

Sept. 14, 1937.

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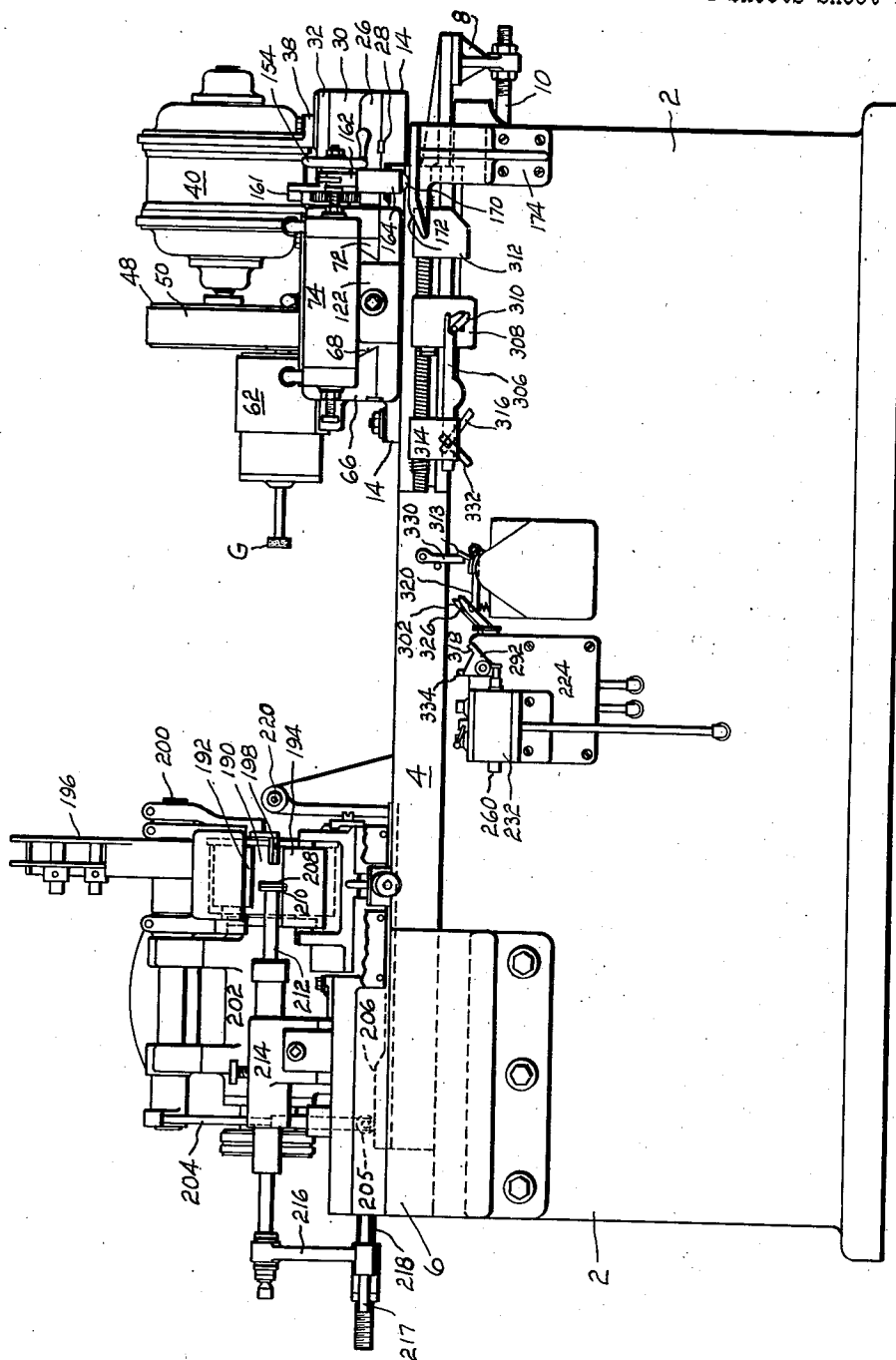
2,092,876

GRINDING MACHINE

Filed March 1, 1935

4 Sheets-Sheet 1

FIG. 1



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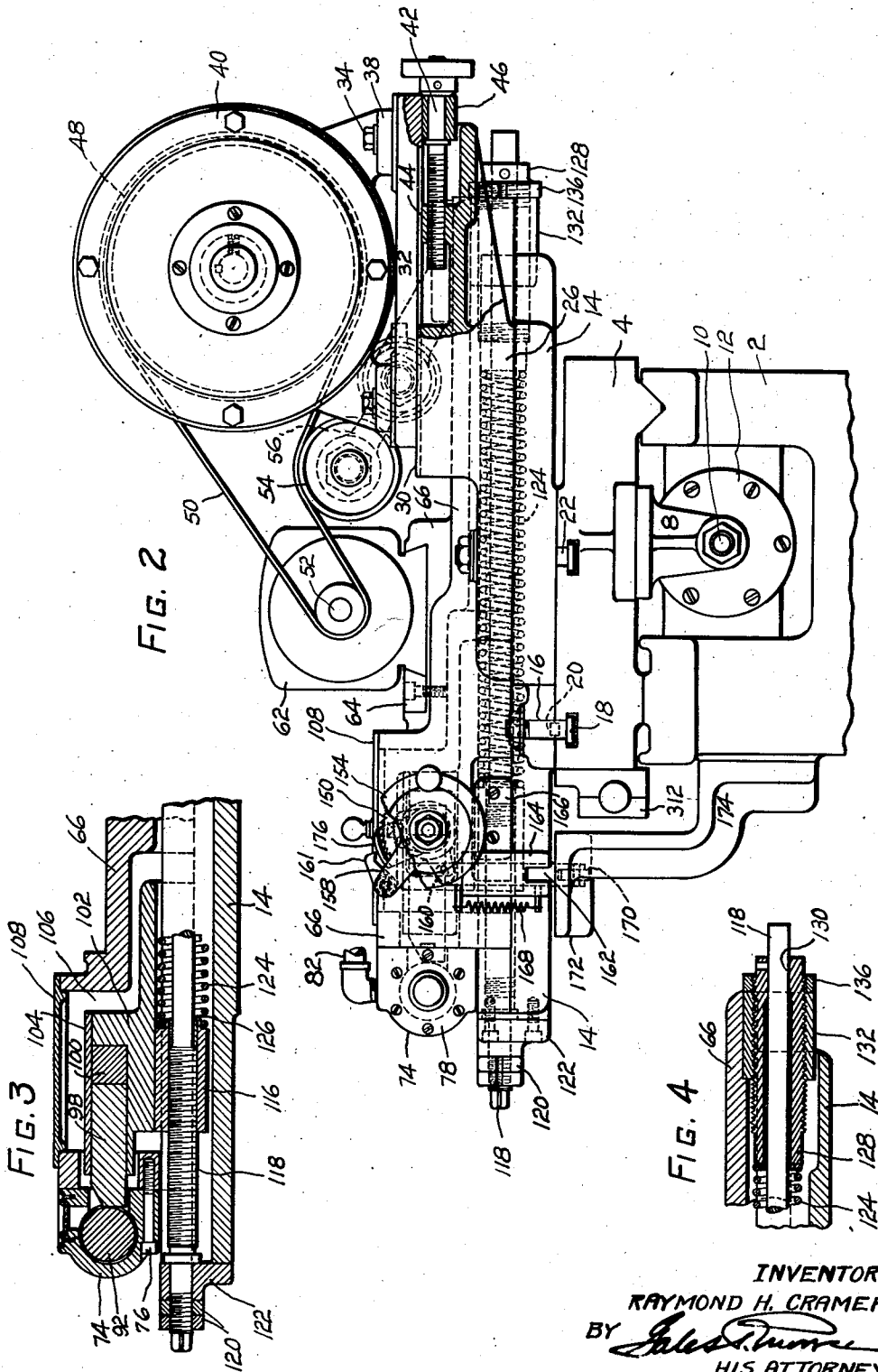
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GRINDING MACHINE

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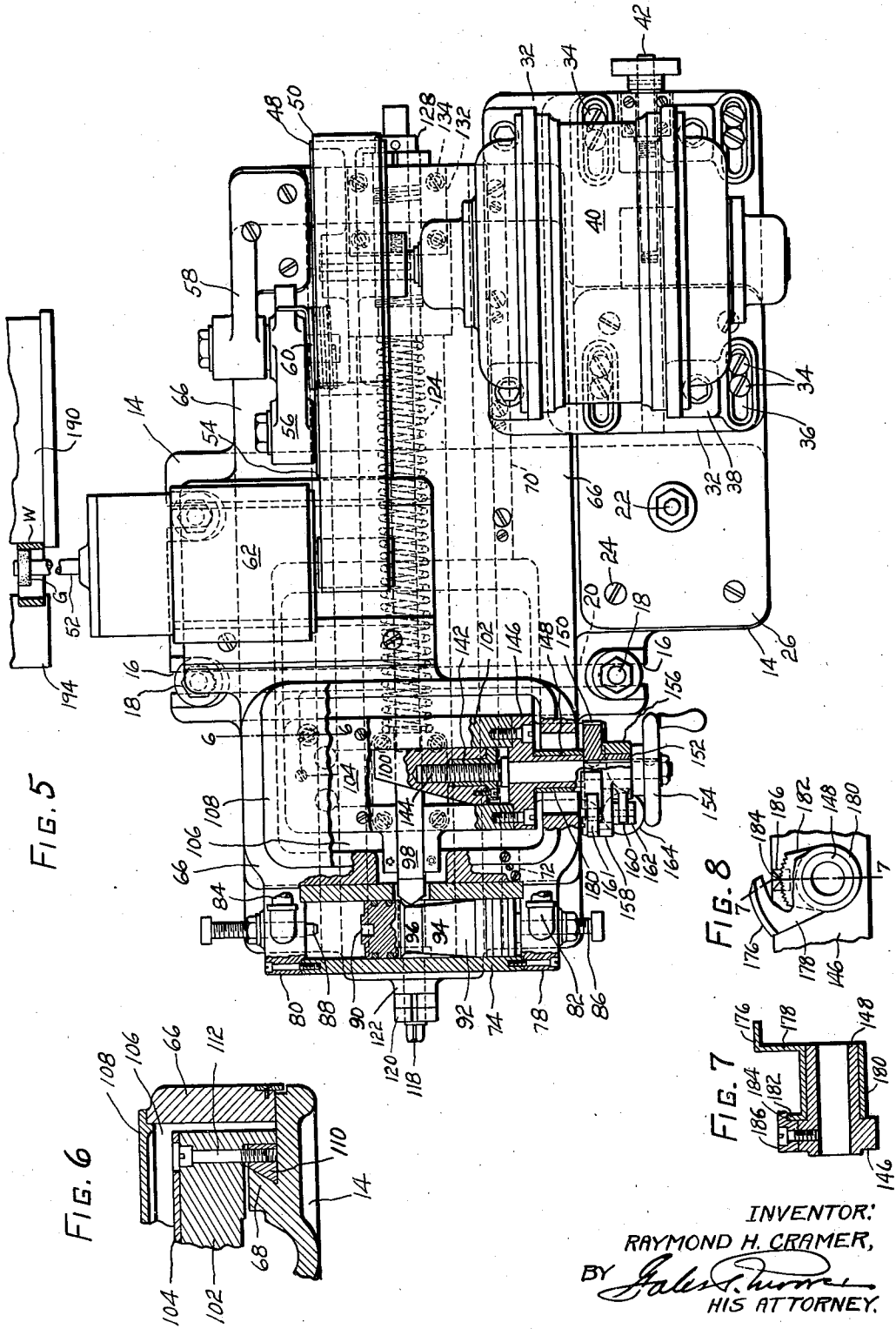
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GRINDING MACHINE

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GRINDING MACHINE

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FIG. 9

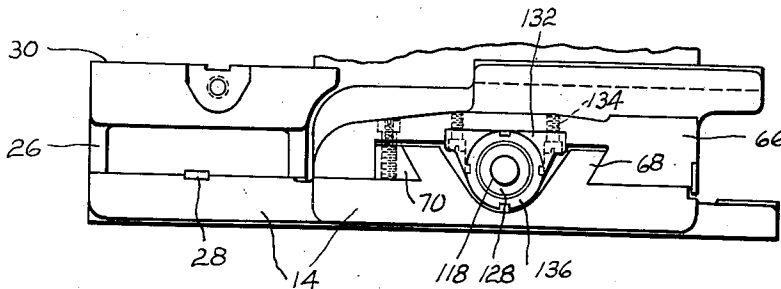


FIG. 10

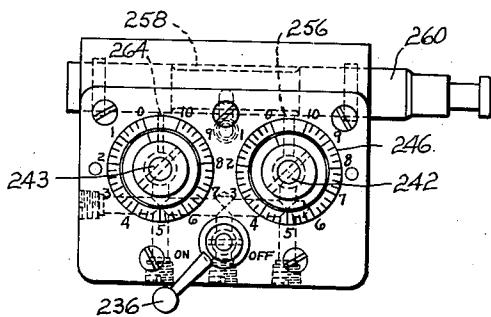


FIG. 11

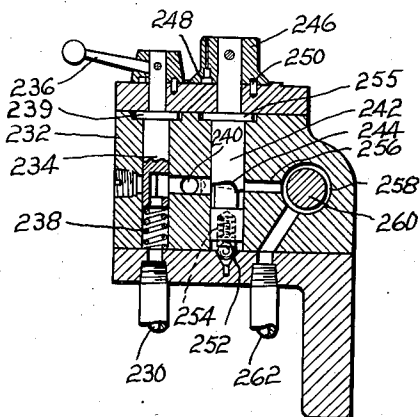
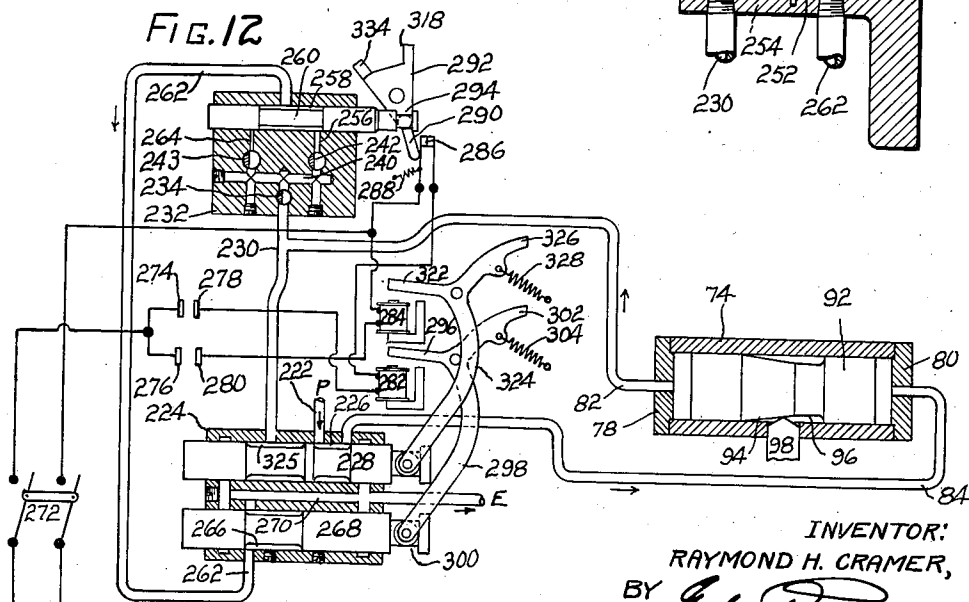


FIG. 12



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UNITED STATES PATENT OFFICE

2,092,876

GRINDING MACHINE

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Application March 1, 1935, Serial No. 8,906

24 Claims. (Cl. 51—50)

This invention relates to grinding machines and the like and comprises all of the features of novelty herein disclosed. An object of the invention is to provide improved feed mechanism for controlling the approach and separation of a tool and a work piece. Another object is to provide improved mechanism for automatically compensating for wear of a tool such as a grinding wheel. Another object is to provide an internal grinding machine having advantages in simplicity, cheapness, ease of setup and adjustment, and accurate and reliable control of work size and finish.

To these ends and also to improve generally upon mechanisms of this character, the invention consists in the various matters hereinafter described and claimed. In its broader aspects, the invention is not necessarily limited to the specific construction selected for illustrative purposes in the accompanying drawings in which

Fig. 1 is a front elevation of the machine.

Fig. 2 is a right hand end elevation with parts broken away and in section.

Fig. 3 is a vertical sectional view through a portion of the cross feed mechanism.

Fig. 4 is a vertical sectional view taken at the rear of the cross feed slide and the associated spring abutment.

Fig. 5 is a plan view of the tool head with some parts broken away and in section.

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Fig. 7 is a vertical sectional view taken on the line 7—7 of Fig. 8.

Fig. 8 is an end view of parts shown in Fig. 7 with a part of the pawl shield broken away.

Fig. 9 is a rear elevation of the cross feed slide and associated parts.

Fig. 10 is a plan view of a valve.

Fig. 11 is a sectional view of the valve of Fig. 10.

Fig. 12 is a diagram of the electrical and the fluid pressure connections.

A reference will first be made to general features of construction and operation. A work head and a tool head are mounted for relative movement in two directions, one of the heads reciprocating with a table and the other being on a bridge attached to the frame. One of the heads, preferably the tool head, is given a cross feeding movement controlled by a shiftable piston cam in a cylinder from one end of which fluid is allowed to leak out first through a coarse feed valve and, after a temporary stopping of the feed, through a fine feed valve. The feed is reliably controlled by

work gauges and after completion of feed, the piston cam is reversed to quickly separate the work and the tool. The table has an amplified reciprocation for tool dressing controlled by one work gauge while another gauge controls a final retreat which actuates a mechanism to compensate for tool wear and controls a work loading and ejecting mechanism besides restarting the next cycle so that the machine is fully automatic.

The numeral 2 indicates a main frame provided with ways for a reciprocating table 4 over which arches a stationary supporting bridge 6 for one of the heads. A bracket 8 on the table is connected to a piston rod 10 which is reciprocated by fluid in a cylinder 12. The work head 16 is preferably mounted on the bridge and the tool head, shown as having a grinding wheel for internal grinding, is mounted on the table to slide therewith and preferably also to have cross feeding movement thereon. A support or base plate 14 is slotted at 16 to receive T-bolts 18 which clamp it to the table, the base plate being located by a key 20. An additional T-bolt 22 and screws 24 clamp a supporting plate 26 to the base plate 14, the supporting plate being located by a key 28. The rear end of the supporting plate is elevated as indicated at 30 and has a groove to receive a tongue on a shiftable motor carrying plate 32. The plate 32 is tapped to receive four pairs of clamping screws 34 which pass through slots 36 in feet 38 carrying a motor 40. To shift the plate 32 and with it the motor, an adjusting screw 42 is threaded in a lug 44 of the supporting plate 26 and is journaled for rotation without endwise movement in a block 46 attached to the plate 32. This adjustment is to compensate for variations in the positions of certain parts which are driven by the motor but movable with respect to it. A pulley 48 on the motor shaft drives a belt 50 wrapped around a pulley on a grinding spindle 52, the belt being kept tight by a pulley 54 on an arm 56 which is pivoted on a bracket 58 and urged upwardly by a torsion spring 60. The grinding spindle with its grinding wheel G for grinding the bore of a work piece W is supported by a head 62 adjustably clamped by a plate 64 in a groove of a cross feed slide 66.

The cross feed slide 66 is slotted underneath to straddle upwardly projecting ways 68 on the support or base plate 14, the slide having a long gib 70 and a short gib 72 secured to it by screws. A cylinder 74 is secured to the front of the feed slide 66 by bolts 76, the cylinder being located by a tongue entering a groove at the front of the slide. The cylinder has heads 78 and 80

with ports connected to flexible fluid supply pipes 82 and 84 respectively. The cylinder heads support adjustable abutment screws 86 and 88 the former to limit the slow feeding movement of a piston 92 and the latter being arranged to enter a dash-pot recess 90 in the piston, the piston having a quick movement towards the screw 88 and being finally cushioned. The piston has suitable piston rings near the ends but its central portion constitutes a shiftable cam having one or more inclines. In the illustrated construction there are two meeting conical cam surfaces 94 and 96 which are always urged against a cam follower or abutment 98. Both cam surfaces have a small degree of taper but the surface 94 tapers the more. Hence when the piston is moved slowly in a direction to approach the cylinder head 78, the cam surface 94 will first travel along the cam follower or abutment 98 producing a coarse feed and then the cam surface 96 will come into action to produce a fine feed. In the present invention, as will appear, coarse and fine feeds are further influenced and controlled by changing the speed of the piston at different portions of its stroke. Also the action of either cam can be prevented by limiting the stroke of the piston by the abutment screws. It should be understood that the cylinder and piston are a unit with the cross feed slide 66 and move therewith while the cam follower or abutment 98 is fixed during such feed but is moved a short distance intermittently between feeds to compensate for wheel wear.

The front end of the cam follower or abutment 98 is bevelled in three directions to form an edge engaging the piston cam while the rear end is bevelled in one direction to fit against a cam or wedge 100 which is intermittently shiftable between the side walls or guides of a wedge-containing housing 102 having a transparent cover plate 104. The housing has a forward extension to better hold the cam follower or abutment 98 and is contained in a large chamber 106 of the cross feed slide, the chamber being closed at the top by a cover plate 108 and being large enough to permit the desired feed movement of the slide with respect to the housing. The housing 102 can be adjusted on the ways 68 but is normally anchored to the base plate 14 by a locking gib 110 (Fig. 6) fastened by screws 112. Fastened to the bottom of the housing 102 is a nut 116 in which is threaded an adjusting screw 118 whose front end is journaled for rotation in a plate 122, nuts 120 and a collar preventing endwise movement. The plate 122 is fastened to the front of the support or base plate 14 by screws. The adjusting screw 118 can be turned to procure an initial adjustment of the cross feed slide with respect to the housing 102, as during a setting-up for the character of work.

For producing the power which urges and moves the cross feed slide 66 rearwardly as such movement is permitted and controlled by translation of the piston cam, a strong coil spring 124 is seated around an annular projection 126 of the nut 116 and extends to a similar opposing abutment on a sleeve 128. The sleeve forms a support at 130 for the plain rear end of the screw shaft 118 and is externally threaded in a nut 132 which is secured by screws 134 to the cross feed slide 66. The sleeve has wrench holes so that it can readily be turned to adjust the tension of the spring 124 and is locked in adjusted position by a lock nut 136. Since the cam follower or abutment 98 and the nut 116 are fixed in position on the base plate 14 during feeding, the coil

spring 124 urges the cross feed slide 66 and its cylinder 74 rearwardly, the translation of the piston longitudinally gradually shifting cam portions of smaller diameter and of less inclination along the edge of the cam follower or abutment 98 and so providing one means for varying the feed.

Inasmuch as the grinding wheel continuously wears down to smaller diameter, a compensating mechanism provides for an intermittent but very small augmentation of the rearward stroke of the cross feed slide. This mechanism is actuated by the reciprocating table whenever the table retreats following the completion of a work piece. The mechanism effects this desired result by intermittently shifting the wedge 100 along the bevelled rear end of the cam follower or abutment 98. The wedge is drilled out to receive an internally threaded sleeve 142 having a flange fastened to the wedge by screws. An adjusting screw shaft 144 is threaded in the sleeve 142 and has a plain portion journaled for rotation without endwise movement in a cap 146 which is secured by screws to the housing 102. The cap has a tubular extension 148 projecting through an elongated slot in the slide 66 and abutting against a ratchet wheel 150 which is keyed on the outer end of the screw shaft 144. The ratchet wheel has a tubular extension 152 abutting against a hand wheel 154 which is keyed on the screw shaft. A hub 156 is loosely journaled on the extension 152 and carries a long arm 158 and a short arm 160, the two arms being angularly spaced. The long arm pivotally supports a pawl 161 arranged to engage the ratchet wheel for an intermittent and adjustable feed. The short arm is loosely pivoted to the upper end of a plunger 162 which is slidable in a vertical guide casing 164 on a bracket 166 which projects through a notch in the feed slide and is attached to the lower portion of the housing 102.

The plunger is urged downwardly by a coil spring 168 connecting a pin on the plunger with a pin projecting from the guide casing 164. The lower end of the plunger carries a cam roller 170 arranged to be actuated when it runs along an inclined cam 172 at the upper end of a bracket 174 fastened to the main frame. The cam is of considerable width from front to rear so that it remains in line with the cam roller in different front-to-rear adjusted positions of the fixed housing 102. When the table retreats to the remote position indicated in Fig. 1, the cam roller runs up the cam into a clearance notch of the guide casing 164 and the pawl actuates the ratchet wheel thereby shifting the wedge endwise a small amount. The amount can be varied by a pawl shield 176 on an arm 178 carried by a sleeve 180 which is angularly adjustable on the tubular extension 148, the sleeve having an adjusting arm or sector 182 provided with teeth on its periphery. The teeth are engaged by the pointed edge of a locking detent 184 projecting from a block 186 fastened in a notch at the upper edge of the cap 146. The shield can thus be made to hold the pawl 161 away from the ratchet wheel for more or less of the distance travelled by the pawl to adjust the compensation for wheel wear. The hand wheel 154 can be turned counterclockwise to manually restore the wedge to the in-position as when a new grinding wheel is substituted for a worn one and it also can be used at any time to retract the cross feed slide.

The work head may be of any suitable type which is preferably loaded and unloaded auto-

atically. In the illustrated construction, it is carried on the bridge 6 and comprises a flanged, backing or regulating wheel 190, a pressure idler wheel 192, and a supporting idler wheel 194 the pressure idler wheel being raised and lowered whenever a new work-piece is let down from a magazine 196. There is also an ejector 198 to discharge a completed work-piece from the wheels and to lower the new piece to grinding position. The pressure idler and ejector are actuated simultaneously by arms connected to a rock shaft 200 journaled on a head casting 202. The shaft is rocked by a plunger 204 having a cam roller 205 engaging a cam 206 fastened to the top of the reciprocating table 4. The cam comes into action when the table retreats so that ejection and loading occur when the wedge 100 is given its feed compensating motion above described. Control of size is preferably accomplished by concentric gauge plugs 208 and 210 carried by a gauge rod 212 shiftable endwise in a guide casing 214 adjustable on the work head. The gauge rod is connected by a bracket 216 to a guide rod 217 and to a control rod 218 having a pair of contacts for successively completing electric circuits hereinafter referred to. As will appear, one contact controls an amplified reciprocation of the table to carry the grinding wheel past a fixed dressing diamond 220 carried by a bracket attached to the frame and the other contact controls the more remote retreat of the table for loading and unloading. These gauge contacts also control the operations of certain valves as will appear.

Referring to the diagram of Fig. 12 and also to Figs. 10 and 11, pressure fluid from a pump comes through a pipe 222 to a valve casing 224, the fluid entering an annular passage 226 between collars on a slidable reversing valve 228 and going through the flexible pipe 84 to that end of the cylinder 74 which is nearest to the cam surface 96. Exhaust fluid from the other end of the cylinder goes through the flexible pipe 82 to a pipe 230 connecting the valve casing 224 with a feed control valve casing 232. That branch of the pipe 230 which goes to the valve casing 232 leads to a normally open shut-off valve 234 having a control handle 236 at its upper end and a coil spring 238 engaging the opposite end to keep a tight joint between a collar 239 on the valve and the casing cover. From the shut-off valve, there are branch ports 240 leading to two similar, angularly adjustable escape or feed valves 242 and 243. The valve 242 is the coarse feed valve and is shown in detail in Fig. 11. It comprises a stem having a reduced portion with a cam-like shoulder 244 which restricts the leakage of fluid in accordance with the rotary adjustment controlled by a dial 246 fastened to the upper end of the stem. The dial has a circular groove containing a stop pin 248 arranged to engage a stop pin 250 projecting into the groove from the valve casing, thus to limit turning of the valve. A ball 252 is interposed between a conical seat in the valve casing and a seat on a spring pressed plunger 254 inserted in the lower end of the valve stem. This makes for easy turning of the valve and keeps a collar 255 on the valve against the casing cover. The valve discharges fluid to an escape port 256 leading to an annular passage 258 between collars on a shiftable selector valve 260, the fluid then going out through a pipe 262 to the valve casing 224. The selector valve is shown in a position to allow leakage through the coarse feed valve 242 to its escape

port 256 while a more restricted escape port 264 from the fine feed valve 243 is blocked off by the valve 260 until the latter is subsequently shifted to block off the port 256. The relative amounts of leakage through these ports can be varied by turning the dials and provides a very sensitive control of feed. Fluid discharging past either of the feed valves 242 or 243 to the pipe 262 enters an annular passage 266 between collars on a slide valve 268 and normally passes to a tank through an exhaust port 270.

A source of electric power is connected to a pair of supply wires by a switch 272, one wire leading to a pair of movable contacts 274 and 276. These contacts correspond to the two gauge plugs and they successively complete electric circuits by engaging fixed contacts 278 and 280 respectively. A wire from the contact 278 leads to a magnet 282 and a wire from the contact 280 leads to a magnet 284. A wire from the magnet 284 leads directly back to the main line but the other wire from the first magnet 282 leads first to a switch 286 which is urged to open position by a coil spring 288. This switch is however kept closed during coarse feed by an arm 290 on a pivoted selector lever 292 which has a connection at 294 with the selector valve 260. When the contacts 274 and 278 come together, the magnet 282 is energized and attracts an armature 296 on a pivoted lever having a long arm 298 connected at 300 to the slide valve 268. The resultant swinging of the lever counterclockwise shifts the valve 268 to the right and blocks off the pipe 262, thus temporarily stopping the feed entirely. During this stopping of feed, the table is given its amplified reciprocation for wheel dressing controlled by a lever arm 302 connected by a coil spring 304 to the frame. The arm 302 (see Fig. 1) lifts a latch 306 to release a dog-carrying plate 308 for sliding movement with respect to the table. A pivoted dog 310 on the plate is spaced from a dog 312 fixed on the table and these dogs control the normal grinding reciprocation of the table by alternately engaging a suitable reversing lever 313. Upon the unlatching of the plate 308 however, the dog 310 is not effective to reverse the table for the in-stroke until the table comes out far enough for a plate 314 fixed to the table to engage the plate 308. As the table thus makes its amplified out-stroke, a pivoted dog 316 on the table engages a lug 318 on the selector lever 292 and swings the lever clockwise. The selector valve 260 is thus shifted inwardly blocking off the escape port 256 from the coarse feed valve 242 and opening the escape port 264 from the fine feed valve 243. Leakage from the cam cylinder and its pipe 82 then occurs at a slower rate and the piston cam moves more slowly and produces a slower feed. It will be understood that the aforesaid opening of the switch 286 de-energizes the magnet 282 so that the coil spring 304 will swing the lever 298 clockwise and shift the valve 268 inwardly to its original position to permit the pipe 262 to discharge again to the exhaust port 270.

The normal grinding reciprocation of the table is continued until the second gauge contacts 276 and 280 come together and energize the second magnet 284. This magnet attracts an armature 322 on a lever having a long arm 324 connected to the slidable reversing valve 228. The valve is shifted outwardly to the right to place the pressure fluid from pipe 222 in communication with an annular passage 325 leading to the pipe 230. This directs pressure fluid to the pipe 82 and

quickly reverses the piston cam while exhaust fluid from the other end of the cylinder occurs freely through the pipe 84 to the passage 226 and thence to a short port communicating with the exhaust port 270. It is to be observed that, although the pressure fluid in pipe 230 also has access to the feed valve casing 232 during this reversal of the piston, the leakage of fluid through the fine feed valve 243 is not extensive enough to interfere with such reversal. Reversal of the piston cam of course backs the grinding wheel positively away from the finished work. The table then retreats, an arm 326 on the lever 324 being connected by a coil spring 328 to the frame and operating to lift the pivoted dog 310 so that the latter rides freely over the reversing lever 313. As the table thus reaches its remote position, the cam roller 170 rides up on the cam 172 and produces the hereinbefore described feed compensation for wheel wear. The finished work is meanwhile ejected from the work head and a new piece loaded on it. The table does not stop in the retracted position but immediately returns, this reversal of movement being effected by a table dog 330 which engages the reversing lever 313. As the table returns, a pivoted table dog 332 engages an offset lug 334 on the selector lever 292 and swings it counterclockwise to the original position with the switch 286 closed and the selector valve open to the coarse feed valve. The return of the table retracts the gauges and so opens the magnetic circuits to make ready for the next cycle.

I claim:

1. In a machine of the character described, a support, a feed slide movable with respect to the support, a feed cam slidably carried by one of said members and a cam follower carried by the other, a piston and cylinder unit for causing relative shifting movement between the cam and the follower to control movement of the feed slide, and means including a valve to decrease the speed of shifting for causing the feeding effect of the cam to change during such relative shifting; substantially as described.

2. In a machine of the character described, a support, a feed slide movable with respect to the support, a feed cam carried by one of said members and a cam follower carried by the other, a piston and cylinder unit for causing relative shifting movement between the cam and the follower to control movement of the feed slide, means including a valve for causing the feeding effect of the cam to change during said relative shifting, and a work gauge controlling the last named means; substantially as described.

3. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having a cam, a cam follower carried by the other member, and means for controlling the speed of the cam by throttling the escape of fluid from the exhaust side of the cylinder; substantially as described.

4. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having a cam adapted to control the feed movement of the slide, a valve casing having an escape port communicating with the exhaust end of the cylinder, and a slide valve shiftable to close or open the escape port; substantially as described.

5. In a machine of the character described, a support, a feed slide movable with respect to the

support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having an escape port communicating with the exhaust end of the cylinder, a slide valve shiftable to close or open the escape port, and a reciprocating table having means to effect shifting of the slide valve; substantially as described.

6. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having a plurality of escape ports spaced apart and communicating with the exhaust end of the cylinder, a selector valve shiftable to block off one part and open the other for making the escape ports effective in sequence, and a slide valve shiftable in one direction to momentarily prevent discharge from the open escape port to stop the feed slide, and said slide valve being shiftable in the opposite direction to provide for resumption of feeding movement under control of said open escape port; substantially as described.

7. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having a plurality of escape ports communicating with one end of the cylinder, a selector valve for making the escape ports effective in sequence, and a work gauge controlling the shifting of the selector valve; substantially as described.

8. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having a plurality of escape ports communicating with one end of the cylinder, a selector valve for making the escape ports effective in sequence, a reciprocating table having means to cause shifting of the selector valve, and a work gauge controlling a table movement for such shifting of the valve; substantially as described.

9. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having a plurality of escape ports communicating with one end of the cylinder, a selector valve shiftable from one escape port to the other for making the escape ports effective in sequence, and means for causing a temporary stopping of the escape ports when said selector valve is shifted; substantially as described.

10. In a machine of the character described, a support, a feed slide movable with respect to the support, a cylinder and piston unit carried by one of said members and having means adapted to control the feed movement of the slide, a valve casing having a plurality of escape ports communicating with one end of the cylinder, a selector valve for making the escape ports effective in sequence, a valve for causing a temporary stopping of the escape ports, and a work gauge controlling the shifting of the last-mentioned valve and the selector valve; substantially as described.

11. In a machine of the character described,

a support, a feed slide movable with respect to the support, a feed cam carried by one of said members and a cam follower carried by the other, a work head and a tool head, one of said heads being movable with the slide, means for causing relative shifting movement between the cam and the follower to control the feed slide, and a shiftable wedge for controlling an intermittent adjustment of the feed slide to compensate for tool wear; substantially as described.

12. In a machine of the character described, a support, a feed slide movable with respect to the support, a feed cam carried by one of said members and a cam follower carried by the other, a work head and a tool head, one of said heads be-

support, a work head and a tool head, one of said heads being movable with the slide, a cam, means for shifting the cam with respect to the slide, a cam follower engaging the cam, a wedge engaging the follower, an adjusting screw having threaded connection with the wedge, the cam and the adjusting screw being mounted one on the slide and one on the support and means for turning the screw; substantially as described.

18. In a machine of the character described, a support, a feed slide movable with respect to the support, a work head and a tool head, one of said heads being movable with the slide, a cam shiftable on the slide, means for shifting the cam with respect to the slide, a cam follower engaging the

between one of said piping connections and the exhaust line to control a slow feed of the slide, a sliding carriage supporting one of the heads to cause relative traversing movement between the tool and the work, and a valve shiftable by a movement of the carriage to prevent escape of fluid from the throttling port; substantially as described.

24. In a machine of the character described, a work head, a tool head, a feed slide supporting one of the heads, a cylinder and piston unit for actuating the slide, a reversing valve having pip-

ing connections with opposite ends of the cylinder, an exhaust line, an escape valve having a pair of throttling ports of different throttling effect, each being in communication with and interposed between one of said piping connections and the exhaust line, a selector valve in communication with the throttling ports and shiftable from one to the other to make the ports effective in sequence to change the character of the feed, and a valve shiftable to prevent escape of fluid from either of the throttling ports; substantially as described.

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