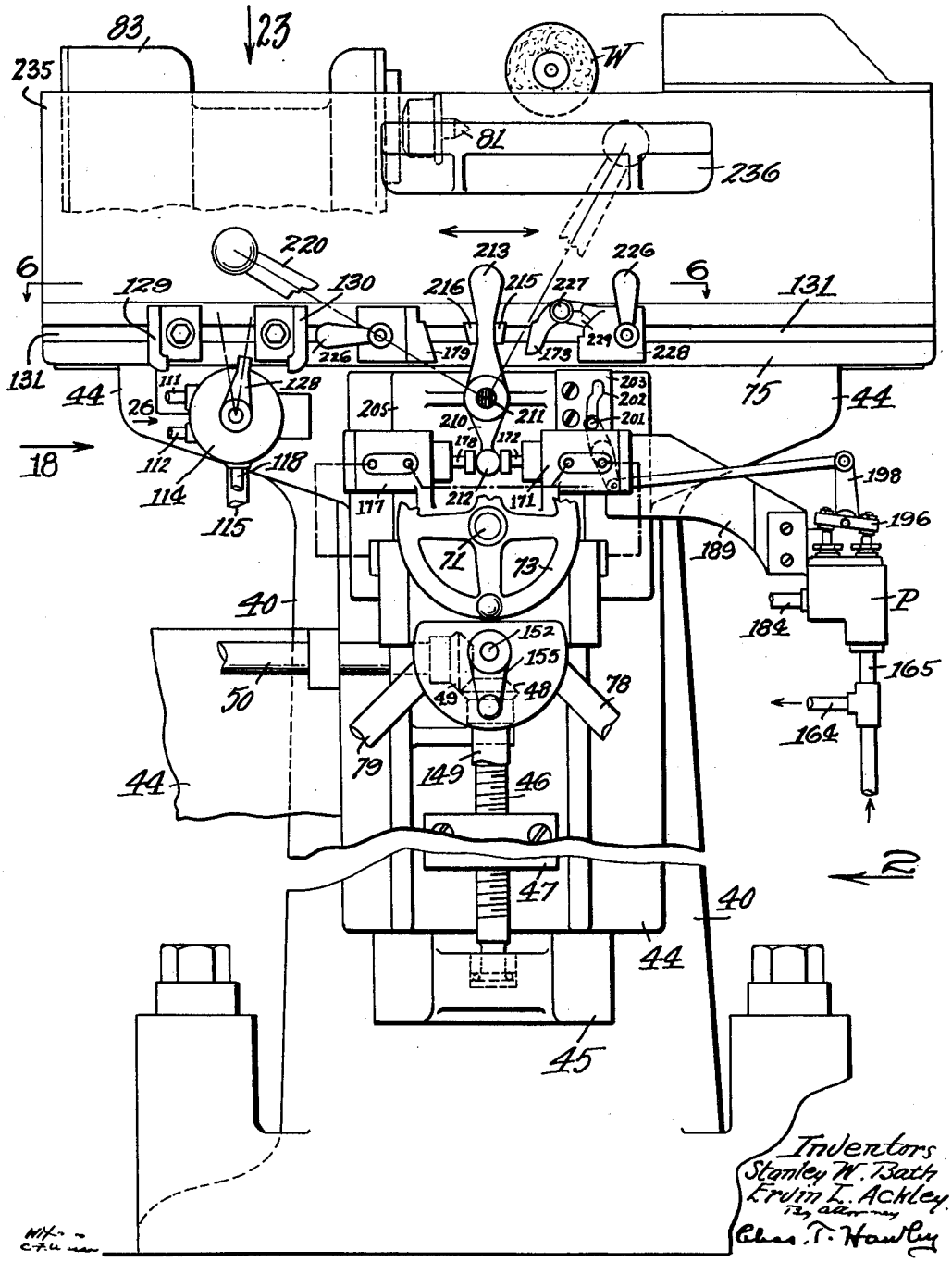
May 24, 1938. S. W. BATH ET AL 2,118,139

MACHINE FOR GRINDING FLUTES

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Fig. 1.



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MACHINE FOR GRINDING FLUTES

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Fig. 2.

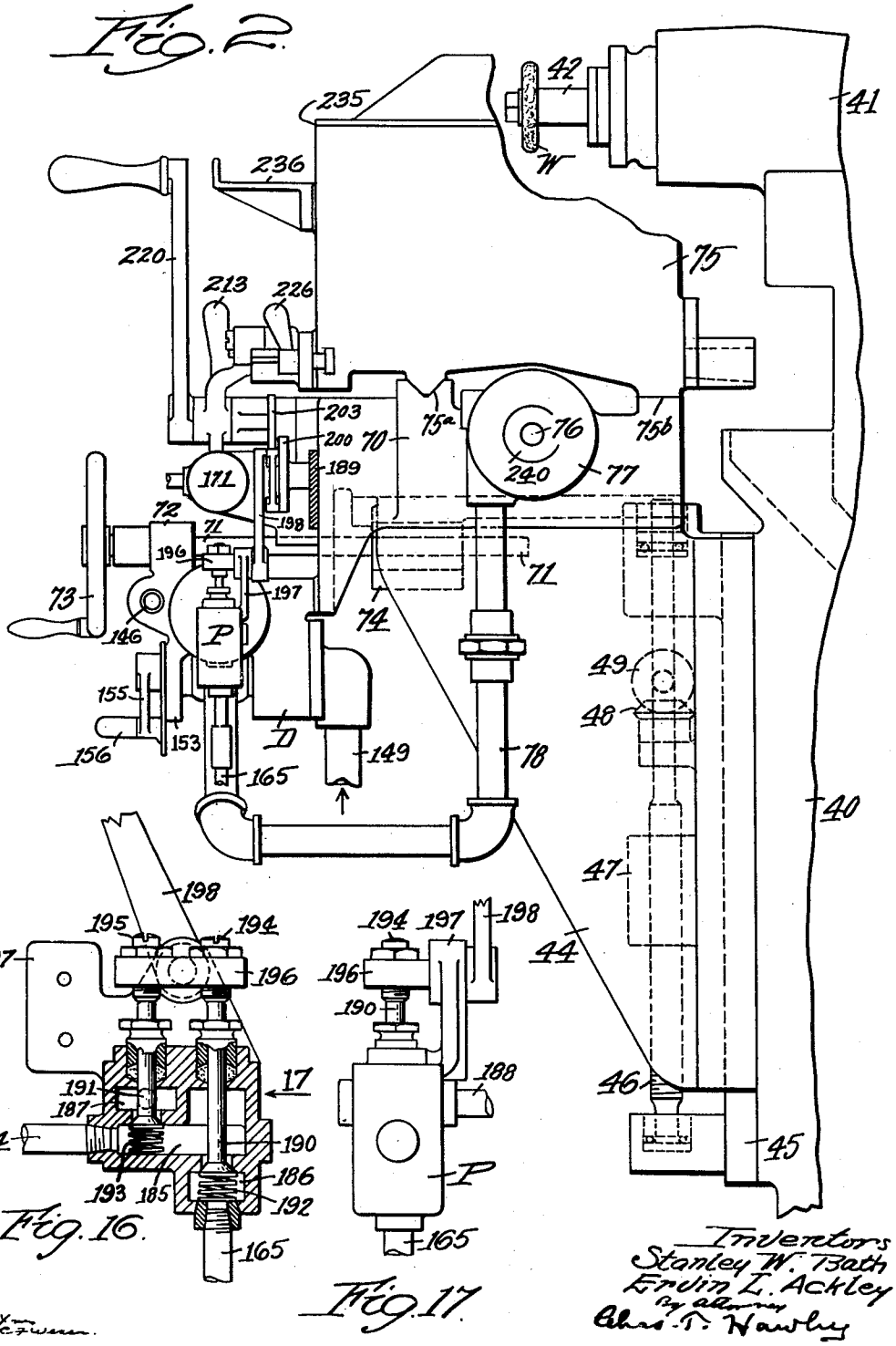


Fig. 16.

Fig. 17.

Inventors
Stanley W. Bath
Erwin L. Ackley
By Albert T. Hawley
Attorney

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MACHINE FOR GRINDING FLUTES

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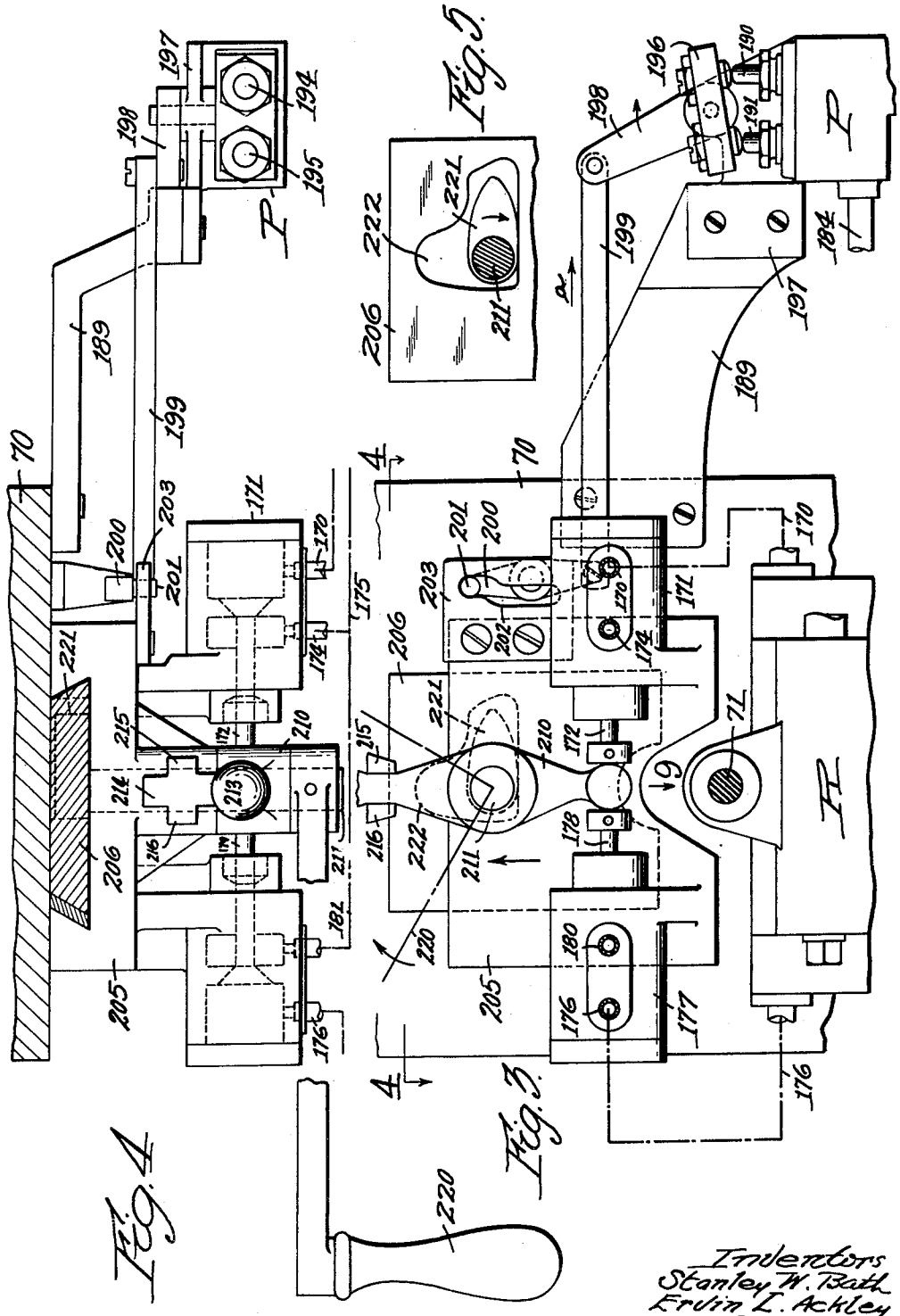


Fig. 4

Fig. 3

Fig. 5

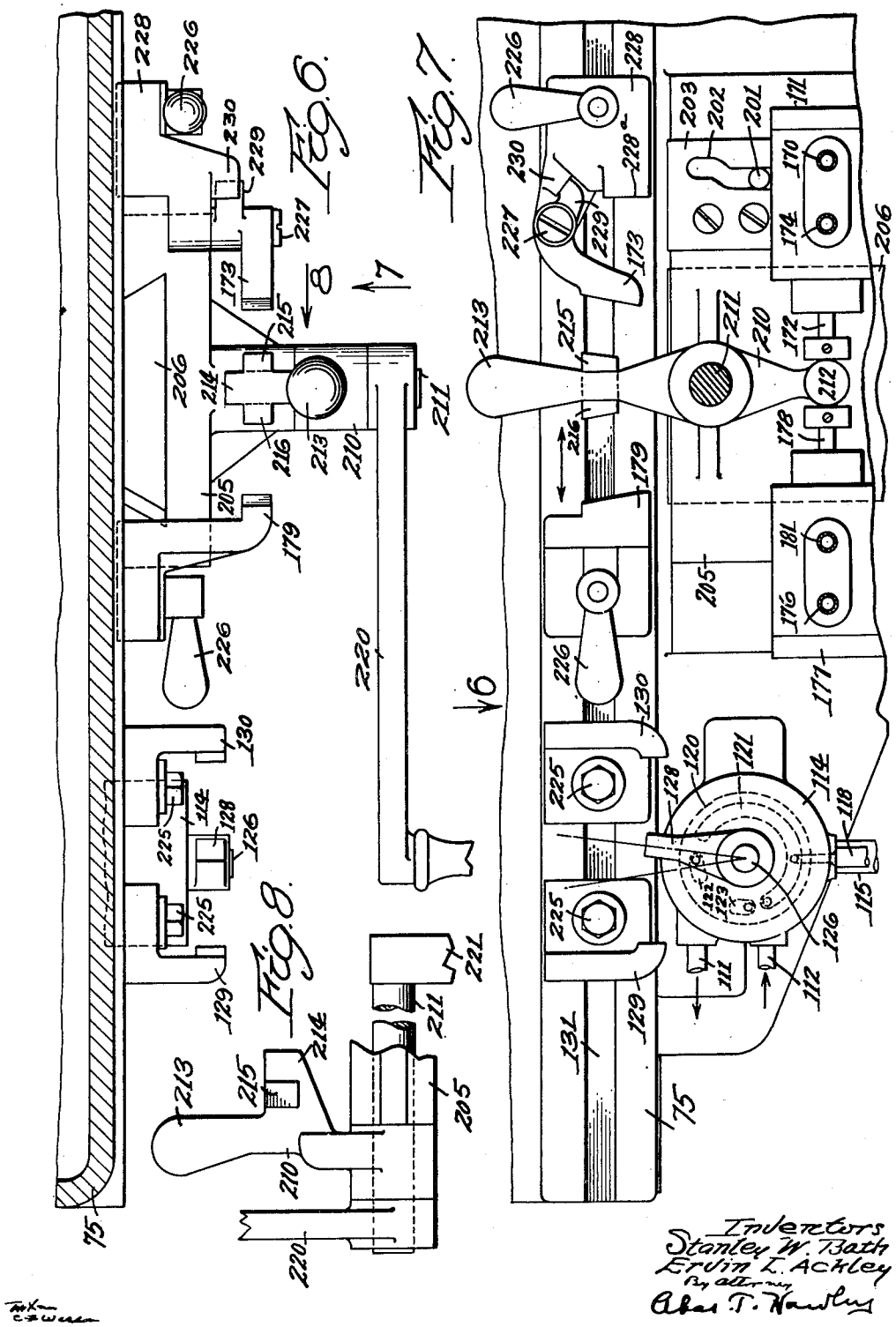
Inventors
Stanley W. Bath
Ervin L. Ackley
By attorney
Chas. T. Hawley

Witness
C. F. Wesson

May 24, 1938. S. W. BATH ET AL 2,118,139

MACHINE FOR GRINDING FLUTES

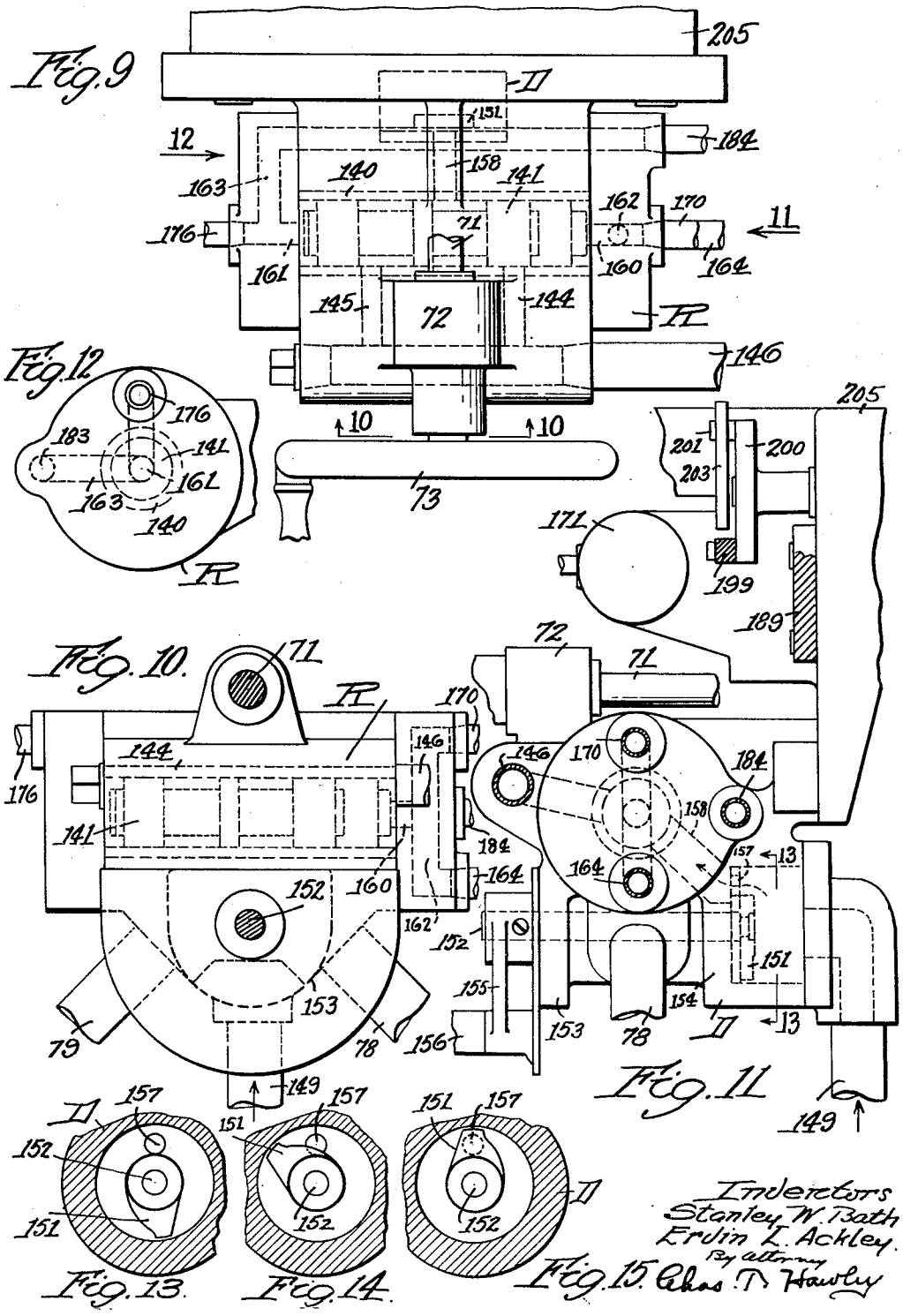
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MACHINE FOR GRINDING FLUTES

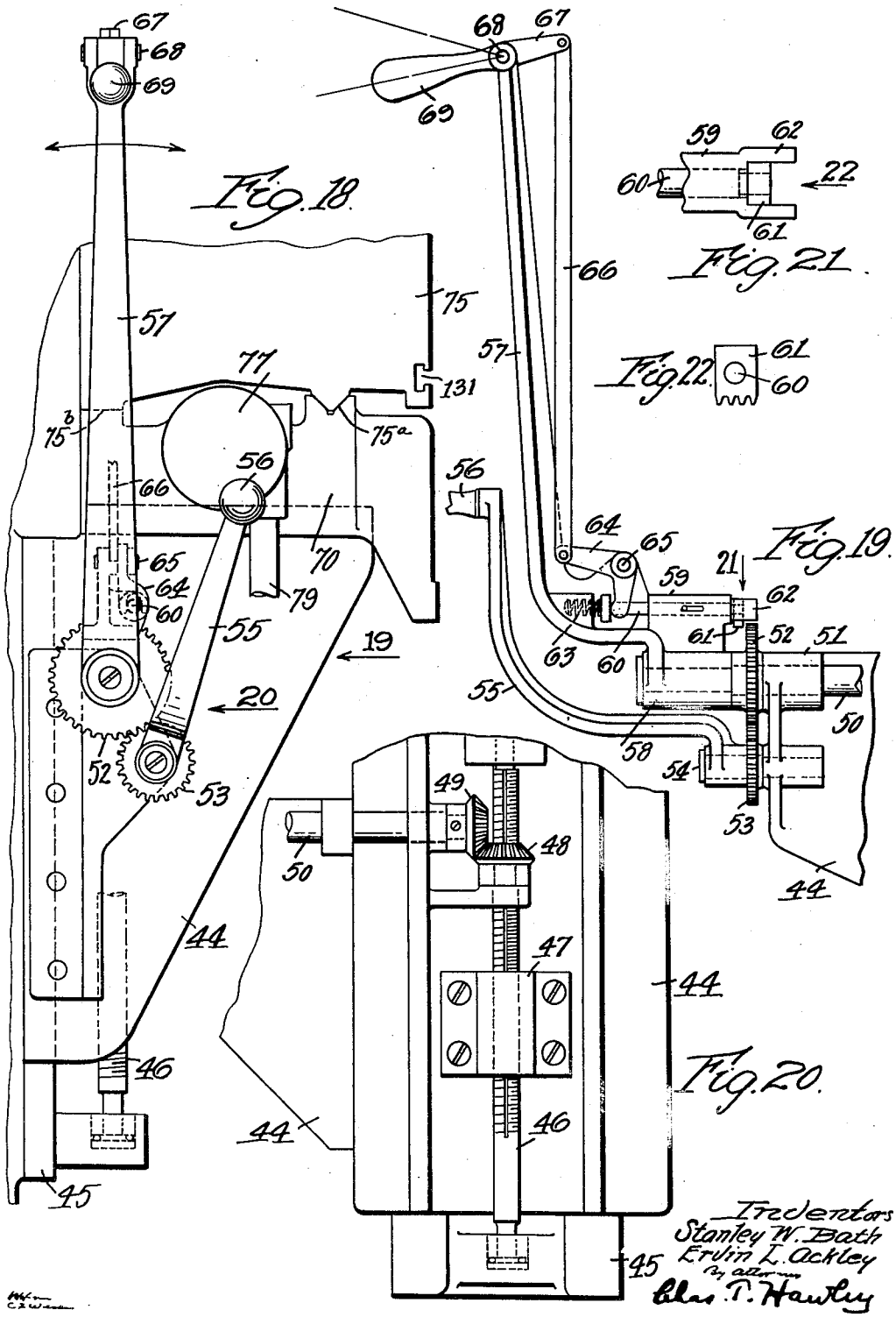
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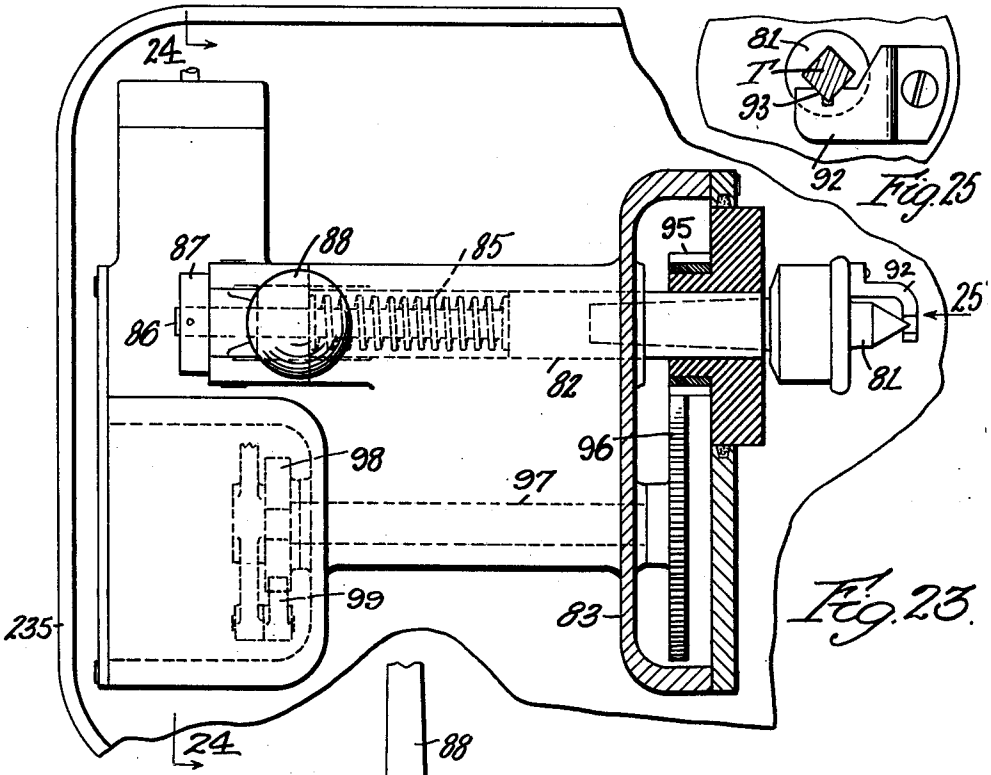


Fig. 23.

Fig. 25

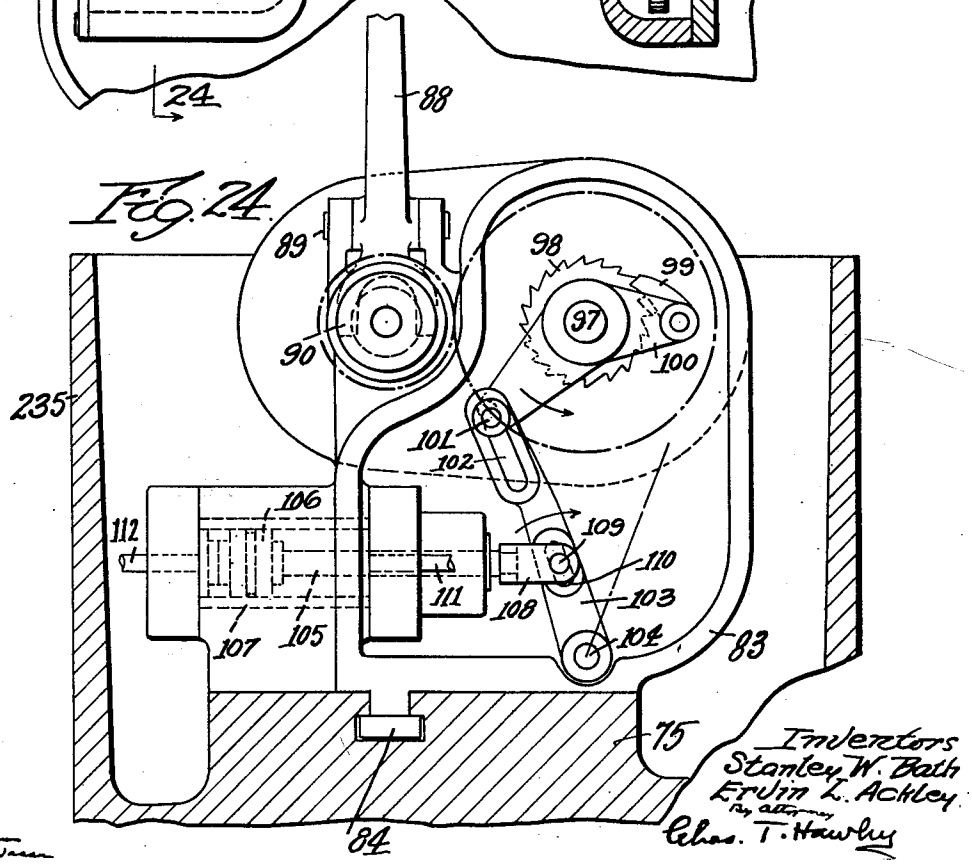


Fig. 24.

Inventors
Stanley W. Bath
Erwin L. Ackley
By attorney
Chas. T. Hawley

Witness
C. E. Warren

May 24, 1938. S. W. BATH ET AL 2,118,139

MACHINE FOR GRINDING FLUTES

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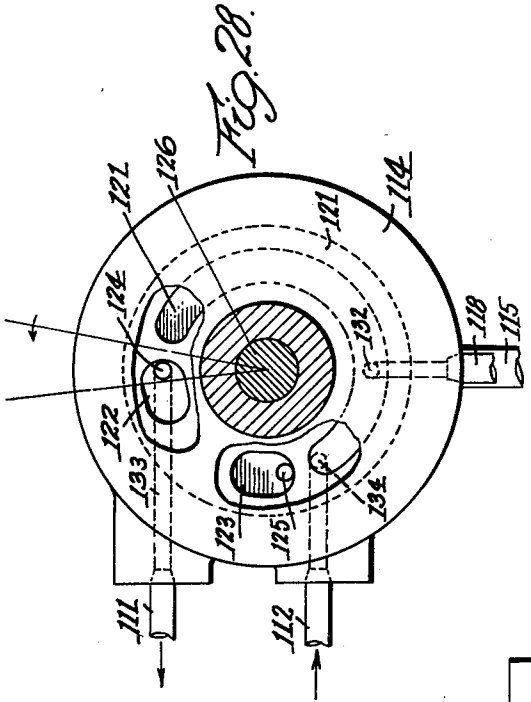


Fig. 28.

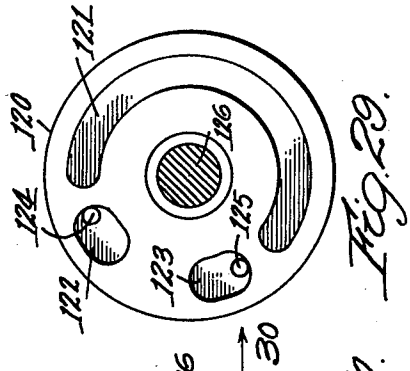


Fig. 29.

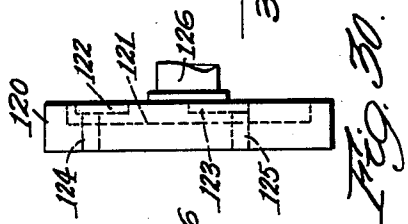


Fig. 30.

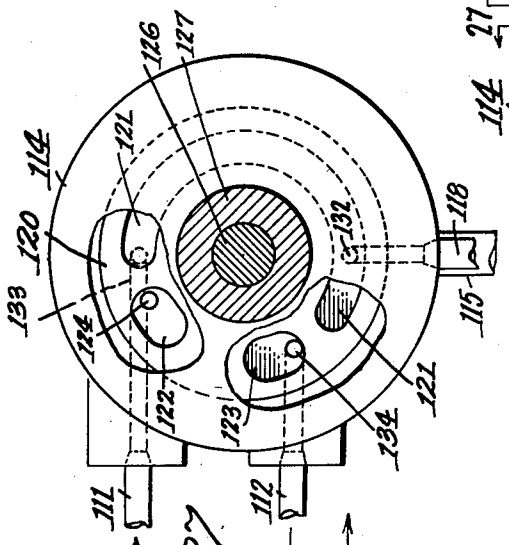


Fig. 27.

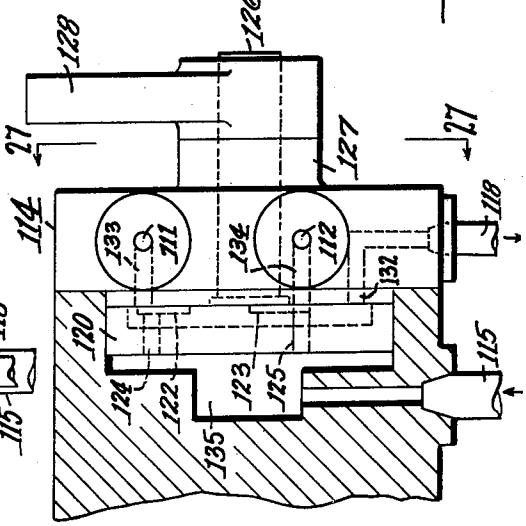


Fig. 26.

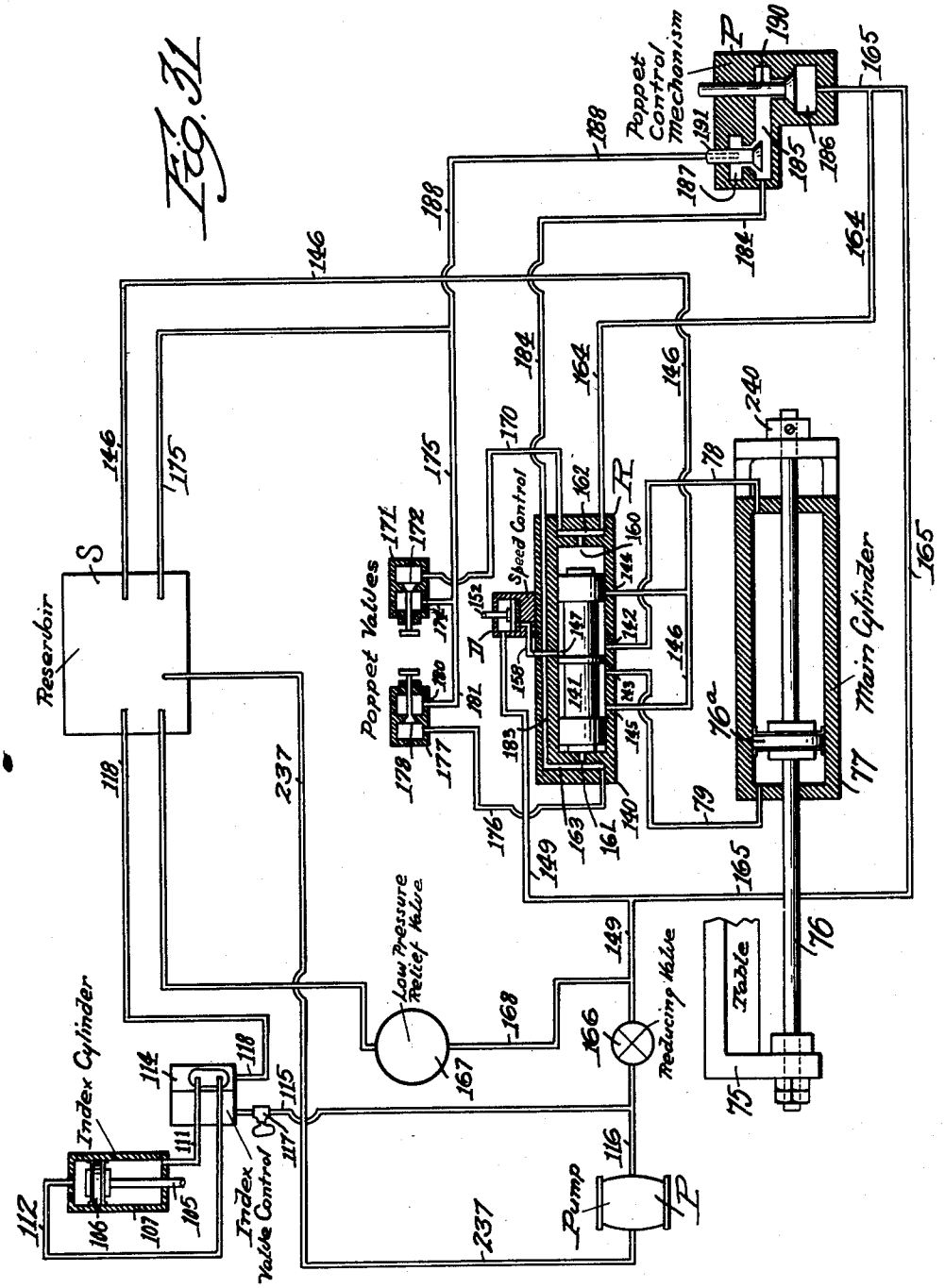
Inventors
Stanley W. Bath.
Erwin L. Ackley
by attorney
Chas. P. Hawley

May 24, 1938. S. W. BATH ET AL 2,118,139

MACHINE FOR GRINDING FLUTES

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Fig. 11



Inventors
Stanley W. Bath
Erwin L. Ackley.
By attorney
Chas. T. Hawley

May 24, 1938. S. W. BATH ET AL 2,118,139

MACHINE FOR GRINDING FLUTES

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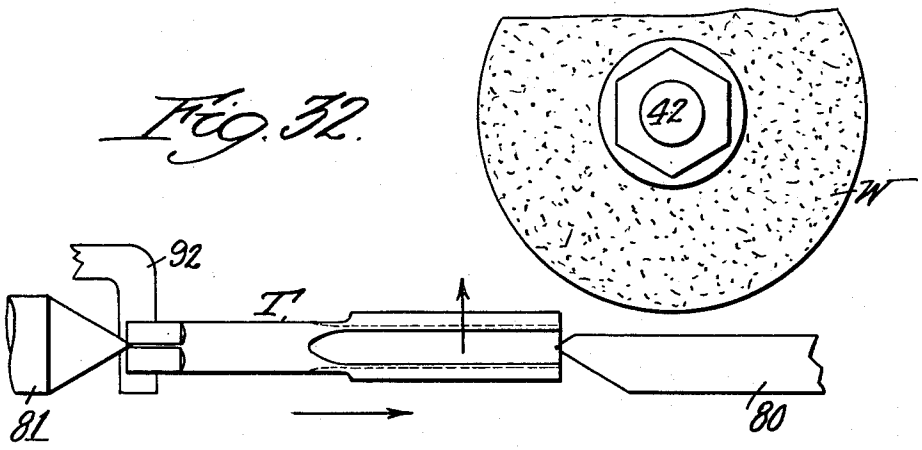


Fig. 32.

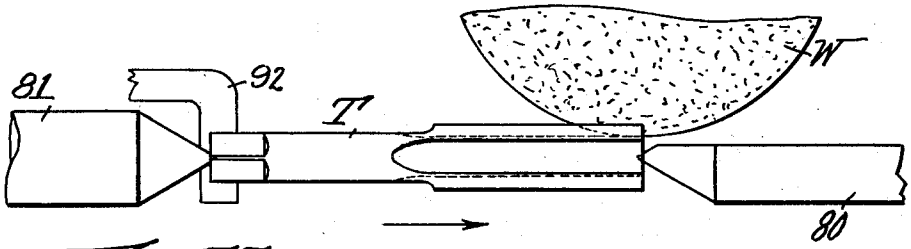


Fig. 33.

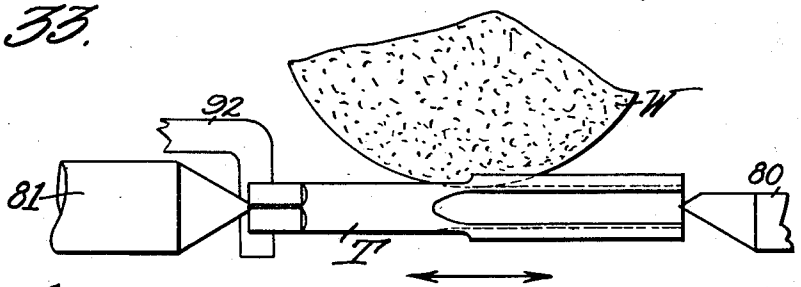


Fig. 34.

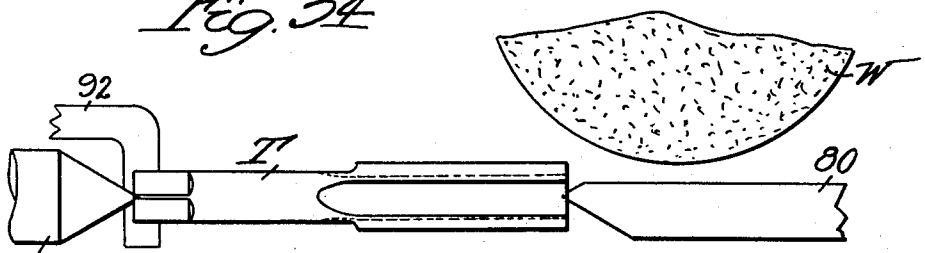


Fig. 35.

Inventors.
Stanley W. Bath
Erwin L. Ackley
by attorneys.
Rhea T. Hawley

Patented May 24, 1938 2,118,139

UNITED STATES PATENT OFFICE

2,118,139

MACHINE FOR GRINDING FLUTES

Stanley W. Bath, Shrewsbury, and Ervin L. Ackley, Worcester, Mass., assignors to John Bath & Company, Worcester, Mass., a corporation of Massachusetts

Application June 1, 1936, Serial No. 82,808

16 Claims. (Cl. 51—92)

This invention relates to the manufacture of taps for threading holes in metal, and relates more particularly to the finishing of the longitudinal flutes in such taps or in other similar articles.

It is customary to rough out these flutes with a milling cutter before the taps are hardened and to finish the flutes by grinding after the hardening operation.

It is the general object of our invention to provide an improved machine for performing the flute-grinding operation.

In the preferred form, our improved machine is hydraulically actuated, and important features of our invention relate to novel devices by which the operator may conveniently vary and control the operation of the machine through manipulation and adjustment of the hydraulic mechanism.

Our invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawings, in which

Fig. 1 is a front elevation of our improved flute-grinding machine;

Fig. 2 is a partial right-hand elevation, looking in the direction of the arrow 2 in Fig. 1;

Fig. 3 is an enlarged front elevation of certain control mechanism;

Fig. 4 is a sectional plan view, taken along the line 4—4 in Fig. 3;

Fig. 5 is a front elevation of a cam and cam plate to be described;

Fig. 6 is a sectional plan view, taken along the line 6—6 in Fig. 1;

Fig. 7 is a partial front elevation, looking in the direction of the arrow 7 in Fig. 6;

Fig. 8 is a detail side elevation, looking in the direction of the arrow 8 in Fig. 6;

Fig. 9 is a plan view of certain parts, partly in section, and looking in the direction of the arrow 9 in Fig. 3;

Fig. 10 is a sectional front elevation, taken along the line 10—10 in Fig. 9;

Fig. 11 is a right-hand side elevation of certain parts, looking in the direction of the arrow 11 in Fig. 9;

Fig. 12 is a left-hand detail side elevation, looking in the direction of the arrow 12 in Fig. 9;

Fig. 13 is a detail sectional view showing a speed control valve and taken along the line 13—13 in Fig. 11;

Figs. 14 and 15 are views similar to Fig. 13 but showing the valve in successive different positions;

Fig. 16 is a sectional front elevation of certain valve control mechanism shown at the right in Fig. 1;

Fig. 17 is a side elevation of the control mechanism, looking in the direction of the arrow 17 in Fig. 16;

Fig. 18 is a left-hand side elevation of the table-elevating mechanism, looking in the direction of the arrow 18 in Fig. 1;

Figs. 19 and 20 are front elevations of parts of said mechanism, looking in the direction of the arrows 19 and 20 respectively in Fig. 18;

Fig. 21 is a detail plan view, looking in the direction of the arrow 21 in Fig. 19;

Fig. 22 is an end view, looking in the direction of the arrow 22 in Fig. 21;

Fig. 23 is a sectional plan view of the work spindle head, looking in the direction of the arrow 23 in Fig. 1;

Fig. 24 is a sectional side elevation, taken along the line 24—24 in Fig. 23;

Fig. 25 is a detail side elevation, looking in the direction of the arrow 25 in Fig. 23;

Fig. 26 is a side elevation, partly in section, of certain index valve mechanism, looking in the direction of the arrow 26 in Figs. 1 and 27;

Fig. 27 is a sectional front elevation, partly broken away and taken along the line 27—27 in Fig. 26;

Fig. 28 is a view similar to Fig. 27 but showing certain parts in a different position;

Fig. 29 is a front elevation of the index valve disc;

Fig. 30 is a side elevation thereof, looking in the direction of the arrow 30 in Fig. 29;

Fig. 31 is a diagrammatic view showing the hydraulic connections; and

Figs. 32 to 35 inclusive show successive steps in a flute-grinding operation.

Referring to Figs. 1 and 2, our improved flute-grinding machine comprises a frame 40 having a wheel head 41 mounted in fixed position thereon and supporting a grinding wheel W on a wheel spindle 42. The wheel spindle may be rotated by any suitable driving mechanism, such as an electric motor or belt and pulley connection (not shown).

Vertical adjustment of work

A bracket 44 (Fig. 2) is slidable in guideways 45 on the front of the frame 40 and is movable vertically by a screw 46 rotatable in fixed bearings and threaded through a nut 47 fixed on the

bracket 44. A bevel gear 48 is keyed to the screw 46 and is freely slidable thereon. The gear 48 is supported on the bracket 44 and engages a bevel gear 49 (Fig. 20) on a shaft 50 extending laterally to the side of the machine, where it is supported in a bearing 51 (Fig. 19) on the bracket 44.

A gear 52 is keyed to the shaft 50 and meshes with a smaller gear 53 mounted on a stud 54 and provided with a crank arm 55 and handle 56. By turning the handle 56, the screw 46 may be rotated. As the screw is held in fixed vertical position, the nut 47 and bracket 44 will be correspondingly raised or lowered.

The handle 56 is used for major adjustments of the work-supporting bracket 44, but for finer adjustments, particularly during the grinding operation, we provide an additional crank arm 57 (Figs. 18 and 19) which is loosely mounted on the outer end of the shaft 50.

The hub 58 of the crank arm 57 is provided with an offset axially extending bearing 59 for a plunger 60 having a toothed plate 61 (Fig. 22) secured to its outer end and slidable between guiding projections 62 (Fig. 21) formed on the offset bearing 59.

A coil spring 63 (Fig. 19) is mounted in a pocket in the crank arm and normally forces the plunger 60 to the right in Fig. 19, causing the teeth on the plate 61 to engage the teeth of the gear 52 which is fast on the shaft 50.

The crank arm 57 is thus normally connected direct to the gear 52 and shaft 50. Provision is made, however, for disengaging the toothed plate 61 from the gear 52 when it is desired to make a substantial adjustment in the position of the bracket 44 by means of the crank handle 56.

For this purpose a bell crank 64 (Fig. 19) is pivoted at 65 on a projection of the bearing 59, and is connected by a link 66 to a handle lever 67, which is pivoted at 68 to the upper end of the crank arm 57. By moving the handle portion 69 of the lever 67 downward, the bell crank 64 may be caused to withdraw the plunger 60 against the pressure of the spring 63, thus disengaging the toothed plate 61 from the gear 52. As soon as the handle portion 69 is released, however, the plate and gear will be reengaged. The use of the handle 69 during the grinding operation will be hereinafter explained.

A bed 70 (Figs. 2 and 18) is slidable forward and rearward along guideways on the top surface of the bracket 44. An adjusting screw 71 is rotatable in a bearing 72 at the front of the bed 70 and is provided with a hand-wheel 73. The screw 71 is threaded in a nut 74 on the bracket 44. Forward and rearward manual adjustment of the bed 70 is thus made easily available.

A work table 75 is slidable transversely of the machine along guideways 75a and 75b (Fig. 2) on the bed 70. The work table 75 (Fig. 31) is connected by a piston rod 76 to a piston 76a slidable in a main hydraulic cylinder 77 shown in end view in Fig. 2. Pipes 78 and 79 (Fig. 31) connect the cylinder 77 to hydraulic supply and control mechanism to be described.

Work spindle head

The tap T to be ground is mounted on the sliding work table 75 between a fixed tail center 80 (Fig. 32) and a head center 81. The head center 81 (Fig. 23) is mounted in the end of a work spindle 82 slidable and rotatable in a bearing in the work spindle head 83 which is mounted on the sliding table 75 and which is adjustable longitudinally of the table as indicated at 84 in Fig. 24.

A coil spring 85 is mounted on a reduced portion 86 of the plunger 82 and pushes the plunger to the right in Fig. 23 until the head center 81 engages the work or until a collar 87 on the plunger portion 86 engages the rear end of the plunger bearing.

A hand lever 88 is pivoted at 89 on the plunger bearing and extends upward therefrom. The lower end of the lever 88 is forked as indicated at 90 (Fig. 24) and engages the inner face of the collar 87 previously described. By pressing the handle 88 to the right in Fig. 23, the head center 81 may be withdrawn to permit insertion or removal of the work. A dog or driver 92 (Figs. 23 and 25) is mounted on an enlarged portion of the head center 81 and is notched as indicated at 93 to loosely receive the shank of a tap T.

Indexing mechanism

For the purpose of indexing the work, the head center 81 or the work spindle 82 is provided with a pinion 95 (Fig. 23) meshing with a gear 96 mounted on a countershaft 97 rotatable in a fixed bearing in the work head 83. At its opposite end the countershaft 97 is provided with a ratchet wheel 98, the teeth of which are engaged by a pawl 99 pivotally mounted on an index lever 100, which in turn is loosely pivoted on the outer end of the countershaft 97.

The feed lever 100 is provided with a stud 101 (Fig. 24) extending through an elongated slot 102 in the upper end of an actuating lever 103 pivoted at 104 on the work spindle head 83.

A piston rod 105 and piston 106 are slidable in an index cylinder 107, and the piston rod is connected by a slotted head 108 and cross-pin 109 to the index lever 103, with the cross-pin extending through a second slot 110 in the index lever.

Pipes 111 and 112 connect the opposite ends of the cylinder 107 to an index valve mechanism 114 (Fig. 1) mounted on the front side of the bracket 44 and connected by a pipe 115 (Fig. 31) to a high pressure supply pipe 116 which in turn is connected to a pressure pump P.

A shut-off valve 117 is preferably provided in the pipe 115 for a purpose to be described. The valve mechanism 114 is also provided with an exhaust pipe 118 through which liquid may be discharged to a reservoir S.

The index valve mechanism 114 is shown in detail in Figs. 26 to 30 and comprises a casing in which is rotatably mounted a disc 120 having an arcuate recess 121 in one face thereof and having smaller recesses 122 and 123 in the same face but provided with ports 124 and 125 extending through the disc from opposite ends of the recesses 122 and 123.

The disc 120 is mounted on a short shaft 126 rotatable in a bearing 127 formed on the casing of the valve mechanism. The shaft 126 is provided at its outer end with an arm 128 (Fig. 1) extending upward into the path of index dogs 129 and 130 adjustably secured in a T-slot 131 in the front of the sliding table 75.

The exhaust pipe 118 (Fig. 27) is connected to a port 132 which communicates with the arcuate recess 121 in all working positions of the disc 120. The pipes 111 and 112 are also provided with ports 133 and 134 respectively and the supply pipe 115 is connected to a recess 135 (Fig. 26) behind the disc 120 and in constant communication with the ports 124 and 125.

When the index valve disc 120 is in the position

shown in Fig. 27, the supply pipe 115 is connected through the port 125, recess 123 and the port 134 to the index cylinder pipe 112, thus giving the indexing mechanism an operating or feeding movement.

At the same time, the pipe 111 from the opposite end of the cylinder is connected through the port 133, arcuate recess 121 and port 132 to the exhaust pipe 118. At this time the port 124 and recess 122 are out of alignment with the port 133.

When the valve disc 120 is shifted to the position shown in Fig. 28, the supply pipe is connected through the port 124, recess 122 and port 133 to the pipe 111, which thus supplies oil under pressure at the right-hand end of the index cylinder 107 (as viewed in Fig. 24) and gives the feeding mechanism an idle return stroke. At the same time, the pipe 112 is connected through the port 134 and arcuate recess 121 to the port 132 and exhaust pipe 118, while the supply port 125 and recess 123 are out of operative position.

The arm 128 is engaged by the dog 130 and shifted from the right-hand position shown in Fig. 1 to the left-hand position indicated by the broken line as the table 75 is moved to the left to withdraw the work from the wheel. At the right-hand limit of table travel, when the wheel is in the flute, the arm 128 is engaged by the dog 129 and is returned to the position indicated in Fig. 1, thus giving the indexing mechanism an idle return stroke without indexing action.

On each engagement of the arm 128 by the dog 130, the piston 106 will move to the right in Fig. 24, and the pawl 99 will engage the teeth of the ratchet wheel 98 and give the countershaft 97 a partial revolution which is communicated through the gear 96 and pinion 95 to the work spindle 82, thus indexing and advancing the work angularly.

If it is desired at any time to discontinue the indexing, the valve 117 (Fig. 31) may be closed, after which the arm 128 and valve disc 120 may be shifted as previously described but no indexing action will take place.

Reversing valve and speed control valve

The supply of liquid to the main cylinder 77 is controlled by a reversing valve R (Fig. 31) comprising a cylinder 140 having a floating piston or bobbin 141 freely slidable therein.

The pipes 78 and 79 previously described connect ports 142 and 143 in the cylinder 140 to the opposite ends of the main cylinder 77 which actuates the sliding table. Exhaust ports 144 and 145 in the cylinder 140 are connected through an exhaust pipe 146 to the reservoir S.

An additional port 147 is connected through a speed-control device D (Figs. 11 and 31) to a branch supply pipe 149 which provides oil under pressure. The speed-control device D is shown in detail in Figs. 11 and 13 to 15, and comprises a throttle valve plate 151 mounted on a short shaft 152 rotatable in fixed bearings 153 and 154 (Fig. 11) and having an arm 155 secured to the front end of the shaft and provided with a handle 156 (Fig. 2).

By manually adjusting the handle 156, the throttle valve plate 151 will vary the flow of oil from the supply pipe 149 through the port 157 (Fig. 11) to the passage 158 which connects the speed control device D to the port 147 in the reversing valve mechanism R (Fig. 31). The throttle valve plate 151 may be manually adjusted to any desired position and directly controls the rate of travel of the sliding table.

The reversing valve cylinder 140 (Figs. 9 and 31) is provided with end ports 160 and 161 communicating with cross passages 162 and 163. The cross passage 162 is connected by a branch pipe 164 (Fig. 31) to a pressure supply pipe 165 which in turn communicates with the pressure pipe 149 previously described.

As substantially higher pressure is required for operation of the index mechanism, it is customary to provide a reducing valve 166 between the pipes 116 and 149 and a low pressure relief valve 167 in a branch pipe 168 connecting the pipe 149 to the reservoir S. With this arrangement, substantially lower pressure is provided in the pressure supply pipes 149, 165, and 164.

The cross passage 162 (Fig. 31) is also connected by a pipe 170 to a casing 171 containing a poppet valve 172 under the control of a dog 173 on the sliding table 75 (Figs. 6 and 7) through connections to be described. The casing 171 is also provided with a port 174 (Fig. 31) connected to an exhaust pipe 175 communicating with the reservoir S.

The cross passage 163 at the opposite end of the reversing valve cylinder is connected through a pipe 176 (Fig. 31) to a second poppet valve casing 177 having a valve 178 under the control of a second dog 179 on the sliding table 75. A port 180 in the casing 177 is connected by a branch pipe 181 to the exhaust pipe previously described.

When the machine is in operation, both ends of the piston 141 are exposed to equal pressures, except as one or the other poppet valves is opened to partially relieve the pressure.

Poppet valve control mechanism

The cross passage 163 in the left-hand end of the cylinder 140 is also connected through a passage 183 (Fig. 31) and pipe 184 to a chamber 185 in a poppet valve control mechanism P. A second chamber 186 in the mechanism P is connected to the pressure supply pipe 165 and a third chamber 187 is connected by a pipe 188 to the exhaust pipe 175.

The control mechanism P is mounted on an arm 189 (Fig. 4) secured to the bed 70 and comprises a poppet valve 190 controlling communication between the chambers 186 and 185 and a second poppet valve 191 controlling communication between the chambers 185 and 187.

The parts are shown in Fig. 31 in the position assumed when the machine is at rest, with the poppet valve 190 closed to cut off pressure oil from the pipe 184 and cross passage 163, but with pressure oil supplied through the pipe 164, cross passage 162 and port 160 to move the floating piston or bobbin 141 to the left-hand position indicated in Fig. 31. At the same time the left-hand end of the cylinder 140 is connected through the passage 183 and pipe 184 to the exhaust pipe 188 through the open poppet valve 191.

The detailed construction of the mechanism P is shown in Figs. 3, 4, 16, and 17.

Springs 192 and 193 (Fig. 16) are positioned under the valves 190 and 191 and tend to close said valves. The stems of the valves 190 and 191 extend upward through suitable glands and are engaged at their upper ends by contact screws 194 and 195 in opposite ends of a rock arm 196, pivoted on a bracket 197 mounted on the arm 189 as previously stated. The rock arm 196 is connected to an arm 198, which in turn is connected through a link 199 (Fig. 3) to a rock arm 200

having a pin 201 extending into a slot 202 in a cam plate 203. The rock arm 200 is pivoted on the bed 70 and the cam plate 203 is mounted on a slide plate 205 (Fig. 4) vertically movable on a dove-tailed guideway 206 secured to the face of the bed 70.

Upward movement of the slide plate 205 by mechanism to be described causes the cam plate 203 to move the rock arm 200 and shift the link 199 in the direction of the arrow *a* in Fig. 3. This in turn moves the arm 198 and rock arm 196 in a direction to depress and open the poppet valve 190 (Figs. 16 and 31) and to permit simultaneous closing of the poppet valve 191 by its spring 193.

The valves 190 and 191 are then in a position which is the reverse of that shown in Fig. 31, and the pressure supply pipe 165 (Fig. 31) is then connected through the chambers 186 and 185 to the pipe 184 and through the passage 183, cross passage 163 and port 161 to the left-hand end of the cylinder 140 of the reversing valve mechanism R.

As the right-hand end of the cylinder 140 is always supplied with pressure oil through the pipe 164, both ends of the cylinder are then under equal pressure and the bobbin 141 will remain in whatever position it happens to occupy until one or the other of the poppet valves 172 or 178 are opened to reduce the pressure in the associated end of the cylinder 140.

If the piston 141 is in the position shown in Fig. 31 and the poppet valve 172 is open, the pressure pipe 164 will be connected through the pipe 170, casing 171 and port 174 to the exhaust pipe 175, thus reducing the pressure in the cross passage 162 and in the right-hand end of the cylinder 140.

As full pressure is still maintained in the left-hand end of the cylinder, the piston 141 will be shifted to the right, connecting the port 147 to the port 143 and thus admitting oil under pressure through the pipe 79 to the left-hand end of the main cylinder 77.

The piston 141 will remain at the right-hand end of the cylinder 140 until the poppet valve 178 is opened, whereupon the pressure in the left-hand end of the cylinder 140 will be reduced and the piston 141 will return to the position shown in Fig. 31, with oil under pressure supplied through the ports 147 and 142 and pipe 78 to the right-hand end of the main cylinder 77.

The connections between the dogs 173 and 179 and the poppet valves 172 and 178 will now be described.

Manual and automatic control of table travel

A reversing lever 210 (Figs. 6 and 7) is loosely mounted on a shaft 211, which in turn is supported in a bearing in the slide plate 205. A downward projection of the lever 210 terminates in a ball-shaped end 212 positioned between the heads of the poppet valves 172 and 178. The lever 210 also extends upwardly to provide a handle 213 and a rearward projection 214 (Fig. 6) of the lever 210 supports oppositely disposed lugs 215 and 216, having downwardly inclined outer faces positioned for engagement by the dogs 173 and 179 respectively.

A handle 220 is connected to the front end of the shaft 211 and a lifting cam 221 (Figs. 3, 5, and 8) is secured to the rear end of the shaft 211. The cam 221 cooperates with a cam opening in plate 206 fixed to the front of the bed 70.

By swinging the handle 220 upward toward vertical position, the cam 221 is moved in a clockwise direction as indicated in Fig. 5 and the slide plate 205 is moved upward. Such upward movement acts through the rock arm 200 and link 199 to shift the poppet valve control mechanism P as previously described and place the machine in condition for operation.

The upward movement of the slide plate 205 also lifts the lugs 215 and 216 into the path of travel of the dogs 173 and 179. It is of course understood that these dogs, as well as the dogs 129 and 130 previously described, are all conveniently adjustable lengthwise of the sliding table 75 and that they may be secured in adjusted position by bolts 225 for the dogs 129 and 130 and by handle nuts 226 for the dogs 173 and 179.

The dog 173 (Figs. 6 and 7) is pivoted at 227 to an adjustable support 228 and has a projection 229 engaging an abutment 230 on said support. The dog 173 thus swings freely in a clockwise direction but is rigidly held from movement in the opposite direction. This permits a run-off of the table 75 to the left beyond the position determined by the dog 173, when desired.

The operative faces of the dogs 173 and 179 are also beveled or inclined to correspond to the bevel of the lugs 215 and 216.

The sliding table 75 is preferably provided with an upwardly extending wall 235 (Figs. 23 and 24) enclosing the head and tail stocks and protecting the mechanism from grinding wheel dust. A shelf 236 (Fig. 2) may be mounted on the front side of the table wall 235 for the convenience of the operator. A supply pipe 237 (Fig. 31) extends from the reservoir S to the pump P.

Operation

Many features of the operation of the machine have been described at considerable length in connection with the detail description of the parts, but for convenience a comprehensive statement of the cooperation of the several parts will now be given.

The operation to be performed is indicated in Figs. 32 to 35, in which a tap T is shown mounted between tail and head centers 80 and 81 and positioned for engagement by a grinding wheel W.

In Fig. 32 the parts are shown just after a fresh tap has been inserted, the tap being loosely positioned angularly by the dog 92. The tap is then raised to the level of the wheel, as indicated in Fig. 33, and the sliding table is moved to the right, carrying the work under the wheel.

The table is then reciprocated, as indicated by the double arrow in Fig. 34, and the work is raised very slightly during the grinding operation until the desired polished surface is attained.

The work is then lowered and removed to the left, as indicated in Fig. 35, in which position the tap is indexed, after which the described operations are repeated, this procedure being followed until all flutes of the tap are ground.

Major adjustments of the work vertically are accomplished by use of the handle 56 (Figs. 18 and 19) after the toothed plate 61 has been withdrawn from engagement with the gear 52 by rocking the handle 69. The raising and lowering of the work during the grinding operation, as described in connection with Figs. 32 to 35, is accomplished by swinging the arm 57 (Figs. 18 and 19).

The reciprocating motion of the table is under the control of the manually operated handle 220 (Fig. 4) and cam 221 (Figs. 3 and 5) by which the plate 205 and reversing lever 210 are raised or lowered.

When the plate 205 is raised, the cam slot 202

reverses the position of the rock arm 196 forming part of the poppet valve control mechanism P, which action opens the valve 190 and closes the valve 191 (Fig. 31). This supplies oil under pressure through the pipe 184 to the left-hand end of the reversing valve cylinder 140, all as previously described.

Oil under pressure is thus supplied at both ends of the floating piston or bobbin 141 and the piston 141 moves toward one end or the other of the cylinder as one or the other of the poppet valves 172 and 178 is opened to relieve the pressure on the associated end of the cylinder 140.

The lifting of the slide plate 205 not only brings the lugs 215 and 216 on the reverse lever 210 into the path of movement of the dogs 173 and 179, but by reason of the inclined surfaces on the lugs and associated dogs, the length of stroke of the sliding table 75 and the travel of the work supported thereon is also controlled by the extent of lifting action.

By swinging the handle 220 through a greater or less arc, the cam 221 will lift the slide plate 205 a greater or less distance and the dogs 173 and 179 will engage wider or narrower portions of the lugs 215 and 216 on the reverse lever 210.

The higher the reverse lever and lugs are positioned, the longer will be the travel of the table in both directions. This manual control of table travel is of particular advantage in a machine for grinding flutes, as the flutes in different taps vary slightly in length and it is desired to grind each flute far enough to provide a bright surface but not far enough to force the wheel into solid metal. By operating the lever 220 with one hand and the lever 57 with the other hand, the operator can easily control both the depth and length of the cut, so that an effective grinding operation is quickly performed.

When the slide plate 205 is lowered at the end of the grinding operation, the poppet valve control mechanism P is returned to initial position and shifts the valves 190 and 191 to the position shown in Fig. 31 with the pipe 184 connected to the exhaust.

The floating piston 141 will be immediately shifted to the left in Fig. 31, connecting the pipe 78 to the pressure supply and moving the table 75 to the left until further travel is prevented by a stop collar 240 on the piston rod 76.

Near the end of this left-hand travel, the dog 130 engages the arm 128 of the index mechanism, shifting the position of the valve disc 120 (Figs. 27 to 30) and effecting the indexing of the work.

As the table 75 completes its left-hand travel, an abutment 228a (Fig. 7) engages the rearward projection 214 on the reverse lever 210 and swings the lever anti-clockwise to open the poppet valve 172 (Fig. 31). This relieves the pressure on the right-hand end of the piston 141, so that the piston will move immediately to the right as soon as the control mechanism P admits pressure oil to the pipe 184.

When the slide plate 205 and reverse lever 210 are lifted to effect resumption of grinding operations, the lugs 215 and 216 will be at the right of the dog 173, but the dog will yield to permit passage of the lugs as the table moves to the right, which movement is immediately initiated as above described.

As previously stated, the rate of travel of the table 75 may be manually controlled by the speed control valve 151 shown in Figs. 13 to 15, and this valve when once set commonly does not require further attention unless a change in class of work takes place.

Having thus described our invention and the advantages thereof, we do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what we claim is:—

1. In a grinding machine, a sliding table, table-moving mechanism, a single control device for said mechanism, table-reversing means, and manual means to move said device toward and away from the path of table movement, said device when moved by said manual means toward said path placing said machine in operation and said device when additionally moved by said manual means in the same direction being effective to change the range and extent of working travel of said table as defined by said reversing means and during a grinding operation.

2. In a grinding machine, a sliding table, dogs on said table, table-moving mechanism, a control and reverse lever for said mechanism which is normally in lowered inoperative position, and manual means to move said lever vertically into position for engagement by said dogs and by further movement to vary and determine the length of the working stroke of said table during a grinding operation.

3. In a grinding machine, a sliding table, dogs on said table, table-moving mechanism, a control and reverse device for said mechanism, a support on which said control and reversing device is movably mounted, said support being normally in lowered inoperative position, and manual means to raise said support and to thereby move said device into the path of travel of said dogs.

4. In a grinding machine, a sliding table, dogs on said table, hydraulic table-moving mechanism, a control and reverse device for said mechanism, a support for said device, means to lower said support so that said device will clear the dogs, and table-stopping means controlled by said lowering movement.

5. In a grinding machine, a sliding table, a pair of associated reversing dogs on said table, table-moving mechanism, a control and reverse device for said mechanism normally out of position to engage either of said dogs, means to move said device into position for alternate engagement by both of said dogs, and automatic means to immediately move said table to reloading position, and stop said table in such position whenever said device is moved out of operative relation to both of said dogs and regardless of the direction of travel of the table when said device is so moved.

6. In a grinding machine, a sliding table, dogs on said table, hydraulic table-moving mechanism, a control and reverse device for said mechanism, a support for said device, means to lower said support so that said device will clear the dogs, a valve device effective to cause the table to move to reloading position, and a control connection between said support and said valve device.

7. In a grinding machine, a sliding table, dogs on said table, hydraulic table-moving mechanism, a control and reverse device for said mechanism, a support for said device, means to lower said support so that said device will clear the dogs, a valve device effective to cause the table to move to reloading position, a control connection between said support and said valve device, and a cam on said support acting to shift said control connection as said support is lowered.

8. In a grinding machine, a sliding table, dogs on said table, hydraulic table-moving mechanism, a control and reverse device for said mechanism, said device being alternately engaged and moved by said dogs, means effective to vary the extent of working travel of the table resultant from alternate engagement of said device by said dogs while the portions of said dogs which engage said device maintain a fixed relation to said table, and means continuously under manual control effective to operate said first means to selectively vary the table travel while the machine is performing a grinding operation on a piece of work.

9. In a grinding machine, a sliding table, dogs on said table, table moving mechanism, a control and reverse device for said mechanism, said device being alternately engaged and moved by said dogs, and manual means to shift said device bodily relative to said dogs and transversely of their path of travel and to thereby vary the extent of working travel resultant from engagement of said device by said dogs.

10. In a grinding machine, a sliding table, dogs on said table, table-moving mechanism, a control and reverse lever for said mechanism, and means to shift said lever vertically, said dogs having lever-engaging surfaces slanting downwardly toward each other, whereby the range of table travel is determined by the vertical position of said lever.

11. In a grinding machine, a sliding table, a hydraulic table moving mechanism, a reversing valve device therefor, a pressure supply, and a manually operated control mechanism effective to expose both ends of said reversing valve device to full pressure during the time that the machine is in operation and also effective to maintain full pressure at one end of said valve device and to simultaneously connect the other end of said device to the exhaust to relieve the pressure thereon at any point in the table travel and to thereby effect movement of said valve device by which said table is caused to move to predetermined initial position and to stop in such position.

12. In a grinding machine, hydraulic table-moving mechanism, a reversing valve device therefor, a pressure supply and a control mechanism effective to connect both ends of said reversing valve device to said pressure supply during the time that the machine is in operation, and means to connect the pressure connection at one end or the other of said reversing valve to the exhaust at each end of table travel and thereby partially reduce the pressure at the corresponding end of said reversing valve and effect reversal thereof.

13. In a grinding machine, hydraulic table-moving mechanism, a reversing valve device therefor, a pressure supply continuously connected to both ends of said valve device while the machine is in operation, a relief valve for each end of said cylinder, exhaust connections for said relief valves, and means to open a selected relief valve at each end of the table travel to effect reversal of said travel.

14. In a grinding machine, hydraulic table-moving mechanism, a reversing valve device therefor, a pressure supply continuously connected to both ends of said valve device while the machine is in operation, a relief valve for each end of said cylinder, exhaust connections for said relief valves, means to open a selected relief valve at each end of the table travel to effect reversal of table travel, and means to shift the connection at one end of said valve device from pressure to exhaust when the machine is to be stopped and to thereby cause the machine to be stopped in reloading position.

15. In a grinding machine, a frame, a work-supporting member, a lifting screw for said member, a cross shaft geared to said screw, a gear fixed to said cross shaft, an arm loose on said cross shaft, a handle on said arm, a driving element on said arm engaging said gear, and a connection between said driving element and said handle whereby said driving element may be moved to inoperative position by rocking said handle on said arm.

16. The combination in a grinding machine as set forth in claim 15, in which a second gear engages the gear on the cross shaft, and a second arm and handle are connected to turn said second gear, said second arm and handle being available for major vertical adjustments of said member.

STANLEY W. BATH.
ERVIN L. ACKLEY.