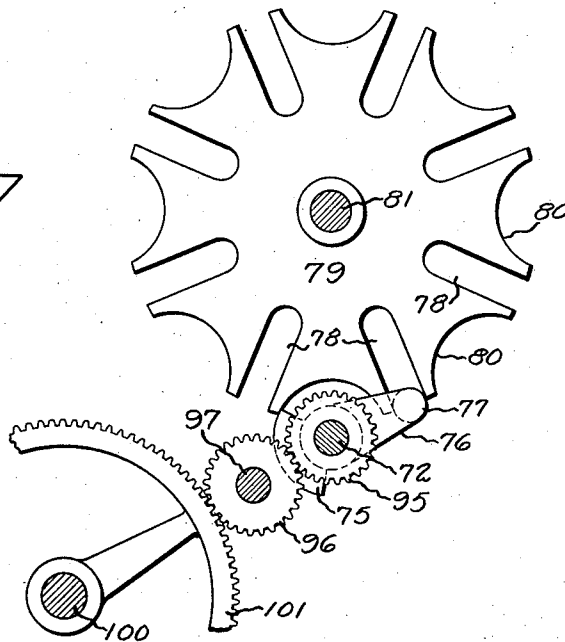


FIG. 7



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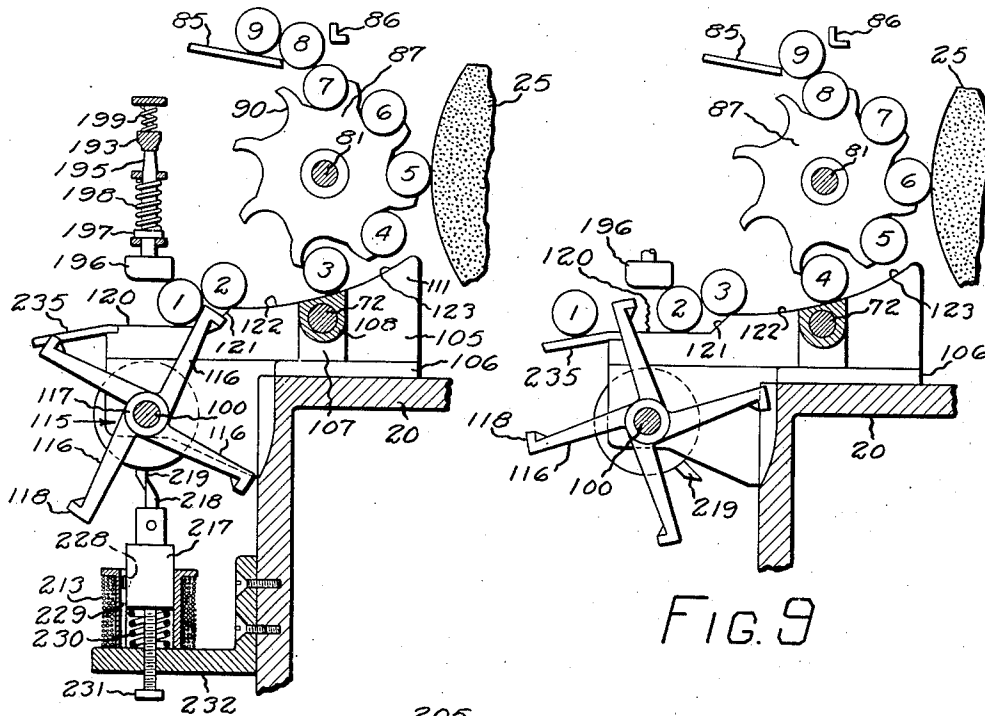


FIG. 8

FIG. 9

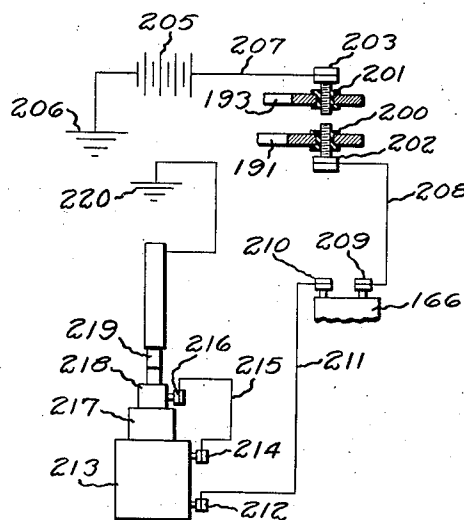


FIG. 10

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UNITED STATES PATENT OFFICE

2,137,644

GRINDING MACHINE

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Application March 26, 1936, Serial No. 70,950

11 Claims. (Cl. 51—165)

The invention relates to grinding machines, and with regard to its more specific features to a size controlling apparatus therefor.

One object of the invention is to provide an efficient work sizing apparatus. Another object of the invention is to provide a compensating mechanism of simple and practical construction. Another object of the invention is to make a grinding machine of a certain type substantially automatic in operation. Another object of the invention is to improve the machine disclosed in United States Letters Patent No. 1,779,779 to Charles H. Norton. Another object of the invention is to provide a size controlling mechanism for a machine of the type disclosed in the aforesaid patent to Norton. Another object of the invention is to provide an efficient transmission mechanism for a grinding machine having a turret wheel, a cross slide operating mechanism and a work sizing and compensating apparatus. Another object of the invention is to provide a simple size controlling apparatus for an external grinder. Another object of the invention is to provide a control preventing the size controlling apparatus from over-compensating. Another object of the invention is to provide an efficient and practical compensating apparatus to compensate for reduction in diameter of a grinding wheel while the machine is operating. Another object of the invention is to provide a size controlling apparatus and improved turret drive which may be incorporated by way of addition to a machine as disclosed in the aforesaid Norton patent. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of many possible embodiments of the mechanical features of this invention,

Fig. 1 is a front elevation of a grinding machine incorporating the apparatus of this invention;

Fig. 2 is a transverse view of the cross slide and operating mechanism therefor, portions of the machine frame being broken away more clearly to show the mechanism, and the compensating mechanism being shown in cross section on the line 2—2 of Fig. 1, Fig. 2 showing the parts in a different position from Fig. 1;

Fig. 3 is a vertical sectional view taken on the

line 3—3 of Fig. 1, illustrating the transmission mechanism;

Fig. 4 is an enlarged view, partly in front elevation and partly in vertical section, of the size controlling mechanism;

Fig. 5 is a view, partly in side elevation and partly in section, of the apparatus shown in the left-hand portion of Fig. 2 but on an enlarged scale;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 5 and illustrating the compensating pawl and ratchet and electromagnetic drive for the pawl;

Fig. 7 is a sectional view on an enlarged scale and on the line 7—7 of Fig. 1, showing further details of the transmission and including the Geneva drive;

Fig. 8 is an enlarged fragmentary vertical sectional view on the line 8—8 of Fig. 1, showing the magazine, turret, size control mechanism, and swastika work piece removing apparatus;

Fig. 9 is a fragmentary view similar to Fig. 8, showing the parts in a different position;

Fig. 10 is a wiring diagram.

For a clearer understanding of the present invention, reference should be had to Charles H. Norton Patent No. 1,779,779 dated October 28, 1930, above referred to. Considering now Figure 1, the machine may comprise a suitable base or frame 20 supporting work heads 21 and 22 in which are rotatably mounted coaxial spindles, not herein disclosed but shown in the Norton patent, having on the ends thereof work gripping disks, also disclosed in the Norton patent, which are movable axially to engage the work piece being ground. As indicated in Figs. 1 and 2, there is provided a grinding wheel head 23 having bearings for rotatably mounting a spindle 24 upon which is mounted a grinding wheel 25. The wheel head 23 is supported upon the usual cross slide 26 for movement toward and away from the work pieces being ground.

Considering now the cross feed and adjustment of the position of the grinding wheel 25, and referring to Figure 2, the machine has a feed screw 30 engaging a half nut 31 which is attached to the cross slide 26. To the front of the feed screw 30 is fastened a gear 32 which meshes with pinion teeth 33 on the rear of a shaft 34, both the feed screw 30 and the shaft 34 being journaled in suitable journals in the machine frame. A gear 36 is fastened to the shaft 34 and meshes with a gear 37 fastened to a shaft 38, also journaled in the machine frame. Rotation or oscillation of the shaft 38 moves the cross slide 26 and there-

fore the grinding wheel 25, and the angular position of the shaft 38 therefore determines the position of the grinding wheel 25 with relation to a work piece.

5 Turning now to Figure 3, the machine is provided with a main drive shaft 40 which may be driven from any suitable source of power. Grinding wheel 25 may be driven from this shaft 40, as disclosed in the patent to Norton. Further as
10 disclosed in the patent to Norton and as indicated in Figure 3, a sprocket wheel 42 is fastened to the shaft 40 and transmits power by means of a chain 43 to a sprocket wheel 44 which is fastened to a shaft 45 suitably journaled in the machine frame.
15 On the shaft 45 is a worm 46 engaging a worm wheel 47 mounted on a shaft 48 journaled in bearings 49 and 50. A gear 51 is mounted on the shaft 48 and meshes with a gear 52 on a shaft 53 mounted in journals 54 and 55. The gear 52
20 meshes with a gear 56 which is mounted on a shaft 57 supported by journals 58, 59 and 60. On the front of the machine is a cam wheel 61 fastened to the shaft 57.

The mechanism so far described is or may be
25 virtually the same as that shown in the aforesaid Norton patent. The cam wheel 61 operates to oscillate the shaft 38 in a manner that will be presently described and operating, except for the compensation feature, like the mechanism described in the Norton patent. I provide, how-
30 ever, a different drive for the turret wheel operating through a Geneva motion which is positive and accurate, the transmission for which I will now describe.

35 Fastened to the shaft 57 is a bevel gear 65 which meshes with a bevel gear 66 fastened to a vertical shaft 67 which is journaled in bearings 68 and 69. On the upper end of the shaft 67 is a bevel gear 70 meshing with a bevel gear 71
40 which is fastened to a shaft 72. Referring now to Figure 1, the shaft 72 is journaled at the right-hand end of the machine frame in a journal 74 and otherwise as will appear. The shaft 72 is horizontal and on the extreme left-hand end
45 thereof is a Geneva locking partial cylinder 75. As better shown in Figure 7, also mounted on the shaft 72 is a Geneva arm 76 on the end of which is a Geneva pin 77 which fits in radial slots 78 of a Geneva plate 79, which is the driven element of the Geneva motion. The plate 79
50 has segment cut-outs 80 exactly fitting the partial cylinder 75 for locking the parts together between angular motions. This driving mechanism thus constitutes a Geneva driving mechanism intermittently to rotate a shaft 81 to which
55 the plate 79 is fastened. Inasmuch as there are eight slots 78 and eight cut-out segments 80, eight revolutions of the shaft 72 procure one revolution of shaft 81 by intermittent stages. A
60 Geneva drive of this type holds the driven part rigidly in a definite position between each angular motion. Furthermore, angular motion starts gradually, accelerates to a maximum velocity, and slows down gradually to a stop. While some
65 clearance for proper operation of such a mechanism may exist between the partial cylinder 75 and the cut-outs 80, as grinding thrust is always in a single direction and the clearance may be the same for every one of the cut-outs 80, each
70 successive work piece will be held, during grinding, at exactly the same position which may be determined within plus or minus a half a thousandth of an inch. However, plus or minus a
75 vertical position of the work piece will, owing to

the large diameter of the grinding wheel, make a variation in size of the work piece of less than one-half of a ten thousandth and this is still an incommensurable figure in grinding of cylindrical work pieces. Therefore, this drive for the
5 turret of the Norton patent greatly improves its action. Furthermore, through the transmission described, I am enabled to drive the work piece remover which passes work pieces under the size controlling device with a motion which is syn-
10 chronized with relation to the turret. This mechanism and its drive will be fully described hereinafter.

Considering now the control of work pieces in this automatic machine, and referring to Fig. 15 8, there is provided, as in the Norton patent referred to, a work piece holding magazine 85. This may be simply a trough or an inclined slide upon which a number of work pieces may be placed. I provide a stop 86 to prevent the work
20 pieces from overrunning the turret 87. The turret 87 may be formed substantially as shown in the Norton patent, and may consist of two identical plates fastened to the intermittently operated shaft 81, and in this present embodiment of
25 the present invention I show it as having eight work piece receiving notches 90, to correspond with the eight divisions of the Geneva driven plate 79. After a number of work pieces are placed on the trough or magazine 85, and the
30 machine set in operation, the work pieces will be removed one by one from the trough 85 and moved to grinding position in engagement with the grinding wheel 25 and thereafter moved away
35 from grinding position. Furthermore, one work piece will be retained in correct grinding position while the Geneva mechanism holds the driven parts stationary. The turret 87 thus operates
40 as an escapement feeding and work holding device.

Referring now to Figs. 1 and 7, fastened to the
45 shaft 72 is a gear 95 which is located close to an additional journal 94 for the shaft 72. The gear 95 meshes with a gear 96 mounted on a stud 97 projecting from a bracket 98 in which is formed the journal 94. The bracket 98 also
50 provides an additional journal 99 for a shaft 100 to which is fastened a gear 101 meshing with the gear 96. As the shaft 72 is continuously rotated, the shaft 100 will also be continuously rotated and in the same angular direction, that is to say counterclockwise, Figure 7.

Referring now to Figures 1 and 8, I provide a casting 105 having a right angle web or base
55 portion 106 for attachment to the machine frame 20, a solid connecting portion 107 forming a bearing 108 for shaft 72 and a pair of parallel irregular shaped portions 110, 111 which together constitute a track down which successive work
60 pieces 1 to 9 inclusive may roll. The parallel irregular shaped portions 110, 111 are extended downwardly to form journal portions 113 and 114 for the shaft 100 which extends between the
65 portions 110 and 111 and has fastened to it therebetween a swastika wheel 115. I have so denominated this wheel 115 because it comprises four arms 116 projecting from a central hub 117 and each arm having an arcuate tip 118, each extending in the same direction. In
70 Figure 8 one of the arms 116 is shown engaging work piece #1 which is on the track comprising the parallel portions or rails 110, 111, the work piece 1 being on track portion 120 which is straight and horizontal. Work piece #2 rests upon track portion 122 which is separated from
75

the track portion 120 by an intervening track portion 121 with a steep grade. Work piece #2 is prevented from dropping down the steep grade 121 by means of the arcuate portion 118 of one of the arms 116. Track portion 122 merges into arcuate track portion 123 which follows the contour of the turret 87.

The work piece #3 is, as shown in Figure 8, restrained from rolling down the track portion 122 by arms of one of the work receiving pockets 90. But with the next angular movement of the turret 87 to the position shown in Fig. 9, the work piece #3 is released. The work piece #1 has been pushed to the left and is discharged. The work piece #2 is in the position the work piece #1 formerly occupied. Before completing the description of the cycle of machine operation and the size control mechanism, I shall now briefly describe the mechanism for moving the grinding wheel forward and back to procure a cutting operation on each successive work piece.

Referring now to Figures 1, 2, 5 and 6, the cam wheel 61 rotates counterclockwise and is engaged by a roller 126 on the lower end of a lever 127 having an arcuate upper portion 128, the lever 127 being pivoted on a stud 129 projecting from the front of the machine. When the cam portion 125 strikes the roller 126, the lever 127 is rocked clockwise. A clamping member 130 adjustably mounted on the arcuate portion 128 has connected to it a chain 131 passing over a sprocket 132, the lower end of the chain being connected to a weight 133 mounted in a casing 134 attached to the machine base 20. The weight 133 keeps the chain 131 taut, and therefore the position of the chain is determined by the position of the cam 61. The portion 125 represents a quick retreat of the grinding wheel, while the remainder of the periphery of the cam 61 represents a slow advance of the grinding wheel. Owing to the arcuate shape of the portion 128, the position of advance is constant, so far as the intermittently actuating mechanism is concerned, but the position of retraction is variable.

The sprocket 132 is formed on a hub 135 which is integral with a sector plate 136. A casing 137 is secured to the plate 136. As shown in Figs. 5 and 6, the casing 137 has a bottom portion 139 and the parts within it are substantially insulated from dust and the like. In the plate 136 is a journal 140 for a ratchet wheel hub 141 to which is integrally attached a ratchet wheel 142. In the hub 141 is an internal gear form into which fits one end of a long pinion gear 143. By means of a shaft 144, a collar 145 is attached to the gear 143; the shaft 144 has on the front thereof a knurled knob 146 integral with a dial 147.

Collar 145 is journaled in a journal 150 formed on the end of an arm 151 which is loosely mounted on the front end of the shaft 38. The journal 150 has a rearwardly projecting portion 152 detachably secured by means of a screw pin 153 to a projecting portion 154 integral with the plate 136. Therefore, arm 151 and plate 136 move as a unit. A spring pressed friction 156 engages the collar 145 and constitutes a friction device to hold the parts including the pinion gear 143 in adjusted position. The pinion gear 143 meshes with a large gear 158 which is fast upon the shaft 38. Thus, if the pinion gear 142 is not permitted to revolve, angular motion of the sprocket 132 and therefore the plate 136 results in equal angular motion of the shaft 38, the drive being through the gear 143 which acts

as a lock. But the gear 143 can be revolved by hand and also automatically, as will be described.

Referring now to Figures 5 and 6, I provide a slide 160 which is movable in ways 161 and 162 provided in the plate 136 and the casing 137 respectively. Referring now to Figure 6, a pin 163 extends through the enlarged end 164 of the portion 139 of the casing 137 and extends into the slide 160. The pin 163 has a tight fit with one of the two parts and a loose fit with the other one; for example, it is shown as slidably keyed to the slide 160. At the other end of the connecting portion 139 is a support 165 for a solenoid 166 having a solenoid core 167 extending into the slide 160 and attached thereto by means of a screw 168. A boss 170 projects upwardly from the slide 160 and has a bore 171 perpendicular to the motion of the slide. In the bore 171 is a pawl 172 which is spring pressed by means of a spring 173 towards the ratchet wheel 142. Spring 173 is backed up by a removable cap screw 174. When the electromagnet 166 is energized, the slide 160 and pawl 172 are moved to the right, Figure 6, and move the ratchet wheel 142 a distance of one or more teeth. The distance which the pawl moves may be adjusted by means of a brass screw 175 passing through a brass boss 176 in a brass plate 177 secured to a projection 178 of the portion 139 of the casing 137. The screw 175 has a knurled head 180 and a locking nut 181. The parts mentioned as of brass are merely preferably of any non-magnetic material in order not to interfere with the action of the solenoid 166.

Thus automatically at any time the gear 142 may be turned, by one or more ratchet teeth thereof, which acts to rotate the gear 158 through a smaller angular distance. It matters not whether the whole unit is moving or not, since angular motion of the gear 143 which is driven by the ratchet 142 effects a displacement between the driving member 136 and the driven gear member 158 and so alters the relation between them and advances the limit position of the grinding wheel for each cycle of machine operation. At any time the same thing can be effected manually by rotating the knob 146 in a clockwise direction. However, the operator may wish to make an adjustment in the other direction, in which case he will grasp the knurled head 146 and pull. A spring 183 pressing against the collar 145 holds the gear 143 in engagement with the internal gear form in the hub 141, but by pulling on the knurled head 146 the gear 143 may be pulled out of this gear form. This disconnects gear 143 from the ratchet 142, and under such conditions adjustment may be made in either direction. If the adjustment is a major adjustment, as for the grinding of a different size of work piece (perhaps involving substitution of a different turret 87), the arm 151 and gear 158 may be revolved any number of times without moving the plate 136 and sprocket 132, simply by unscrewing the screw pin 153 and thus breaking the connection between plate 136 and arm 151, at the same time withdrawing the gear 143 from the internal gear form in the hub 141. For the purpose of revolving the arm 151, I provide a handle 184 in addition to the knurled head 146. This handle 184 projects from a counterweight 185 which is provided to balance the parts including the casing 137, ratchet 142 and the other parts associated therewith and just described.

By reason of the fact that the cam wheel 61

is operated from a driving mechanism which also drives the Geneva pin 77, the turret 87 is synchronized with the motion of the cam wheel 61. Furthermore, every revolution of the cam wheel 61 is accompanied by a revolution of the pin 77, as the gearing between these elements is a one to one gearing. Insomuch as there are eight slots 78 in the Geneva plate 79, a single revolution of the turret 87 represents eight revolutions of the cam 61 and, therefore, eight complete reciprocations of the grinding wheel 25. The timing of the turret and the cross slide movement is such that each work piece is stationary and in grinding position, as shown in Figure 8, until the wheel 25 has advanced to its limit position and remained there for a short length of time to "spark out", and has just started backward on its rapid retraction, whereupon the turret 87 revolves one step to carry the next work piece, for example the work piece 6, into grinding position. The work piece 6 will have reached grinding position about the time the grinding wheel has been fully retracted, or at least before the grinding wheel has been substantially advanced toward the work piece. The rise 125 on the cam 61 represents a retraction sufficient to measure the largest difference between unground and ground work pieces and it will be seen that the remainder of the cam 61 represents a slow movement. Thus, the entire grinding operation is performed with the work piece in grinding position. The work rotating plates are synchronized with the mechanism herein described, as fully set forth in the aforesaid patent to Norton, so that the work piece is revolved positively as soon as the grinding wheel engages it. Furthermore, work piece revolving plates are out of engagement with the work piece as soon as the turret 87 starts to revolve.

Considering now the automatic sizing mechanism, and referring to Figures 1, 4, 8 and 9, I provide an upward extension 190 of the part 111 which supports a triangularly shaped bracket 191 integrally secured to it. On top of the bracket 191 is a bracket 192. An arm 193 is pivoted at 194 to the bracket 192 and engages the top of a rod 195 to the bottom of which is secured a calipering head 196. On the rod 195, which is screw threaded, is a pair of nuts 197 which limit the downward movement of the calipering head 196. A spring 198 on the rod 195 and inside of the triangular bracket 191 resiliently holds the parts in their lowermost position. A spring 199 acts upon the lever 193 to keep it in engagement with the rod 195.

As best shown in Figures 4 and 10, at the right-hand end of the triangular bracket 191 is an insulating sleeve 200 and at the right-hand end of the lever 193 is an insulating sleeve 201. An adjustable terminal screw 202 extends through the sleeve 200 and an adjustable terminal screw 203 extends through the sleeve 201. Referring now to the wiring diagram of Figure 10, a battery 205 has one terminal grounded, as shown at 206. A conductor 207 connects the other end of the battery 205 to the terminal screw 203. The terminal screw 202 is connected by a conductor 208 to one terminal 209 of the solenoid 166. The other terminal 210 of the solenoid 166 is connected by means of a conductor 211 to a terminal 212 of a solenoid 213. The other terminal 214 of solenoid 213 is connected by means of a conductor 215 to a terminal 216 secured directly to the solenoid core 217. A contact detent 218 which

is secured in the solenoid 217 is normally in engagement with the contact detent 219. The contact detent 219 is grounded as shown at 220, this being a diagrammatic way of representing that it is uninsulated from the machine as a whole. The ground 206 represents the machine as a whole and, therefore, when the screws 203 are brought together, both solenoids 166 and 213 are energized. Energization of the solenoid 166 advances the limit position of the grinding wheel 10 through mechanism already fully described.

The adjustment of the terminals 202 and 203 and of the nuts 197 is such that, so long as the work piece is not oversize, within certain limits, the screws 202 and 203 will not come together. Therefore, no change will be made in the setting of the machine. But when, as and if a particular work piece is oversized, the terminals 202 and 203 will be brought together, and the limit position of the grinding wheel will be advanced so that correction is made. Oversize is a relative term, and actually no pieces commercially oversized will be turned out since correction is made within limits of commercial requirements. For example, if the allowable limit is plus or minus three ten thousandths, the compensating mechanism is set to act whenever a work piece is one tenth of a thousandth oversize, and the compensating adjustment is two tenths of a thousandth of an inch. This keeps the machine, theoretically, producing work pieces one tenth of a thousandth either way of the required size, which as a practical matter, would result in holding work pieces to within three ten thousandths plus or minus.

The calipering head 196 also operates as a stop to hold the work piece in position before it is positively moved by the four armed swastika wheel 116. Referring now to Figure 9, the work piece 2 is held in position by the calipering head 196 which in turn holds the work piece 3 above the sharp incline 121, and until such time as the next arm of the swastika wheel engages the work piece 2. The arcuate portion 118 of the swastika wheel arm 116 receives the shock of work pieces which are dropping into the position of the work piece 2 in Figure 9. The arcuate portion 118 also holds back the work piece 2 (Figure 8) until the work piece 1 has been pushed under the calipering head 196 so that work piece 2 will not advance under the head 196 while it is being supported by passage of the work piece 1 thereunder.

The purpose of the solenoid 213 and associated mechanism is to prevent over-compensation. For example, assuming that work piece 1 is one tenth of a thousandth of an inch larger than the exact theoretical size, and all adjustments are properly made, work pieces 2, 3 and 4 will be oversized. As the work piece #1 passes under the head 196 (assuming now the terminal 210 is grounded and the mechanism now to be described is not provided), the machine is compensated. This will bring the theoretical size back to zero (assuming compensation is only one ten thousandth). But work piece #2 was already ground, and this will pass under the sizing mechanism in due course. This will also register as oversized, and actuate the compensating mechanism which will now compensate to one tenth of a thousandth undersize. Work piece #3, likewise, will cause compensation to two tenths of a thousandth undersize. Work piece #4 will cause compensation to three tenths of a thousandth undersize. Thus, undersized work pieces will be produced. As there is a certain

variation that cannot be entirely eliminated, a theoretical undersized condition of three ten thousandths will in practice sometimes result in work pieces more than four tenths of a thousandth undersize.

Furthermore, it is desirable to compensate by two tenths of a thousandth which, under the conditions named, would produce undersized work pieces on an average seven ten thousandths undersized. Therefore, it is quite desirable to provide the mechanism to prevent such over-compensation. It is noted that the machine may be adjusted to cause compensation to occur in time to affect #5 work piece, that is to say to bring #5 work piece to the correct size.

To avoid this condition, I have provided mechanism whereby coincident with a compensation of the machine, no further compensation thereof will occur until all or nearly all of the series of oversized work pieces have been discharged by the machine. In other words, the compensating mechanism will not act again until a work piece reaches the sizing mechanism which was ground after the compensating was effective. This I term a hold-over mechanism.

Referring now to Figures 4 and 8, pinned to the shaft 100 is a collar 221. On the shaft 100 and in engagement with the collar 221 is a fiber washer 222. A metal collar 223 is mounted loosely on the shaft 100 and projecting downwardly therefrom is the contact detent 219. A metal collar 224 is urged against the collar 223 by means of a spring 225 backed up by nuts 226 on the shaft 100.

Friction will tend to drive the collar 223 and with it the contact detent 219 as the shaft 100 revolves, but there is no positive drive for the collar 223 and it will remain stationary so long as the contact detent 218 is in engagement with it, as shown in Figure 8. But energization of the solenoid 213 draws downwardly the core 217 and with it the contact detent 218 and as the shaft 100 is constantly revolved, the contact detent 219 immediately starts to revolve and passes beyond contact with the detent 218. It comes in engagement with it again after four work pieces have gone underneath the calipering head 196. Removal of the detent 218 from the detent 217 opens the circuit through the solenoids 166 and 213 whether or not the contacts 202 and 203 are together, and thus prevents over-compensation. The solenoid core 217 fits in the solenoid 213 and is prevented from turning therein by means of a key 228 fitting in a spline 229 in the solenoid. A spring 230 urges the core 217 upwardly and a stop screw 231 is provided to limit the upward motion and also for adjustment. This stop screw 231 extends through an L shaped supporting bracket 232 which supports the solenoid 213. The bracket 232 is made of resinoid or any other insulating substance and is attached to the machine base 20.

The swastika having the arms 116 revolves constantly and at one quarter of the rate of revolution of the cam wheel 61. It revolves twice while the turret 87 is revolving once. There are four arms 116 of the swastika wheel, whereas there are eight pockets 90 in the turret. Therefore, work pieces are removed from the machine as fast as they are delivered by the turret. As each work piece is removed, it may roll down an incline 235, shown in Figures 8 and 9, into a basket or any other receptacle. Thus, the machine is completely automatic provided the magazine 85 is kept full of work pieces, and of course

the magazine 85 may be made as long as desired and contain a great number of work pieces.

It will be noted that the energization of solenoids 166 and 213 procures, automatically, the deenergization thereof. But the contact between detents 218 and 219 is a sliding contact and the solenoid 166 will have completed its work before the circuit is broken at detents 218 and 219. Detents 218 and 219 are latch shaped to prevent contact on the reverse side and by means of the adjustments provided, this mechanism may be made to operate effectively, as described.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:—

1. In a grinding machine, a grinding wheel, means for presenting work pieces seriatim to the grinding wheel, means for measuring the size of each work piece after it is ground, compensating mechanism to change the position of the grinding wheel with respect to a work piece responsive to the means for measuring the size of each work piece, and means to stop operation of the compensating mechanism for a limited time to prevent over-compensation by reason of passage of a plurality of work pieces already ground through the means for measuring the size of each work piece.

2. In a grinding machine, a grinding wheel, means to advance and retract the grinding wheel relative to work pieces, means to feed work pieces seriatim to a grinding position relative to the grinding wheel and to discharge the work pieces after grinding, means to cause intermittent actuation of the means to advance and retract in timed relation with the means to feed work pieces whereby each work piece is operated upon by the grinding wheel which is advancing relatively to it, work sizing apparatus positioned to receive the work pieces from the means to feed, means to move the work pieces one by one through the work sizing apparatus as they are discharged after grinding, and compensating means responsive to the work sizing apparatus to alter the position of advance of the grinding wheel responsive to an off-size condition of a work piece.

3. In a grinding machine as claimed in claim 2, the combination with the parts and features therein specified, of a hold-over mechanism to prevent over-compensation.

4. A controlling apparatus for grinding machines comprising a track, a calipering head, and a plurality of arms mounted on a hub to push work pieces along the track and under the head, the track being so positioned with relation to the head and so shaped that the head operates as a stop to provide escapement action of the apparatus.

5. Controlling apparatus for grinding machines comprising a track, a calipering head, a swastika wheel, and means for revolving the swastika wheel, the track being so shaped that in conjunction with the head and the swastika wheel it acts as an escapement.

6. In a grinding machine, means to advance work pieces to grinding position and to discharge

them therefrom one by one, a track to receive the work pieces, a calipering head, a plurality of arms mounted on a hub to move work pieces one by one under the head, electric mechanism operated by movement of the head, a contact normally closed but frictionally operated upon by rotation of the hub, means to permit the contact to rotate, and an electric circuit controlling the grinding operation, said electric circuit including the contact whereby to stop operation of the control for a limited period.

7. In a grinding machine, a pair of parallel rails, a multi-armed wheel on an axis below the rails, the arms rising above the rails, a calipering head above the rails, contact closing mechanism operated by the head, a shaft upon which the arms are mounted, the axis of the shaft being substantially normal to the long dimension of the rails, and means to revolve the shaft.

8. In apparatus as claimed in claim 7, the combination with the parts therein specified, of a disk on the shaft, spring means to frictionally urge the disk to revolve, a revoluble contact connected with the disk, a stationary withdrawable contact, and a solenoid to withdraw the withdrawable contact.

9. In a grinding machine, controlling apparatus comprising a pair of rails, a multi-armed wheel in a plane perpendicular to the plane of the

rails and on an axis parallel to the plane of the rails, a sizing head above the rails, and means to revolve the wheel.

10. In a grinding machine, a turret having work piece receiving pockets, a multi-armed wheel to move work pieces subsequent to discharge by the turret, a calipering head positioned to measure work pieces moved by the multi-armed wheel, a transmission train to move the multi-armed wheel, and a Geneva motion operated by the transmission train to rotate the turret intermittently.

11. In a grinding machine, a grinding wheel, a turret having work piece holding pockets, the turret being positioned so that it brings work pieces adjacent the grinding wheel for grinding thereby, track means to receive the work pieces from the turret after they are ground, calipering mechanism comprising a plurality of arms extending radially from a central hub, the axis of which is perpendicular to the plane of the track, a calipering head radially in line with the arms, means angularly to move the arms, thereby moving a work piece on the track past the calipering head, and electric mechanism operated by the calipering head to compensate for over-sized work pieces.

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