

Feb. 12, 1952

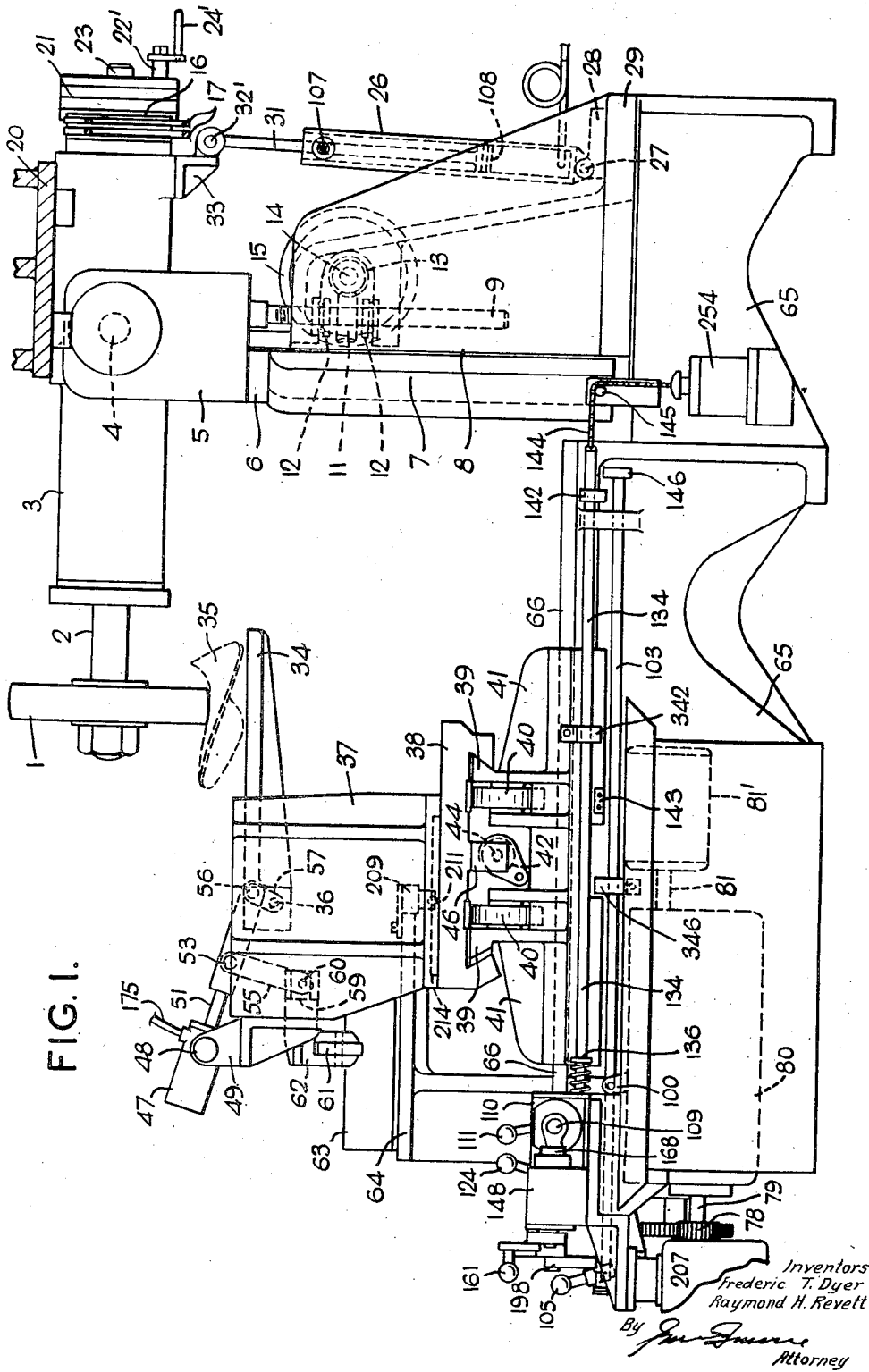
F. T. DYER ET AL

2,585,376

PROFILE GRINDING OR POLISHING MACHINE

Filed Feb. 24, 1950

18 Sheets-Sheet 1



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PROFILE GRINDING OR POLISHING MACHINE

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18 Sheets-Sheet 2

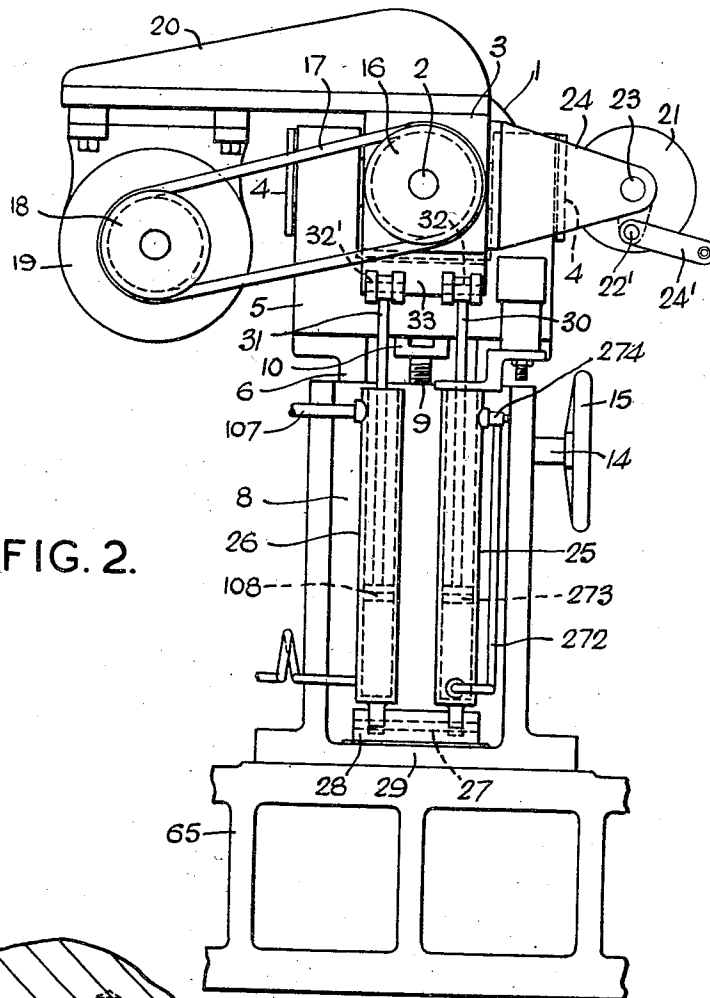


FIG. 2.

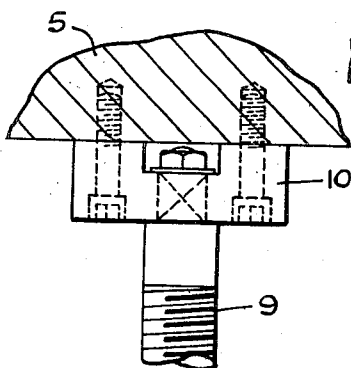


FIG. 2A.

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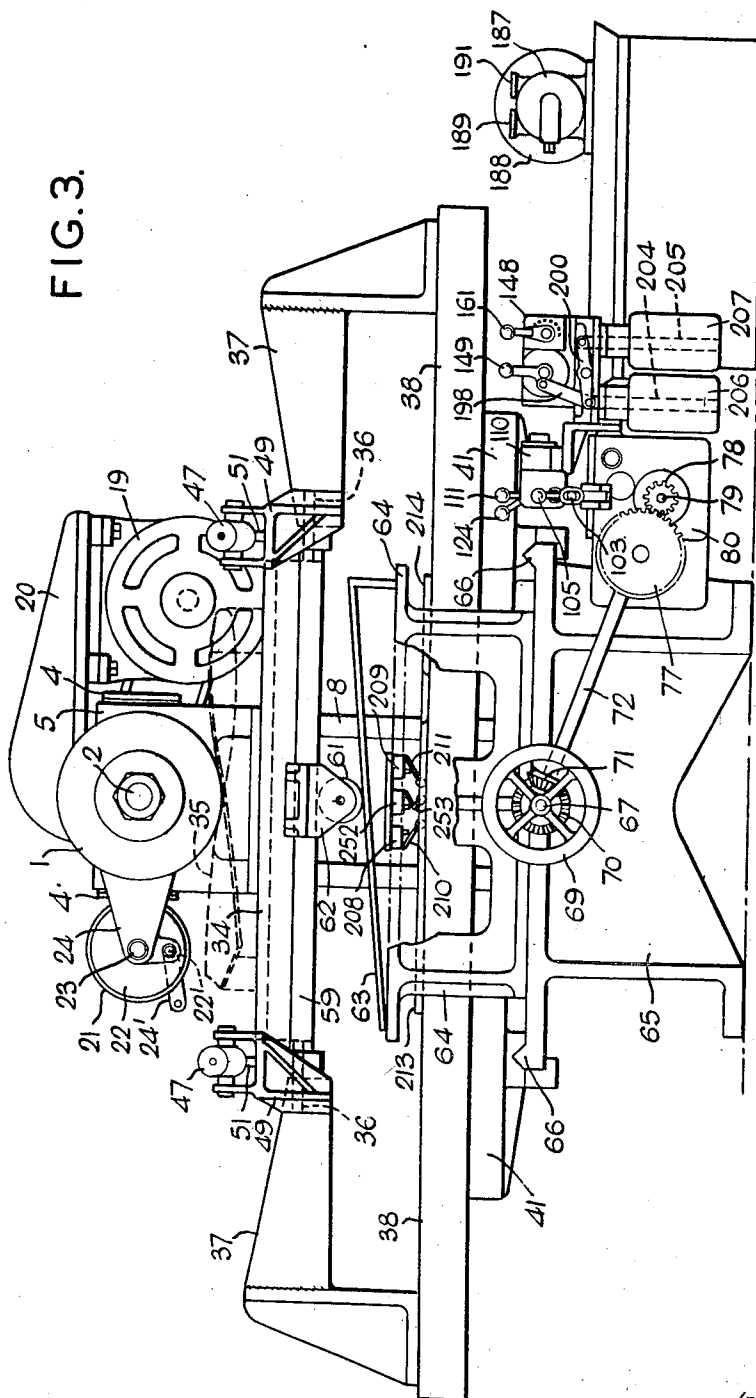
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PROFILE GRINDING OR POLISHING MACHINE

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FIG. 3.



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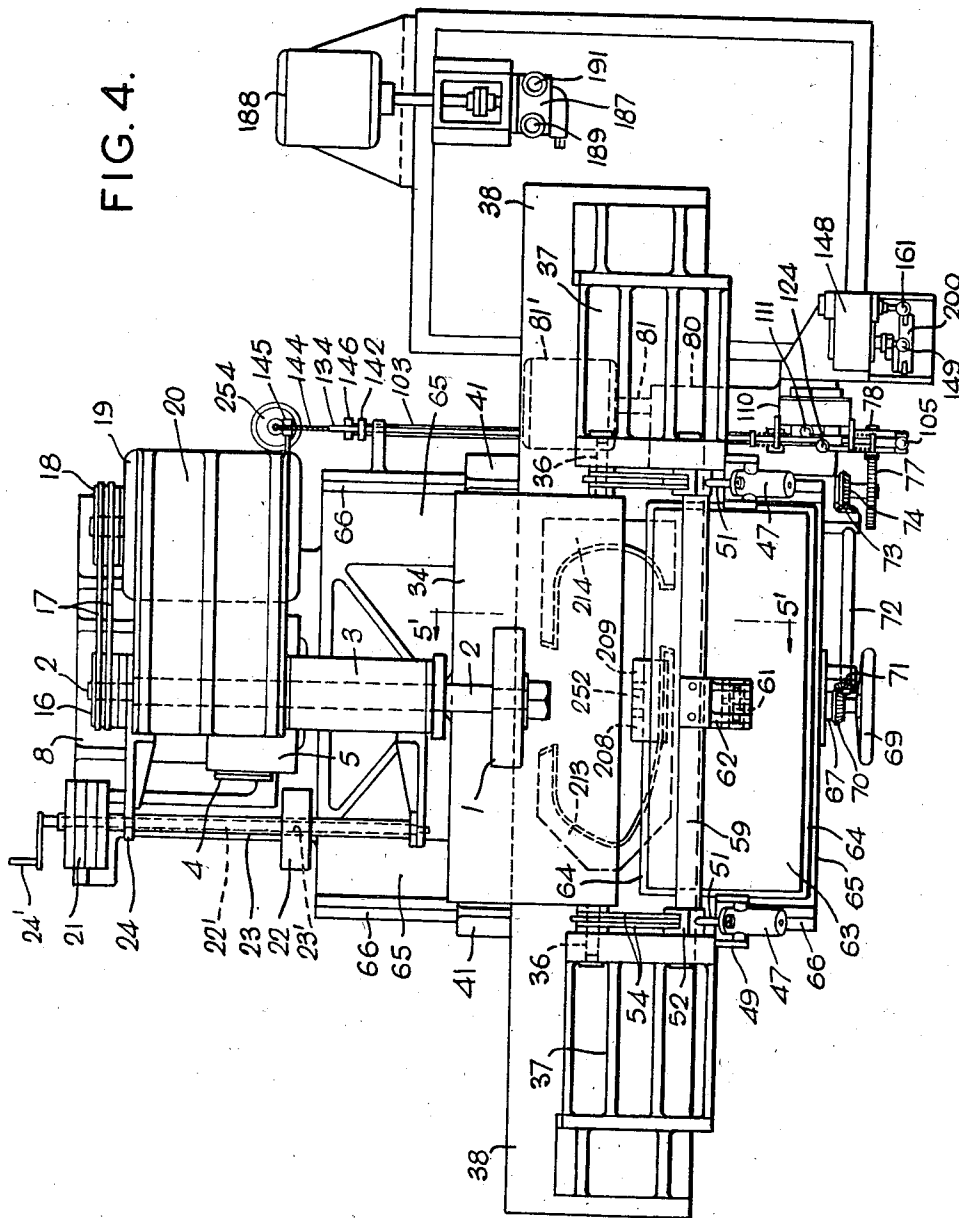
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PROFILE GRINDING OR POLISHING MACHINE

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FIG. 4.



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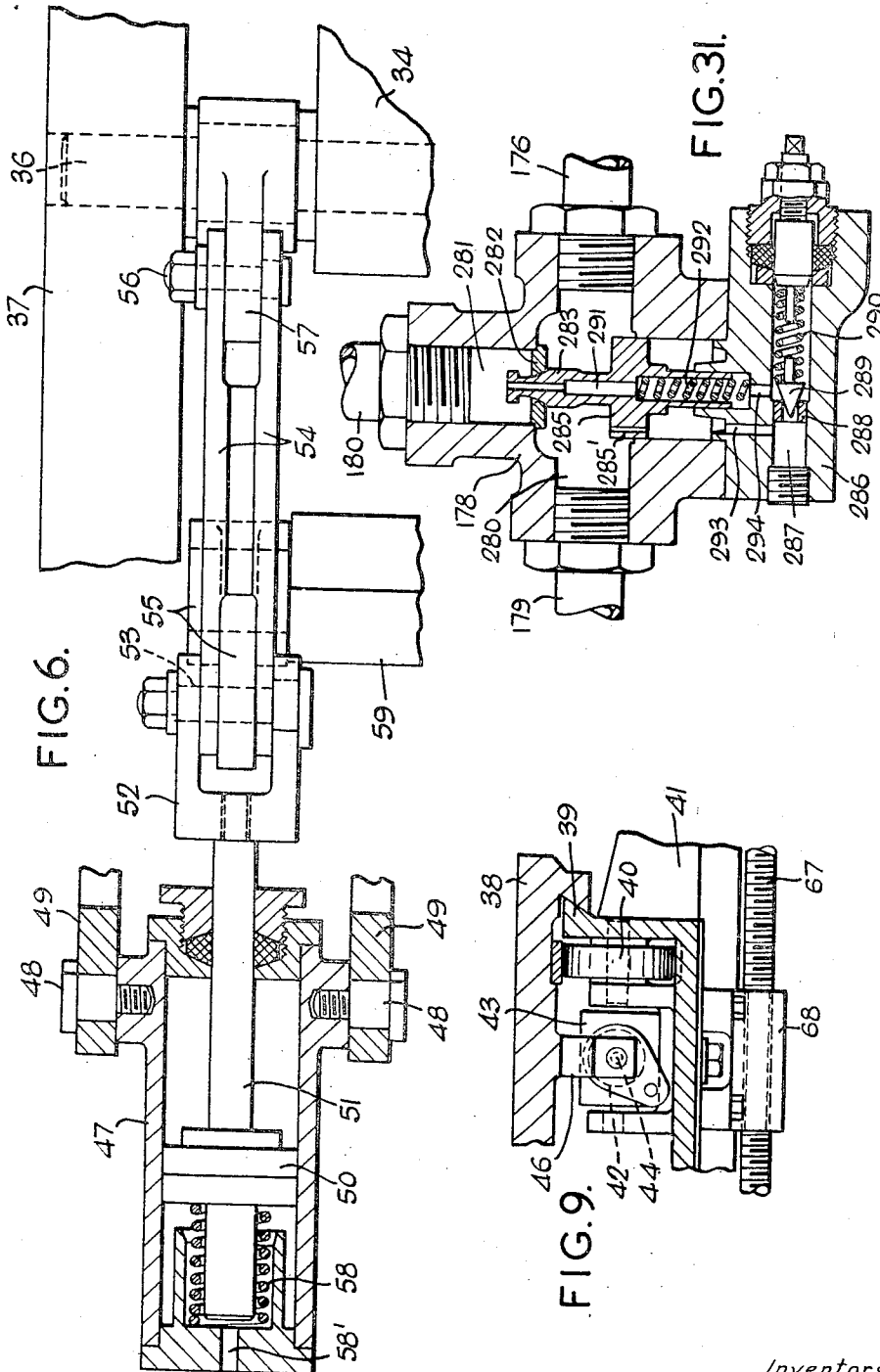
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PROFILE GRINDING OR POLISHING MACHINE

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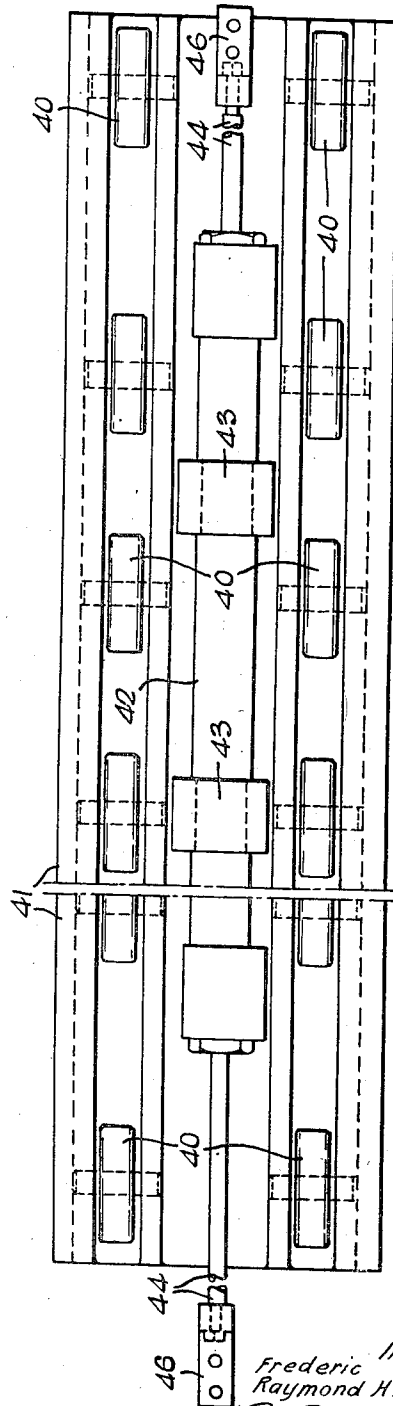
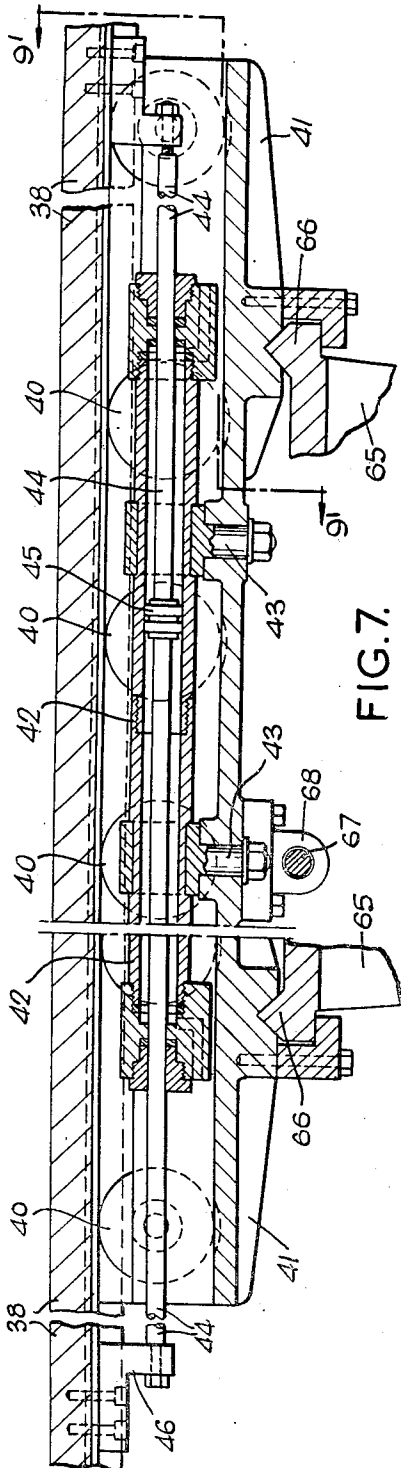
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PROFILE GRINDING OR POLISHING MACHINE

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FIG. 10.

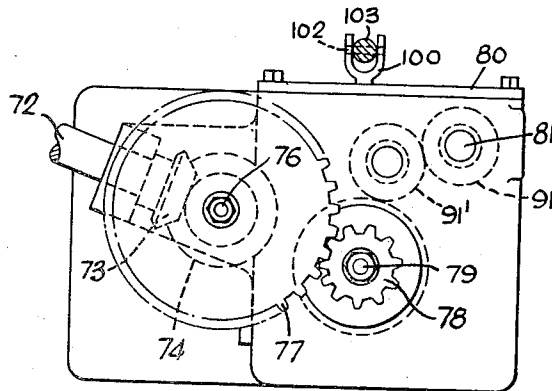
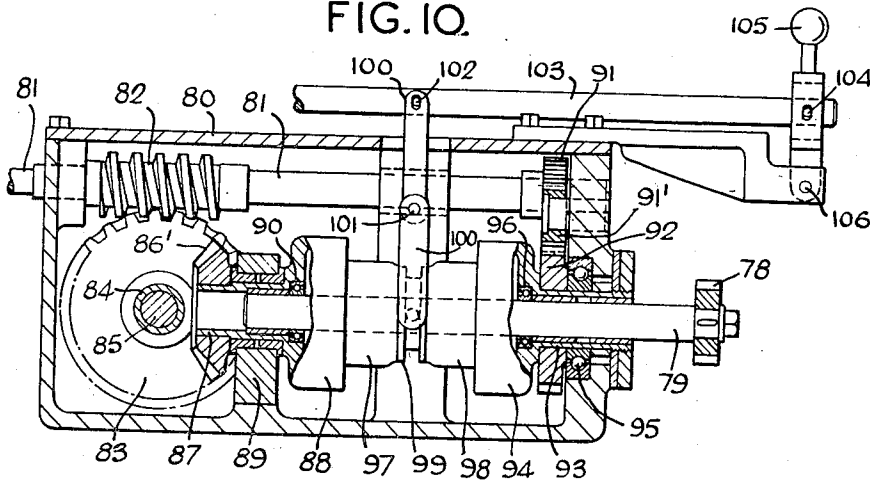


FIG. 11.

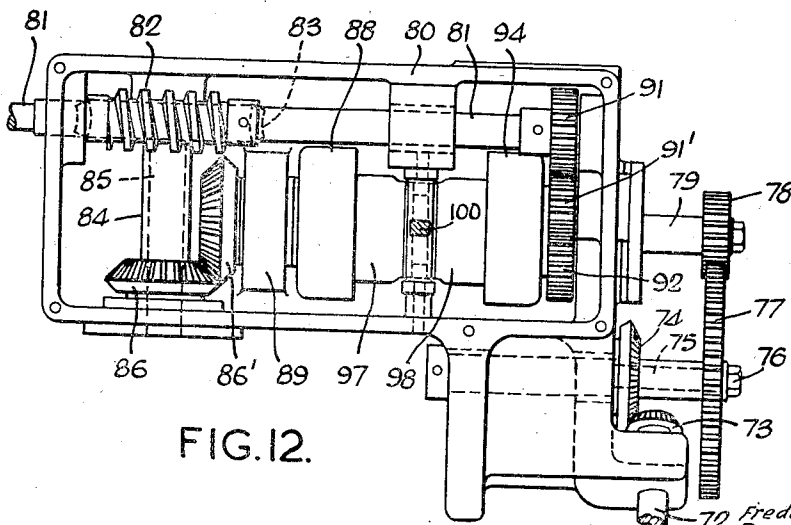


FIG. 12.

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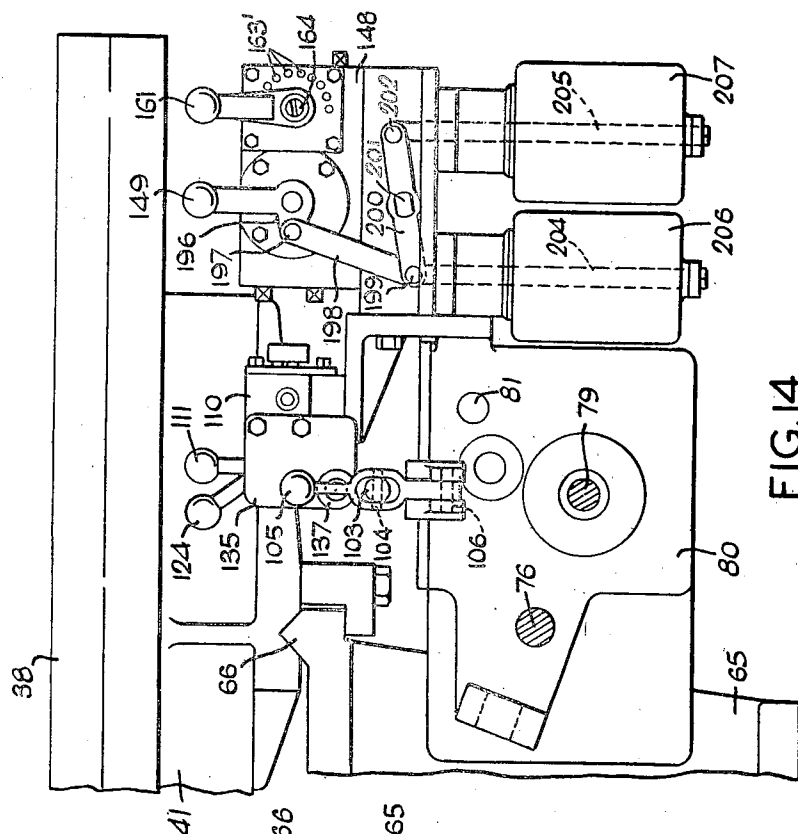


FIG. 13.

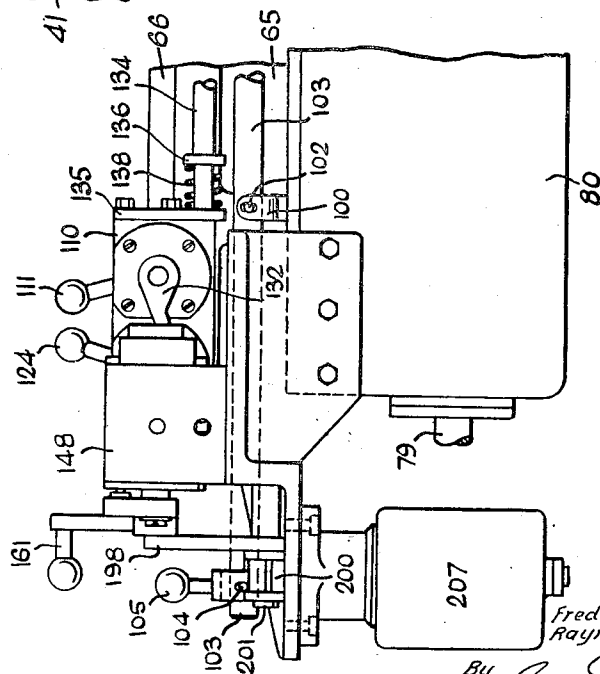


FIG. 14.

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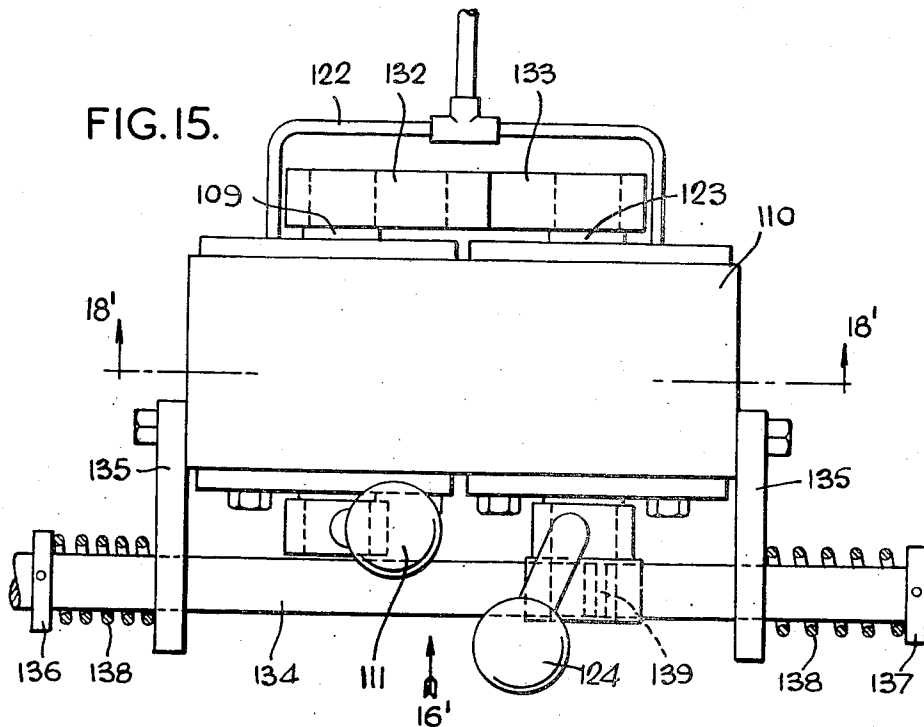
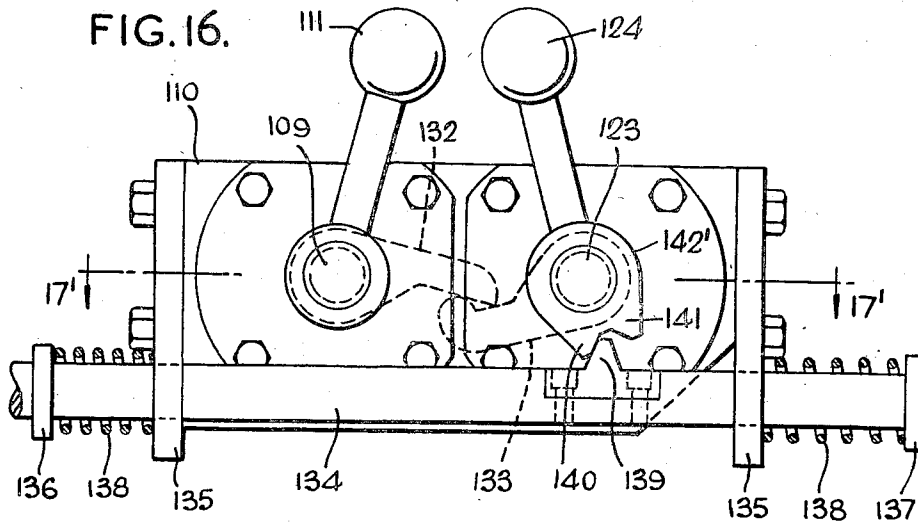
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PROFILE GRINDING OR POLISHING MACHINE

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FIG.17.

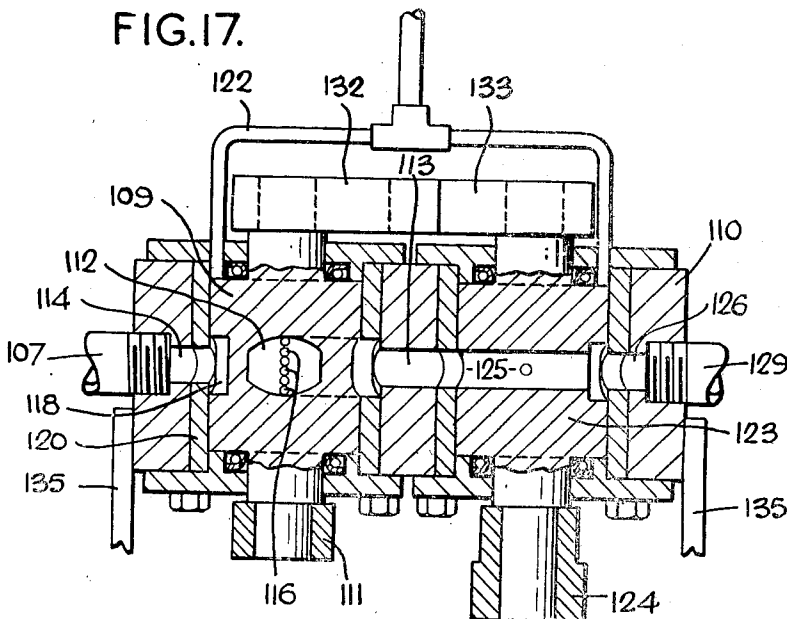
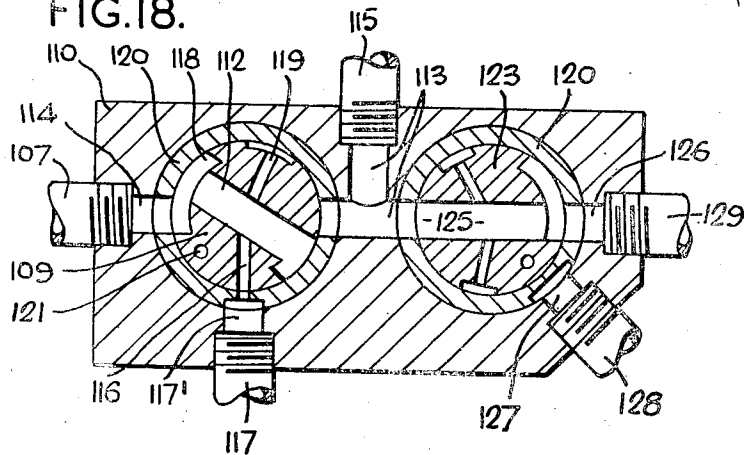


FIG.18.



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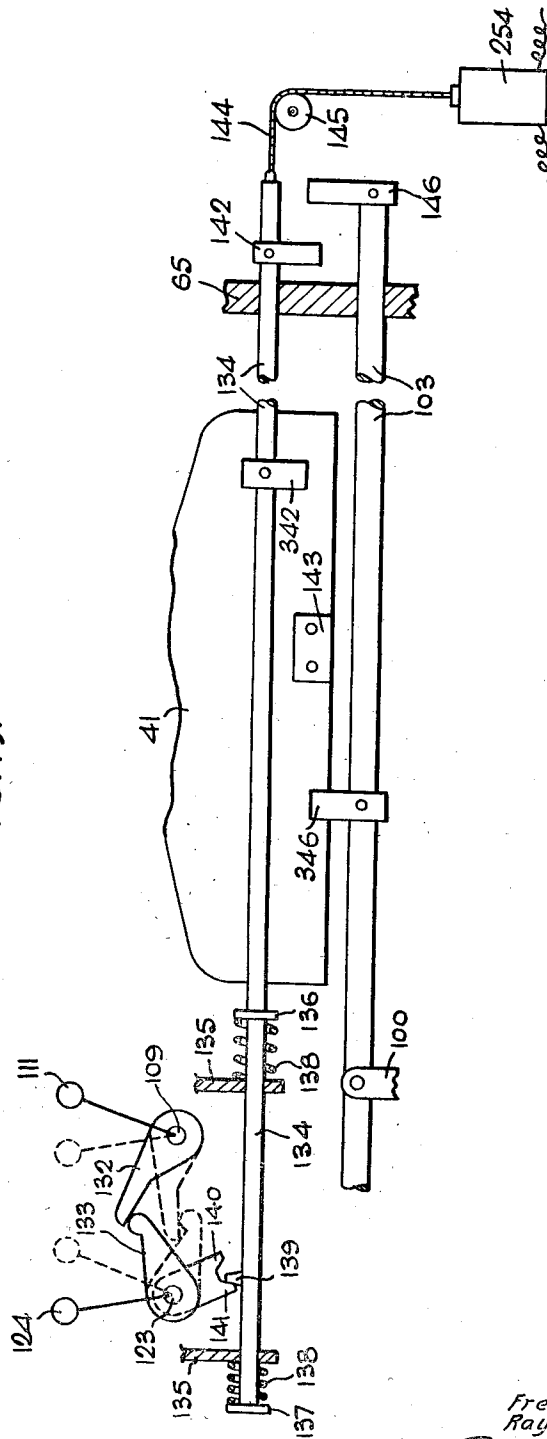
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PROFILE GRINDING OR POLISHING MACHINE

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FIG. 19.



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PROFILE GRINDING OR POLISHING MACHINE

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FIG. 20.

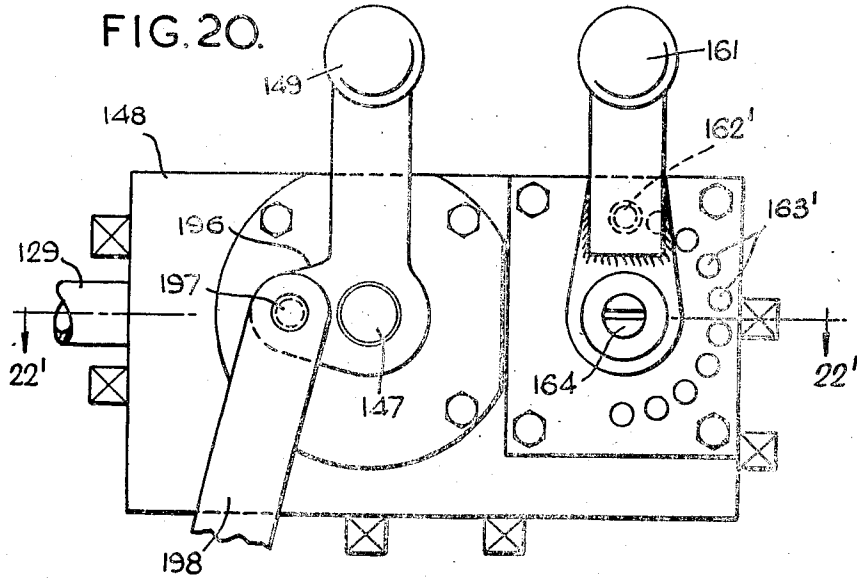
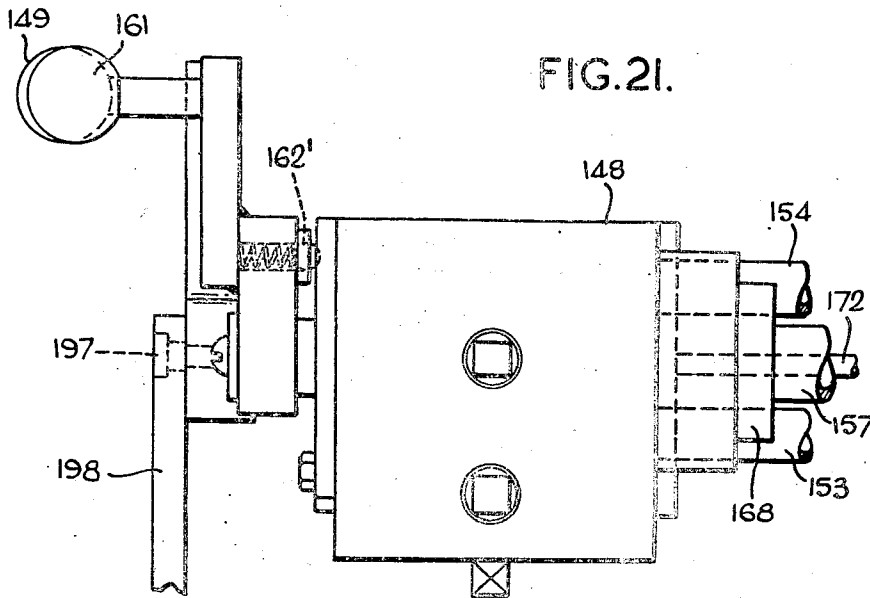


FIG. 21.



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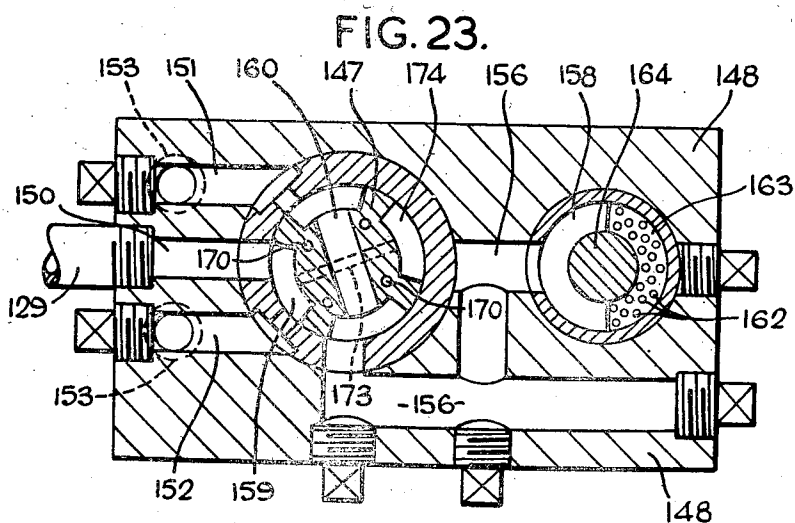
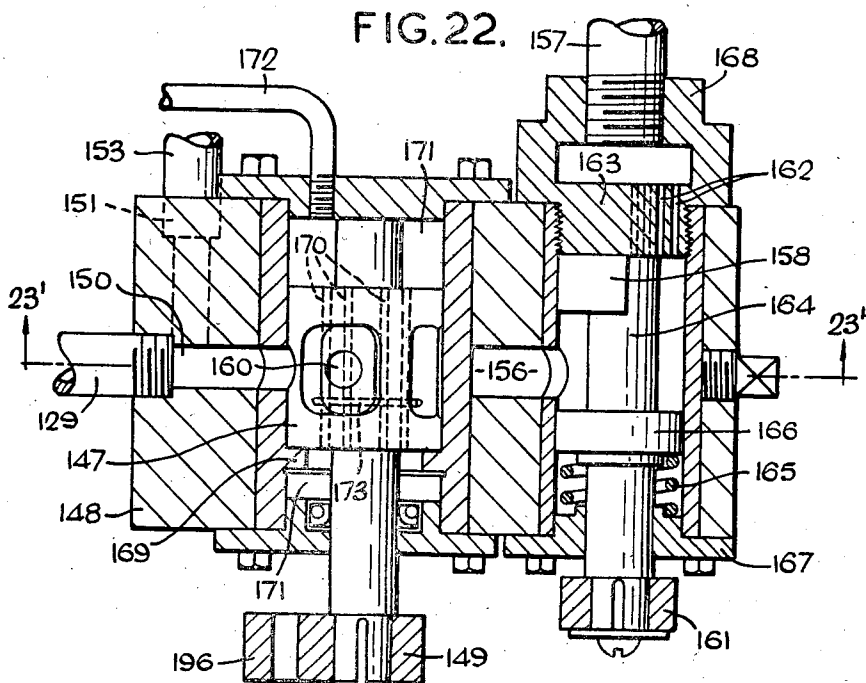
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18 Sheets-Sheet 14



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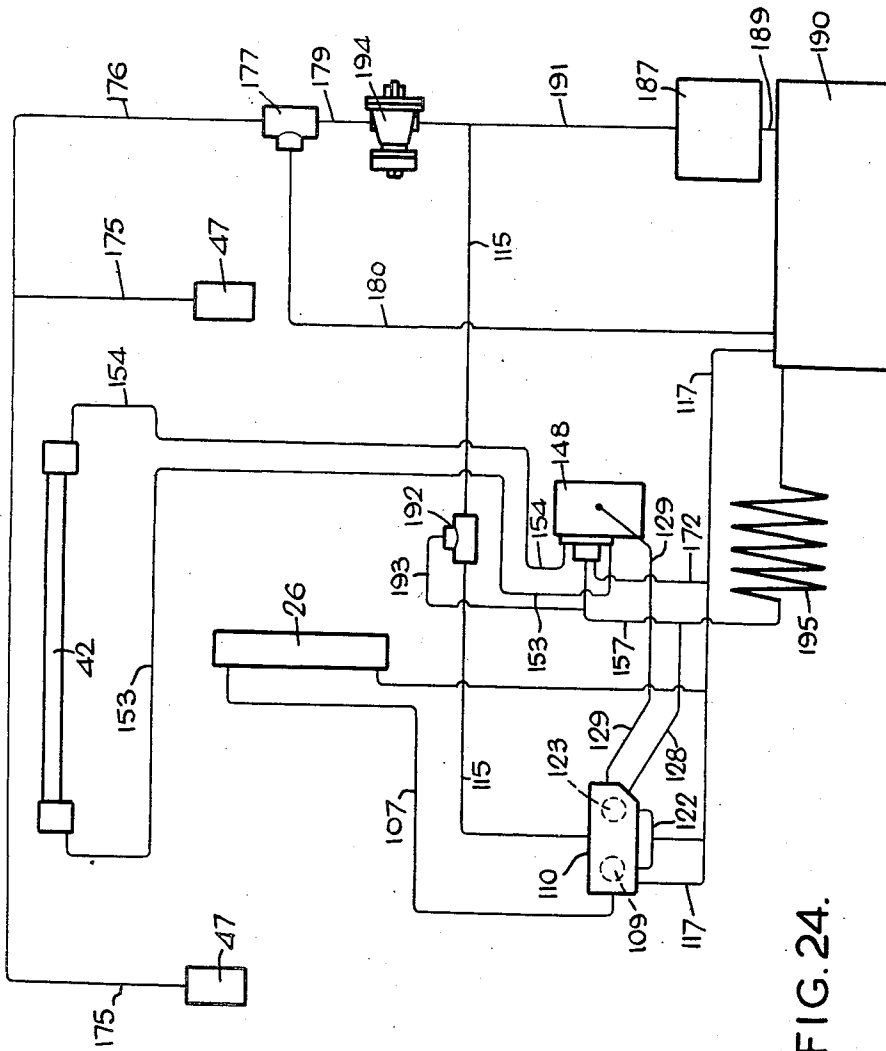


FIG. 24.

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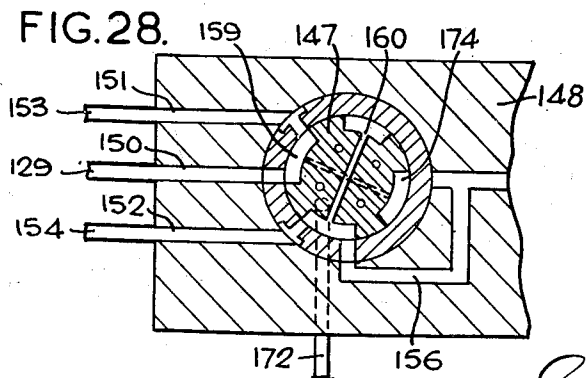
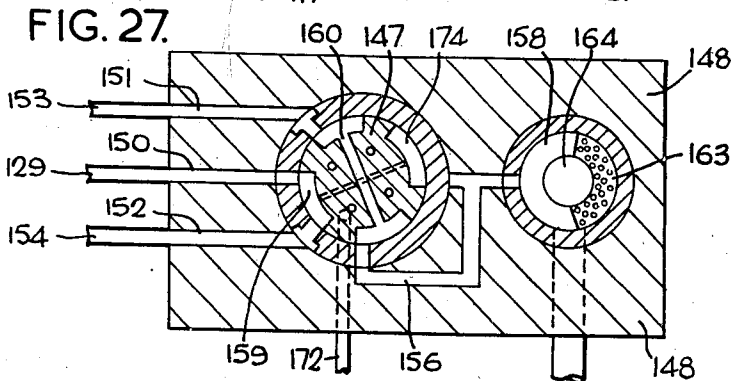
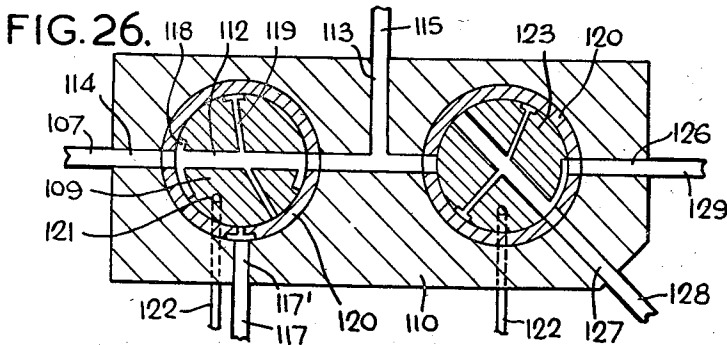
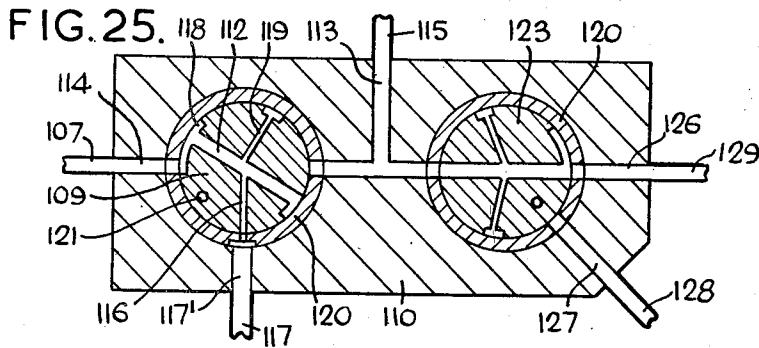
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PROFILE GRINDING OR POLISHING MACHINE

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18 Sheets-Sheet 16



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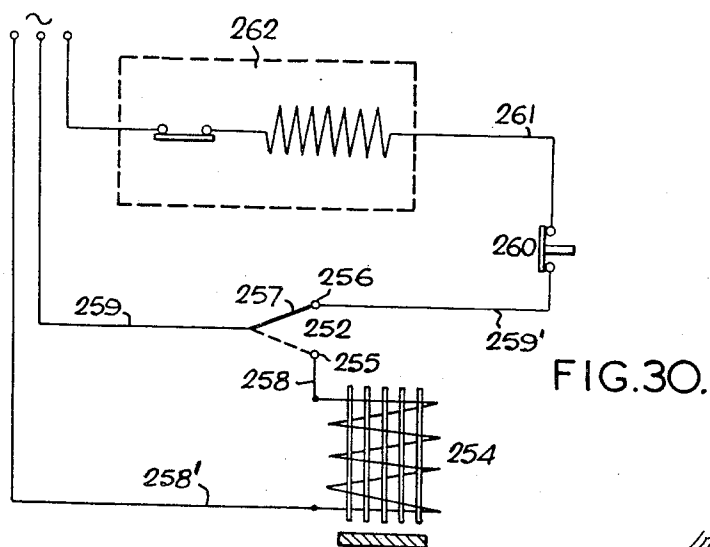
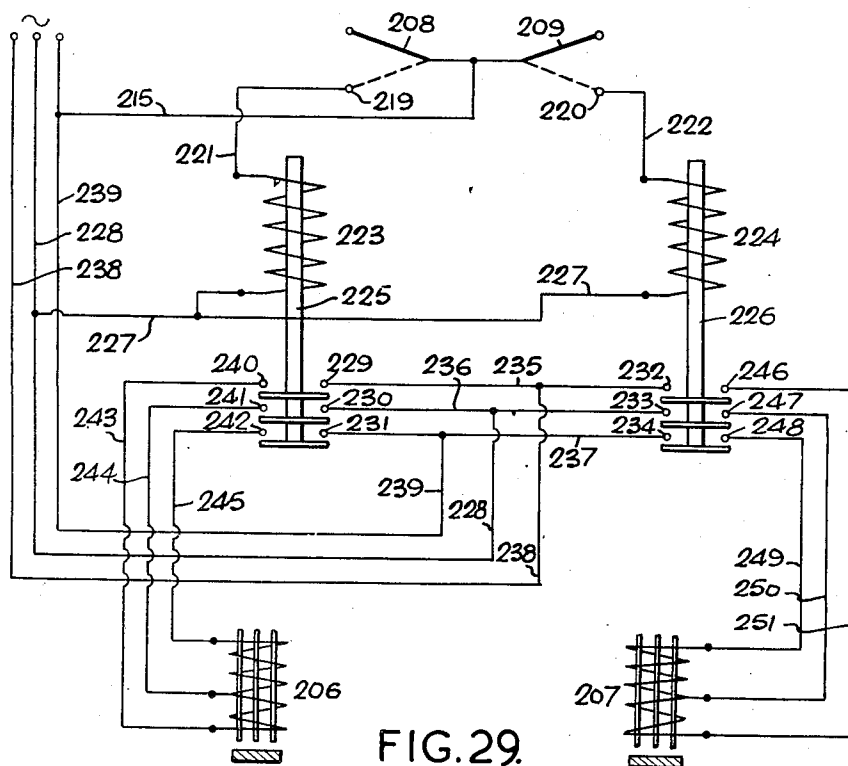
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PROFILE GRINDING OR POLISHING MACHINE

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PROFILE GRINDING OR POLISHING MACHINE

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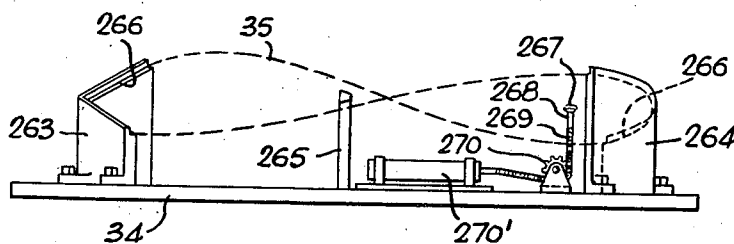


FIG. 32.

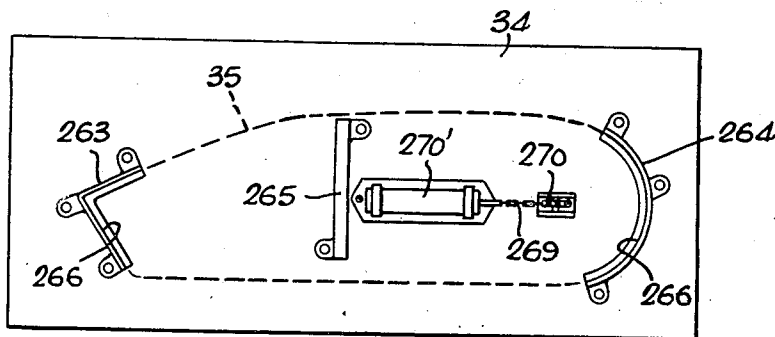


FIG. 33.

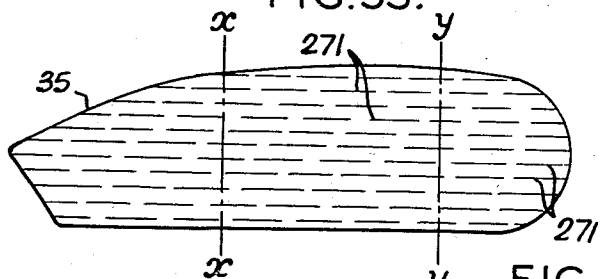


FIG. 34.

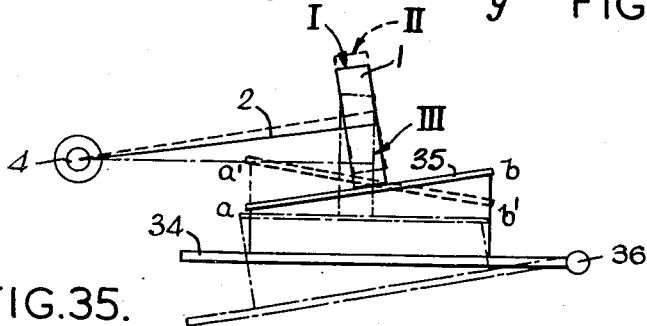


FIG. 35.

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UNITED STATES PATENT OFFICE

2,585,376

PROFILE GRINDING OR POLISHING
MACHINE

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Application February 24, 1950, Serial No. 146,020
In Great Britain April 12, 1949

17 Claims. (Cl. 51—94)

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The invention relates to a machine especially intended for grinding or polishing the mould boards of ploughbodies, but it is also capable of being used for grinding or polishing other articles having a varying profile.

An especial object is to avoid the arduous and skilled manual labour hitherto necessary with the use of the usual machine used for grinding or polishing mould boards, which machine comprises a power driven grinding wheel against which the mould board is manually pressed by means of a cradle on which the mould board is supported, the cradle having a shaft capable of sliding and rotating in a bearing so that the cradle can be moved in various directions by means of handles on the cradle and grasped by the operator.

The use of this old machine or appliance requires considerable skill as well as much arduous manual labour.

A machine according to the invention not only avoids these disadvantages by carrying out the required operations automatically, but it ensures a much increased output.

The machine according to the invention comprises a power driven grinding wheel which is so mounted that it can rise and fall during operation on the article being ground, the article being supported on a work table which is adapted to make reciprocatory traversing movements relative to the grinding wheel, and also feeding movements in a direction inclined, for instance, at right angles to the direction of the reciprocatory movements.

In order to ensure that the grinding wheel is maintained normal to the surface being ground, the work table is adapted to be tilted as required by the varying profile of the article being ground, the tilting means being such that adequate resistance of the work to the pressure of the grinding wheel is maintained.

The reciprocation and the tilting of the work table are preferably effected with the aid of hydraulic cylinders, and in order that the grinding wheel can be lowered into and elevated away from its operative position as required, a hydraulic cylinder is preferably provided for this purpose.

Suitable valves for controlling the various hydraulic cylinders and manual and automatic means for operating the valves are provided.

Safety devices are also preferably provided for stopping the machine and ensuring elevation of the grinding wheel to an inoperative position when the machine stops.

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The feeding of the work table is preferably effected by mechanism which can be operated manually or by power and this is preferably controlled so that it can be arrested automatically when required.

A particular construction of machine embodying the above features will now be described by way of example with reference to the drawings.

In the drawings—

Figure 1 is a side elevation of the whole machine.

Figure 2 is a rear elevation of part of the machine, showing the cylinder for raising the grinding wheel and dashpot cylinders.

Figure 2a is a front elevation of the attachment of the vertical screw to the crotch.

Figure 3 is a front elevation of the whole machine partly broken away to show the micro-switches.

Figure 4 is a plan of the whole machine.

Figure 5 is a side elevation, looking in the direction of the arrows 5'—5' Figure 4, showing one of the hydraulic cylinders and linkage for tilting the work table and the follower roller and bracket.

Figure 6 is a plan of the tilting cylinder and linkage, with the cylinder in section.

Figure 7 is a sectional elevation showing the traversing table, the double acting hydraulic cylinder for reciprocating it, the feed carriage and the V guides on the base for the feed carriage.

Figure 8 is a plan corresponding with Figure 7, but with the traversing table removed in order to show the rollers on which it reciprocates.

Figure 9 is a fragmentary end sectional elevation on 9'—9', Figure 7.

Figures 10, 11 and 12 are, respectively, a sectional side elevation, a front elevation and a plan of the gear box and self-acting mechanism for driving the feed screw for the feeding carriage, the cover plate of the gear box and the push rod and its lever being omitted in Figure 12.

Figures 13 and 14 are, respectively, a side elevation and a front elevation of part of the machine, showing the gear box and valve boxes on a larger scale than shown in Figures 1 and 3.

Figure 15 is a plan of the valve box containing the stop and start valve and the wheel elevating valve, the push rod operatively connected with the stop and start valve also being indicated.

Figure 16 is a side elevation as seen in the direction of the arrow 16', Figure 15.

Figure 17 is a sectional plan of the valves on the line 17'—17', Figure 16.

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Figure 18 is a sectional elevation of the valves on the line 18'-18', Figure 15.

Figure 19 is a diagrammatic side elevation illustrating the co-operation of the push rod and coupling cams between the stop and start and wheel elevating valves.

Figures 20 and 21 are, respectively, a front elevation and a side elevation of the valve box containing the reversing valve and the speed control valve for the hydraulic cylinder which reciprocates the traversing table.

Figure 22 is a sectional plan on the line 22'-22', Figure 20.

Figure 23 is a sectional elevation on the line 23'-23', Figure 22.

Figure 24 is a diagrammatic illustration or flow sheet of the hydraulic system.

Figures 25 and 26 are diagrams indicating the flow when the stop and start valve and the wheel elevating valve are each in two different positions.

Figures 27 and 28 are diagrams indicating the flow when the reversing valve is in two different positions.

Figure 29 is a diagram of the electrical connections between the microswitches and the solenoids which operate the traversing table reversing valve.

Figure 30 is a diagram of the electrical connections between the emergency microswitch and the solenoid which closes the stop and start valve should the traversing table accidentally make a stroke of undue length, and also the connections between the emergency microswitch and the motor starter.

Figure 31 is a sectional elevation of a relief valve.

Figures 32 and 33 are a front elevation and a plan, respectively, of jigs or supports for fixing a mould board on the work table.

Figure 34 is a diagrammatic plan of a mould board, and

Figure 35 is a diagrammatic side view illustrating the mode of grinding.

In the machine illustrated by the drawings, a grinding or polishing wheel 1, Figures 1 to 4, is secured to one end of a spindle 2, which is mounted to rotate in a bearing housing 3, which may be fitted with ball bearings of any approved type, not illustrated.

The bearing housing 3 is pivotally mounted, that is, it has trunnions 4 mounted to rotate in a crotch 5, so that the spindle 2 can oscillate in a vertical plane. The crotch 5 is fixed on a vertical slide 6, which slides in guides 7 on the front of a stationary column 8.

Means for varying the height of the pivotal support for the bearing housing for the purpose of varying the initial height of the grinding wheel 1 to suit the size of the grinding wheel or of the article being ground, comprises a screw threaded shaft 9, Figures 1 and 2a, having a boss 10 secured to its upper end and screwed to the bottom of the crotch 5. A nut 11 in engagement with the screw threaded shaft 9 is mounted to rotate against the ball thrust bearings 12.

The exterior of the nut 11 is formed as a worm wheel and is in engagement with a worm 13 on a cross-shaft 14 having a hand wheel 15, rotation of which effects the raising or lowering of the crotch 5.

The spindle 2 of the grinding wheel 1 extends beyond the bearing housing 3 and is fitted with a V grooved pulley 16 driven by belts 17 from a pulley 18 on the shaft of an electric motor 19

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mounted on a bracket 20 fixed to the upper side of the bearing housing 3.

Means for counterbalancing the electric motor 19 and for varying the downward pressure of the grinding wheel 1 comprise weights 21 and 22, carried by a rod 23 supported by brackets 24, 24 fixed to the bearing housing 3.

The weight 22 can be slidden along the rod 23 to vary the downward pressure of the grinding wheel 1, by means of a screwed shaft 22', engaging within a screw threaded hole 23' in the weight 22, the shaft 22' being mounted to rotate in the brackets 24, 24 and being provided with a handle 24', Figure 4.

Two hydraulic cylinders 25 and 26, Figures 1 and 2, are pivotally mounted at their lower ends on a pivot pin 27, which is carried by a bracket 28 fixed on the base 29 of the column 8. The piston rods 30 and 31 of the cylinders 25 and 26, respectively, are pivotally connected with the bearing housing 3 by a pivot pin 32, 32', carried by a bracket 33 fixed to the bearing housing.

The hydraulic cylinder 25 is equipped to act as a dashpot to cushion the oscillations of the bearing housing 3 and, therefore, of the grinding wheel 1 during operation. A pipe 272 connects the two ends of the cylinder 25, so that low pressure oil can be displaced from one side of the piston 273 to the other. Low pressure oil from any convenient source can be supplied to the pipe 272 through the union 274. The hydraulic cylinder 26, conveniently termed the "elevating cylinder," is used to raise the grinding wheel from its operative position into an inoperative position, when required.

The means for controlling these cylinders will be described later on.

A work table 34, Figures 1, 3, 4, 5 and 6 for supporting the article to be ground, is pivotally mounted by trunnions 36, 36, supported by brackets 37, 37, fixed to a traversing table 38, which reciprocates or traverses on V slides 39 and rollers 40 on a feed carriage 41. Some of these parts are shown more clearly in Figures 5 to 9.

A mould board 35 for a plough body is only indicated in dotted lines in Figures 1 and 3. Means for fixing it on the work table are described later on.

The reciprocation of the traversing table 38 is effected by a double acting hydraulic cylinder 42, which is fixed to the feed carriage 41 by eye-bolts or clamps 43, Figure 7. The rod 44 of the piston 45 of the cylinder 42 is connected at its ends to brackets 46 screwed to the traversing table 38. The control of pressure fluid to and from the cylinder will be referred to later.

The pivoted work table 34 is tilted by hydraulic cylinders 47, Figures 1, 3, 4, 5 and 6, which are pivotally mounted on trunnions 48 in forked brackets 49 fixed on the brackets 37, 37.

Each cylinder 47 has a piston 50, Figure 6, one end of the rod 51 of which is fixed in a fork 52 carrying a pivot pin 53 for the adjacent ends of links 54, 54, and for the adjacent end of a lever 55. The other ends of the links are pivotally connected by a pivot pin 56 to a lever 57 fixed on the adjacent trunnion 36 of the work table 34. A compression spring 58 is provided in each cylinder 47, which is compressed by the piston 50 when it is forced in one direction by pressure fluid to tilt the work table upwards by means of the links 54 and lever 57, the spring 58 assisting the return of the piston when the pressure fluid is released and the work table is to be tilted

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downwards. 58' is an air vent. The levers 55, 55 are fixed on a follower arm 59 pivotally mounted at its ends on trunnions 60 in the ends of the brackets 37, 37. A follower roller 61, carried by a bracket 62 fixed on the arm 59, engages with a cam 63 which, in the example illustrated in Figures 1, 3 and 4, is an inclined plate fixed on a cam table 64, mounted on the stationary base or framework 65 of the machine. The function of the follower roller 61 and of the cam 63 is to determine the degree of upward tilt of the work table under the action of the hydraulic cylinders 47, 47, during reciprocation of the work table 34 to suit the varying profile of the mould board 35.

The feed carriage 41, which supports the traversing table 38, is mounted on V slides 66 on the base 65, Figure 3. It is fed, that is, advanced and retracted, relatively to the grinding wheel 1, in a direction normal to the direction of reciprocation of the traversing table 38, by means of a feed screw 67 mounted to rotate in the base 65 and engaging with a nut 68, Figures 7 and 9, fixed on the feed carriage 41. The feed screw 67 has a hand wheel 69, Figures 3 and 4, by which the operator can effect the feeding by hand.

For automatic operation of the feed screw 67, a so-called self-acting mechanism is provided and will now be described.

The feed screw 67 has a bevel wheel 70 meshing with a bevel wheel 71 on the adjacent end of a shaft 72, the other end of which has a bevel wheel 73 meshing with a bevel wheel 74 fixed on a sleeve 75 mounted to rotate on a fixed shaft 76, Figures 11 and 12. A larger spur gear 77 is also fixed on the sleeve 75 and is driven by a spur wheel 78 fixed on the out-put shaft 79 of a gear box 80. The gear box 80 comprises gearing for rotating the out-put shaft 79 in either of two directions accordingly as the feed-screw 67 is to advance or retract the feed carriage 41, the gearing being such that the advance of the feed-carriage 41 is slow to suit the required rate of feed of the article being ground, while the retraction or return of the feed carriage is relatively quick.

As illustrated by Figures 10, 11 and 12, this gearing includes an input shaft 81, which may be driven from any convenient source of power, such as an electric motor 81'.

The input shaft 81 has a worm 82 meshing with a worm wheel 83 fixed on a sleeve 84, which is mounted to rotate on a fixed shaft 85. A bevel wheel 86 fixed on the sleeve 84 meshes with a bevel wheel 86' fixed on the tubular boss 87 of a clutch member 88. The boss 87 is mounted to rotate in a bearing 89 and also on a ball bearing 90 on the output shaft 79.

A spur gear 91 fixed on the input shaft 81 meshes with a spur gear 91' which in turn meshes with a spur gear 92 which is fixed on the tubular boss 93 of a clutch member 94. The boss 93 rotates in a ball bearing 95 and also on a ball bearing 96 on the output shaft 79.

The two clutch members 88 and 94 are adapted to be selectively secured to the output shaft 79 accordingly as the output shaft is to be rotated slowly in one direction to effect a slow feeding movement of the feed carriage 41, or quickly in the opposition direction to effect a quick return movement of the carriage.

For this purpose, two clutch elements 97 and 98 are provided for engagement with the clutch elements 88 and 94, respectively. In the ex-

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ample illustrated, the well known type of friction plate clutch element is indicated by 97 and 98, the details not being shown, as these are well known. Any other type of clutch element may be used.

The clutch elements 97 and 98 are thrust into operative engagement with their respective co-acting elements 88 and 94 by a sliding collar 99 which is thrust in one direction or the other, as required, by a shifting forked lever 100 pivoted on a fulcrum pin 101. The shifting lever 100 has a pin and slot connection 102 with a push rod 103 having a pin and slot connection 104 with an operator's lever 105, which is pivotally mounted on a fulcrum pin 106.

Accordingly as the operator swings the lever 105 to the right or left, as seen in Figure 10, so will the output shaft be rotated to effect the slow feed or quick return of the feed carriage.

If the operator's lever be moved into a central or neutral position, neither of the clutch elements 97 or 98 will be in operative engagement and the feed under power will cease.

In such condition, the hand wheel 69, referred to above, can be rotated by the operator.

The means for controlling the operation of the various hydraulic cylinders will now be described.

As the pipe connections between the valves and cylinders cannot be indicated clearly in the general views of the machine, detail views of the valves will be referred to first and then the pipe connections will be obvious from an inspection of the diagram or flow sheet, Figure 24, and the diagrams, Figures 25 to 28.

The elevating cylinder 26, Figure 2, has a pipe 107 connected to its upper end for supplying pressure fluid, for instance oil, to act on the upper side of the piston 108 to push down the piston rod 31 and thereby to elevate the grinding wheel 1 into an inoperative position, when required. When the grinding wheel 1 is to be allowed to descend to the operative position, the supply of pressure oil to the pipe 107 is cut off and the pipe is connected with an exhaust pipe to allow the oil in the cylinder to flow freely away or exhaust, thereby relieving the pressure on the piston 108, so that it can rise in the cylinder 26 and allow the grinding wheel to descend to operative position.

The pipe 107 is connected with a valve conveniently termed the "wheel elevating valve." It is a rotary plug valve 109, Figures 15 to 18, fitted in a valve box 110 and provided with an operating lever 111. It has a transverse port 112 which, when the valve is rotated in one direction by the lever 111, is brought into a position to connect a pressure oil supply passage 113 with a passage 114 with which the pipe 107 is connected. Pressure oil supplied by a pipe 115 can then flow to the elevating cylinder 26.

When the valve is rotated by the lever 111 in the opposite direction, the port 112 is shut off from the pressure oil supply passage 113, but it is connected by means of a number of holes or branch ports 116 with an exhaust passage 117 leading to an exhaust pipe 117. The end of the port 112 adjacent to the passage 114 is enlarged, as indicated at 118, to ensure that this end remains open to the passage 114 in either position of the valve. Consequently, when the port 112 is cut off from the supply passage 113, oil from the pipe 107 can flow through the ports 112 and 116 to the exhaust passage 117. Holes 119 in the valve 109 merely allow pressure oil to pass to the periphery of the valve to counteract

any undue transverse pressure between the valve and its casing 120, which might cause it to stick and offer undue resistance to rotation. Bleed holes 121 connecting the ends of the plug valve 109 with an exhaust bleed pipe 122 are provided to balance end pressures on the valve.

A stop and start valve controls the supply of pressure oil required by the hydraulic cylinder 42, which effects the reciprocation of the traversing table 38.

The pressure oil does not pass directly from the stop and start valve to the cylinder 42, but to a reversing valve which controls the flow alternately to and from the opposite ends of the cylinder as will be described later on.

The stop and start valve consists of a rotary plug valve 123, Figures 15 to 18, fitted in the valve box 110 and having an operating lever 124 by which it is rotated in one direction to bring a transverse port 125 into communication with the pressure oil supply passage 113 and with a passage 126, and is rotated in the opposite direction to shut off the port 125 from the passage 113 and to connect the passage 126 with an exhaust passage 127 to which an exhaust pipe 128 is connected. A pipe 129 is connected to the passage 126 and this pipe is also connected to the reversing valve, as explained later on; suffice it to say, that, when the valve 123 is in a position to allow pressure oil to pass to the pipe 129, the traversing table is reciprocated, but when the pipe 129 is connected with the exhaust pipe 128, by means of the port 125 and the exhaust passage 127, the traversing table is arrested.

In order that the grinding wheel shall never be in contact with the article being ground while that article is stationary, due to arrest of the traversing table, coupling means are provided between the stop and start valve 123 and the wheel elevating valve 109 to ensure that, when the wheel elevating valve is operated to lower the grinding wheel, the stop and start valve is operated to ensure reciprocation of the work table, and also that, when the stop and start valve is operated to cause the work table to cease reciprocating, the wheel elevating valve is operated to cause the grinding wheel to be raised to an inoperative position.

The coupling means are such that it is only possible for the wheel elevating valve 109 to be operated so long as the traversing table and the work table thereon are reciprocating, that is, so long as the stop and start valve is open.

The coupling means illustrated in Figures 15 and 16 consist of two interengaging cams 132 and 133 fixed on the valves 109 and 123.

When the cams 132, 133 and the valve operating levers 111 and 124 are in the positions indicated in full lines in the diagrammatic Figure 19, the stop and start valve 123 is closed and the wheel elevating valve 109 is open to pressure oil so that the grinding wheel is elevated to an inoperative position and the traversing table and work table are stationary. An attempt to lower the grinding wheel by moving the lever 111 to the position indicated in dotted lines will cause the opening of the stop and start valve 123 as the cam 132 will depress the cam 133 into the position indicated in dotted lines, so that the traversing table will at once be reciprocated.

So long as the stop and start valve 123 is open, that is, the cam 133 is in the depressed position, the lever 111 can be operated freely either to elevate or to lower the grinding wheel.

Assuming that the stop and start valve 123 is open and that the wheel elevating valve 109 is closed, as indicated in dotted lines in Figure 19, movement of the lever 124 to close the valve 123 and thereby to arrest the traversing table will cause the valve 109 to open and thereby to elevate the grinding wheel owing to the raising of the cam 132 by the cam 133.

A push rod 134, Figures 15, 16 and 19, mounted to slide in guides 135 on the valve box 110, has two collars 136 and 137. A helical spring 138 is interposed between each collar and the adjacent guide 135. The push rod 134 has a tooth 139 for alternate engagement with two rather widely spaced teeth 140, 141 on a rocker 142, which is fixed on the stop and start valve 123. The function of this mechanism is to shut off the stop and start valve 123 to pressure oil and open it to exhaust, and thereby to open the wheel elevating valve 109 to pressure oil and shut it off from exhaust when the feed carriage 41 has completed its predetermined feeding movement, thereby stopping the machine and elevating the grinding wheel; and also to enable the operator to open the stop and start valve 123 to pressure oil and shut it off from exhaust, and to shut off the wheel elevating valve 109 from pressure oil and open it to exhaust when the feed carriage has been brought back into position to commence another feeding operation.

Two adjustable clamps 342, 346, forming abutments, are mounted on rods 134, 103, respectively. As the feed carriage 41 advances, a tappet 143, projecting from the side of the feed carriage 41, engages with the clamp 342 on rod 134, and as the feed carriage further advances, the rod 134 is also advanced until the collar 142 at the end of rod 134 engages with the collar 146 on the rod 103. Further feeding-in of the carriage will cause the rod 103 to advance, thereby halting the drive of the feed carriage 41, at the same time, the rod 134, being connected by tooth 139 to the stop and start valve, as hereinbefore described, causes the reciprocating table to stop and at the same time the grinding wheel is elevated.

The feed carriage is then returned by the manual operation of the clutch lever 105, and as the feed carriage returns, the abutment 143 on the feed carriage strikes the clamp 346 on the rod 103, again halting the carriage, so that the feed carriage will again be ready to advance when required.

The clamps 342, 346 are adjustable so that the amount of feed in either direction is controllable, the clamps being slidden along their respective rods to the desired positions.

Another function of the above mechanism is to close the stop and start valve 123 and to open the wheel elevating valve 109 to pressure oil when an emergency electric solenoid 254 is energized, as hereinafter explained. For this purpose, the push rod 134 is connected by a chain 144, Figures 4 and 19, to the core of the solenoid 254, the chain passing over a guide pulley 145. The collar 142 also engages with a collar 146 on the push rod 103, hereinbefore referred to with reference to Figures 10 and 11, for operating the clutch of the feed mechanism, so that when the push rod 134 is pulled by the emergency solenoid 254, the feed clutch is shifted into a neutral position to stop the self-acting feeding mechanism.

The reversing valve, namely, the valve which controls the supply and exhaust of pressure oil

to and from the ends of the double acting hydraulic cylinder 42 to effect reciprocation of the traversing table 38, consists of a rotary plug valve 147, Figures 20 to 23, fitted in a valve box 148 and provided with an operating lever 149.

The pipe 129 from the valve box 119 (before described with reference to Figures 15 to 19) is connected to a passage 150 in the valve box 148. Two passages 151 and 152 in the valve box 148 are connected by pipes 153 and 154, respectively, to opposite ends of the double acting hydraulic cylinder 42. An exhaust passage 155 communicates with an exhaust pipe 157 through a speed control valve 158, described below.

The plug valve 147 has a port 159 for alternately connecting the passage 150 with the passages 151 and 152. So long as the start and stop valve 123 is in the on or open position to allow pressure oil to the pipe 129, the oil can pass alternately to the ends of the double acting cylinder 42.

The valve 147 has a transverse port 160 for alternately connecting the passages 150 and 151 with the exhaust passage 156, the arrangement of the ports 159 and 160 being such that when pressure oil is passing from the passage 150 to one of the passages 151, 152, to one end of the cylinder, oil is exhausting from the other end of the cylinder through the other passage and the port 160 to the exhaust passage 156.

A valve 158 of semi-circular shape is formed on a spindle 164 provided with a hand lever 161 by which it can be rotated. A spring 155 between a collar 166 on the spindle 164 and a cover plate 167 presses the valve 158 against a plug 163 provided with perforations 162.

The rate of flow of oil in the exhaust passage 156 is regulated by the valve 158, which can be rotated by its hand lever 161, so that it uncovers more or less of the perforations 162.

The plug 163 is fixed in the valve box 148 and forms part of the union 168, to which the exhaust pipe 157 is connected. The hand lever 161 is provided with a spring loaded ball catch 162' for engagement with a series of recesses 163' to hold the lever in any position to which it may be set. As the lever 161 is moved from the uppermost position to the lowermost, so will more of the perforations 162 be covered by the valve 158 and the flow of exhaust oil be checked or throttled and the speed of reciprocation of the traversing table 38 be reduced. When the lever is moved in the opposite direction, the speed of reciprocation will be increased.

One end of the valve 147 abuts against an annular shoulder 169. In order to equalise the pressure on the ends of the valve 147, balancing holes 170 are provided in the valve, connecting the spaces 171 at the ends of the valve. An exhaust pipe 172 drains away any pressure oil which may leak past the valve.

A transverse hole 173 allows pressure oil to pass from the port 159 to a port 174 on the opposite side of the valve to equalise lateral pressure on the valve to prevent it sticking.

The tilting cylinders, namely, the hydraulic cylinders 47, 47 which tilt the work table, are supplied with pressure oil by pipes 175, 175, branched from a pipe 176, Figure 24, which is fitted with an automatic relief valve, indicated generally by 177 in Figure 24.

The automatic relief valve 177 may be of any suitable type, a known form being shown by way of example in Figure 31.

It comprises a casing 178 having a transverse

passage 280 and an exhaust passage 281. A pipe 179 supplies pressure oil to one end of the passage 280. An outflow pipe 176 is connected to the other end of the passage 280. An exhaust pipe 180 is connected to the passage 281. A valve seating 282 for a valve 283 is fitted in the passage 281.

The valve 283 is formed with a piston 284 sliding in a passage 285 which is connected with the passage 280 by a bleed hole 285' in the piston. A cover 286 is fitted to the lower part of the casing 178. A passage 287 in the cover contains a valve seating 288 and a valve 289 provided with a closing spring 290. A passage 291 extends right through the valve 283 and accommodates a closing spring 292. Holes 293 and 294 in the cover 286 connect the passages 285, 291 with the passage 287.

So long as the pressure of the oil in the pipe 179 is sufficient to enable the hydraulic cylinders 47, 47 to tilt the work table 34 upwards, the valves 283 and 289 are closed and pressure oil can flow as required from the pipe 179, across the passage 280 and out through the pipe 176. Oil can also flow through the bleed hole 285' to fill the passage 285 below the piston, the hole 293 and the adjacent part of the passage 287.

When the work table is tilted downwards, due to the cam 63 acting on the follower roller 61, as hereinbefore described, the pressure of the oil in the hydraulic cylinders 47, 47 and pipe 179 increases above that in the pipe 179. Consequently, the pressure in the passage 287 is sufficient to open the valve 289 to exhaust. The pressure under the piston 284 being then momentarily less than that above it enables the piston to descend to open the exhaust valve 283. Consequently, the pressure in the hydraulic cylinders 47, 47, being relieved, they allow the work table to tilt downwards under the action of the cam 63.

Pressure oil for the various hydraulic cylinders is preferably supplied by a rotary pump 187, Figures 4 and 24, driven by an electric motor 188.

The pump 187 draws oil by a pipe 189 from a supply tank or sump 190 and delivers it by a pipe 191.

The pipe 115 leads oil from the pipe 191 to the pressure oil passage 113 in the valve box 110, Figures 17 and 18, to supply pressure oil to the wheel elevating valve 109 and the stop and start valve 123 hereinbefore described with reference to those figures.

In order to avoid excessive pressure accidentally arising in the system, a relief valve 192 of any suitable type, for instance, of similar construction to the valve 177, is provided on the pipe 115, the relief valve 192 allowing oil to escape through an exhaust pipe 193 connected with the pipe 157, should undue pressure be reached.

As the pressure of oil required for the tilting cylinders 47, 47 need not be so high as that required for the other hydraulic cylinders, a pressure reducing valve 194, Figure 24, may be interposed between the delivery pipe 191 and the pipe 179. The pressure reducing valve 194 may be of any suitable type.

The oil exhausted from the various valves is led to the sump 190 for re-circulation by the pump 187.

A cooling coil 195, Figure 24, may be provided on the exhaust pipe 157, as more oil passes to

the sump through this exhaust pipe than through the others.

As it is desirable that the reversing valve 147 shall be operated automatically once the machine is started, the following means are provided:

The hand operating lever 149 of the reversing valve 147, Figures 1, 13, 14 and 20, has a lug 196 which is pivotally connected at 197 to one end of a link 198, the other end of which is pivotally connected by a pin 199 to a rocking lever 200 supported on a fulcrum pin 201. The rocking lever 200 is pivotally connected at 199 and 232 to the cores 204 and 205, respectively, of two electric solenoids 206 and 207. Two microswitches 208 and 209 are fixed on the cam table 64, Figures 1, 3 and 4, their operating levers 210 and 211 depending in the path of stops or templates 213 and 214 which are fixed on the traversing table 38.

As indicated in Figure 29, a lead 215 from one phase line 239 of a three phase A. C. supply supplies current to the two switches 208 and 209. Their fixed contacts 219 and 220 are connected by leads 221 and 222, respectively, to the energising coils 223 and 224 of contactors 225 and 226, these coils being both connected by a common lead 227 to the second phase line 228 of the supply.

Three fixed contacts 229, 230, 231 and 232, 233 and 234 of the contactors 225 and 226 are connected by leads 235, 236, 237 to the three phase lines 238, 228 and 239 of the supply.

Three fixed contacts 240, 241, 242 of the contactor 225 are connected by leads 243, 244, 245 to the three phase solenoid 206. Three fixed contacts 246, 247, 248 of the contactor 226 are connected by leads 249, 250, 251 to the three phase solenoid 207.

The solenoids 206 and 207, as hereinbefore described, operate the reversing valve 147, Figure 14, which controls the double acting hydraulic cylinder 42, which reciprocates the traversing table 38. Consequently, as the traversing table 38 in its reciprocations brings the stop or templates 213 and 214 alternately into engagement with the operating levers 210 and 211 of the microswitches 208 and 209, Figures 3 and 4, to close these switches, the solenoids 206 and 207 will be alternately energised to operate the reversing valve 147.

The stops or templates 213 and 214 are shaped and arranged to vary the stroke or degree of reciprocation of the traversing table 38 to suit the varying length of the mould board being ground. The shape is clearly shown in Figure 4.

A third microswitch 252, Figure 3, is fixed on the cam table 64 intermediate of the microswitches 208 and 209. It has an operating lever 253. Should the traversing table 38, when reciprocating, accidentally make a stroke of undue length in either direction so that the operating lever 210 or 211 jumps the corresponding stop or template 213 or 214, the operating lever 253 will be engaged by the stop or template and close the microswitch 252 and cause the emergency solenoid 254 to be energised. As hereinbefore explained, the solenoid 254 operates the push rod 134, Figures 1, 4 and 19 to close the stop and start valve 123 to cut off the supply of pressure oil and at the same time open the wheel elevating valve 109, so that the grinding wheel 1 is elevated to an inoperative position. Moreover, the collar 142 on the push rod 134 engages with the collar 146 on the push rod 103,

so that the gear of the feeding mechanism for the feed carriage is declutched.

From the diagram of connections shown in Figure 30, it will be seen that the microswitch 252 has two fixed contacts 255 and 256. One supply lead 259 from one phase line of a three phase A. C. supply is connected with the switch arm 257. The contact 255 is connected by a lead 258 to the single phase solenoid 254, to which a return lead 258' is connected for connection to the second phase line of the three phase supply. The contact 256 is connected by a lead 259' to a hand operated emergency stop switch 260 connected by a lead 261 through the no voltage coil of the motor starter 262 to the third phase line of the supply. The starter 262 controls the motor 19, which drives the grinding wheel 1.

When the emergency microswitch 252 is closed, the switch arm 257 is moved off contact 256 on to contact 255, so that not only is the solenoid 254 energised, but current flowing through the lead 259 will be interrupted and the motor 19, which drives the grinding wheel 1, will be stopped.

Convenient means for fixing a mould board 35 on the work table 34 are illustrated in Figures 32 and 33. They comprise two end brackets 263 and 264 and an intermediate bracket 265 screwed to the table.

The upper edges of the end brackets 263, 264 are shaped to conform to the adjacent ends of the mould board 35, indicated in dotted line, and are also rabbeted, as indicated at 266, so that the ends of the mould board fit the rabbeted parts to prevent the mould board shifting. It is supported in the middle by the bracket 265, the upper edge of which is plain but conforms in shape to the adjacent contour of the mould board. A hole 267 receives a countersunk clamping head 268 on a chain 269, which passes under a sprocket 270 and is secured to the piston rod of a small hydraulic or compressed air cylinder 270', by which the chain can be tightened.

The mould board is preferably fixed in position, so that the paths of the grinding wheel relatively to it extend along it longitudinally, as indicated diagrammatically by the dotted lines 271 in Figure 34.

Owing to the varying width of the mould boards, these paths vary in length. By shaping and arranging the stops or templates 213, 214 to correspond with the required paths, the length of reciprocation of the traversing table is correspondingly varied, in order that the grinding wheel shall remain on the mould board and not pass beyond either end.

The reason for tilting the work table will be evident from an inspection of the diagram, Figure 35. The cross section of the usual mould board is practically a straight line, the inclination of lines at different sections varying from one end of the mould board to the other. For instance, the sections on $x-x$, $y-y$, Figure 34 may be represented by lines a , b , and a' , b' , Figure 35.

Assuming that the line of contact of the periphery of the grinding wheel 1 is parallel to the line a , b , when at the position $x-x$, Figure 34, and as indicated at I in Figure 35, it would not be parallel on reaching the position $y-y$, but would be grinding on one peripheral edge only, as indicated at II in dotted lines in Figure 35, if the work table were not tilted. Consequently, it is necessary to tilt the work table downwards to allow the wheel to assume the correct position, as indicated at III, Figure 35.

In the example described, the work table is gradually tilted downwards during the relative travel of the grinding wheel in one direction and gradually tilted upwards during the return.

Mould boards for special purposes sometimes have a concave or curved line at a cross section. In grinding such a mould board, it is advisable to use a grinding wheel having a convex grinding surface.

In this specification and in the appended claims, the expression "grinding wheel" is to be construed as including a polishing wheel.

We claim:

1. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table and means for swinging said spindle about its pivotal support for elevating and lowering said grinding wheel into an inoperative and an operative position, respectively.

2. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table and means for cushioning the rising and falling movements of the grinding wheel during operation.

3. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said pivotal support for said grinding wheel spindle comprising a bearing housing for the grinding wheel spindle, trunnions on said housing, a crotch for supporting said trunnions, a column for supporting said crotch, and means for raising and lowering said crotch relatively to said column for initially adjusting the height of the grinding wheel relatively to the work table.

4. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table rela-

tively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said pivotal support for said grinding wheel spindle comprising a bearing housing for the spindle of the grinding wheel, a pivotal support for said bearing housing and a hydraulic cylinder for oscillating said bearing housing about said pivotal support.

5. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said traversing means including a traversing table provided with said pivotal supports for said work table, hydraulic cylinders for tilting said work table about said pivotal supports, and means for varying the degree of tilt of said table according to the varying contour of the article to be ground.

6. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said traversing means including a traversing table provided with said pivotal supports for the work table, and said feeding means including a feed carriage for supporting said traversing table, and a hydraulic cylinder on said carriage for reciprocating the traversing table thereon.

7. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said traversing and feeding means including a traversing table provided with said pivotal supports for said work table, a feed carriage for supporting said traversing table, means for reciprocating the traversing table on the feed carriage, said base supporting the feed carriage and means for feeding said feed carriage on said base in a direction inclined to the direction of reciprocation of the traversing table.

8. A grinding machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work ta-

ble relatively to said grinding wheel, a base for supporting said traversing means, feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table said traversing and feeding means including a traversing table provided with said pivotal supports for said work table, a feed carriage for supporting said traversing table, means for reciprocating said traversing table on said feed carriage, hydraulic cylinders on said traversing table for tilting said work table about its pivotal supports, a cam table mounted on said base, a cam mounted on said cam table, a follower roller operatively carried by said work table for engagement with said cam during reciprocation of said traversing table for varying the degree of tilt of the work table by said hydraulic cylinders to suit the varying profile of the article being ground.

9. A machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, a traversing table having pivotal supports for said work table, means for tilting said work table about its pivotal supports, a feed carriage supporting said traversing table, a base supporting said feed carriage, a cam table mounted on said base, a cam mounted on said cam table, a double acting hydraulic cylinder on said feed carriage for reciprocating said traversing table thereon, a reversing valve controlling the flow and exhaust of pressure fluid to and from said hydraulic cylinder to effect the reciprocation of the traversing table, electro-magnetic means for operating said reversing valve, switches carried by said cam table in circuit with said electro-magnetic means, and stops on said traversing table for alternately engaging with said switches and thereby controlling the electro-magnetic operation of said reversing valve.

10. A grinding machine as specified in claim 9, wherein the reversing valve has an exhaust passage, and a speed regulating valve in said exhaust passage to regulate the flow of exhaust pressure fluid from said passage for regulating the speed of reciprocation of the traversing table.

11. A grinding machine as specified in claim 9, provided with a hydraulic cylinder for swinging the spindle of the grinding wheel about its pivot for elevating the grinding wheel to an inoperative position and to allow it to be lowered to an operative position, a wheel elevating valve controlling the flow of pressure fluid to and from said hydraulic cylinder, a stop and start valve controlling the supply of pressure fluid to said reversing valve which controls the hydraulic cylinder effecting the reciprocation of the traversing table, and coupling means between said wheel elevating valve and said stop and start valve for effecting operation of said wheel elevating valve to cause elevation of the grinding wheel to an inoperative position when said stop and start valve is operated to cut off the supply of pressure fluid to said reversing valve, and to permit of said wheel elevating valve being operated to allow the grinding wheel to be lowered to operative position when said stop and start valve has been operated to open the supply of pressure fluid to said reversing valve.

12. A machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a

spindle, a pivotal support for said spindle, a work table for supporting the article to be ground, a traversing table having pivotal supports for said work table, means for tilting said work table about its pivotal supports, a feed carriage supporting said traversing table, a base supporting said feed carriage, a cam table mounted on said base, a cam mounted on said cam table, a double acting hydraulic cylinder on said feed carriage for reciprocating said traversing table thereon, a reversing valve controlling the flow and exhaust of pressure fluid to and from said hydraulic cylinder to effect the reciprocation of the traversing table, electro-magnetic means for operating said reversing valve, switches carried by said cam table in circuit with said electro-magnetic means, stops on said traversing table for alternately engaging with said switches, and thereby controlling the electro-magnetic operation of said reversing valve, an emergency switch on said cam table for engagement with either of said stops on said traversing table in the event of either of the aforesaid switches over-running its respective stop, an emergency electro-magnetic device in circuit with said emergency switch, and means operated by said emergency electro-magnetic means for operating the stop and start valve to cut off the supply of pressure fluid when said emergency switch is closed, for stopping the feed to the feed carriage, the reciprocation of the traversing table and elevating the grinding wheel.

13. A machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel, means for supporting said grinding wheel which permit of rising and falling movements thereof during operation, a work table for supporting the article to be ground, a traversing table, pivotal supports for said work table on said traversing table, means for tilting said work table about said pivotal supports for maintaining mutual rising and falling movements with said grinding wheel, a feed carriage supporting said traversing table, means for reciprocating said traversing table on said feed carriage relatively to said grinding wheel, a stationary base supporting said feed carriage, and means for advancing and retracting said feed carriage on said base in a direction inclined to the direction of reciprocation of said traversing table, said means comprising a feed screw revolubly mounted on said base, a nut on said feed carriage engaging with said feed screw, and means for rotating said feed screw.

14. A grinding machine as specified in claim 13, wherein the said means for rotating the feed screw includes a gear box having a slow speed forward feed gear and a quick return gear, a power shaft for driving said gears, and means for alternately connecting said gears operatively with said feed screw.

15. A grinding machine as specified in claim 13, wherein the said means for rotating said feed screw includes a gear box having a slow speed forward feed gear, a quick return gear, a power shaft for driving said gears, means for alternately connecting said gears operatively with said feed screw, and a push rod for operating said alternate connecting means, the feed carriage having a tappet operating means for the disengagement of the gears at the end of the slow feeding movement and at the end of the quick return movement of the feed carriage.

16. A machine for grinding mould boards of plough bodies and other articles of varying pro-

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file, comprising a grinding wheel, means for supporting said grinding wheel which permit of rising and falling movements of said wheel during operation, other means for elevating said grinding wheel to an inoperative position including a hydraulic cylinder, a traversing table, a feed carriage supporting said traversing table, a stationary base supporting said feed carriage, a work table pivotally mounted on said traversing table, means including a hydraulic cylinder for reciprocating said traversing table on said feed carriage relatively to said grinding wheel, a nut on said feed carriage and a feed screw revolvably mounted on said base and engaging with said nut for advancing and returning said feed carriage on said base in a direction inclined to the direction of reciprocation of said traversing table, a wheel elevating valve and a stop and start valve respectively controlling the supply of pressure fluid to said wheel elevating hydraulic cylinder and said cylinder for reciprocating said traversing table, coupling means between said valves for ensuring operation of the wheel elevating valve to effect elevation of the grinding wheel when the stop and start valve is operated to cut off the supply of pressure fluid to the hydraulic cylinder which reciprocates the traversing table and to permit of operation of the wheel elevating valve to effect lowering of the grinding wheel when the stop and start valve is operated to permit of flow of pressure fluid, means including a push rod for operating said stop and start valve, a power driven gear box for driving said feed screw of said feed carriage, said gear box including a slow forward gear and a quick return gear, means for the disengagement

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of said gears including a push rod, and means including a tappet on said feed carriage for sliding both of said push rods to enable them to effect their respective operations as said feed carriage completes its advance movement and its return movement.

17. A machine for grinding mould boards of plough bodies and other articles of varying profile, comprising a grinding wheel having a spindle, a bearing housing for said spindle, a pivotal support for said bearing housing, a work table for supporting the article to be ground, pivotal supports for said work table, traversing means for reciprocating said work table relatively to said grinding wheel, and feeding means for advancing and retracting said work table relatively to said grinding wheel in a direction inclined to the direction of reciprocation of said work table, said bearing housing being provided with an adjustable weight for varying the downward pressure of said grinding wheel.

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