PUBLISHED
JUNE 15, 1943.
BY A. P. C.

E. FOUQUET
GRINDING MACHINES
Filed Nov. 24, 1941

Serial No
420,313
6 Sheets-Sheet 1

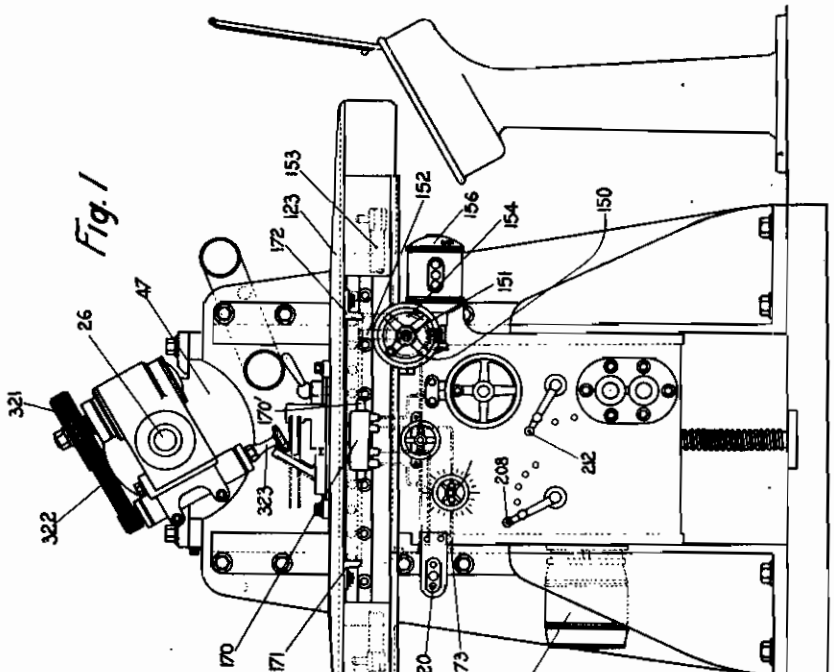

Fig. 1

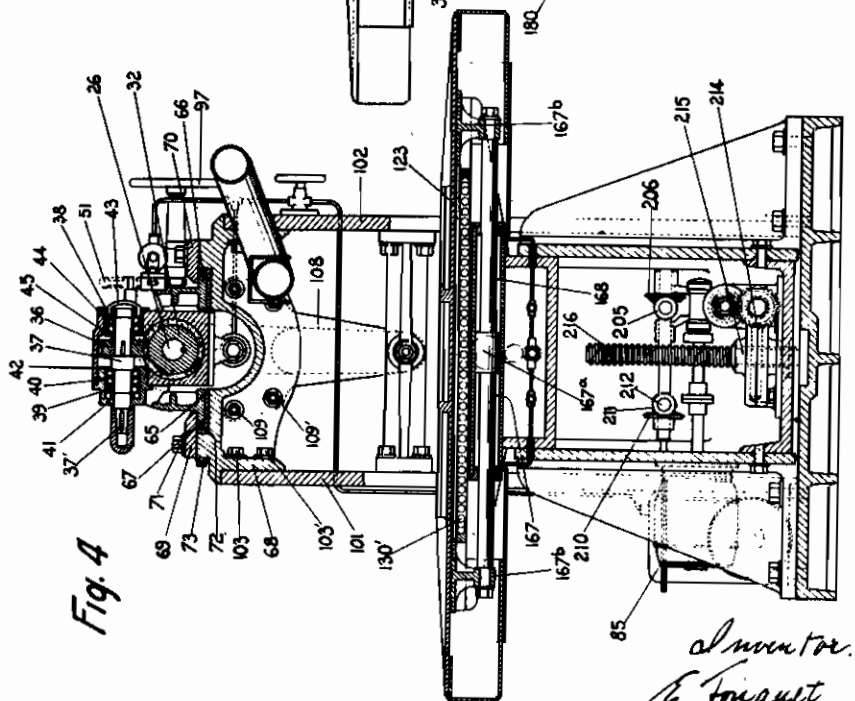

Fig. 4

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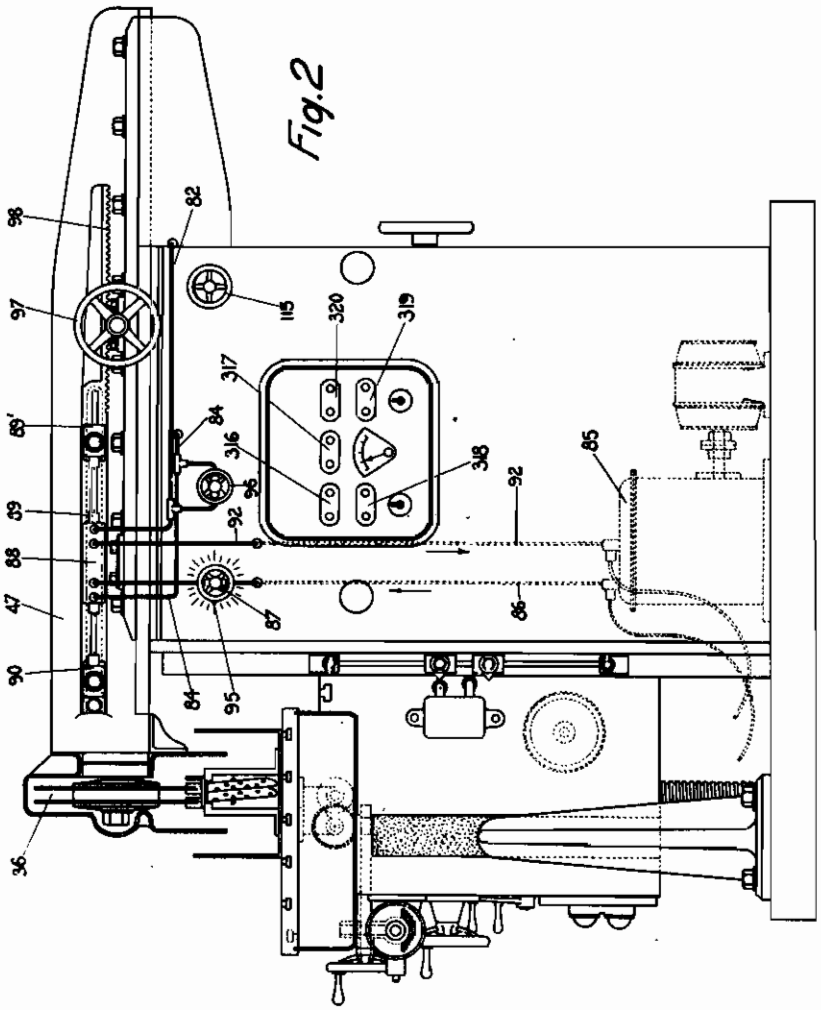
Fig. 2



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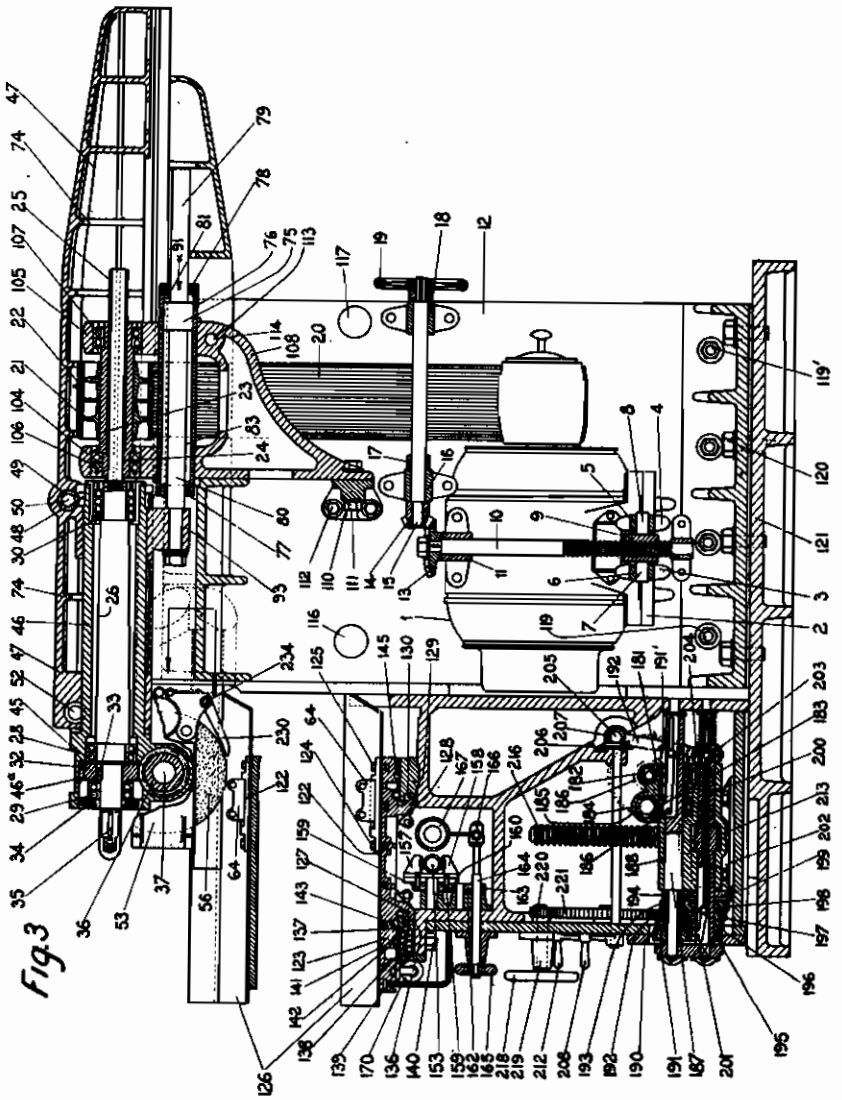

Fig. 3

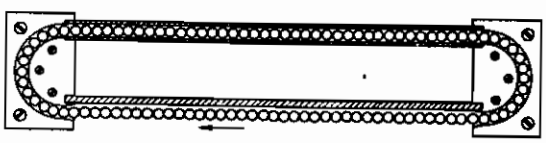

Fig. 13

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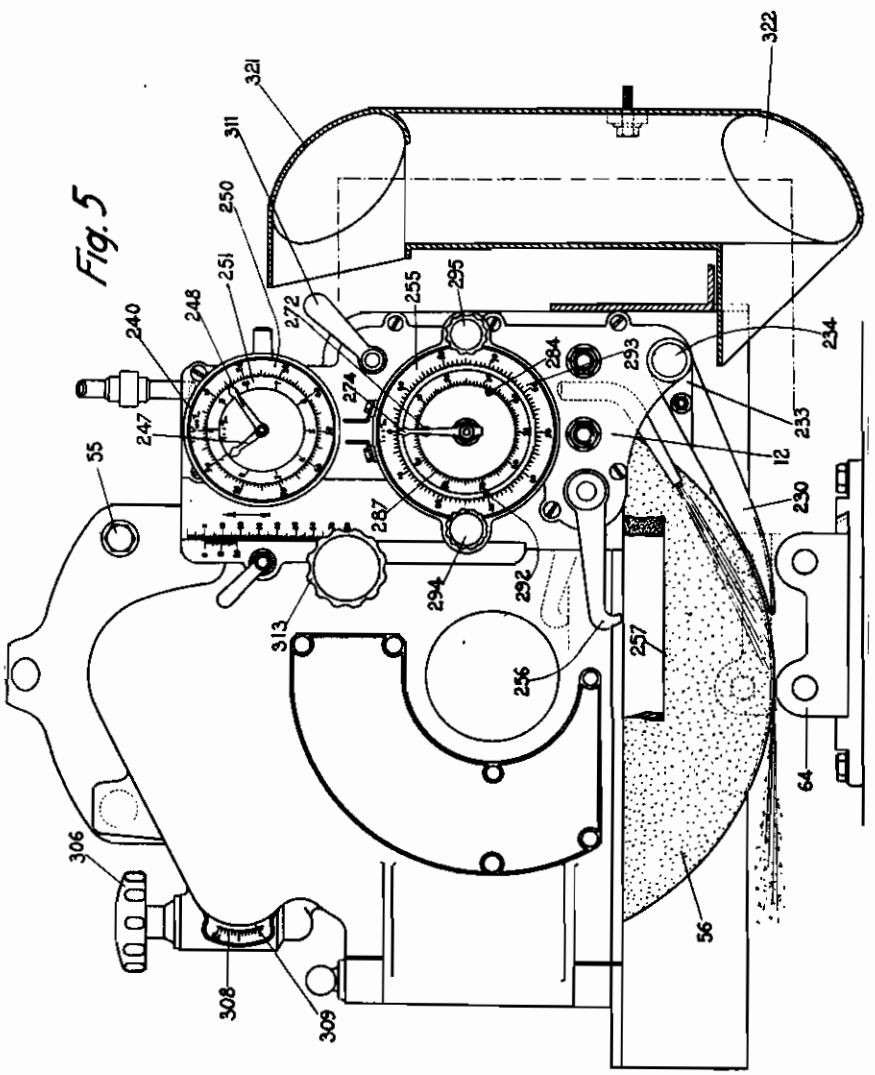
Fig. 5



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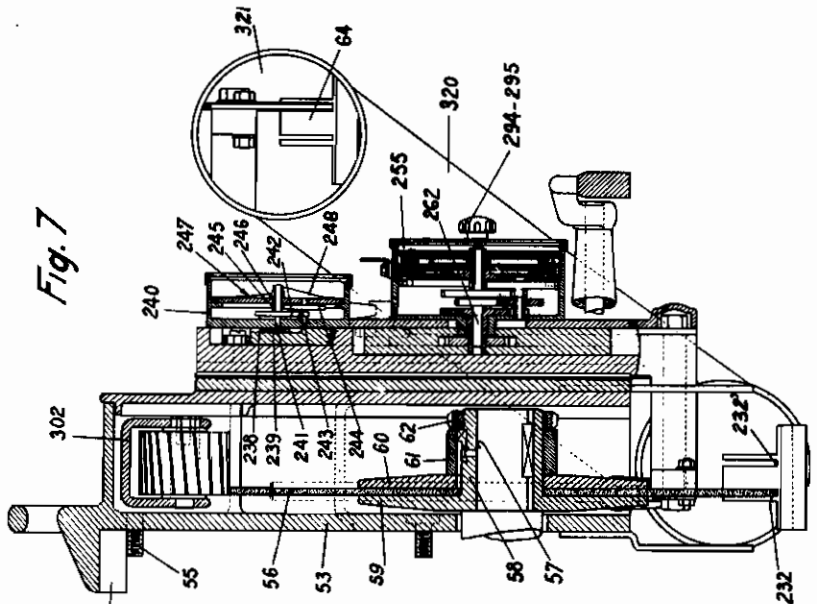

Fig. 7

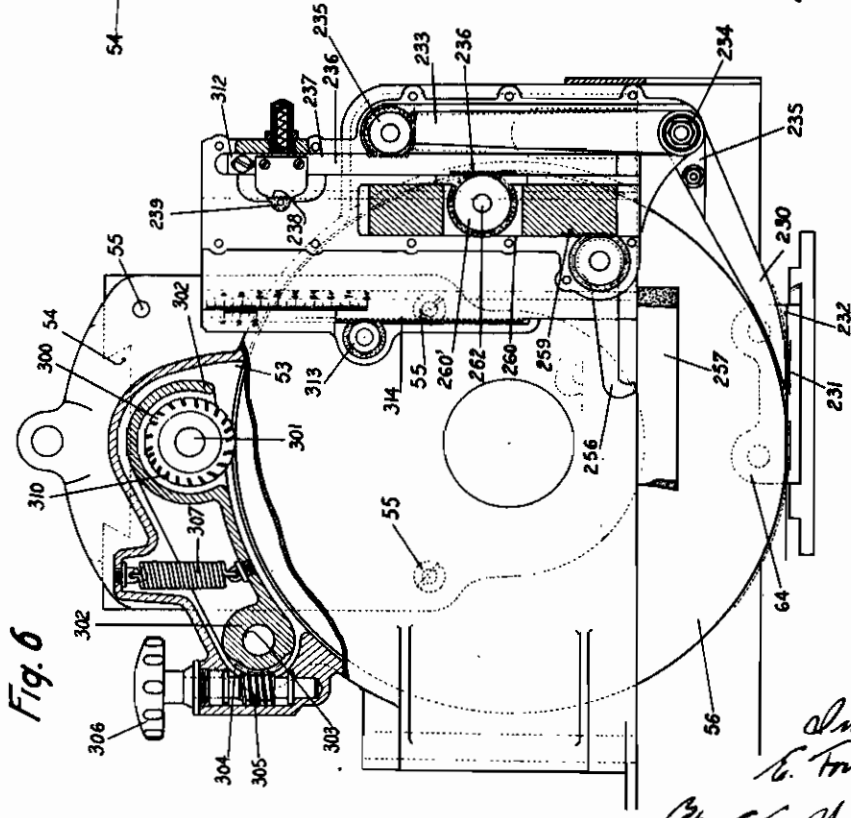

Fig. 6

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Fig. 8

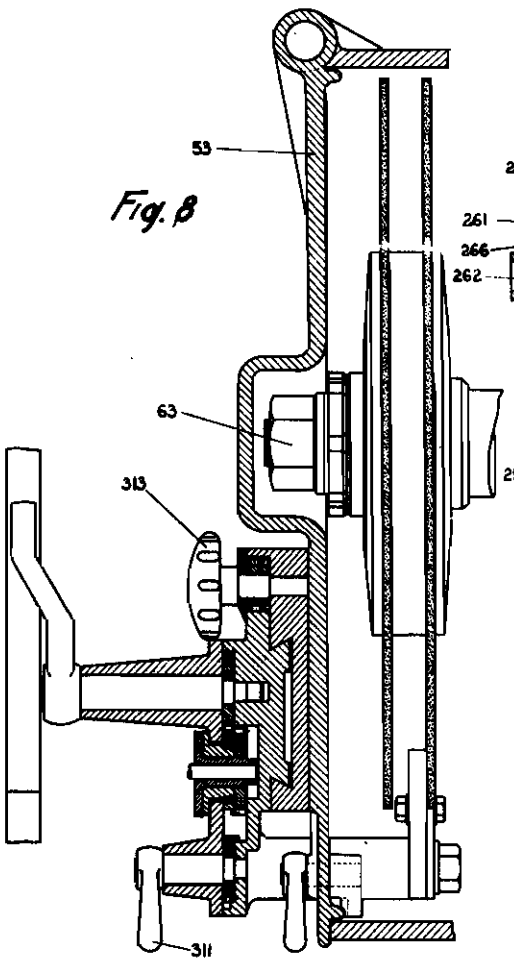


Fig. 9

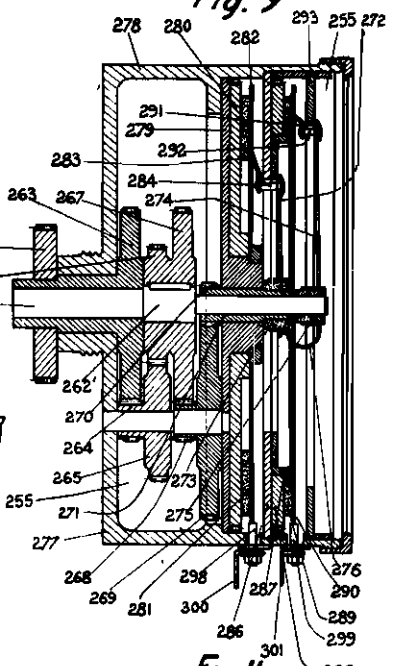


Fig. 11

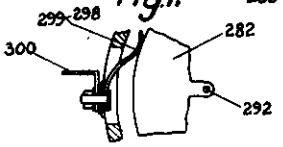


Fig. 10

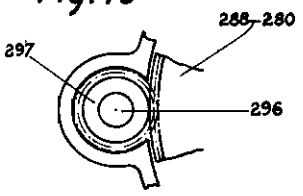
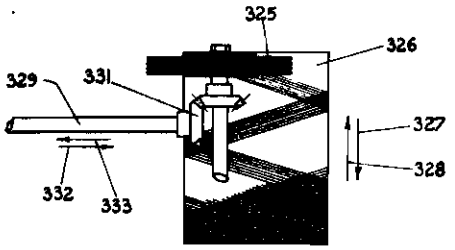


Fig. 12



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Published June 15, 1943 Serial No. 420,313

ALIEN PROPERTY CUSTODIAN

GRINDING MACHINES

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vested in the Alien Property Custodian

Application filed November 24, 1941

The present invention concerns a grinding machine for machining and forming metal or other jobs by means of grinders, and more particularly for machining by means of cut-in grooves, slicing, and surfacing by means of thin grinders assembled on a same hub.

This machine, designed for permitting a very rapid rotation of the grinders, comprises a multiple grinder carrying member fitted with a slide capable of effecting, along the machine axis, a very rapid reciprocating motion, and further a job carrying table which may be driven, on one hand, transversely to the machine axis, in a very fast reciprocating motion, and, on the other hand, in a more or less fast reciprocating vertical motion according to the nature of the work to be carried out.

The advantage of the high speed of the reciprocating motions of both the slide and the job carrying table, of the order of at least 1 metre per second, consists in particular in the fact that the place of work on the job moves very quickly, thus facilitating the elimination of the heat generated by the work of the grinder.

The grinder carrying member comprises a number of parts adapted to receive the grinders and to cause them to rotate at different speeds. In principle, besides, it will be advantageous to transfer from one grinder carrying spindle to the other the same grinder when its diameter has changed under the effect of its wear. Thus, one may first place on a so-called primary spindle a grinder with a large diameter. When this grinder has been partially worn out, it will be transferred to a so-called secondary spindle, rotating with a speed adapted to its new diameter. The grinder may finally be transferred to a spindle rotating at a very high speed.

One spindle at least is mounted on an arm capable of being rotated with respect to the slide of the grinder carrier while taking part in the reciprocating motion of the slide, and this for bringing said spindle into the suitable position for the work of the grinder placed upon it.

In order to permit very rapid displacements of the table in its reciprocating motion, the latter is supported on its frame by ball bearings of a special design described below.

The working speed of the machine, especially in scraping out jobs, is such that it necessitates a device permitting to fix in advance the depth of the work to be performed by the grinder and to stop the machine or to reverse its movement when the desired cut is obtained. The movements of the operator are, indeed, generally not sufficiently fast, thus causing the risk of overrunning the desired depth, or stopping the machine too early in the absence of an automatic stopping device.

Various other auxiliary devices are provided, such as an indicator of the amount of wear, permitting to account, at any moment, for the wear of the grinder; an auxiliary grinding device permitting to round off the main grinder before commencing work, or to modify its diameter in the course of work, or further, in the case of multiple grinders, to maintain them all at the same diameter by causing the auxiliary grinder to act upon those which are less worn out, in order to reduce their diameter to the size of the smaller ones; a periscope for supervising the work; and a device allowing to effect with the same machine surfacing jobs by means of inclined crossed lines.

Other features of the present invention will appear from the following specification relating to an embodiment chosen by way of example, with reference to the joined drawings, in which:

Figure 1 is a front elevation of a machine fitted with an auxiliary spindle rotating at high speed.

Figure 2 is a side elevation with a simple spindle and large diameter grinder in work position on the primary spindle.

Figure 3 is a sectional elevation through the line I—I of Figure 1, showing the general drive of the machine, passing through the axis of the primary spindle and then through the table axis. The lower part of the secondary grinder carrier is shown in work position with its feeler and periscope in dotted lines.

Figure 4 is a general front view of the machine with section through the secondary spindle and the longitudinal axis of the table and gear box.

Figure 5 is an outside view at a larger scale of the grinder case, with the dials of the control apparatus and of the wear indicator, the auxiliary grinder and the periscope being also shown.

Figure 6 shows the same device, partially in section, with the lid of the transmission members removed.

Figure 7 is a partial transverse section of Figure 6 through the axis of the latter and then through the grinder axis.

Figure 8 is a partial section of Figure 6.

Figure 9 is a section at a larger scale of the control apparatus.

Figures 10 and 11 show details of the contact control of Figure 9.

Figure 12 is a diagram illustrating the principle of surfacing by multiple grinders operating by crossed lines, and

Figure 13 is a diagrammatic plan view of a roller bearing of the table.

The various combinations of parts constituting the machine will now be described in succession.

Device for driving the grinders in rotation

This device consists in an electric motor 1 acting, over a belt 20, on a multiple pulley 21 keyed to a socket 23 mounted, through bearings 106, 107 in supports 104, 105 of a stool 108 fixed, as explained further, to the frame 12 of the machine.

The motor 1 may be lifted or lowered with respect to the frame for correctly tightening the belt 20. For this, bearings 11 support a vertical screw 10 driven in rotation by a bevel gear 13, 14 from a shaft 15 mounted in bearings 16, 18 and on which is keyed a control hand wheel 19.

The thread of screw 10 is in mesh with a nut 9 integral with pins 7, 8 engaged in blocks 5, 6 arranged in slides 3, 4 integral with an oscillating support 2 on which is fixed the motor 1.

Thus, by acting upon the hand wheel 19, the screw 10 will be set in rotation, thus causing the nut 9, together with motor 1, to rise or lower.

Grinder-carrying head

This head, supporting the full cones adapted to receive the grinders, comprises (Figure 3) an axis 26 carrying at one of its ends the spindle 35, called the primary spindle, which is fitted with the grinder when the latter has its largest diameter, and at the other end longitudinal grooves 25 cooperating with keys provided inside the socket 23 so that the shaft 26 may slide freely in this socket but is driven in rotation by the latter and therefore by motor 1.

The shaft 26 is integral longitudinally with a cylinder or arm 46 in which it may rotate by means of ball bearings 28, 29, 30. On the shaft 26 is keyed, by means of a key 33, a helical gear 32 for setting the secondary spindle 37 (Figure 4) in rotation over the wheel 36 keyed to this spindle. The spindle 37 rotates in ball bearings 38, 39. The nut 41 maintains the cage 40 of bearing 39 against a shoulder 42, while cage 44 of bearing 38 and minion 36 are blocked by nut 43. The whole is supported by a cage forming extension of arm 46. The arm 46 (Figure 3) is mounted rotatably in the slide 47 provided with ribs 74 and adapted for protecting the pulleys 21, 22 without being disturbed in its movement by the latter.

The rotation of the cylindrical cage 46 is set up by the helical wheel 48 driven by the endless screw 49 keyed to shaft 50, the rotation of which is set up by a hand wheel 51 (Figure 4). A wedge brake 52 (Figure 3) permits to fix the arm 48 in any desired position. As seen, Figure 3 has been drawn for a certain position of the arm (with the secondary spindle 37 below the primary spindle 26), while Figure 4 shows another position (secondary spindle above the primary spindle); Figure 1 shows a third position and shows how a pulley 321 may be mounted at the end of spindle 37 for driving, over a belt 322, a third spindle 323, or high speed spindle, rotating in the extension of the arm, forming a cage 45, and on which the grinder may be mounted after its diameter has decreased by its work on the primary spindle, followed by work on the secondary spindle.

The slide 47, carrying along with it the cage-arm 46, 45, receives in the axial direction of the machine a very fast reciprocating motion in the following manner: An extension 93 of slide 47 is made, by means of a bolt, integral with the rod 80 of a piston 75 movable in a cylinder 76 fitted at both its ends with stuffing boxes 77, 78 through which passes the rod 80 and its extension 79. Cylinder 76 is fixed to the stool 108 and this is fixed to the cradle 66 (Figure 4) by bolts 109, 109', and to the cross member 110 by bolt 111. The ends of the cross member are bolted to the sides 101 and 102 of the machine by bolts 112. The cradle 66 itself is fixed to the sides 101, 102 by bolts 103, 103' (Figure 4). The stool 108 is provided with a bore 113 through which passes a spindle 114 carrying a hand wheel 115 (Figure 2). The object of the latter is to give the stool the required resistance to the pull of the heavy belt 20. The bolts 116, 119' and 120, 120' (Figure 3) fix the whole to the support 121.

For determining the movements of piston 75 and therefore of slide 47, a hydraulic control of a known type is used, permitting to introduce a fluid under pressure alternatively in one or other chamber 81 and 83 while it is evacuated from the other chamber. This is obtained by means of a distributor 88 supplied with fluid under pressure from a compressor 85 by the pipe 86 and distributing and evacuating it through the pipes 82 and 84 leading to the chambers 81 and 83. The distributor 88 is of the known type consisting in a chamber in which a rod 89 provided with suitable ports is moved at the ends of the stroke for reversing the fluid distribution. This movement is set up when the rod 89 strikes against the adjustable stops 89' and 90 carried along in the movements of the slide. The fluid returns to the compressor by pipe 92.

An adjustable valve 87 provided with a divided scale 95 is inserted in the pipe 88 and permits to choke more or less the passage of liquid and thus to adjust the linear speed of the slide.

The reciprocating motion may also be obtained by hand. For this, a by-pass is used, controlled by a hand wheel 98 and permitting to connect chambers 81 and 83, and thus equalise the pressures on either side of piston 75. A hand wheel 97 will then permit to move the rack 98 moving the slide, while fluid passes from chamber 81 into chamber 83 over the by-pass 96, which is closed when it is desired to work with the hydraulic control.

This hydraulic distribution thus permits to obtain a reciprocating motion of the slide 47 with variable speeds, and to adjust, by means of the stops 89', 90, the stroke of the slide. If it is desired to work with a fixed grinder, without reciprocating movement, the fluid under pressure is sufficient for fixing the position of the grinder, when the valves 87 and 96 are closed.

Job-carrying table

The job to be machined, 64 (Figure 3), is blocked in its mounting 122 which is itself fixed to table 123 by bolts 124 and 125. Between the fitting 122 and table 123 is arranged the emptying channel 126.

The table 123 may be driven into two movements: a first very rapid reciprocating movement (of at least 1 metre per second) perpendicular to the longitudinal axis of the machine, and the other a vertical reciprocating motion for scraping out jobs. On Figure 3, the whole of the table has been shown in the lower position, and the upper part of the table has been shown also

in the upper position, cooperating with the grinder 50 fixed to the secondary spindle.

The to and fro motion of table 123 perpendicularly to the axis is effected at very high speed on ball bearings.

For this, the table rolls on its frame over particular ball bearings, the principle of which is illustrated in figure 13 showing one of these bearings in plan view.

It is supposed that at a certain moment the motion takes place in the direction of arrow F. The balls B are arranged in two straight lines connected by round parts at the ends of the lines. In the round parts, the balls move in open round channels C, C'. In one line, the left line in figure 13, the balls B are carriers and carry the load of the job moving in the direction of arrow F; in the other line, the right one, the load does not rest on the balls and these are, for instance, simply contained in a tube T. The operation of the device is as follows: the load causes the balls B of the left line to move in the direction of arrow F; they roll in this channel C and then pass into the tube T, into channel C' and resume their place with the carrying balls. When the job moves in the opposite direction, the motion of the balls is, of course, also reversed.

Table 123 (figure 3) carries at its lower part two bars 127, 128 inclined by 45° for instance. Opposite 128 is fixed another bar 129 comprising a rolling path 130, inclined by 90° for instance. In the hollow prism thus obtained are placed balls forming the carrying line of the bearing, while the other line is on the left on the picture. Opposite bar 127 is another bar 137, subjected to the action of a spring 138 bearing against a fixed plate 139. The roller balls, the carrying line of which is inserted between bar 127 and bar 137, are here referred to as 136. A nut 140 permits to block the spring 138.

The table 123 itself rests on the bars 129 and 137 by means of bearings 141, 145 made up in the same manner, with the difference that the non carrying lines are arranged without friction in grooves, 143 for instance, drilled in the lower face of table 123, while on the carrying balls, 141 on the left, for instance, the table rests by means of a V-shaped groove 142.

It will readily be seen how this arrangement permits to take up the slack of the whole device. By unscrewing the nuts 140, of which there are a great number arranged all along the table, the springs 138 will be set free. These springs press the balls 136 against bar 127, and, owing to the slope of the latter, the table 123 will thus be pulled downward and bear upon the carrying balls 141. The same effect is set up on the bars 128 and 129. It is therefore simply necessary to retighten the nuts 140 and the table will be ready for a new operation.

One will now examine the manner in which is obtained the to and fro motion of the table, and this either by means of a hand wheel, by an electric motor or by a hydraulic motor.

The hydraulic drive, which is the usual, is effected in a manner similar to that for the to and fro motion of slide 47, described above. It comprises a cylinder 167 (figure 4) in which is movable a piston 167a separating the two chambers 167 and 168. The rods of this piston are connected by the extensions 167b to table 123. Chambers 167 and 168 are alternately supplied with compressed fluid by a distributor 170 (figure 1) which may cooperate with the movable and adjustable stops 171 and 172. The distributor 170 is connected on one hand to chambers 167 and 168, and, on the other hand, by two pipes, to the compressor 85, one of these pipes carrying the adjusting valve 173 permitting to vary the speed of the reciprocating motion. The operation is the same as that already described for the reciprocating motion of the slide, i. e. the fluid arriving to the distributor 170 and distributed by the latter to chamber 168 repells piston 167a until the stop 172, connected to the movement of the piston, strikes against the axis 170' of the distributor 170, with the effect of reversing the push of the fluid and thus the direction of motion of the table.

The displacement of table 123 by hand or with the electric motor is set up as follows:

A clutch wheel 150 (figure 1) of the dog clutch type is mounted on an endless screw 151 driving the helically threaded nut 152, the hub of which is slidable on the fixed screw spindle 153 (figures 1 and 3). On the axis of wheel 150 is further freely rotatable the helical wheel 154 meshing with the endless screw 153 keyed to the shaft of the electric motor 156. It will be seen that when the wheel 154 is coupled to shaft 151 by means of the clutch wheel, motor 156 will drive the screw 153, while, for the other position of the clutch wheel, the wheel 154 is uncoupled from the shaft 151 and rotation of screw 153 is set up by the hand wheel.

The rotation of screw 153 is transformed into a displacement of the carriage perpendicularly to the screw by the two half-nuts 157, 158 (Figure 3) which may come to mesh with screw 153. The movement of the half-nuts 157, 158 towards or away from one another is obtained by the usual means of two pins 159, 159' moving in two helical ramps and closing or opening the half nuts according to the direction of rotation of a gear 160. The rotation of gear 160 is set up by pinion 162 meshing with pinion 163 keyed to a shaft 164 carrying the hand actuated flap 165. It will further be seen that the actuation of hand wheel 165 causes the operation of the by-pass valve 166 so as to connect with one another the chambers 167 and 168 of the cylinder, and at the same time a closing of the half nuts 157, 158, with the result of equalising the pressure in the cylinder and consequently permitting the drive either by hand, through the hand wheel 150, or by the electric motor 156. If, on the contrary, the half nuts 157, 158 are opened by means of the hand wheel 160, the communication between chambers 167 and 168 will be closed and consequently conditions for hydraulic drive set up.

The parts will now be examined permitting the upward movement of the table 123. This upward movement is obtained either with the electric motor or by hand.

The frame supporting the table 123 may move with respect to the fixed support of the machine by means of a screw 216 (cf. in particular Figure 4) fixed in the support and engaged by a nut 215 integral in height with the table carrying frame and driven in rotation by the helical wheel 214 actuated by the endless screw 213 (Figure 3) keyed to shaft 200. This shaft 200 carries a number of stepped gears 195, 196, 197, 198 and 199 freely rotatable on the shaft but which may be coupled with it, each individually, by means of a key 201 arranged in a groove of shaft 200 and mounted at the end of a rod 202 sliding longitudinally inside the shaft 200 and integral with a grooved ring 203 driven by a fork 204 mounted on a lever 192 pivoted to the axis 205. This fork

is actuated by the bevel gear 206, 207, the rotation of the axis carrying the conical wheel 207 being determined by a selector lever (Figures 1 and 3) which may be set in a number of positions corresponding to various positions of key 201 and consequently to various speeds of shaft 200.

The gears 195, 196, 197, 198 and 199 are in mesh with gears 190, 191, 192, 193 and 194 keyed to shaft 187 rotating in the case 188 and on which are freely rotatable two helical wheels 181 and 183 meshing respectively with the endless screws 182 and 184. The endless screw 184 is integral with a gear 185 driven from wheel 186 integral with the endless screw 182. The screw 182 lastly, is driven by the electric motor 180 (Figure 1). It is clear that owing to this transmission, the two helical wheels 181 and 183 will rotate at different speeds. These wheels 181 and 183 may be alternately coupled to shaft 187 by the sliding key 186*a* integral with a ring 191' driven by a fork mounted at the end of a lever, the angular displacement of which (Figure 4) is determined by the bevel gear 210, 211, the wheel 211 being driven by the selector lever 212 (Figures 3 and 4) which may be set into three different positions, two of which correspond to the two different speeds given to the shaft 187 by the wheels 181 and 183 respectively, and the third, or neutral position. corresponds to the nondrive of shaft 187 by motor 180.

The manual drive is set up (Figure 3) by a hand wheel 218 keyed to shaft 219 and a driving pinion 220 in mesh with the gear 221 which is in turn in mesh with gear 192. One will thus have either a hand drive, provided, of course, that key 201 couples the shaft 200 with the gear 197.

Grinder-device for the control of the machine-wear indicator

The grinder 56 (Figures 3, 6 and 7) is contained in a case 53 serving at the same time as a support for the wear indicator and for the device for control of the machine. The case 53 comprises a full extension 54 (Figures 6 and 7) fitting into a dovetailed groove 46*a* (Figure 3) of cage 45 of arm 48 for supporting the whole. On Figure 7, the spindle on which is engaged the grinder 58 is supposed to be ended by a cylindrical part 57 instead of a cone 37' as in Figure 4. With this difference, the arrangements are exactly the same. The grinder 56 (Figure 7) is inserted between the flange 59 integral with the socket 58 coupled by a key to part 57 and flange 60 clamped by the spacing member 61 and nut 62. The whole is stopped (Figure 8) by nut 63.

The device for automatically stopping the grinder will now be described, assuming the grinder 56 to be in the position shown on Figures 3, 6 and 7. The grinder is adapted to cut grooves 232, 232' (Figures 6 and 7) into the job 64 held, as already explained, on table 123 which, for this work, moves rapidly upwards.

According to the invention, a feeler 230 (Figure 6) is used, in contact with the bottom of the groove 232 and provided with a very hard lining 231 which thus remains tangent to the grinder periphery. The feeler 230, mounted with hard friction on shaft 234, normally forms one arm of a bent lever pivoted in 234 and the other arm of which carries a toothed sector 233 meshing with the gear 235 driving the rack 236 sliding in the groove 237. A part fixed to the rack 237 carries itself a small rack 238 meshing with pinion 239 which thus receives the angular displacements of feeler 230 (which are equal in amplitude to the wear of the grinder) and transmits them on one hand to the control device, and on the other to the wear indicator referred to as a whole as 240 and shown more in detail on Figure 7. It is seen that the axis 241 carrying pinion 239 also carries a gear 242 driving pinion 243 which, over wheel 244, drives pinion 245 cut in the socket 248 to which is keyed a needle 247, while another needle 248 is keyed directly to shaft 241. The needle 248 (see Figure 5) reads hundredths of millimetres inscribed on the dial 250, and needle 247 indicates full millimetres carried by dial 251. It is clear, without further explanations, that the displacements of needles 247 and 248 measure the amount by which the feeler 230 has pivoted about the axis 234 or, more exactly, the amount by which the working point of the grinder is being raised with increasing wear of the grinder, said rise comprising the upward motion of the job plus the wear of the grinder.

The control device will now be described, permitting to determine in advance the depth of the groove in order to stop the machine when the required depth is attained. A feeler 258 (Figure 6) rests against a bar 257, the upward movement of which is integral with that of the table 123. The toothed hub of this feeler drives the rack 259 sliding in a groove 260 and carrying along with it, in its upward and downward movements, the gear 280' rolling on the rack 236 (driven, as explained, by the feeler 231). This gear 280' is integral (Figure 9) with a shaft 282 which, over wheel 263 and gear 284, 285, drives the gear 288, 287 keyed to a full shaft 282'. The gear 287 drives, over the gear 288, 289, the needle carrying socket 270 engaged on shaft 262'. This socket carries, over an insulating ring 273, needle 272, while shaft 262' carries, also over an insulating ring 275, the needle 274. These two needles (Figure 3), respectively indicating on a dial hundredths and full millimetres, are constantly connected electrically with one another by means of a spring blade 278 integral with the needle 274 and sliding over a conducting ring integral with the needle 272 (Figure 9).

The whole arrangement is enclosed in a case 277. In the case is also arranged a base plate 278 on which is mounted an insulating supporting disc 279, on the hub of which is freely rotatable a gear 280 carrying, on one side, an insulating ring 281 to which is fixed a conducting circle 282 in which is cut out a tongue 283 folded up and carrying a platinated contact piece 284 protruding over the dial (Figure 5) and with which may come into contact the needle 272. On a second insulating disc 287 is rotatable a gear 286 supporting, over an insulating ring 289, the conducting ring 290 in which is cut out the tongue 291 to which is riveted the platinum head contact piece 292 which may come into contact with the needle 274 (see also Figure 5). The scale division into hundredths of millimetres, seen in Figure 5, is carried by disc 287, while another disc 293 carries the full millimetre scale division.

The gears 280 and 286 may be rotated at will by means of the knobs 294, 295 (Figure 5) keyed to shafts 296 (Figure 10) carrying gears 297 in mesh with said toothed rings. Blades or brushes 298, 299 (Figures 9 and 11) slide on the conducting rings 282 and 290 insulated from the case 277 and connect these rings, over a wire 300, to the source of current, and, by a wire 301, to relays actuating electric distant control devices for reversing the current or stopping the machine.

It is clear that the rotations of gear **260'**, depending both upon the displacements of feeler **230** (through the mesh of this wheel with the rack **236**) and upon the movements of feeler **256** (by the rise of the shaft of this wheel under the action of the rack **259**), give a measure of the depth of the groove cut by the grinder. It will therefore merely be necessary to bring, by means of the knobs **294**, **295**, the contacts **284** and **292** upon the scale divisions in full, tenths and hundredths of millimetres, corresponding to the required depth, for stopping the machine and, if necessary, lowering the table **123** at the required moment, due to the contacts successively set up between the needles **272**, **274** and the corresponding contact parts.

Device for rounding off and correcting the grinders

The device adapted for rounding off the new grinders, i. e. giving them a first wear making them perfectly round, or for maintaining all the grinders at the same diameter when a number of them are working together, consists (Figure 6) in an auxiliary grinding wheel **300** pivoted on a shaft **301** fixed in a bracket **302** pivoted to the pin **303**. The hub of the bracket carries a toothed sector **304** meshing with screw **305** driven by the knob **306**. The spring **307** constantly urges the auxiliary grinding wheel in the direction of push so as to neutralize the various slacks. There is further provided (Figure 5) a dial **306** and a free needle **309** permitting the operator to determine the position to be given to the auxiliary grinder **300** at the moment it comes to act upon the grinder. The grinder **56** rotating at low speed, one will rotate slowly the knob **306** so that the screw **305**, acting upon sector **304**, applies the auxiliary grinder **300** against the periphery of grinder **56** which, by its rotation, carries the latter round with it. It will be seen that the drive only takes place upon contact, i. e. on the not round parts of the grinder. The pressure exerted by the auxiliary grinder **300** and its lines **310** will crush the support of the grinding particles and round off the grinder **56** or give its edge a required shape.

Periscope

The machine is fitted (Figures 5 and 7) with a periscope **320** provided with mirrors **321** and **322**. The job **64**, invisible inside its casings, may be followed, during work, in mirror **321** in which it forms an image. The job may also be illuminated by any suitable source of light.

Surfacing device

The machine may be fitted (Figure 12) with a multiple grinder **325** for effecting surfacing jobs by means of crossed lines. For this, the job **326** will be fixed on the table **123** which is set into a rapid to and fro motion according to the arrows **327** and **328**, while the grinder carrier **329**, driving the grinder over a bevel gear **331**, moves according to the arrows **332** and **333**. Other sorts of perpendicular drives may of course be used instead of the bevel gear. The machining obtained in this manner shows crossed or sinusoidal lines, the slope of which depends on the speeds of table **123** and slide **47** respectively to one another. This method permits to obtain very plane surfaces, since correction of the grinder itself will be effected over the whole surface of the job.

Operation

The operation of the machine will be described by way of example in the case where the grinder is mounted on the secondary spindle, in the position shown in Figure 3, and where it is desired to cut into the job **64** grooves **232**, **232'** of a predetermined depth. The job is fixed to table **123**. By means of the knobs **294** and **285**, the operator sets the contacts **284** and **264** onto the desired scale divisions corresponding to the required depth of the grooves. Table **123** is then lifted by means of the hand wheel **218** until the job **64** reaches the grinder. The operator then lowers the feeler **256** mounted with hard friction on its axis, so that the needles **274** and **272** are in the zero position. He then places the bar **257** exactly in contact with the feeler **256**, the bar being mounted on a not visible slide permitting to move it relatively to table **123** while coupling it to the table in vertical movement. The wear indicator has on the other hand been brought to zero by acting upon lever **311** (Figure 5), so that the rack **236** (Figure 6) strikes against the stop **312**. By acting lastly on knob **313** (Figure 8), the rack **314** (Figure 6) is lifted, displacing the whole arrangement and bringing the feeler **230** tangent with the grinder.

The various motors are then started by actuating the contacts **316**, **317**, **318**, **319** and **320** (Figure 2). The grinder **56** is set in rotation, slide **47** takes a rapid to and fro motion, while motor **180** lifts the table **123** with the speed required for scraping out work.

As the work goes on and the grinder consequently penetrates into the job **64**, the feeler **230**, gradually lifted by the bottom of the groove according to the wear of the grinder, actuates the needles of the wear indicator over the rack **236**. At the same time, the bar **257** lifts the feeler **256** acting upon the rack **258**. This motion is transmitted to the needles **272** and **274** over the rack **259** and wheel **260'**, the angle of rotation of **200'** being decreased by an amount corresponding to the wear of the grinder due to the differential rolling of **260'** on the rack **236**.

As soon as the needles **272** and **274** come in touch with the contacts **204** and **292**, i. e. when the grooves have attained the required depth, the machine is stopped. It is then merely necessary to reset the various apparatus to zero for effecting a new operation.

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