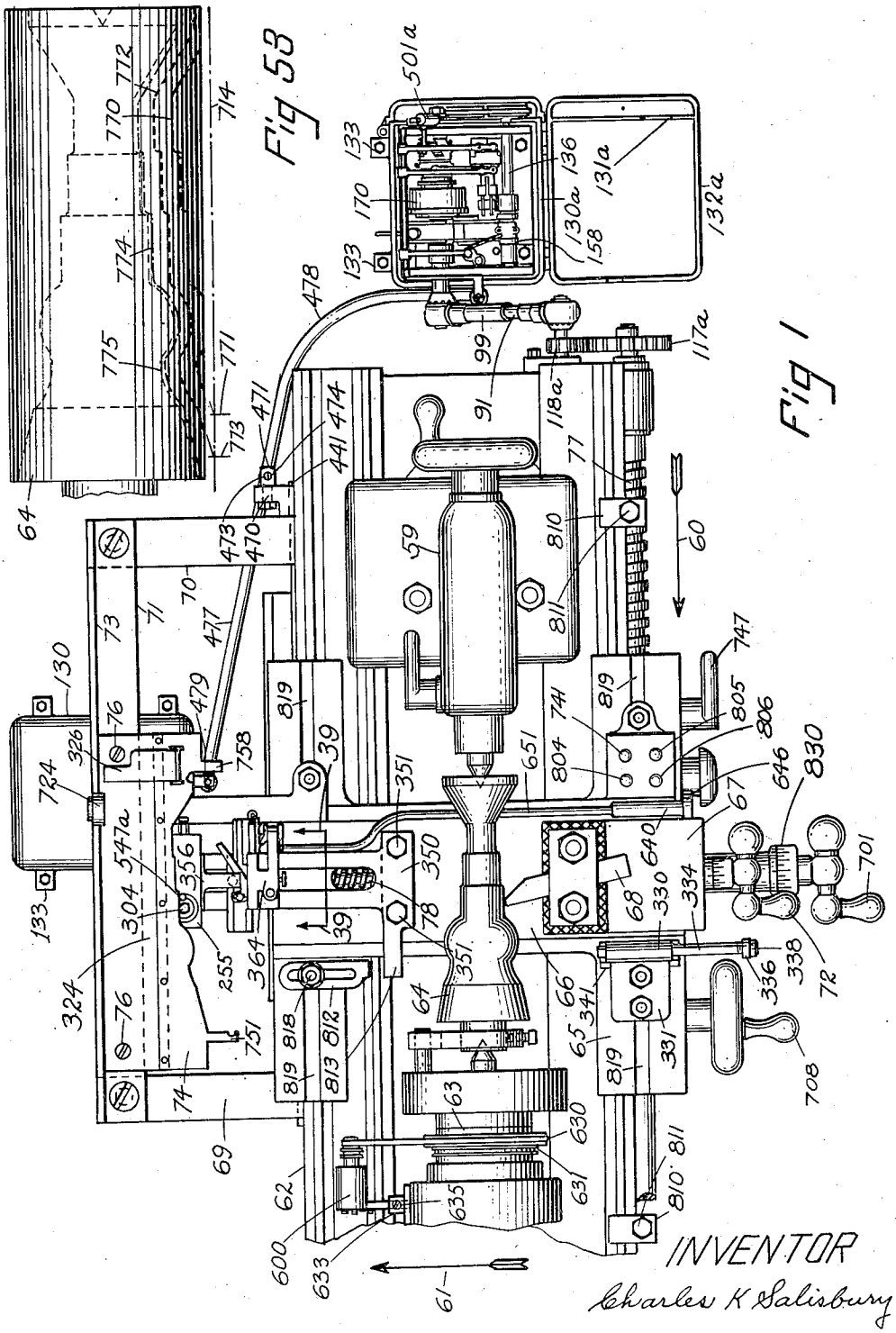
June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 1

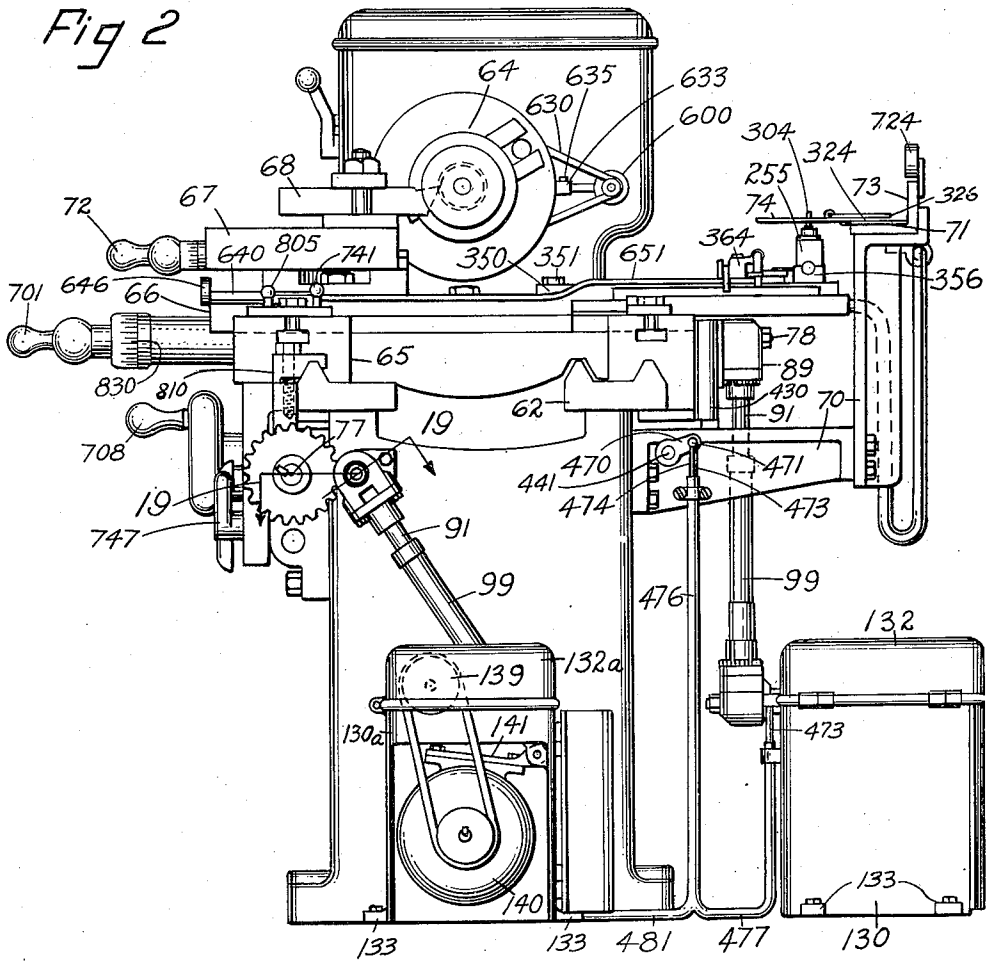


June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 2

Fig 2



INVENTOR

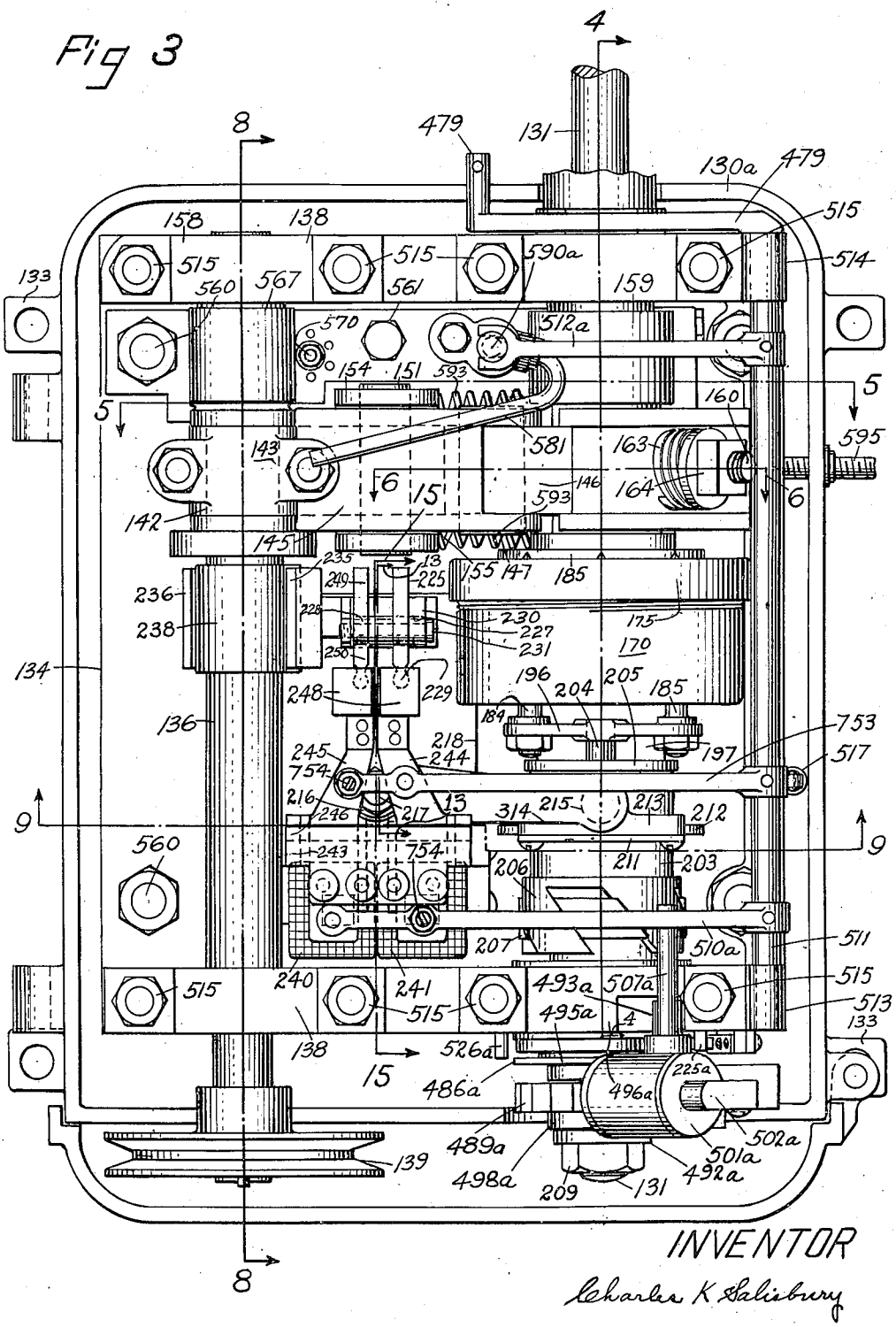
Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 3

Fig 3



INVENTOR

Charles K. Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 4

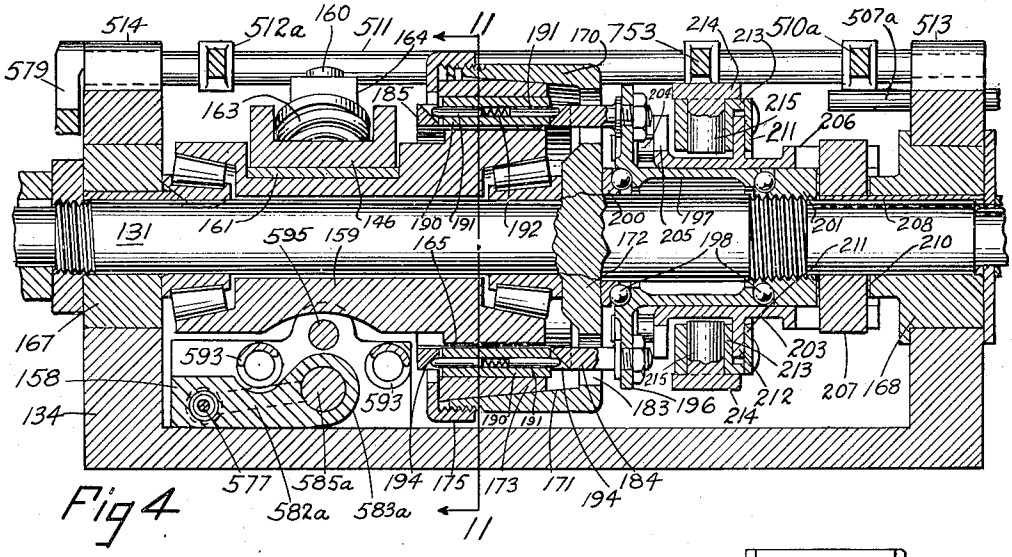


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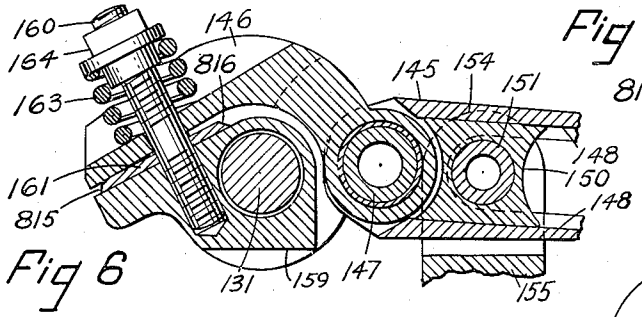


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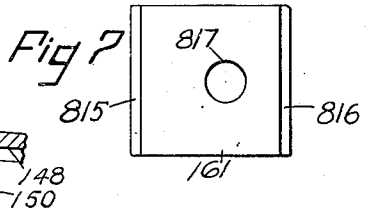


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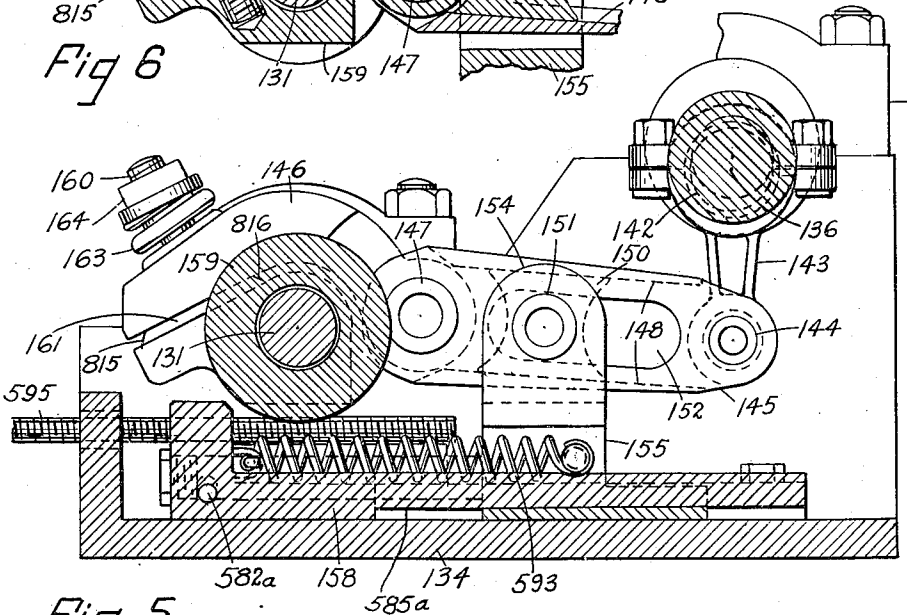


Fig 5

INVENTOR

Charles K. Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 5

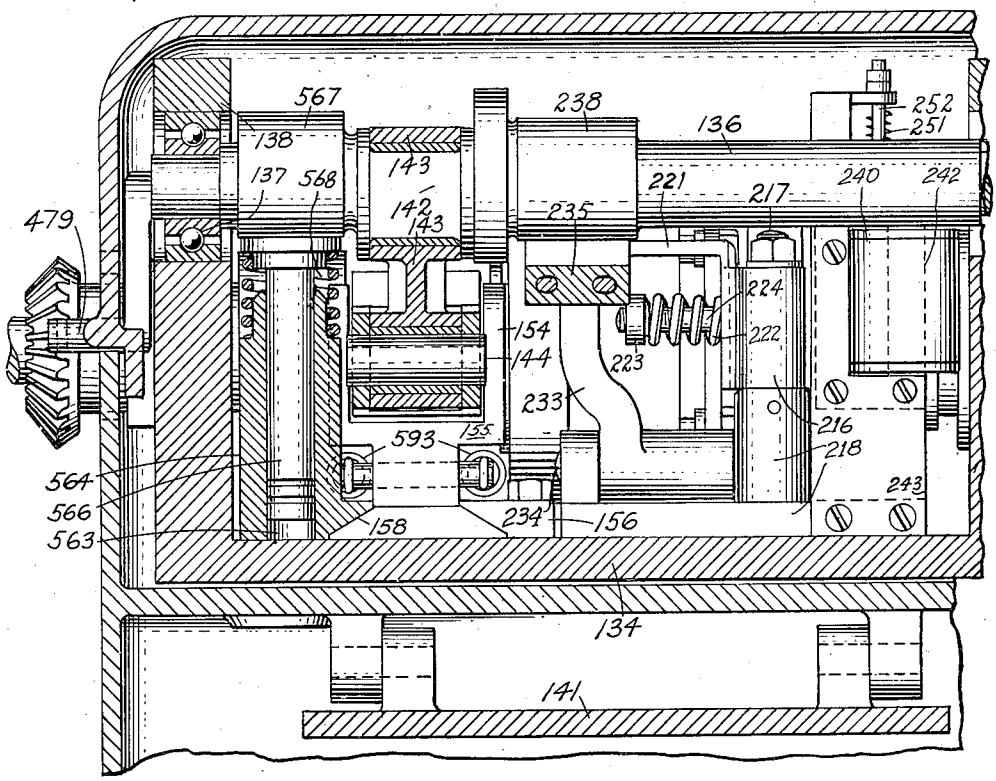


Fig. 8

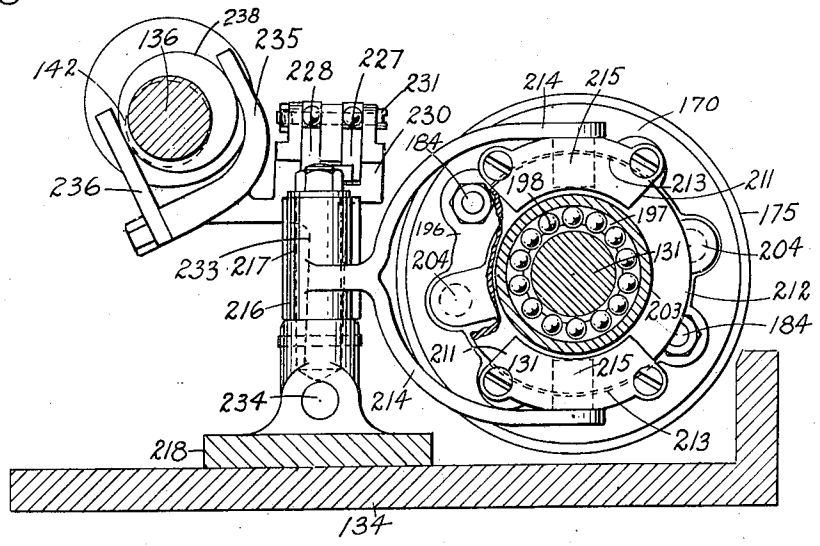


Fig 9

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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Fig 10

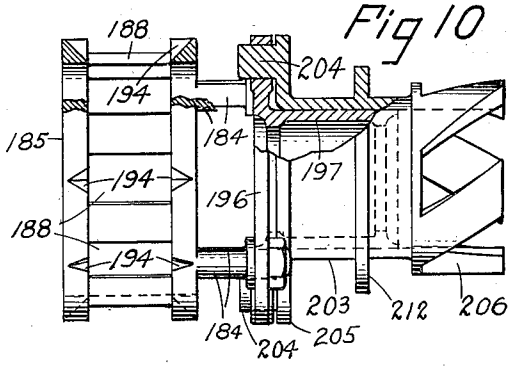


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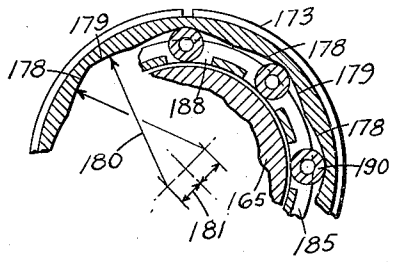
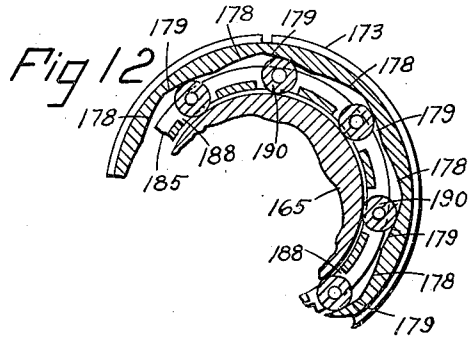


Fig 12



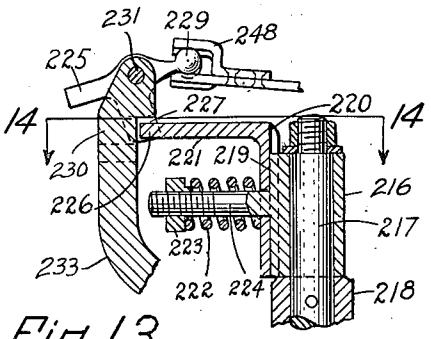


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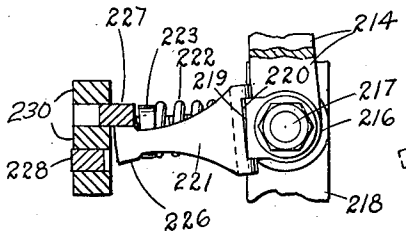


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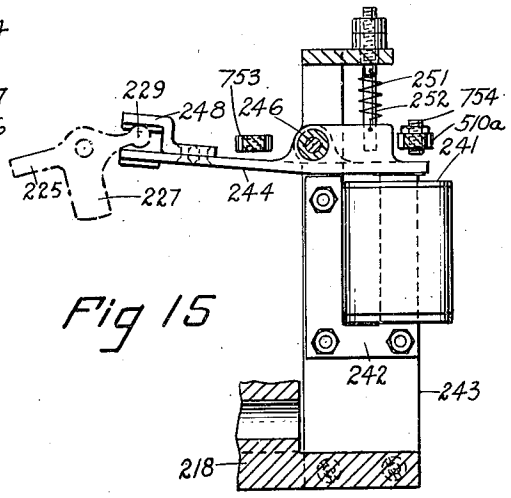


Fig 15

INVENTOR

Charles K Salisbury

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TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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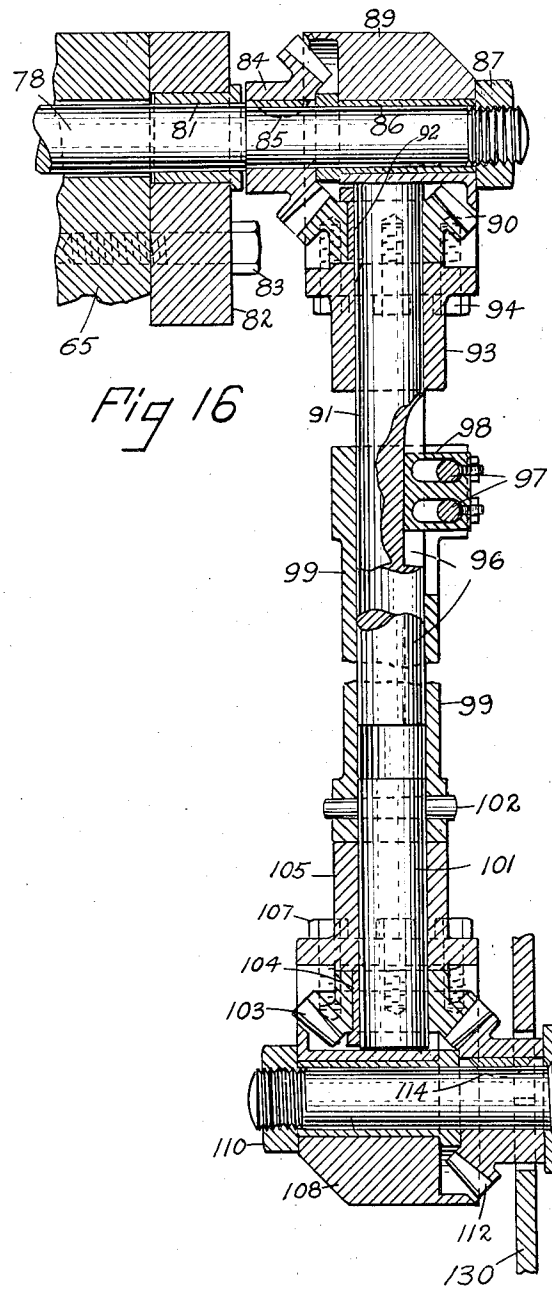


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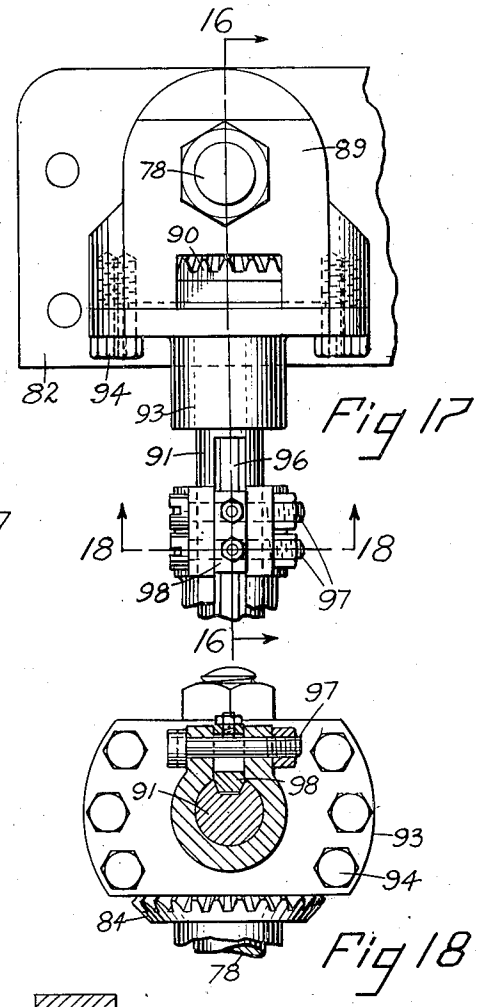


Fig 17

Fig 18

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 8

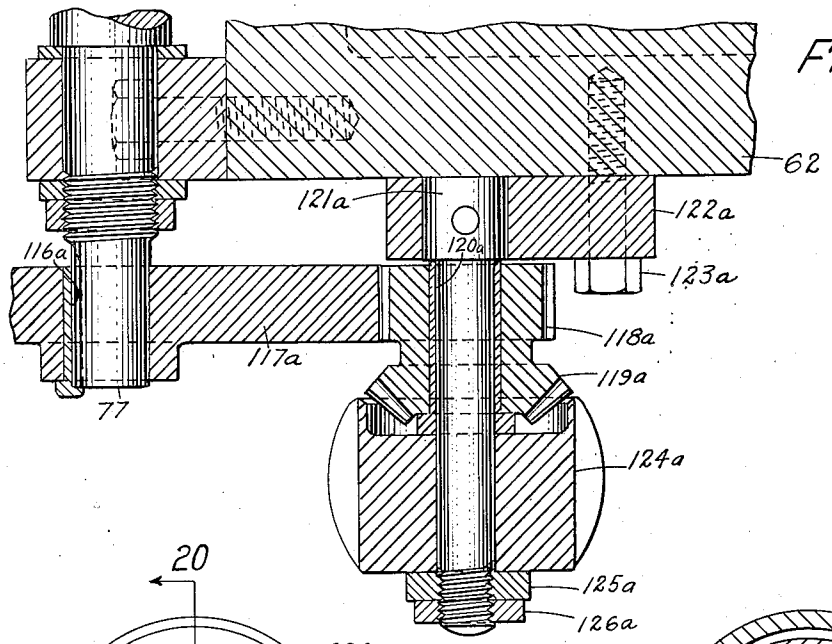


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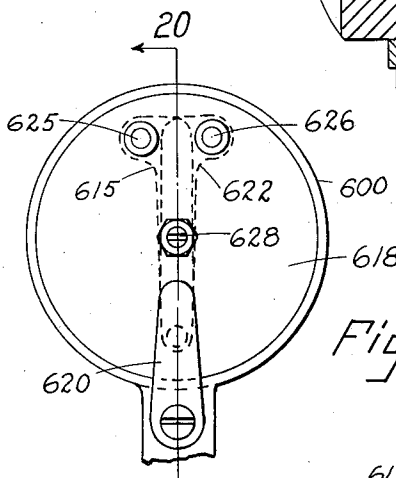


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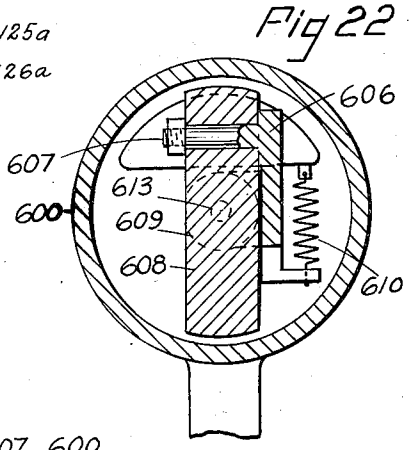


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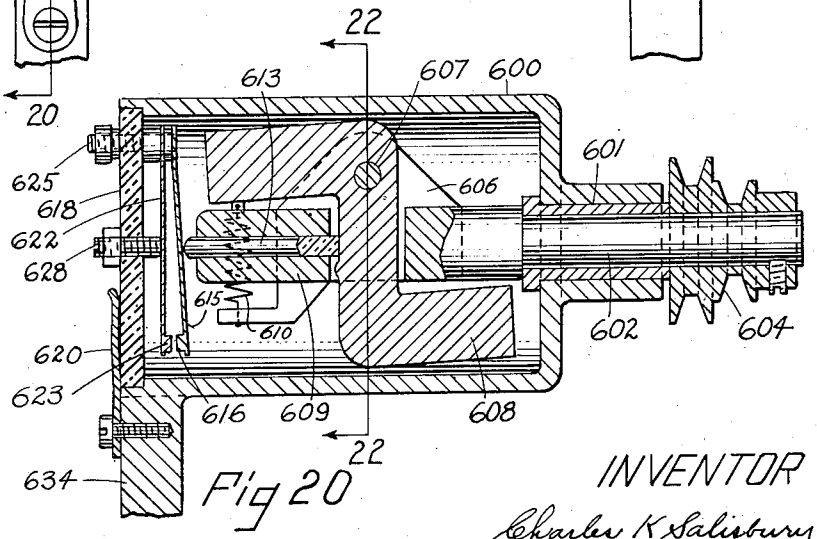


Fig 20

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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Fig 23

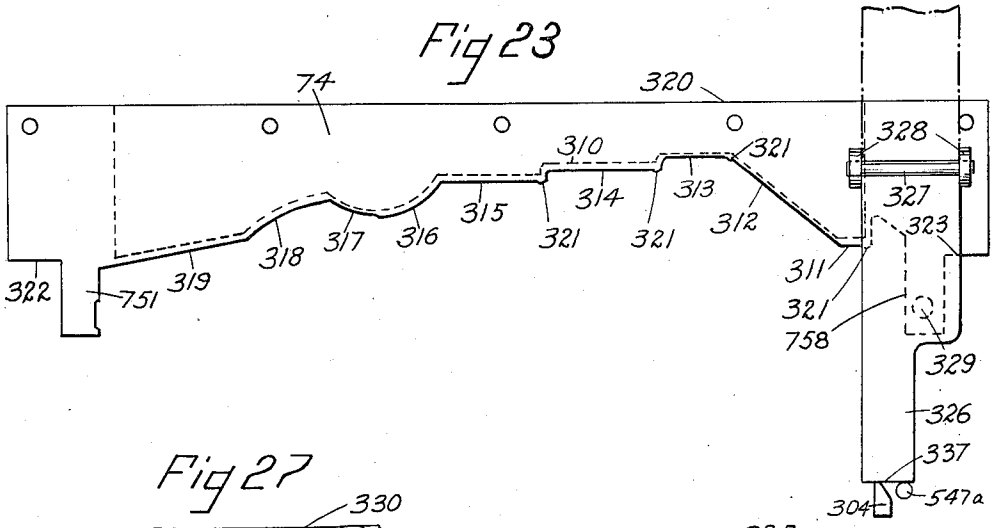
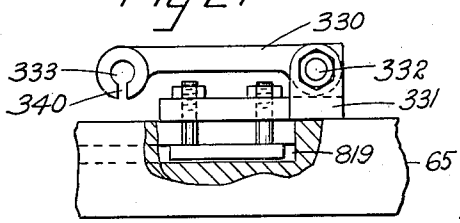


Fig 27



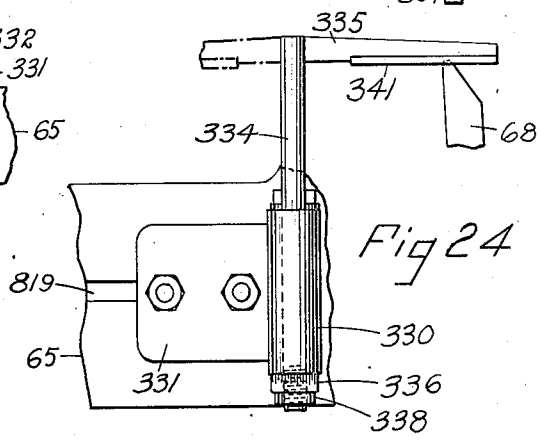


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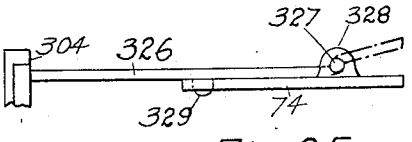


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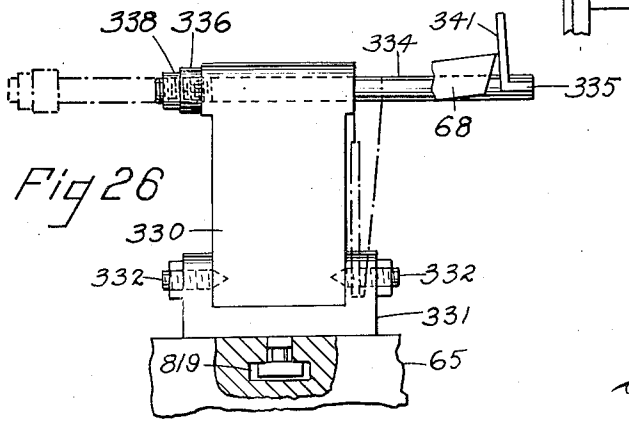


Fig 26

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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Fig 28

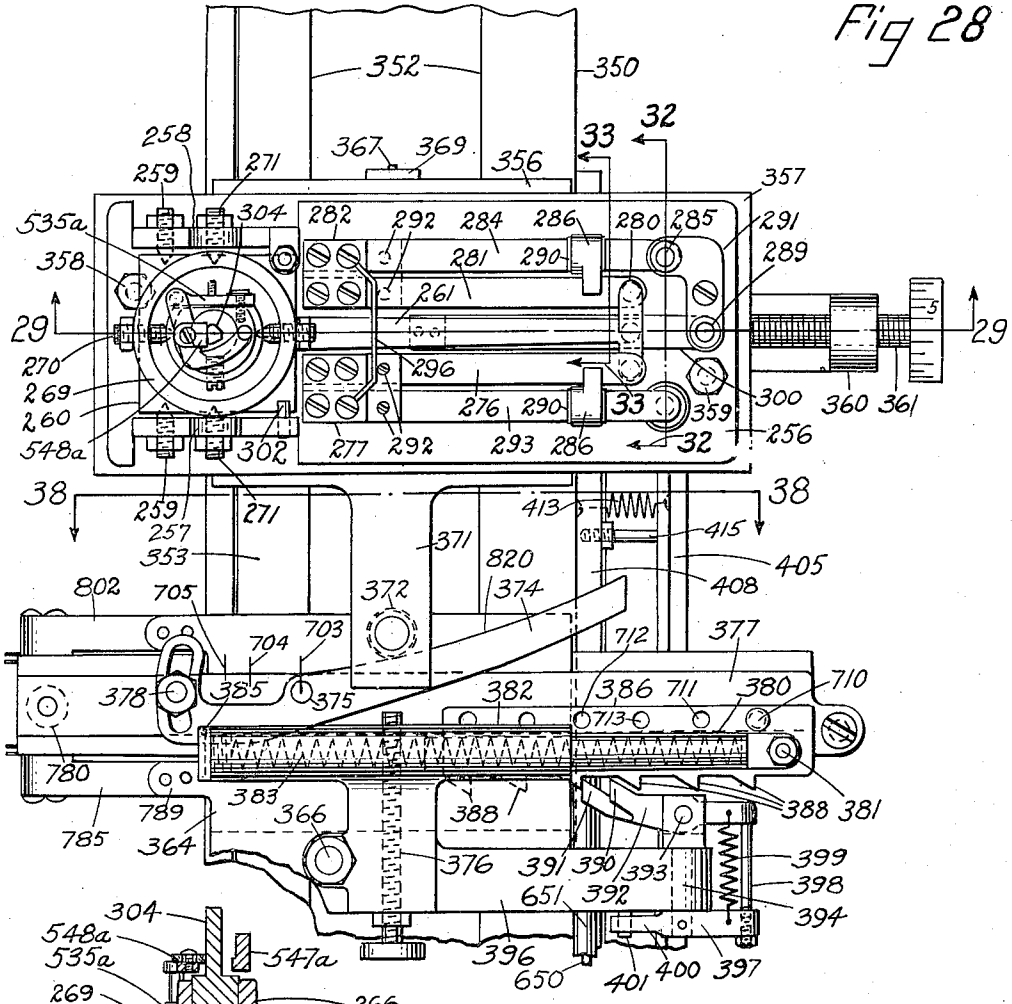
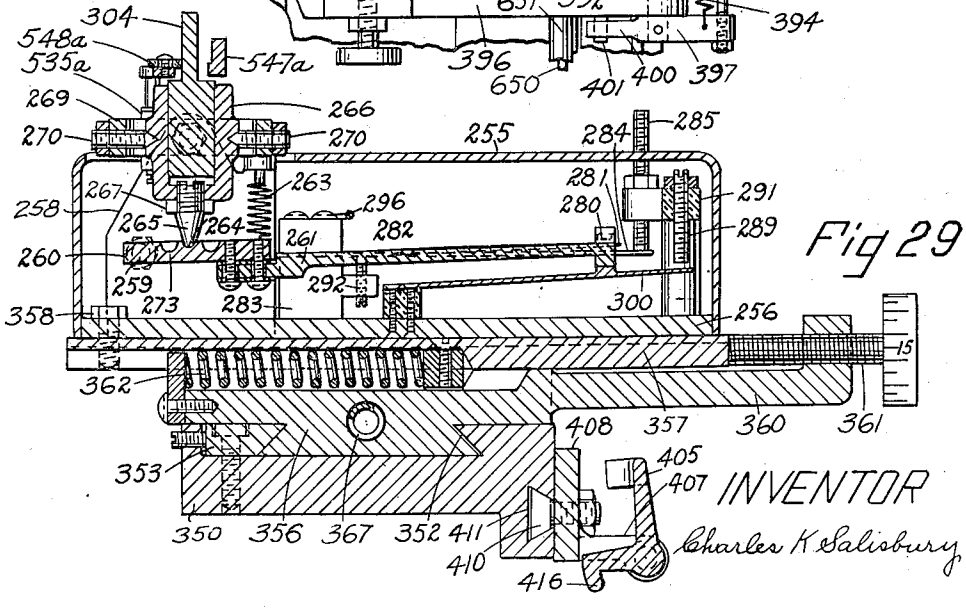


Fig 29



INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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Fig 30

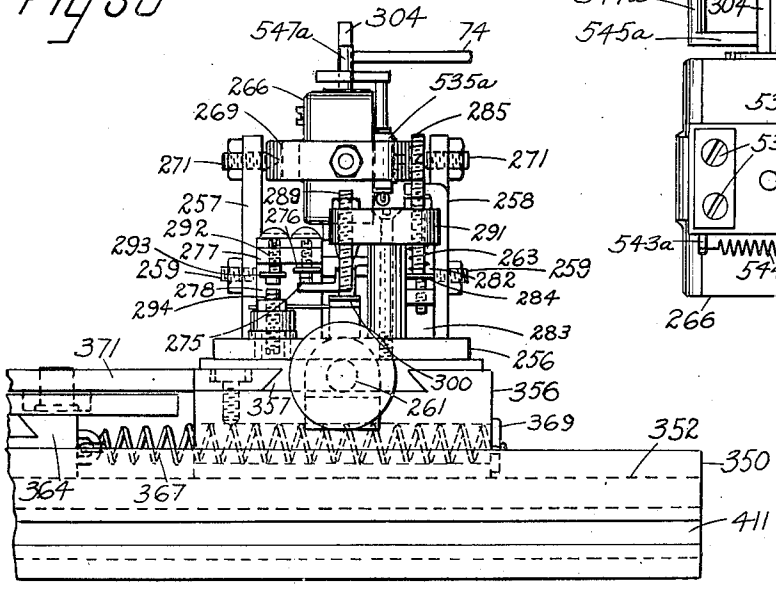
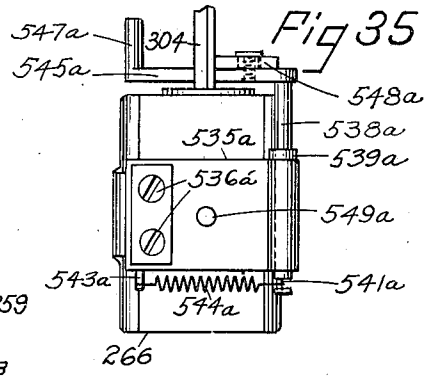


Fig 35



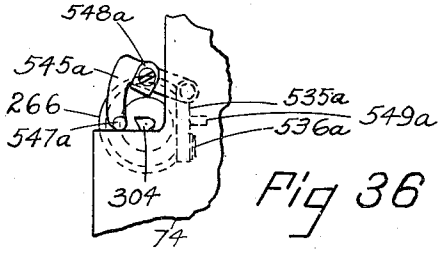


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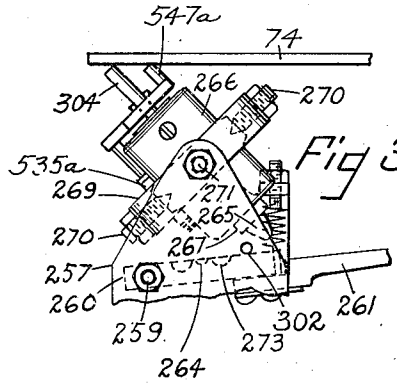


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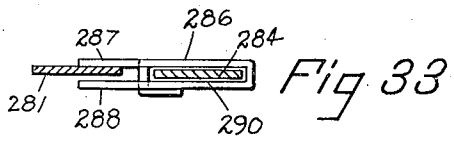


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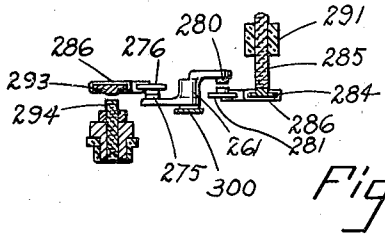


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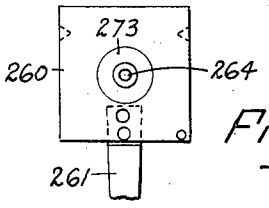


Fig 31

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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Fig 37

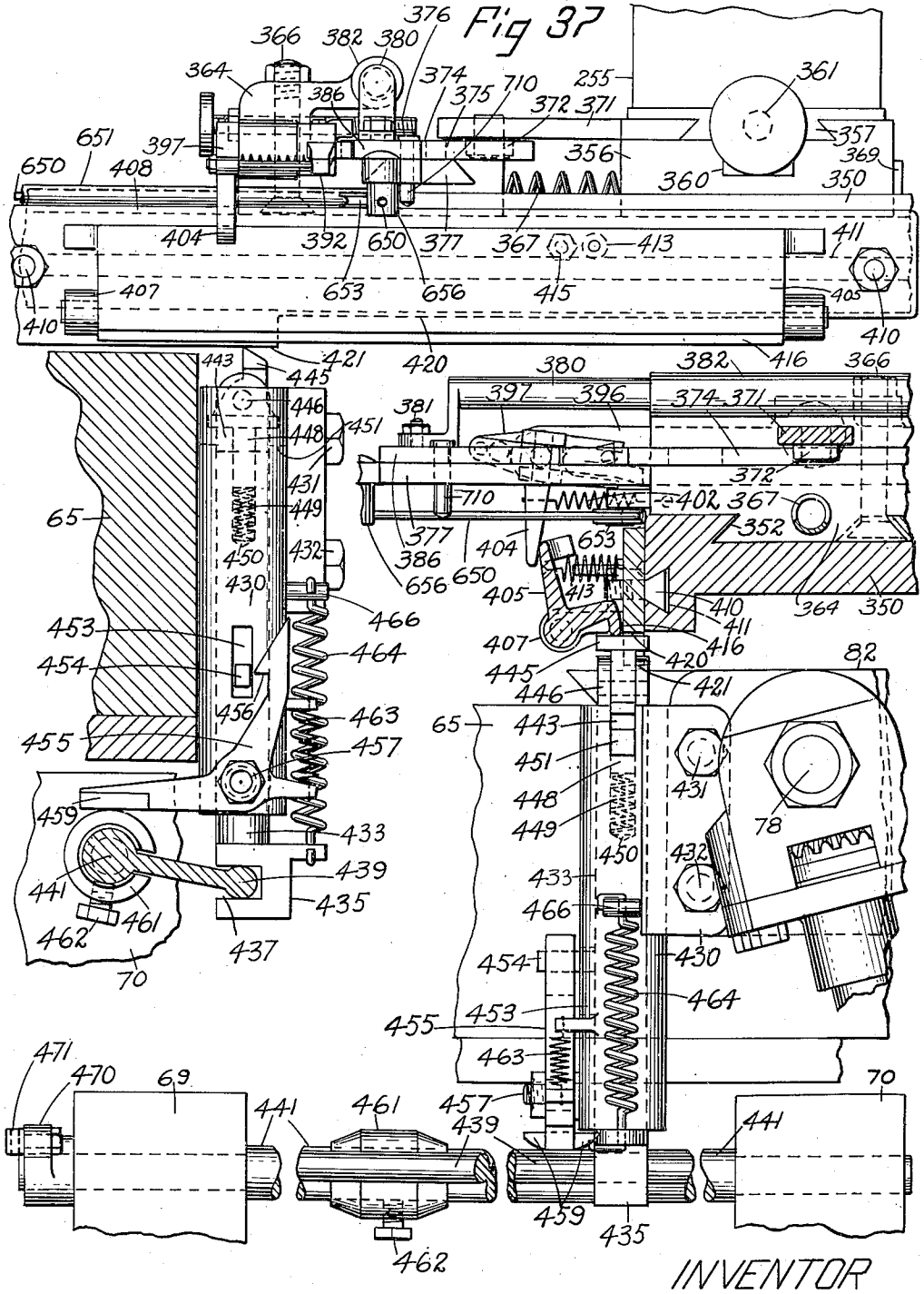


Fig 38

INVENTOR

Charles K. Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

Filed April 1, 1943 15 Sheets-Sheet 13

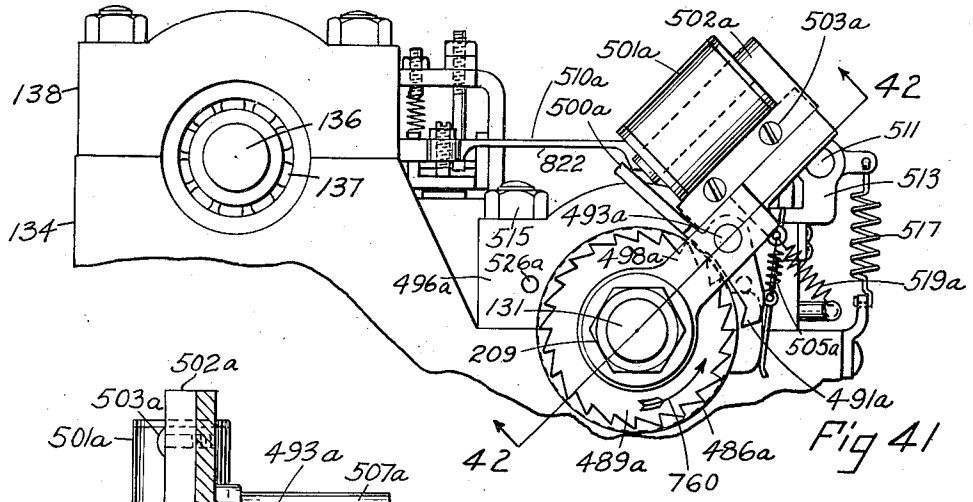


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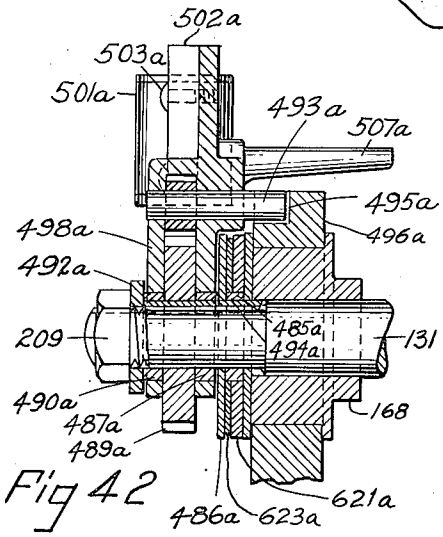


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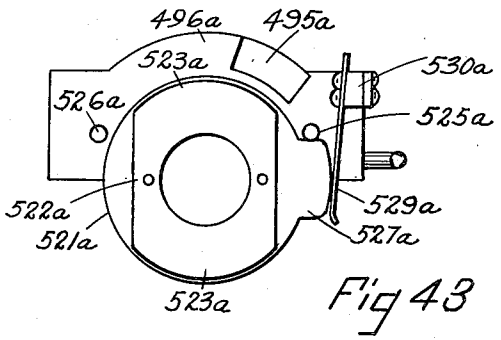


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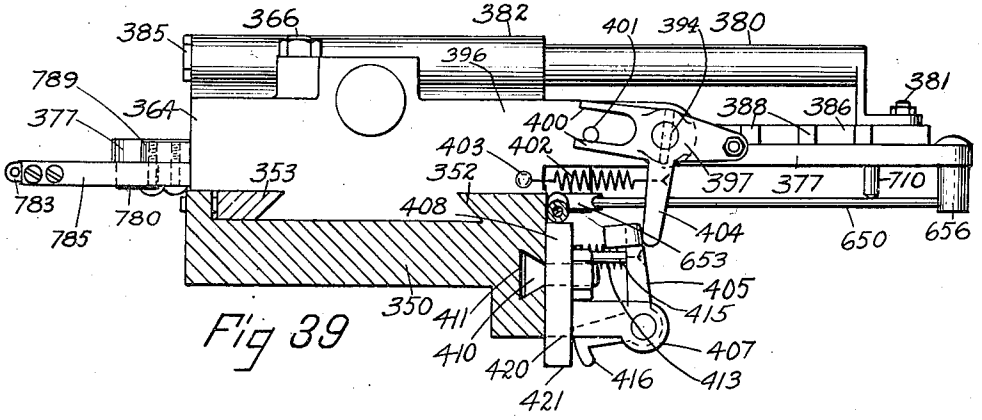


Fig 39

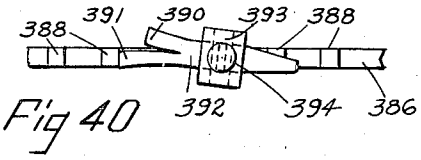


Fig 40

INVENTOR

Charles K Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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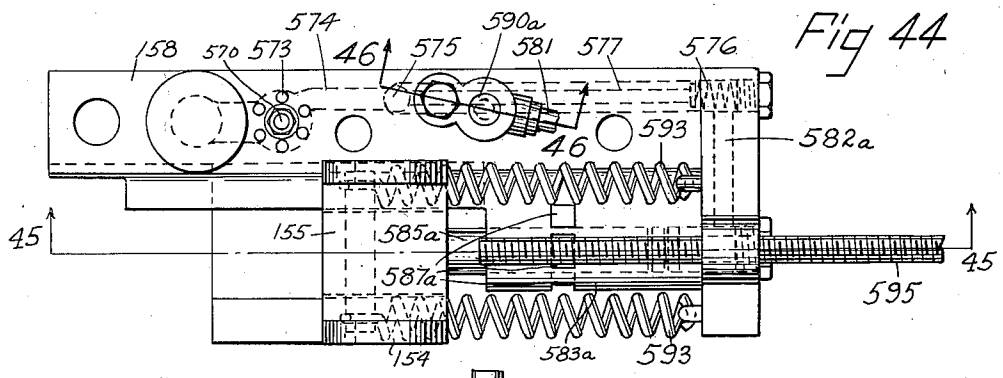


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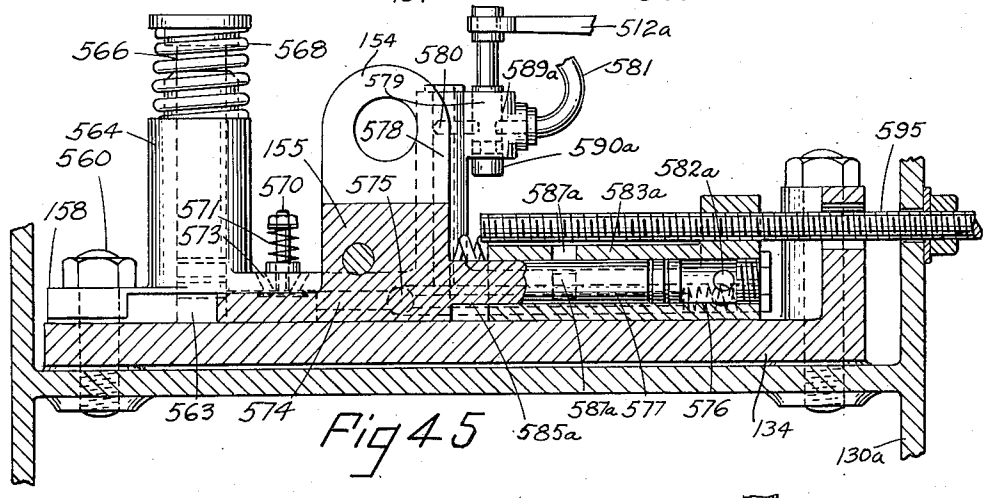


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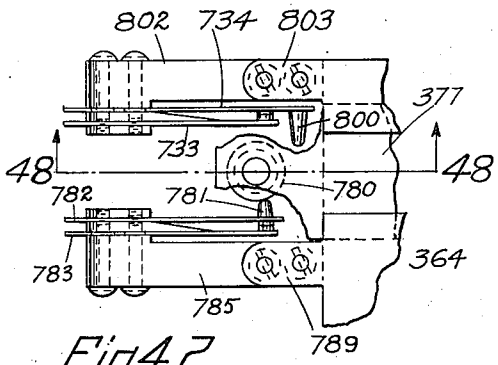


Fig 47

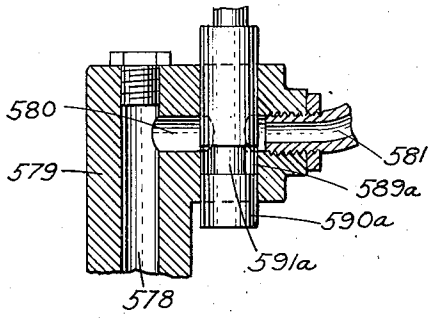


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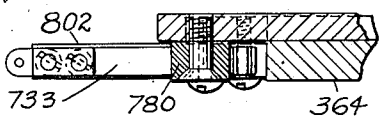


Fig 48

INVENTOR

Charles K. Salisbury

June 18, 1946. C. K. SALISBURY 2,402,450

TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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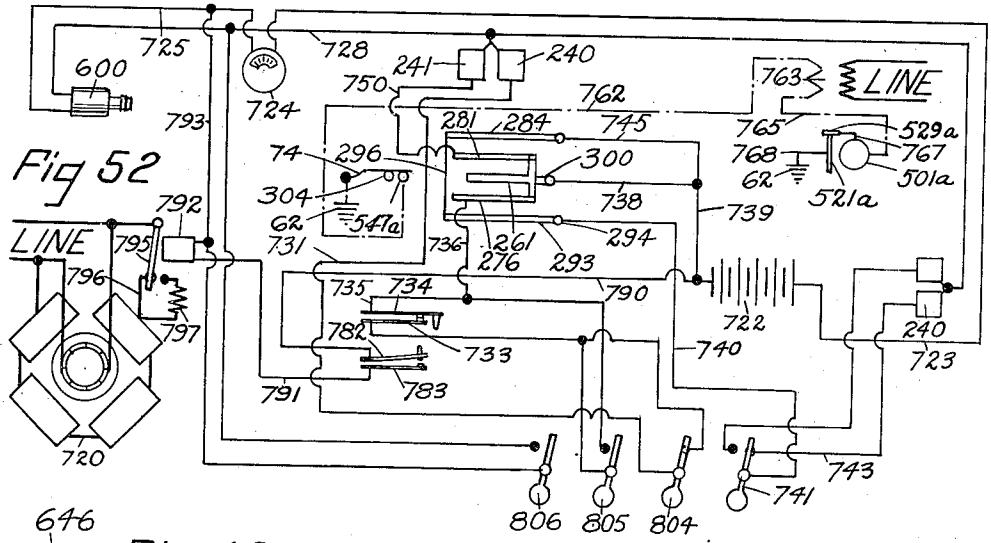


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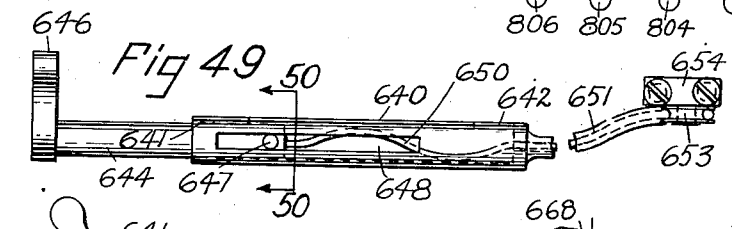


Fig 49

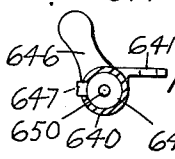


Fig 50

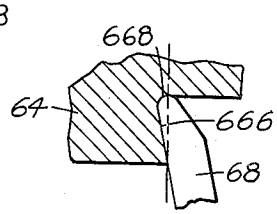


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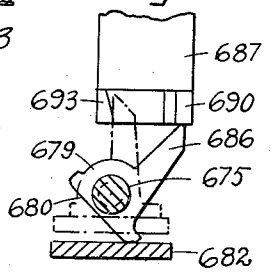


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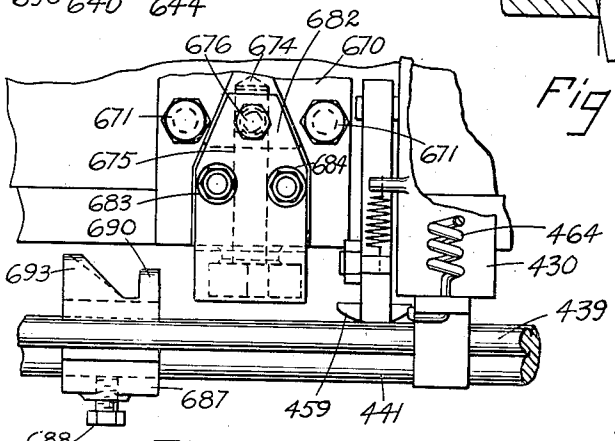


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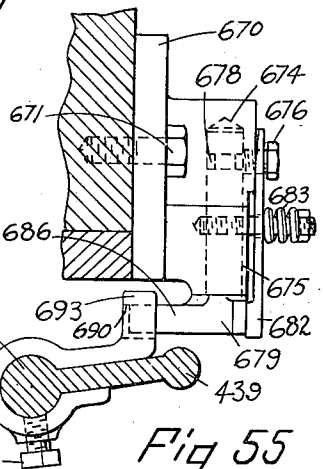


Fig 55

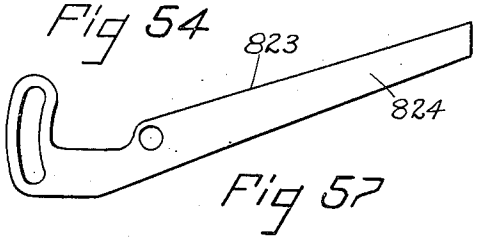


Fig 57

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TRACER CONTROLLED FEED MECHANISM FOR MACHINE TOOLS

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26 Claims. (Cl. 82—14)

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My invention relates to tracer controlled feed mechanism for machine tools.

The objects of my invention are; to provide a tracer controlled machine tool adapted to automatically finish work by a series of graduated cutting operations taken in one direction, to provide such mechanism with high speed return of the tool to the starting point, to provide suitable forms for the cutting tool, pattern, and tracer point to accurately machine the work when cut in one direction, to provide means to vary the cutting depth in successive automatically controlled cutting operations, to provide means to reverse the direction of feed of electrically controlled mechanism by superimposed mechanical control without change in the electrical control circuits, to provide a direct acting cutting pressure control mechanism for reciprocating mechanism that is variable as to the pressure developed in opposite feed directions, to provide a cutting pressure control of that nature that becomes operable at a predetermined cutting pressure, to provide a two-way roller clutch in which the rollers are held in pressed contact with the active surface of the driven clutch member to reduce wear and to aid the return of the rollers to their inoperative position upon disengagement, to provide a swinging and telescoping drive shaft for power application, to provide a control in which the starting and finishing points of successive cutting operations are controlled by the contour of the pattern, to provide a pattern that is readily formed from micrometer or comparator measurements, and correctly set through tracer co-operation, to eliminate tool chatter in tracer controlled cutting mechanism by balanced cutting pressure, to provide a tool setting indicator to co-operate with the pattern and tracer for rapid adjustment of the tool, to provide a tracer having overlapping feed controls that is adjustable as to the tracer movement required between in-feed and out-feed contact positions, to provide increased tool cutting speed during the finishing operation, to provide a tracer controlled roller clutch in which the driven member is provided with inclined driving surface, to provide a tracer bar so mounted as to yield to undue pressure and to simultaneously disconnect from control, to provide a two-way roller clutch using variable leverage to change the feeding rate, to provide abutment stops co-operating with cutting pressure control mechanism to limit the movements of the slides, to provide an electrical feed stop comprising means to interrupt one of the cycle controlling electric circuits while that circuit is

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out of control, to provide an electrically controlled lock for the power feed in one direction when a slide has reached a predetermined limit, to provide a yielding contact plate moving with the tracer to contact the pattern electrically to actuate reversing mechanism, to provide a mechanical reversing mechanism actuated by movement of a slide, and to provide means to stop the action of electrically controlled mechanism by superimposing mechanical control without change in the electric control circuits.

With the above and other objects in view, my invention consists of the mechanism herein described and shown in the drawings, in which:

Figure 1 is a plan view of a machine tool controlled by the mechanism herein described.

Figure 2 is an end view of the mechanism shown in Figure 1 with the tail stock support removed.

Figure 3 is a plan view of one unit of the reciprocating power clutch mechanism in its foundation case, with the case cover removed. It shows parts common to both control units with the exception of those parts used only with the carriage control unit which have the reference letter *a* in addition to the reference numeral.

Figure 4 is a sectional view of the roller clutch and its mechanical control mechanism assembled on its shaft and taken on line 4—4 of Figure 3. It shows parts common to both units with the exception of those parts which carry the reference letter *a* used only with the carriage control unit.

Figure 5 is a sectional view of the variable leverage control, taken on line 5—5 of Figure 3.

Figure 6 is a sectional view of the cutting pressure control, taken on line 6—6 of Figure 3.

Figure 7 is a plan view of a cutting pressure control plate.

Figure 8 is a partial sectional view of the power mechanism and foundation case, taken on line 8—8 of Figure 3. It shows parts common to both control units.

Figure 9 is a cross sectional view of the clutch and its mechanical controls, taken on line 9—9 of Figure 3.

Figure 10 is a side view of the clutch roller cage and its associated control mechanism, in partial section.

Figure 11 is a partial cross sectional view of a part of the clutch mechanism taken on line 11—11 of Figure 4 and showing the position of the rollers and the cage when the rollers are in their inoperative position.

Figure 12 the mechanism shown in Figure 11, with the rollers deflected by the cage to the driving position.

Figure 13 is a side view of the hook-up mechanism, sectioned on line 13—13 of Figure 3.

Figure 14 is a plan view of the hook-up mechanism sectioned on line 14—14 of Figure 13.

Figure 15 is a side sectional view of one of the control coils with its armature and associated parts, taken on line 15—15 of Figure 3.

Figure 16 is a side sectional view of the cross slide actuating telescoping power shaft taken through its complete length, sectioned on line 16—16 of Figure 17.

Figure 17 is a rear view of the upper end of the mechanism shown in Figure 16.

Figure 18 is a bottom view of the mechanism shown in Figure 17, sectioned on line 18—18 of Figure 17.

Figure 19 is an adaptation of the upper end of the telescoping power shaft shown in Figures 16, 17, and 18, where a reducing gear is incorporated in the drive to operate the lead screw, and is sectioned on line 19—19 of Figure 2.

Figure 20 is a sectional view of a simplified rotation operated feed stop, sectioned on line 20—20 of Figure 21.

Figure 21 is an end view of the mechanism shown in Figure 20, taken from the contact end.

Figure 22 is a cross sectional view of the mechanism shown in Figures 20 and 21, sectioned on line 22—22 of Figure 20.

Figure 23 is the top view of a templet formed for cutting in one direction, and also showing the tool setting plate carried thereby.

Figure 24 is the top view of the tool setting indicator in its relation to the tool setting plate shown in Figure 23.

Figure 25 is an end view of the mechanism shown in Figure 23.

Figure 26 is an end view of the tool setting indicator in its relation to the mechanism shown in Figure 25, with the indicator bar folded to the inoperative position as shown by dash and dot lines.

Figure 27 is a side view of the indicator base in position taken when folded, and with indicator bar withdrawn.

Figure 28 is the plan view of the tracer and its cutting adjustment control, with the tracer cover removed.

Figure 29 is a cross sectional view of the mechanism shown in Figure 28, taken on line 29—29 of Figure 28.

Figure 30 is an end view of the tracer and a portion of the feed control for the tracer.

Figure 31 is a plan view of the tracer contact lever.

Figure 32 is a cross section of the contact springs taken on line 32—32 of Figure 28 to show relation of the parts.

Figure 33 is a cross section of the contact springs, taken on line 33—33 of Figure 28, showing the insulated overlapping feed control plate of one set.

Figure 34 is a side view of the safety tracer bar in the position taken when deflected by undue pressure.

Figure 35 is a slightly enlarged side view of the pattern contacting electrical control for power reverse.

Figure 36 is a plan view of the mechanism shown in Figure 35, showing action when contacting the pattern and when following a shoulder on the pattern.

Figure 37 is a side view of the tracer feed control mechanism and reversing control, with parts in position for cutting operation.

Figure 38 is a cross sectional view of the mechanism shown in Figure 37, taken on line 38—38 of Figure 28.

Figure 39 is a view of the tracer depth control mechanism and support, taken on line 39—39 of Figure 1.

Figure 40 shows the escapement plate and the escapement detent removed from the mechanism to show relative position during the cutting movement.

Figure 41 is the rear end view of the electrically controlled locking and reversing mechanism, showing position of the parts during the return movement.

Figure 42 is a sectional view of the mechanism shown in Figure 41, taken on line 42—42 of that figure.

Figure 43 shows the circuit control plate removed from the mechanism to show rotated position relative to the bearing cap and the contact arm during the return movement.

Figure 44 is plan view of the hydraulic control of the variable leverage speed control mechanism.

Figure 45 is a sectional view of the mechanism shown in Figure 44, taken on line 45—45 of Figure 44. All parts are common to both control units with the exception of those parts which carry the reference letter *a* which are used only with the carriage control unit. It shows a partial section through the foundation case and the base support to show relative mounting.

Figure 46 is a sectional view of the outlet control valve of the hydraulic mechanism, taken on line 46—46 of Figure 44.

Figure 47 is a plan view of the cutting speed control switch and also the feed stop switch.

Figure 48 is a sectional view of the mechanism shown in Figure 47, taken on line 48—48 of that figure.

Figure 49 is a side view of the manual resetting device for tracer cutting depth and stop switch mechanism.

Figure 50 is a cross sectional view, taken on line 50—50 of Figure 49.

Figure 51 shows balanced cutting pressure operation of the cutting tool.

Figure 52 is a diagram of the electric connections.

Figure 53 is a diagrammatic showing of cutting operations.

Figure 54 is a modified mechanical reversing control.

Figure 55 is a side view of the modification shown in Figure 54.

Figure 56 is a top view of the trip mechanism of the reverse mechanism shown in Figures 54 and 55.

Figure 57 is a modified depth control plate.

It will be noted that to show a complete operable mechanism, a lathe has been chosen for illustration. It is understood that any mechanism controlled by a pattern is included.

A lathe having a bed 62, Figures 1 and 2, has a work spindle 63 adapted to rotate a work piece 64 (Figure 1).

A carriage 65 slides on the bed and carries a cross slide 66 which is provided with a compound rest 67 on which a cutting tool 68 is supported to operate on the work. Two two-piece brackets, 69 and 70, are rigidly fixed to the rear of the lathe bed. These carry a pattern supporting base rail 71 provided with a vertical wall 73, and secured to the brackets in planes parallel with the turning axis of the lathe.

A pattern composed of a formed control portion 74 and a base portion 324 (Figure 1) rigidly secured thereto, is fixed to the base rail by screws 76.

The carriage is moved in either direction by a lead screw 77 (Figures 1, 2, and 19) while the cross slide is moved by a cross feed screw 78 (Figures 1, 16, 17, and 18).

The lead screw and the cross feed screw are operated by independent individual roller clutch units that are identical in construction and in operation in all parts used in control of the cutting feeds. However, the lead screw operating unit has additional parts that operate only during the return movement of the carriage. These additional parts control the speed of carriage return and reverse and lock the lead screw. Those parts common to the operation of both units carry the same reference numbers in both units, but those parts added or changed to operate only with the lead screw, carry the reference letter *a* also. This also applies to the special parts of the swinging drive shaft.

The rear end of the cross feed screw 78 extends through a bushing 81, Figure 16, which is in a plate 82 secured to the rear of the carriage by bolts 83, Figure 16.

A miter gear 84 (Figures 16 and 18) on the screw 78, is driven by a key 85 (Figure 16) to rotate with the screw and is locked thereto by a sleeve 86 and a nut 87 on the screw.

A gear housing 89, Figures 2, 16, and 17, is supported on the sleeve and is free to swing thereon.

The housing carries a miter gear 90 which meshes with the gear 84 and is secured to the upper end of a drive shaft 91 by a key 92 (Figure 16). This shaft is free to turn in a bearing 93 secured to the gear housing by bolts 94.

The shaft has a lengthwise keyway 96 to engage a key 98 at the upper end of a hollow shaft 99 to permit of telescoping of the shafts for continued drive connection.

The hollow shaft is fixed to a stub shaft 101 (Figure 16) by a taper pin 102. The stub shaft is driven by a miter gear 103 through a key 104 extending through a bearing sleeve 105 secured by bolts 107 to a gear housing 108.

The housing is free to swing on a sleeve 109 secured by a nut 110 to the end of a roller clutch shaft 131 which has a miter gear 112 secured thereto by a key 114 for clutch drive.

The clutch unit operating the cross slide is housed in a foundation case 130, Figures 1 and 2, while that operating the lead screw is housed in 130*a*, Figures 1, 2, and 3, which differs from 130 because of a clearance 131*a* in the cover 132*a*.

It is desirable that a reduction gear be used in the drive of the lead screw. The reducing gear 117*a* Fig. 19 is keyed at 116*a* to the end of the lead screw and meshes with a pinion 118*a* made integral with a miter gear 119*a*. A bearing sleeve 120*a* extends through the bore of 118*a* and 119*a*, and they are free to turn on a stud 121*a* fixed in a plate 122*a* secured to the bed of the lathe by bolts 123*a*.

A gear housing 124*a* freely swings on the stud and is retained by a nut 125*a* and a lock nut 126*a*.

The remaining parts of the shaft are identical with those of the shaft used in cross slide operation.

It is not possible to provide speed change directly in the drive shaft gear, where used in driving the cross slide, as the movement of the carriage would result in a change in the setting of the tool and tracer. However, the gear reduction may be at the lower end of the drive and be integral with the operating unit, for either drive (not shown). The foundation cases 130 and 130*a* are preferably secured to the floor foundation, independent of the lathe, by means of bolting lugs 133, Figures 1, 2, and 3, as this permits of ready installation and prevents vibration. The case 130*a* can be placed as most convenient for connection to the lead screw, but the case 130 should be so placed as to permit the drive shaft to be in a vertical position at about midway of the carriage movement.

The arrangement shown of the miter gear drive of the cross feed screw through the telescoping shaft, permits of free sliding movement of the carriage without effecting the cross slide.

The roller clutch units operating the lead screw and the cross feed screw, are shown in detail in Figures 3, 4, 5, 6, 8, and 9, and comprise a supporting base frame 134 in which a crank shaft 136 may rotate in ball bearings 137 (Figure 8) which are secured by bearing caps 138.

The shaft carries a pulley 139 which is driven by a motor 140 supported by a hinged bracket 141 in the lower part of the foundation case, as shown in Figure 2.

The shaft has a small crank throw 142 on which a connecting rod 143 is secured to give the reciprocating motion to the clutch.

The lower end of the connecting rod is provided with a bearing boss through which extends a bearing pin 144 to connect with an end of a walking-beam 145.

The opposite end of the walking beam is hinged to an arm 146, Figures 3, 5, and 6, by a bearing pin 147.

The beam has internal slide surfaces 148, Figures 5 and 6, on which a slide block 150 is free to move. This block has its bearing on a pin 151 which extends through openings 152 in the sides of the beam and also through upward extending projections 154 of a variable leverage slide 155, Figures 3, 5, 6, and 8 slidingly secured to the supporting frame by a plate 156 (Figure 8) at one side, and by a pump base 158, at the other.

The arm 146 is flexibly secured to a clutch sleeve 159 by a stud 160 inserted therein (Figures 3, 4, 5, and 6) which extends through a control plate 161, the arm 146, and through a stiff coiled spring 163. These are all secured together by an adjusting nut 164 to form a rockable resilient drive connection by which the rotative speed of the clutch shaft is reduced in response to the increase of load placed upon it. The control plate 161 is provided with opposite control ends 315 and 316, Figures 5, 6, and 7, which determine the relative pressure before yielding. By varying the distance of these ends from the central opening 317, the pressure in opposite feed directions may be varied. The yielding pressure is determined by the spring 163 (which may be of any modulation), adjusted by the nut 164.

The sleeve 159 is carried on the clutch shaft by heavy roller bearings at either end of the sleeve (Figure 4) to give rigid support to an oscillating clutch member 165 formed integral with the sleeve.

The clutch shaft is rotatably supported on the frame in plain bearings 167 and 168 against both side and end movement.

The clutch shaft has an integral outer clutch ring support 170 (Figures 3, 4, and 9) open at one end and connected at the other end to the shaft 131 by a flange 172, Figure 4.

The support 170 is provided with a tapered bore

171 in which a hardened outer clutch ring 173 (Figures 4, 11, and 12), is rigidly held by a screw cap 175, Figures 3, 4, and 9.

The clutch ring 173 has eight internal clutch depressions formed into driving faces 178 and 179 (Figures 11 and 12) of a curved form having about thirteen times the radial distance indicated at 180 (Figure 11) that the radial point is at one side of the clutch center, as indicated at 181.

This face form gives a positive drive upon roller contact, but releases without sticking upon reversal of the drive.

The flange 172 is pierced with four openings 183, Figure 4, through which extend four studs 184 integral with a roller cage 185, Figures 4, 10, 11, and 12, to support and to operate the cage.

This cage is in the form of a light cylindrical sleeve operating between the clutch member 165 and the clutch ring 173. It is pierced with eight slots 188, Figures 10, 11, and 12, in which eight rollers 190, Figures 4, 11, and 12, are free to move sidewise to a limited extent.

The rollers are drilled lengthwise and carry a pin 191 having a rounded outer end, Figure 4, in either end pressed outward by a compressed spring 192.

When the rollers are in their assembled position, the outer end of the pin engages in a groove 194 in either end of the cage that has faces inclined both toward the roller and also in the sidewise directions as shown in Figure 10. The spring pressure then acts to maintain contact of roller and clutch ring at all times, and also acts to keep the roller in its central position when not deflected therefrom by pressures greater than allowed by the spring. The spring action also provides for uniform pressure on all rollers and at both ends of the roller, when in driving contact.

The cage is deflected sidewise from its inoperative position (Figure 11) to move the rollers to their driving position shown in Figure 12, by the following mechanism:

The outer end of the studs 184 extend through and are removably secured to a flange 196 at one end of a sleeve 197, Figures 4, 9 and 10, which is closely held against endwise movement but is free to oscillate on the clutch shaft, by ball bearings 198 at either end of the sleeve.

The bearings are without cage and are supported by a fixed race 200 and by an adjustable race 201, Figure 4.

A clutch control sleeve 203 slides endwise on the sleeve 197 but is prevented from oscillating thereon by two driver pins 204 fixed in a flange 205 of the sleeve 203 and freely slidable in the flange 196, as shown in Figures 3, 4 and 10.

The opposite end of the sleeve 203 has a helical extension 206 (Figures 3, 4, and 10) which engage with a matching helical driver plate 207 (Figures 3 and 4). This driver plate is locked to the clutch shaft by a key 208 (Figure 4) and is held endwise by a nut 209 (Figure 3), which holds the assembly together.

A thin washer 210 (Figure 4) aids in adjustment of the parts. The above arrangement allows end movement of the sleeve 203 to rotate the cage relative to the clutch ring to move the rollers into operative contact. The movement of the sleeve 203 is obtained by the following mechanism.

The sleeve 203 has an operating flange 212, Figures 3, 4, 9, and 10, which engages with two control forks 213 having matching plates 211 secured on the opposite side of the operating flange to allow close control during rotary motion of the flange. Positive endwise movement in either direction is provided by two shifter forks 214 (Figures 3, 4, and 9), which carry pins 215 having bearings in the control forks.

The opposite ends of the shifter forks are rigidly fixed to a sleeve 216 (Figures 3, 8, 9, 13, and 14) which is free to oscillate on a stud 217, Figures 8 and 9, fixed vertically in a base plate 218 which is secured to the frame 134.

The sleeve 216 is provided with a vertical flat driving surface 219 (Figures 13 and 14) against which a flange retained matching surface 220 of a hook-up arm 221 is forced by a spring 222 (Figures 8, 13, and 14), the pressure of which is adjusted by a nut 223 on a stud 224 fixed in the sleeve.

This provides a yieldable drive for the clutch cage.

The outer end 226 of the hook-up arm is moved sidewise upon contact with either of two hook-up levers 227 and 228 to force the clutch rollers into operative contact. This is done by the following mechanism.

The hook-up levers are freely pivoted in individual slots in a carrier head 230 by a bolt 231 (Figures 3, 9, 13, and 14) and are separated enough to permit of individual action without interference. The lever 227 is provided with an operating arm 229 and also with a counterbalancing arm 225, while the lever 228 is provided with an operating arm 250 and a counterbalancing arm 249.

The carrier head is rigidly fixed to the upper end of a lever 233 (Figures 8, 9, and 13) which is pivoted by a pin 234 to the base plate 218 (Figures 8 and 9) to oscillate thereon.

The upper end of the lever is also fixed to a driving fork 235 having an adjustable fork plate 236 secured thereto by bolts.

This fork drive contacts either side of an eccentric cam 238 on the power crank shaft to oscillate the carrier head.

The hook-up levers are controlled, electrically, by square wound coils 240 and 241 (Figures 3, 8, and 15) operating with square laminated cores 242 fixed to a coil supporting frame 243 which is fixed to the base plate 218. Two armature levers 244 and 245 are freely pivoted to the coil frame by a pin 246 and are each provided with an extended end formed into a fork 248 to engage the respective operating arm of its hook-up lever.

The armatures are retracted by adjustable springs 251 and this movement is limited by stop screws 252, Figures 8 and 15.

It will be here noted that all parts having reciprocating motion, or being subject to movement from rest, should be made as light as possible to prevent wear, to prevent sound upon contacting stationary control parts, and also to allow of the greatest operating speed.

Where possible, all reciprocating parts should be hardened to reduce the contact surface required to obtain reduced size of parts and still maintain endurance of the mechanism. The clutch mechanism is an improvement on that shown in my co-pending application, Ser. No. 330,525, and operates as follows.

The power driven crank shaft 136, the connecting rod 143, the walking beam 145, the arm 146, the clutch sleeve 159, and the pressure control mechanism comprising, the control plate 161, the spring 163, and the adjusting nut 164, together with their bearings and supports, constitute the driving mechanism of the clutch.

The maximum degree of oscillation of the clutch

sleeve for any crank throw is determined by the position of the slide block 155 which controls the leverage of the walking beam, and is obtained only when the arm is held by the spring against the upper surface of the control plate during the complete revolution of the crank shaft (Fig. 5). Any resistance to movement of the clutch sleeve, great enough to overcome the pressure of the spring, will permit the arm to pivot noiselessly on one end of the control plate during a portion of the revolution and the oscillation of the clutch sleeve will be reduced in extent, or be completely stopped if the resistance be great enough. This action is shown in Figure 6.

The clutch roller springs 192 act to force the rollers outward relative to the cage and into contact with the clutch faces 178 and 179 of the clutch ring 173. These are inclined toward each other and react to move the cage to its central position (Figure 11). In this position, the rollers are held away from the clutch sleeve about two one-thousandths of an inch and the sleeve may freely oscillate without clutch action.

The hook-up arm 221 is operatively connected to the cage by the mechanism shown and is normally held in a central position in common with the cage. Side deflection of this arm in one direction will result in clutch engagement to rotate the clutch shaft 131 in one direction, while deflection in the opposite direction will result in clutch engagement for the opposite direction of rotation.

The clutch rollers should all be in driving contact with the clutch sleeve at the start of its oscillating movement to insure noiseless action and efficient drive.

As the hook-up arm 221 drives through the spring 222, the inertia of the cage and connected parts will prevent the rollers from contacting as early as with a positive drive, and the timing of the reciprocation of the carrier head 230, relative to the power movement of the clutch sleeve, must be advanced to correspond to the speed of the crank shaft, which is about 2000 R. P. M. in the usual application. In practice it has been found desirable to advance the timing of the clutch engagement to a point slightly earlier than the start of the power movement of the clutch sleeve. Any slight variation in timing may be then obtained by adjustment of the spring 222.

When the armature 244 is deflected by the electrical action of the coil 241, or by mechanical depression of the lever 510a, the very light hook-up lever 227 is swung outward in the carrier head by means of the sliding engagement of the armature fork with the arm 229. The spacing of the hook-up levers 227 and 228, and the width of the contact end of the arm 221 (Fig. 14) are such as to permit the hook-up levers to swing beyond the engaging point of the arm for movement in one direction only.

Upon engagement with the hook-up lever 227, the hook-up arm will be forced, by rotation of the crank shaft, to move the clutch rollers into driving contact in the direction controlled by the armature 244. Continued rotation of the crank shaft then starts the clutch sleeve on its power movement and the clutch shaft 131 will be rotated until the end of the movement, as the rollers are held in contact until the driving movement is completed. Upon reversal of the clutch sleeve, the rollers will be automatically released and the roller actuating parts will be returned to their central position by means of the roller springs. The cycle of clutch action is now complete, and will be repeated as long as the armature 244 is deflected. If, however, the armature 245 be deflected, the hook-up lever 227 will move the rollers for contact in the opposite direction and the rotation of the clutch shaft will be reversed.

The armatures 244 and 245, of both control units, are electrically operated by a tracer which is shown in detail in Figures 28, 29, 30, 31, 32, 33, 34, 35, and 36, and the protective cover 255 of which is shown in Figures 1, 2, and 29.

A base 256, Figures 28, 29, and 30, is provided with upward extending side plates 257 and 258, Figures 28, 29, 30, and 34, through which pivot screws 259 extend to pivotly support a finger plate 260. This plate is provided with an extended contact arm 261 which is insulated from the plate.

The plate is retracted in an upward direction by a tension spring 263 (Figures 29 and 30) and is provided with a control depression 264 in its upper surface (Figures 29, 31, and 34) in which the lower end of a control finger 265, Figures 29 and 34, acts to operate the tracer contacts.

The control finger is adjustably locked in a tracer bar 266 by a nut 267 as shown in Figures 29 and 34, and the bar is pivotally supported in a gimbal ring 269, Figures 28, 29, 30, and 34, by pivot screws 270. The gimbal ring is pivotally supported between the side plates by pivot screws 271, and the tracer bar is free to swing on its pivot supports in any direction. This provides against damage to the tracer by forcible contact with the templet.

A ring 273, Figures 29, 31 and 34, is cut in the finger plate concentric with the control depression. This ring is deeper than the control depression to permit the control circuits to be broken when the tracer finger is moved to enter it by excessive movement of the tracer bar.

The outer end of the control finger carries an upward movement contact 275, Figures 30 and 32, that may contact with a contact point on a spring control lever 276 serving to control the feed of the tool in the direction of an arrow 61 of Figure 1, hereafter known as the in-feed.

The spring lever 276 is supported at its opposite end by insulating blocks 277 and 278, from the base.

A downward moving contact 280, Figures 28, 29, and 32, is carried at the outer end of the control finger to contact a control lever 281 to control the cross slide movements opposite to the arrow 61, hereafter known as the out-feed.

This lever is secured by insulating blocks 282 and 283.

These blocks also support a control lever 284, Figures 28, 29, 30, and 32, which is of greater length than the lever 281 and is provided with a contact to meet the lower end of an adjustable contact screw 285 which extends through an insulating block 291 fixed to the base. This lever carries a driver connection comprising an encircling plate 286 (Figures 28, and 33) insulated therefrom by a thin wrapping 290 (Figures 28 and 33) and secured to the lever by pressure. This plate has two points, 287 and 288 which extend on either side of the lever 281 with a clearance which determines the feed overlap of out-feed and carriage circuits.

A contact lever 293, of the same construction as 284 (Figures 28, 30, and 32), is supported by the blocks 277 and 278 and contacts with the upper end of an insulated contact screw 294 supported by the base.

The lever 293 is also provided with an insulated driver 286 of the construction as used to operate the control lever 276.

The tension of the contact levers, and also their position, is determined by adjusting screws 292.

The control levers 284 and 293 are connected at 296 (Figures 28 and 29) to form a control circuit for the carriage feed with two contact openings in series, and both required to be closed to become operable.

A stop screw 289 extends through the insulated block 291 to contact the end of a circuit connecting spring 300 (Figures 28, 29, 30 and 32) when the tracer point is moved beyond its normal bounds and serves to break the circuits controlling cross feed and carriage movements. All views of the tracer show the parts in position for control of the tool in the in-feed direction, with the carriage feed control circuit opened between the control spring 293 and the contact screw 294 to interrupt the carriage feed.

The operation of the tracer, which is an improvement on the tracer shown in my co-pending application, Ser. No. 330,525, now Patent No. 2,373,265 granted April 10, 1945, is as follows:

The tracer bar is normally held in its undeflected position by means of the spring 263 which holds the control finger 265 in the control depression 264 of the finger plate 260. In this position, the in-feed circuit is closed between the contact arm 261 and the spring control lever 276, and the clutch controlling the cross slide will operate to move the tracer point toward the pattern. Upon contact therewith, the tracer will be deflected and contact will be made between the contact lever 293 and the contact screw 294 to close the circuit controlling the carriage movements. As the carriage and in-feed controls overlap, the in-feed and the carriage feed will both operate until the in-feed circuit is opened by further deflection of the tracer, when the carriage alone will move.

Further deflection of the tracer will establish contact of the control lever 281 and the contact arm 261, and the clutch will operate to move the tracer in the out-feed direction while the carriage is still moving. This is due to the overlapping of the carriage and the out-feed controls. Still further deflection will open the carriage controlling circuit between the control lever 284 and the contact screw 285, and the out-feed alone will operate. Any further deflection will cause the control finger to move from the control depression and into the circuit breaking ring 273, and all clutch control circuits are opened.

The pattern 74, Figures 1, 2, 23, and 25, is formed for one direction of control movement in the direction of arrow 60 of Figure 1. The outline required to control the tool for correct dimensioning of the finished parts is shown in dotted line 310 in Figure 23, when the tracer point 304 is of the same form and of the same size as the cutting tool 68 with which it operates.

Due to the air gaps in the tracer contacts required for operation, and also because of the overlapping control features of the tracer, the controlling point of the tracer will not be the same when moving in the in-feed direction as when moving toward the out-feed.

The dimensioning, diametrically, of a piece turned by the pattern on surfaces 311, 314, 315, 316, 318, and 319, Figure 23, is made while the tool is moving in the out-feed direction and the tracer point will be deflected, relative to the tool, to a greater extent than it will be when the dimensioning is determined by surfaces 312, 313, and 317, where the tool is moving in the in-feed direction. The pattern guide surface is consequently of greater distance from the dotted reference line 320 at the points 311, 314, 315, 316, 318, and 319.

Where there is little back-lash in the cross feed, and the tracer in-feed and out-feed contacts are closely adjusted, the variation of machining from the dotted line will be slight. These conditions are not usual and variation in the dimensioning of the pattern should be made for correction.

A slight increase of control diameter is shown at the various points 321 where true cylindrical turning is required. These points are the dimension determining parts of the pattern, with the surfaces 311, 313, 314, and 315, reduced to about one one-thousandths of an inch or less than the required diameter. This is to prevent additional out-feed from vibration in the mechanism.

The above variations in the pattern outline are of value only during the finishing cut, whether one or both directions of machining are used.

Tracer points are commonly made enough larger than the diameter of the tool with which they operate to partially compensate for the contact air gaps. Where oversize points are used, the variation of the control surfaces of the pattern will vary from those given to obtain the result, but those surfaces will have the same relation to each other, and the variations should be incorporated in the pattern.

To render it easy to correctly form a pattern, it has been found that measurements made from a true edge 320 of the pattern may be used to lay out the guide surfaces.

The edge 320 preferably corresponds to the turning center line of the pattern, but may be of a fixed dimension greater or less than that. However, all patterns used on one machine should have the same dimension from center line of pattern to the supporting wall 73 to give uniform construction.

The pattern may be constructed from micrometer or comparator measurements, using the edge 320 as a base. It is then fixed to a base portion 324, Figures 1 and 2, by rivets or screws. The completed pattern is fitted to the base support 71 by tracer controlled measurements made on pattern locating points 322 and 323, both of which are equal to the largest turning diameter of the pattern.

Very exact checking of comparative dimensioning control of the pattern, in the in-feed direction, may be obtained by direct action of the tracer. The pattern is first placed in its correct position on the lathe and the switch 741 is opened to cut out the carriage feed. The carriage is then manually moved to bring the tracer point adjacent to the point of contact on the pattern at which the measurement is to be made. The cross slide is then moved inward by power, under tracer control, until stopped by tracer action. The dimension is then read directly from the cross slide micrometer dial 830. This is of value in correcting the pattern.

Out-feed dimensioning is obtained by operation of both carriage and cross slide control to feed to the point of dimensioning.

A tool setting extension 326, Figures 1, 2, 23 and 25, is hinged to the pattern by a pin 327 (Figures 23 and 24) which extends through closely fitted projections 328 on the pattern and welded to the end of the extension, to permit of folding back when not in use. A closely fitted dowel pin 329 keeps the parts exactly located.

The contact end 337 (Fig. 23) of the extension is exactly dimensioned.

A tool setting indicator co-operates with the extension 326.

Its base member 331, Figures 1, 24, 26, and 27, is securely fixed in a T-slot 819 of the carriage, and has a folding upright member 330 closely pivoted thereto by screws 332.

The upright member has a bored opening 333 (Figure 27) in which is closely fitted a sliding indicator bar 334 which has a sidewise extending feeler arm 335 at one end.

The opposite end of the bar is provided with a closely adjustable indicator nut 336, set by a lock nut 338.

When not in use, the bar may be drawn backward and the arm folded to the dash and dot position of Figure 26. The upright member may then be folded down as shown in Figure 27, or the bar may be withdrawn through a slot 340. The tool setting indicator may be supported by any suitable portion of the lathe instead of by the carriage, as shown.

The tool contacting portion 341 is machined to a very slight vertical angle (Figure 26) and hardened for close setting.

The tool is set when the tracer is in its finish cut position and the work may, or may not, be in position as the tool is retracted relative to the work.

The contact point of tool and of tracer should be of fixed distance apart for all work on the machine, during the finishing operations, and the indicator bar may then be kept to one length.

Each pattern should carry its own setting extension, which should be of the same distance from the supporting wall 73 to the contact point 337, independent of the diameter of the work.

The tool is set as follows: The cross slide 66 is withdrawn to permit the extension 326 to be brought to operative position, as shown by full lines in Figure 23. The machine is then operated as in making tracer controlled measurements, previously noted. The point at which the tracer has stopped the tool is checked by manually moving the indicator bar 334 inward until stopped by the indicator nut 336, and the tool contacting portion then permitted to move across the tool point by the weight of the tool contacting arm 341.

The tool setting gage may closely clear the tool point, or be used as in Fig. 26.

Any adjustment of the tool, relative to the tracer point, is made by means of the manual control 72 to move the cross slide compound rest 67, which is set to move directly toward the work.

Tool setting by this method is very exact, as tool wear and expansion are compensated for. The following provides depth of cut and tracer resetting mechanism.

The tracer cutting depth control mechanism is provided with a base 350, Figures 1, 2, 28, 29, 30, 37, 38, and 39, which is secured to the cross slide by bolts 351 as shown in Figures 1 and 2, and extends toward the rear of the lathe.

The base is provided with a dovetailed slide 352 on its upper surface which is closely adjusted by a movable side plate 353, Figures 28, 29, and 39.

Closely fitting in sliding relation in the slide 352 is the tracer base support 356 which is provided with a tracer cross slide 357 to the upper surface of which the tracer base 256 is secured by bolts 358 and 359, Figures 28 and 29.

This support 356 has an extension 360 in which an adjusting screw 361 is carried to engage with the cross slide to move the tracer for crosswise adjustment against the pressure of a spring 362, Figure 29. The crosswise adjustment need be of limited movement to compensate for variations in length of stock being machined.

Co-operating with the tracer base support, is a cutting depth control 364, Figures 28, 37, 38, and 39, which is solidly clamped in the slide 352 in any desired location by a screw 366 as shown in Figures 37 and 38.

A tension spring 367 extends through an opening in the sliding base support 356 and is locked at the end by a plate 369, as shown in Figures 28 and 37. The other end of this spring is locked to the depth control as shown in Figure 30 to draw the tracer backward in the setting operations.

The base support 356 has a plate 371 which extends toward the depth control and carries a contact roller 372 on its lower side to engage a feeding depth control plate 374 as shown in Figures 28, 37, and 38. The plate 374 closely fits on a pin 375 on the upper surface of a cross slide plate 377 as shown in Figure 28 and is locked at the desired angle by a bolt 378.

The slide member 377 is held in a dovetailed slide in the control member to move freely endwise, and is provided with a tube 380, Figures 28, 37, 38, and 39, which is secured to the plate by a bolt 381. This tube telescopes into a tube 382 formed in the control member. Within the telescoping tubes is a compressed spring 383 (Fig. 28) retained by a screw 385.

This spring acts to move the slide against an escapement to move the tracer backward toward the tool.

An escapement plate 386, Figures 28, 37, 38, 39, and 40, is secured to the slide plate and has equally spaced escapement notches 388 on one edge to engage with escapement points 390 and 391 of a ratchet type escapement lever 392 to provide step by step control movement. This lever is retained by a pin 393 in a slot in one end of a bearing shaft 394 which extends through a bearing extension 396 of the control member. The opposite end of the shaft has an operating member 397 pinned thereto which carries a stop screw 398 and is secured to one end of a light tension spring 399 to maintain the escapement points in position.

The operating member has limit projections 400 (Figure 39) that engage a pin 401 in the bearing extension to limit its movements.

The escapement point 391 is normally held in contact with the escapement plate by a spring 402 which engages with a pin 403 at one end and connects with a downward extending arm 404 of the operating member, at the other.

This spring must be under enough tension to insure escapement movement when in control.

The lower end of the arm 404 contacts one side of a lengthened reversing lever 405 which has bearings at either end in sidewise extending bearing arms 407 of a reversing plate 408.

This plate is provided with two clamping bolts 410 which slide in a dovetailed slot 411 in the base 350 for clamping at any predetermined point.

The reversing lever 405 has a light spring 413 to keep it in operative position when not engaged with the arm 404.

A stop pin 415 limits its movement in the opposite direction.

The reversing lever also has a downward extending arm 416 extending its entire length.

The lower edge of the reversing plate 408 is

formed to two elevations, 420 and 421, as shown in Figures 37, 38, and 39.

The tracer resetting mechanism is constructed as follows: The tubular body 640, Figs. 1, 2, 49, and 50, is fixed to the lathe cross slide by clamps 641 and 642. It is provided with a sliding rod 644 which has a handle 646 and also is provided with a guide pin 647 at its opposite end that extends through a slot 648 in the body (Fig. 49) to limit its movements. A thin and flexible cable 650 is fixed to the inner end of the rod and extends through a small conduit, 651, Figs. 1, 2 and 49, for guidance and protection.

A small grooved pulley 653, Figs. 37, 38, 39 and 49, is fixed to the side of the depth control member 364. This pulley acts to change the direction of control application of the cable which has its outer end secured to a pin 656, Figs. 37, 38 and 39 of the cross slide plate 377.

The forward end of the tubular body 640 provides space in which the cable forms into a spring spiral when the rod 644 is moved forward upon resetting. This keeps the cable in position.

The operation of the combined depth of cut and tracer resetting mechanism is as follows:

If the limit pin 710 be removed from the position shown in Figure 28 and then placed in the hole 712 (Fig. 28), the parts will be in the position shown in Figures 28, 39 and 40 after the resetting handle 646 has been pulled backward to the limit allowed by the pin 710. The tracer will be moved forward through contact of the roller 372 against the depth control plate 374 and the tension of the spring 367 will be increased. The ratchet escapement point 391 will take the position shown in Figures 28 and 40 to restrain the escapement plate 386 and will be held in that position by the spring 402 (Figures 38 and 39) which co-operate with the connecting members 393, 394 and 404. The reversing lever 405 will also be held against the pin 415 by the spring 413 and its lengthened arm 416 will be at the same elevation as the lower elevation 421 of the reversing plate 408 (Figs. 37 and 39).

If the cross slide be now moved in the out-feed direction to a point to permit the contactor 445 (Fig. 37) to be released for upward movement by means of the spring 464, the reversing lever 405 will be deflected to the position shown in Figure 38 and the ratchet point 390 will hold the tracer against action of the spring 367 until the contactor 445 is again brought to a point below the elevation 421 of the plate 408. When this occurs, the spring 402 will again bring the parts to the positions shown in Figures 39 and 40 and the tracer will have been moved one complete notch closer to the tool. These movements will be repeated for each carriage movement until the plate 371 contacts the screw 376 (Figs. 28 and 37) when the tracer takes its finish-cut position. The tracer can be again reset to its third notch position by moving the handle 646 backward.

The reversing of the carriage feed upon completing a cutting operation in direction of arrow 60, is by a spring actuated reverse shown in detail in Figures 37 and 38.

A reversing control plate 430 is fixed by bolts 431 and 432 (Figures 37 and 38) to the plate 82 at the rear of the carriage. It is provided with a vertical drilling through its length in which is slidably fitted a control rod 433 having an enlarged lower end 435 which has a slot 437 in which a lengthened side lever 439 integral with a shaft 441 slides. This shaft has bearings in the brackets 69 and 70, and maintains reversing control for all positions of the carriage.

At its upper end, the control rod is provided with a vertical slot 443 in which a contactor 445 is pivoted by a pin 446. The base of the contactor rests on the upper surface of a vertically sliding pressure pin 448 which has its lower end in contact with a stiff spring 449 in a hole 450 in the end of the control rod.

The object of this construction is to permit of yielding of the contactor in either direction if excessive pressure be applied in a cross feed direction.

The control plate is provided with a matching slot 451 to permit of free action of the contactor.

The side of the control plate has a slot 453 through which a locking pin 454 of the control rod extends.

The locking pin extends into the path of an arm of a locking lever 455 to latch in a notch 456 thereon. This lever is pivoted to the side of the control plate by a bearing stud 457 and has a second arm provided with a slide shoe 459 to contact the upper surface of a releasing collar 461 which may be set at any point of the length of the shaft 441 by a screw 462.

A light spring 463 co-operates with the locking lever and the control plate to bring the lever into latching position.

When in operation, the upper end of the contactor is forced against the lower elevation 421 of the reversing plate (Figure 37) by the pressure of a spring 464 under tension between the lower end of the control rod and a projection 466 on the control plate.

A crank arm 470, Figures 1, 2, and 38, is secured to the end of the shaft 441 and is provided with a pivot bolt 471 tc which the upper end of flexible cables 473 and 474 are fixed. The cable 473 slides in a conduit 476 and in a branching conduit 477 to connect with the outer end of a lever 479 of the cross slide unit housed in foundation case 130 (Figures 1, 2, and 3).

The cable 474 controlling the carriage unit housed in the foundation case 130a passes through the conduit 476 and a branch conduit 481 and is connected to the arm 479 of that unit.

The carriage reversing mechanism operates as follows:

The control rod 433 is first drawn downward against the action of the spring 464 by forced rotary movement of the shaft 441, to its latched position. In this position, the point of the contactor 445 is somewhat below the level of the elevation 421 of the control plate and will remain in that position until the movement of the carriage, during the cutting operation, unlocks the control rod by passing over the releasing collar 641 to raise the slide shoe 459. The parts are then in the position shown in Figure 37. Out-feed movement of the cross slide, beyond the reversing point, will allow the contactor to slide beyond the elevation 421 and the spring 464 will be released to move the parts to the positions shown in Fig. 38. The rotation of the shaft 441 brings the cables 473 and 474 under tension to rotate the shafts 511 and move the arms 510a and 753, of the clutch units, into contact with the armatures controlling the carriage and the cross slide. The in-feed movement of the cross slide is prevented, and the carriage movement is reversed. Up to this point, the carriage and cross slide have been under tracer control and the out-feed alone has been in operation. Upon reversal of the carriage movement, the tracer point will

leave the pattern and the out-feed circuit will be thereby opened. The in-feed circuit is then closed by tracer action and would act to move the armature 245 if it were not prevented by the arm 753. Reversing of the carriage movement may also be done by first withdrawing the reversing plate 408 to a point beyond interference with the contactor 445 and locking it in that position. The releasing collar 461 is then locked to the shaft 441 at the desired reversing point. Upon the slide shoe 459 contacting the collar by movement of the carriage when moving toward the head of the lathe and taking the position shown in Figure 37, the locking lever 455 will act to release the control rod 433 and reversal will take place.

The preferred form of mechanism to again place the clutch mechanism under tracer control at the start of a new cutting cycle, is shown in Figures 3, 41, 42 and 43.

On the outer end of the clutch shaft 131 is assembled a bearing spacer 485a (Figure 42), a flange 486a (Figures 3, 41, and 42), a bearing spacer 487a, a notched detent disc 489a (Figures 3, 41, and 42), a bearing spacer 490a, and a retaining collar 492a, all secured to drive with the shaft by a key 494a (Figure 42) and by a nut 209 on the end of the shaft.

A locking lever 498a is assembled with the above in either side of the notched disc and is supported by the bearing spacers 487a and 490a.

The lever is provided with a heavy detent 491a (Figure 41) pivoted thereto by a pin 493a (Figures 41 and 42) having an end extending into a limiting notch 495a cut in the rear clutch shaft bearing cap 496a as shown in Figures 3, 42, and 43 to limit the rotative movement of the locking lever 498a.

The detent is provided with an oppositely extending armature lever 500a operated by a coil 501a, Figures 1, 3, 41, and 42, in co-operation with its associated solid round core 502a secured to the lever by screws 503a.

The armature and detent are retracted by a light spring 505a as shown in Figure 41.

A rigid arm 507a, Figures 3 and 42 integral with the locking lever, extends beneath an arm 510a fixed at one end to a shaft 511 (Figures 3, 4, and 41) supported in bearings 513 and 514 secured by nuts 515 serving to hold the clutch shaft bearing caps 496 and 496a.

The shaft 511 is secured at its forward end to the lever 479 which is connected by cable to the crank arm of the reversing shaft 441.

The shaft 511 is actuated by a spring 517, Figures 3 and 41, to maintain a tension on the connecting cable and to also retract the superimposed mechanical control of the tracer controlled armatures.

A light spring 519 (Figure 41) serves to maintain the locking lever in position while disengaged.

A directional cut-out switch is assembled on the bearing spacer 485a between the bearing member 168 and the flange 486a, and consists of a disc 521a having a thin sheet spring member 522a riveted thereto with its free ends 523a bent outward to form a frictional drive responding to either direction of shaft rotation.

Stop pins 525a and 526a, Figures 3 and 43, inserted in the bearing cap 496a, limit the extent of rotation in either direction by contacting with an extension 527a of the disc.

A spring contact 529a is supported by an insulating block 530a secured to the bearing cap. This spring permits of a circuit being established through the coil when the switch disc 521a is in the position shown in Figures 41 and 43.

A circuit closer, co-operating with the pattern to control the above locking and reversing mechanism, is carried by the tracer bar as shown in Figures 28, 29, 30, 34, 35, and 36. It is provided a base 535a completely insulated from the tracer bar and secured thereto by two screws 536a (Figure 35). This provides a bearing for a vertical bar 538a at one end.

This bar has a locating collar 539a above the bearing and has an off-set crank 541a turned at its lower end which is operated by a light spring 544a having its other end secured to a pin 543a fixed in the base.

The extended upper end of the vertical bar is fixed to an arm 545a so formed as to extend around one side of the tracer point without interference, to bring a vertical contact pin 547a to a point slightly in advance (in the infeed direction) of the tracer point.

An adjustable insulating block, 548a secured to the arm 545a aids in adjustment and provides insulation from the point.

The contact pin 547a may be somewhat shorter than the tracer point to prevent damage.

It will be noted that the angle of support of the contact arm relative to its contact point permits of the point yielding to contact pressure in either direction of carriage feed without interfering with tracer point contacting the pattern and following same, independent of the form of the pattern or the direction of movement of the tracer on the pattern.

Connection is made by a connecting screw 549a to the connecting wire 762 (Fig. 52) of the circuit controlling the locking engagement. The current for operation is preferably provided by the A. C. transformer 763 at about 16 to 32 volts.

This mechanism operates as follows:

When the carriage has returned to a point to allow the tracer carried contact pin 574a (Figs. 1, 30, 35 and 36) to contact the reversing projection 756 of the electrically grounded pattern 74 (Figs. 1 and 23) a circuit will be established through the connecting wire 762 (Fig. 52), the transformer 763, the wire 765, the coil 501a, the flexible connector 767 to the contact spring 529a, and through the projection 527a of the direction cut-out switch 521a which is grounded to the lathe.

During the return movement of the carriage, the notched detent disc 489a is rotated in the direction of the arrow 760 (Fig. 41) by the clutch 131, and when the end of the detent 491a is moved by action of the coil 501a to contact the disc, the rotary movement of the clutch shaft will carry the locking lever 498a with it to move the arm 507a toward contact with the lower surface of the arm 510a (Figs. 3 and 4). Further movement of the clutch shaft will then carry the locking lever to a point to raise the arm 510a to move the control rod 435 (Figs. 37 and 38) and to release the armatures 244 and 245 from control of the arms 753 and 510a. The reverse movement of the carriage then stops and the cross slide is then moved in the in-feed direction through action of the undeflected tracer.

However, the circuit through the coil 501a is still closed and will remain so until the carriage is started in its cutting or operative movement. The reverse rotation of the clutch shaft will then allow the spring 519a (Fig. 41) to move the locking lever back to its former position and the con-

tact between the contact spring 529a and the projection 527a of the direction switch 521a will be broken and will remain so until again closed by contact of 547a with the pattern and by the reversed movement of the clutch shaft.

A combined lubricating pump and feed speed control for carriage return, is shown in detail in Figures 4, 5, 8, 44, 45, and 46, and consists of the pump base 158, Figures 1, 4, 5, 8, 44, and 45, secured to the bottom of the frame by a main frame bolt 560 (Figures 3 and 45) and by bolts 561 (Figure 3) secured in the frame. The bore 563 of the pump cylinder 564 extends completely through the base, and the union of the base to the frame must be held close to prevent leakage. A thin gasket (not shown) may be used at this point.

A plunger 566 is fitted within the bore of the pump cylinder and is reciprocated by an eccentric cam 567 on the crank shaft, and also by a return spring 568 (Figures 8 and 45).

An inlet valve 570 has a closing spring 571 secured by a nut to close inlet openings 573 through which oil enters from the upper oil tight compartment of the foundation case.

The oil is forced by pump pressure into a duct 574 which is provided with a ball check valve 575 closed by spring 576 operating a slender rod 577 to close the valve.

The duct 574 connects with a duct 578 in a vertical extension 579 of the pump base. This duct is closed at its upper end and is connected by a duct 580 (Fig. 45) to a discharge tube 581 leading to a point above the connecting rod bearing, for lubricating the various bearings.

For varying the rate of feed, a duct 582a is formed in the pump base to connect the duct 574 to a cylinder 583a which is closed by a screw at one end and is fitted with a plunger 585a fixed to the slide 155, at the other.

The cylinder is provided with limit discharge ports 587a which permit of discharge of oil from the cylinder and prevent further movement.

The vertical extension 579 (Figs. 45 and 46) is provided with a vertical bore 589a in which a plunger 590a is closely fitted. This plunger has a reduced valve section 591a to permit discharge.

The plunger 590a is operated by a lever 512a moving with the shaft 511 and, when moved upward to discharge position, the oil is forced out of the cylinder 583a by two heavy springs 593 to return the slide to its low speed position, which is determined by an adjusting screw 595.

This screw also manually sets the slide for any desired clutch shaft speed by moving the slide, when the hydraulic speed change is not used. One end extends beyond the wall of the foundation case and the oil is sealed in by a gasket. The operation of the combined pump and speed of feed control mechanism is as follows:

During the cutting movement, the arm 512a (Figs. 3 and 45) will be held in its raised position by the shaft 511 and the plunger 590a will be in a position opposite to that shown in Figures 45 and 46. The oil drawn through the inlet ducts 573 of the inlet valve 570 by reciprocation of the pump plunger 566, will pass through the duct 574, the outlet ball valve 575, the ducts 578 and 580, the reduced valve section 591a (Fig. 46), and the discharge tube 581, which extends to a point above the connecting rod, for splash lubrication of the clutch mechanism.

During the cutting movement, the variable leverage slide 155 is held by the springs 593 against the end of the adjusting screw 595 to determine the low feed rate for the cutting movement.

When the carriage is reversed, at the start of the return movement, the arm 512a is raised, by action of the shaft 511, and the outlet part the plunger 590 will be cut off by movement to the position shown in Figures 45 and 46. Oil will then be forced through the ducts 577 and 582a into the cylinder 583a (Figs. 4, 44 and 45) to move the plunger 585a therein. This plunger is integral with the slide 155 and it will be moved against the tension of the springs 593 until the ports 587a (Figs. 44 and 45) are uncovered by the end of the plunger.

The leverage of the walking beam 145 will be thus increased to give high speed carriage return.

At the end of the return movement, the plunger 590a is returned to its open position, and the slide block is returned to its low speed position.

A rotation governed feed stop, simplified over the type shown in my pending application, Ser. No. 330,525, has a tubular body 600, Figures 1, 2, 20, 21, and 22, in which a bearing bushing 601 to support a shaft 602 is free to rotate therein. A multiple speed pulley 604 is fixed to the outer end of the shaft for drive.

A plate 606 is fixed to the inner end of the shaft to one side, and carries a bearing pin 607 on which a counterweighted fly lever 608 is supported.

A short shaft 609, having a hole drilled at its center throughout its length, is also fixed to the plate in line with the shaft 602.

A light spring 610, having one end connected to the plate and the other to the lever 608, keeps the lever in its retracted position (Figure 20) when not rotating.

An insulated rod 613, carried in the center drilling of the shaft 609, is moved endwise by the deflection of the lever and its end contacts and moves a spring 615 having a contact 616 at its end, and secured to an insulating plate 618 fitted in the recessed end of the body and retained in position by a spring pressure clip 620. The spring has an external connector 626 (Fig. 21).

A second contact spring 622 has a contact 623 to match with the contact 616 (Figure 20). This spring is also insulated and secured to the plate 618 to provide external connection 625.

Any required adjustment of contacts is made by a screw 628.

The shaft of this feed stop should lie horizontally, and is driven by a belt 630 (Figures 1 and 2) from a multiple speed pulley 631 carried on the lathe spindle.

A supporting plate 633 is secured to the lathe and is provided with a drilled hole in which the shank of a supporting rod 634 of the feed stop is secured by a screw 635.

The rotation governed feed stop operates as follows:

The shaft 602, belt-driven by the lathe spindle, rotates the fly lever 608 (Figs. 20 and 22), which is counterweighted in opposite directions from its bearing pin 607.

Upon reaching a rotative speed, determined by the spring 610, the fly lever will swing on its bearing and the non-conductive rod 613 will be forced outward (Fig. 20) to establish a circuit through the control coils 240 and 241 of both clutch units. This is by way of the contact springs 615 and 622 and the connecting wires 725 and 728 (Fig. 52) of the ground connections of the coils. The feeds can therefore operate, but

will again stop when the spindle of the lathe is reduced below the critical point, and the circuit is opened.

A cutting tool of the form shown in Figure 51 has no tendency to be either drawn into or forced away from the work, and extremely heavy cuts may be therefore taken without chatter if used with the previously described resilient cutting pressure control mechanism.

The receding portion 666 of the cutting tool 68 is so set, or ground, as to counterbalance the pressure developed by the point 668 of the tool.

As the object is to remove the greatest amount of stock in a given time during the rough cutting operation, it is many times advisable to remove the entire excess stock in one rough-cut operation. The arrangement of the cutting tool as above described and the resilient drive make this readily done.

The operation of the complete mechanism is as follows:

In first setting the mechanism, the tool setting to give a cutting diameter equal to the largest diameter of the work to be turned is best obtained by a trial cut. The tool is then retained in that position.

The screw 366 is released to permit the depth control 364 to move freely relative to the base 350.

The escapement 392 is manually released to bring the roller 372 of the support 371 to contact the depth control plate 374 at the point 703 which determines the smallest diameter controlled by the plate 374.

The finish stop screw 376 is then set and fixed at about fifteen one-thousandths of an inch from the stop end of the plate 371 of the tracer support.

The escapement is again operated to bring the roller to position 704 when the contact of stop screw and the plate determine the fixed finish cut position of the tracer.

The carriage reversing control rod 433 having been securely latched in its retracted position, the carriage is moved by the manual control 706 to bring the tracer point opposite to the setting edge 322 (or 323) and the cutting depth control 364 moved manually until the tracer point is brought into operative contact with the setting. The depth control is then securely locked to the base by the bolt 366, and the tracer and the tool are both correctly set for turning the greatest diameter for the finishing cut, and likewise set to correctly finish the outlines followed by the tracer.

The tool setting is still retained, but it is required that the carriage be moved to bring the tracer point opposite to the greatest cutting depth of the pattern. The tracer bar must therefore be deflected by the pattern during movement, or by previous manual shifting to its deflected position.

When the tracer bar has cleared the pattern it is again erected by manual operation.

The total number of cuts used to finish the work varies as conditions dictate, but in this case four will be used as shown in Figure 53.

The feeding depth control plate 374 is first released by its retaining bolt 378, and a limit pin 710 placed in the hole 711 for the setting up operation only. The cross slide plate 377 is then moved manually by operation of the resetting handle 646 to bring up against this pin where it will be latched and held by the escapement 392. The plate 374 is then brought up against the roller 372 to move the tracer support against the pressure of the spring 367 until the tracer point

comes into operative contact with the pattern, and is then securely locked by the bolt 378.

The escapement is then released one full notch and the pin 710 placed in the hole 713 to give four cuts under automatic operation.

The reversing plate 408 is now released and moved to approximately the point shown in Figure 37 to allow the contactor 445 to move to the higher level and trip the reverse when the tool has been retracted to approximately the line 714 of Figure 53. The plate 408 is then locked by the bolts 410 to establish the return reversing point, in direction opposed to the arrow 66.

A point directly beneath the shoe 459 should be noted and the releasing collar 461 set on the reversing shaft by the screw 462 while the tracer is at the deepest part of the pattern. This allows of manual retraction beyond the reversing as required in checking during the early part of the cutting movement, without interference with the reverse.

The trial-cut work piece is now removed for a preliminary automatically controlled cycle.

As all manually controlled switches are in position for automatic operation, the spindle drive motor 720 (Figure 52) and the motors 140 that drive the operating units, are started.

The escapement has been retracted one full notch and the action will be an in-feed movement toward the pattern.

A circuit is maintained by the tracer, when the tracer point is not deflected, through the battery 722, the ground wire 723, the visible ammeter 724, the wire 725, the rotation feed stop 600, through the wire 728 to the coil 240, by wire 731 to the stop switch members 733 and 734, by wires 735 and 736 to the tracer contact lever 276, through the contact arm 261, the circuit closing spring 300, and through wires 738 and 739 to the opposite terminal of the battery. This circuit is maintained until interrupted by the tracer in contact with the pattern. During this interval, the armature operated by the coil 240, of the cross slide operating unit, remains deflected to move the hook-up lever 228 into operative position to engage the clutch rollers at the start of the required reciprocating movement to move the cross slide in the in-feed direction.

A slight in-feed movement, after tracer point contacts the pattern, closes the circuit at the contact of arm 293 and the contact screw 294. This completes the circuit through the coil 240 of the carriage operating unit, through wire 740, the manual reversing switch 741, the wire 743, the wires 725 and 728, and the ground wire 723 to the battery, at one terminal, and from the contact arm 293 through the connector 296 to the contact arm 284, and by wires 745 and 739 to the opposite terminal of the battery.

Manual operation of the control 747 (Figures 1 and 2) connects the lead screw 77 for carriage drive, and the energizing of the coil acts to move the carriage in required direction.

As there is an over-lap of the in-feed and carriage controls, the in-feed circuit is opened shortly after the carriage starts, and the in-feed movement stops.

The tracer point now follows the pattern until an out-feed movement of the point closes the circuit through the coil 241 of the cross slide operating unit. This circuit is through the tracer arm 261, the arm 281, the wire 750 to the coil 241, and as previously noted to complete the circuit.

The over-lap of the carriage feed with the in-feed and with the out-feed, gives continuous car-

riage feed during the entire movement, with the exception of the abrupt direction changes at the end of the cylindrical turnings 313 and 314 and at the start of the surface 316 of Figure 23.

When the tracer point reaches the stop section 751 of the pattern (Figures 1 and 23), the carriage movement stops and the cross slide moves in the out-feed direction until the end of the contactor 445 (Figure 37), previously restrained by the lower elevation face 421 of the reversing plate 408, snaps upward to release one step (one-half notch) of the escapement controlling the cutting depth, and to simultaneously operate the reversing shaft 441.

This serves to increase the tension on the cable 474 leading to the carriage operating unit, and the shaft 511 is rotated in its bearings to move the levers 510*a*, 512*a*, and 753 into operative control. An adjustable screw 754 carried by the lever 753 contacts the upper surface of the armature 245 to move it in opposition to the coil 240 and prevent its control of the carriage movement. At the same time, the screw 754 on lever 510*a* deflects the armature 244 against its retracting spring to bring it into operation to reverse the carriage movement.

By the same movement, the plunger 590*a* is moved to its closed position to give high speed carriage return.

The cable 473 leading to the unit controlling the cross slide is moved simultaneously with the cable 474 and likewise acts to hold the armature controlled by the in-feed coil 240 out of electrical control by means of the lever 753.

The carriage return movement breaks the pattern and tracer contact and the carriage will return at high speed with the tool and the tracer retained in their reversing point retracted positions.

This return movement is limited by the contact pin 547*a* meeting some part of the pattern, usually the rearward extension 758 of Figures 1 and 23. When contact is made, a circuit is established from the frame grounded pattern 74 through the pin 547*a*, by wire 762 to a low tension transformer 763 (16 to 24 volts), by wire 765 to the coil 501*a*, through connection 767 to the switch member 529*a*, the switch member 521*a*, and by wire 768 to the frame ground 62.

When this circuit is closed, the detent 491*a* is moved into locking engagement with the detent disc and the locking lever 498*a* will be rotated with the clutch shaft in direction of the arrow 760 until the movement is stopped either by removal of the superimposed control or by the limit imposed by the notch 495*a*. This movement forces the lever 510*a* upward to rotate the shaft 511 sufficiently to move the reversing shaft beyond the latching point of the control rod 433, by means of the connecting cable 474. This acts to return both units to electrical control by the tracer and, at same time, releases one step (one-half notch) of the escapement controlling the cutting depth.

The contact pin 547*a* yields upon contact with the pattern and should have range enough to stop the returning carriage before the tracer point contacts with the pattern. This is to prevent the possibility of the tracer being moved beyond its operative limits.

The lathe spindle is stopped which automatically opens all feeding circuits. The cross slide is manually retracted beyond its normal return position, and a work-piece 64 (Figure 53) placed in the lathe. The cutting depth slide is reset by

the handle 646 and the machine is ready for automatic operation.

Upon starting the machine the tool will form, in its first cut, the outline shown by line 770 (Figure 53) and the reversal (with its accompanying escapement movement) will take place at the point 771.

The reversal at the start of the second cut provides a second escapement movement, and the tool will form the outline shown by line 772, with return reversal taking place at the point 773.

The third rough cut follows the line 774 for the full length of the work, leaving about fifteen one-thousandths of an inch for the finishing cut.

The escapement movement at the start of the finishing cut acts to increase the cutting speed during the cut, and operates in the following manner:

A disc 780, Figures 28, 39, 47, and 48, of non-conductive material, is secured to the lower side of the rearward extended end of the slide 377 in position to serve as a stop for the slide when it has moved to bring the roller 372 to the point 705 of the depth control plate 374 (Figure 28).

The disc contacts the contact point 781 of a spring lever 782 to close a contact between it and its mating spring lever 783 at the start of the finishing cut, as shown in Figure 47. These levers are fixed to an insulating block 785 which is secured to a supporting projection 789 of the cutting depth control 364, and normally act to keep the circuit open.

The circuit is completed from the spring 782 by wire 791 (Figure 52) to the coil 792, by wire 793 to the wire 725, through the ammeter 724, and by ground wire 723 to the battery 722, and by wire 790 to the spring 782.

When the circuit is completed, the armature 795 is moved to break the circuit through the connector 796 to the shunt field circuit of the commutator type motor 720 (Figure 52) used to drive the lathe spindle and to introduce a resistance 797 to increase its rotative speed.

When the finish cut (line 775) is completed, the carriage return reversal again releases the escapement by one step and the slide 377 is moved to release the contact spring 782 to permit the motor speed to be returned to that required for the rough cut operations. At the same time, the disc 780 is moved to break the normally closed contact between the springs 733 and 734 by contact with the projection 800 carried by the spring 734. Both springs are secured to the insulating plate 802 which is fixed to a projection 803 of the cutting depth control.

This circuit controls the in-feed movements of the cross slide and prevents operation upon return of the carriage to starting position.

It will be noted that all feeds are stopped by stopping the rotation of the spindle, that the in-feed alone may be stopped by opening the manual control switch 804, that the carriage feed may be prevented by moving the switch 741 to its off position between the contacts, that the in-feed may be operated while the infeed circuit is opened by the disc 780 by closing the switch 805, and that all feeds may operate with the spindle inoperative by closing the switch 806.

An alternate form of power mechanism adapted to restore the clutch mechanism to tracer control at the start of the cutting movement of the carriage, is shown in Figures 54, 55 and 56. It consists of a base plate 670 secured to the rear of the lathe carriage by bolts 671, near the control plate 430 with which it operates. The base plate has a vertical drilling 674 in which a bearing

shaft 675 is held by a retaining bolt 676 by extending into a recessed portion 678 near its upper end.

The lower end of the shaft has a rigidly fixed head 679 which is formed (Figs. 55 and 56) with an operating arm 686 and a flat face 680 (Fig. 56) against which a plate 682 is forced by heavy springs 683 and 684 to move the head to the position shown by dash and dot lines (Fig. 56).

A reversing collar 687 (Figs. 54 and 55) co-operates with the snap action arm 686 to rotate the reversing shaft 441 to its tracer control position. This collar is carried by the shaft 441 and is adjustable along its length. It is held by a set screw 688.

The collar has a straight-faced projection 690 (Figs. 54 and 56) against which the arm 686 first contacts during the carriage return to compress the springs by deflection of the head to the full line position shown in Figure 56. The collar is also provided with an angle faced projection 693 (Figs. 54, 55 and 56) against which the arm is forced by the springs when the movement of the carriage has released the arm from the projection 690. The snap action of the arm with the face of the projection 693 acts to rotate the shaft 441 and the control rod 433 will be brought to its latched position at the same time that the armatures, of both clutch units, are again released for tracer control.

The operation of this mechanism is as follows:

When using this form, the tracer contact pin 547*a*, Figures 1, 30, 34, 35 and 36, is not used and is removed from the tracer bar.

The reversing collar 687 is then locked to the shaft 441 at a point that will stop the carriage slightly before the tracer point 304 contacts the projection 758 of the pattern 74 (Figs. 1 and 23), during its return movement.

The returning movement of the carriage will first deflect the arm 686 to compress the springs 683 and 684. Further carriage movement will release the arm to forcibly contact the angled face of the projection 693 and the shaft 441 will be rotated to bring the control rod 433 (Fig. 37) to its latched position. At the same time, the tension on the cables will be relaxed and the springs 517 (Figs. 3 and 41) will raise the arms 510*a*, 753, and 512*a* of the carriage control unit, and the arm 753 of the cross slide unit to return the clutch units to tracer control.

The action of the reversing shaft when controlled by this type is identical with its action when controlled by the electrical power locking type, but a somewhat greater extent of tool retraction must be used during the carriage return to prevent interference.

When using this type of reverse, all parts of the control unit operating the carriage that carry the reference letter *a* are eliminated, with the exception of the lever 510*a*, the hydraulic speed change parts, and also of the back-geared drive shaft. The units are otherwise identical.

Movable stop abutments 810, Figures 1 and 2, of the type commonly used on lathes, are clamped by bolts 811 to the lathe bed to give positive limitation to carriage movement in either direction.

A movable abutment 812, Figure 1, is secured to the carriage by means of a T-bolt 813 secured in the T-slots 819 of the carriage.

These abutments co-operate with the resilient yielding pressure control mechanism to limit the movements.

Forgings and castings generally require one rough cut, and the mechanism should be set and used accordingly.

It is sometimes desired that a uniform depth of successive cuts be maintained. The interchangeable form shown in Figure 57 provides this with a straight contact edge 823 on the plate 824. It is otherwise identical with the plate 374.

The inertia of the cross slide and the parts moving therewith largely determine the allowable reciprocating speed of the clutch driving that slide.

To obtain exact tracer control of the tool, it is required that each reciprocated movement readjust the tracer contacts, the parts come to rest, and the electric mechanism act to move the hook-up lever into operative position before the start of the next reciprocating feed movement.

It has been found that somewhat more than thirty feeding movements in the same direction per second can be used with a twenty inch lathe.

If the reciprocated speed be too high, two movements in succession may result where one is required.

The timing cam 238 may be made separate and adjustable with the crank shaft, instead of integral as shown.

Due to the reciprocating motion, all unnecessary gear connections to both cross feed screw and lead screw should be disconnected. It is also very desirable that all movable drive connections be maintained as close as possible to prevent backlash with attendant wear and sound.

All parts of the clutch units should be secured by lock washers or by cotter pins.

The cross slide is readily moved by the manual control 701 while the machine is in operation to make adjustments, but the power should not be applied from the lathe gearing to operate either the cross feed screw or the lead screw without first disconnecting the drive from the operating units. This is done by releasing the bolts 97 (Figures 16, 17, and 18) to allow the driving key 93 to be moved outward beyond its driving position. The levers 753 and 510*a* have a spring section 822 (Fig. 41) to prevent undue pressure in engaging with the armature elements.

Although I have shown mechanical means to reverse the direction of the carriage member by automatically imposing positive action to control, stop, or move the armatures and hook-up levers, independent of the electric circuits normally controlling their operation, other means may be used. It is only required that such means dominate the operation of the clutch or the power mechanism when in operation. Although I have shown the control mechanism mounted on a lathe, I do not wish to be limited to the lathe, as it is adapted to operate other mechanical devices.

Many of the features herein described are claimed in Patent No. 2,373,265. These include the clutch mechanism and the tracer.

I claim:

1. In combination, a pattern, means to rotate a work piece, a member movable by power toward and from the pattern and lengthwise thereof in a work movement and in a return movement, cutting means carried by the member for operation on the work piece in the work movement, a tracer carried by the member and controlled by the pattern to control movements of the member toward and from the pattern and to control only its work lengthwise movements, means operative by movement of the member to move the cutting means away from the work piece for the return

movement, automatically operated reversing means to control the return movement, means automatically operative to vary the position of the cutting means relative to the tracer control position with the pattern, and automatically operated means to provide another tracer controlled work movement of the member.

2. In combination, a carriage mounted for relative feeding movement in either direction, a power mechanism to move the carriage, a pattern, a tracer controlled by the pattern and adapted to continuously electrically control the power mechanism to move the carriage in only one direction, and means to automatically reverse the direction of movement comprising means interposed between the power mechanism and the carriage to control the movement of the carriage in opposition to the tracer control because of its greater effective control during the return movement.

3. In combination, a member mounted for relative feeding movement in either direction, a reciprocating power mechanism, a clutch member reciprocated by the power mechanism, a driven clutch member having a clutching portion formed into oppositely inclined driving faces, a roller, pressure operated means to hold the roller in continuous contact with the clutching portion and midway of the driving faces when inoperative, power means to move the roller from its inoperative position to contact the first clutch member to move the member in the selected direction, a tracer to control the power means, and a pattern to control the tracer.

4. In combination, a member mounted for movement from one position to another, a slide mounted on the member for movement therewith and also relative thereto, a fixed power mechanism to move the slide, a driving connection between the slide and the power mechanism to move the slide having a telescoping drive shaft to compensate for variation in its length produced by moving the member from one position to another and associated with means to permit movement of the member without effecting the slide, a tracer to control the power mechanism, and a pattern to control the tracer.

5. In combination, a carirage mounted for relative movement in either direction, a power mechanism to move the carriage, a rotatable work carrier, a tool carried by the carriage and moved by the power mechanism to automatically provide a rough-cut and a finish-cut operation on the work, automatic means to increase the rotative speed of the work carrier while making the finishing cut, a tracer to control the power mechanism during the cutting movements, and a pattern to control the tracer.

6. In combination, a support **62**, a member **65** mounted on the support for feeding movement and reverse movement, power means comprising a power operated driving element **146** and a controllable driven element **131** to move the member, a pattern **74**, a tracer element **304** controlled by the pattern to control the driven element for the feeding movement, means **511** under control of the pattern and the tracer during the feeding movement to reverse the direction of movement of the member, and a control device **547***a* moving with the tracer to stop the reverse movement.

7. In combination, a member mounted for relative movement, a power mechanism to move the member, a pattern, a tracer under control of the pattern to be deflected thereby to electrically control the power mechanism to move the member, and means to stop the movement comprising a stop control for the power mechanism interposed between the power mechanism and the member acting independent of the tracer deflection and without change in the electrical connections.

8. In combination, a pattern, means to rotate a work piece, a carriage movable by power in a work movement and in a return movement lengthwise of the pattern, a tracer carried by the carriage and controlled by the pattern to electrically control movement of the carriage only in the work movement, and a carriage reverse comprising a control automatically operated to provide control of the carriage return movement without change in the electrical control connections of the tracer from the connections of the work movement.

9. In combination, a pattern, a carriage, a slide on the carriage movable by power toward the pattern, a tool and a tracer supported on the slide and set in predetermined spaced relation, a locating point on the pattern adapted to define a control position for the tracer when moved into position by power under its control, a retractable locating means having spacing relative to the locating point on the pattern that corresponds to that of the tool and the tracer, and manually operated means to bring the setting of tool and tracer to their predetermined relationship when moved therefrom.

10. In combination, a support, a carriage mounted on the support for traverse movement by power, a pattern fixed relative to the support and having a reference line corresponding to the outline to be formed on the work, a workpiece positioned relative to the pattern, a slide mounted on the carriage and movable by power toward and away from the pattern, a tool carried by the slide and having a predetermined cutting outline and of predetermined size in the cutting outline, said tool operable on the work piece while the carriage is moving in a predetermined direction of traverse movement, and a tracer mounted to move with the slide and the tool, said tracer having a control element of the form and size of the effective portion of cutting tool to contact the pattern to control movement of the carriage and the slide, said control element being variably deflected from a common position in various directions to provide the control required to position the tool relative to the outline being formed on the workpiece, and said pattern having control surfaces for contacting the tracer element that vary from the reference line to the same extent and in the same direction as the tracer element is deflected to provide that position of the tool to thereby form the outline on the workpiece to correspond exactly to the reference line on the pattern when the tool is moved in the predetermined direction under tracer control.

11. In a machine tool, a support, a member mounted on the support for relative movement in either direction, a pattern, a power mechanism, a first clutch member oscillated by the power mechanism, a second clutch member adapted for engagement with the first clutch member during a selected direction of its oscillating movement to transmit movement to the member, a tracer under control of the pattern to control engagement of the clutch members, an adjustable resilient connection interposed between the power mechanism and the member and adapted to yield upon increase of resistance to movement of the member to thereby limit the extent of movement

transmitted, means to provide a reversed movement of the member, and means to provide different yielding action in the different directions.

12. In a machine tool, a carriage, a slide mounted on the carriage for relative movement, a pattern, a power mechanism to move the slide toward and from the pattern, a first clutch member oscillated by the power mechanism, a second clutch member adapted to engage the first clutch member during one direction of oscillation to transmit movement to the slide, a tracer under control of the pattern to control the engagement of the clutch members, and means to define a stop position for the slide when moved toward the pattern upon increase to a predetermined extent of resistance to its movement, said means comprising an adjustable resilient connection interposed between the power mechanism and the member and adapted to yield and to thereby stop the movement of the slide.

13. In combination, a pattern, a carriage movable by power in a work movement and in a return movement, a cross slide mounted on the carriage and movable by power toward and from the pattern, cutting means carried by the cross slide, a tracer carried by the cross slide and controlled by the pattern to control movements of the cross slide in both directions and to control only the work movement of the carriage, automatically operated reversing means to control the return movement, a control operative to stop the carriage, and an automatically operated escapement mechanism adapted to make one control movement at a selected carriage position and to make a second control movement at a second carriage position to provide a second operative position for the cutting means and said escapement mechanism adapted to operate said stop control.

14. In combination, a pattern, a support, a carriage mounted on said support for movement relative thereto, a power mechanism to move the carriage in either direction, a slide on the carriage, a cutting tool on the slide, a tracer on the slide to co-operate with the pattern and adapted to dominate the control of the power mechanism in only one direction of carriage movement, a reversing mechanism interposed between the power mechanism and the carriage to control the power mechanism in opposition to the action of the tracer to return the carriage to the tracer control starting position and complete the cycle of movements, means to interrupt the operation of the power mechanism, and a step by step movement means to determine the position of the tool relative to the control contact of the tracer and pattern for each cycle of movement and to operate the power interrupting means after a predetermined number of cycles.

15. In combination, a pattern, a carriage movable in a work movement and movable by power in a return movement, a power mechanism to move the carriage in the work movement and said power mechanism adjustably operative to automatically reduce the speed of movement of the carriage when the resistance to its movement is increased, a tracer carried by the carriage and controlled by the pattern to control movement of the carriage only in the work movement, automatically operated reversing means to control the return movement, and automatically operated means to provide a second tracer controlled work movement of the carriage.

16. In combination, a pattern having a work control surface and provided with a reverse control extension, a carriage movable by power in a work movement and in a return movement, a tool carried by the carriage for operation in the work movement, a tracer carried by the carriage and controlled by the work control surface of the pattern to control only the work movement of the carriage, a reverse control operative by tracer contact with the reverse control extension of the pattern to control the return movement of the carriage, and a control operative by carriage movement to provide another tracer controlled work movement of the carriage.

17. In combination, a pattern, a carriage movable by a rotatable screw in a work movement and in a return movement, a cross slide mounted on the carriage and movable by a rotatable screw toward and from the pattern, cutting means carried by the cross slide for operation in the work movement, a tracer carried by the cross slide and controlled by the pattern to control the movements of the cross slide in both directions and to control only the work movement of the carriage, automatically operated reversing means to control the carriage return movement, automatically operated escapement means to control the positioning of the cutting means for another operation, and automatically operated means to provide another tracer controlled work movement of the carriage.

18. In an automatically operated mechanism, a pattern, means to rotate a work piece, a carriage movable by power in a work movement and in a return movement in each cycle of multiple cycle carriage movements, a cross slide mounted on the carriage and movable by power toward and from the pattern, cutting means carried by the cross slide to operate on the work piece in the work movement, a tracer carried by the cross slide and controlled by the pattern to control movements of the cross slide in both directions and to control only the work movement of the carriage and said tracer having an overlapping of its control elements to permit simultaneous control in the work movement of the carriage and in at least one of the cross slide movements, automatically operated reversing means to control the return movement of the carriage, automatically operated means to control positioning of the cutting means relative to the tracer, and automatically operated means to provide a tracer controlled work movement in the multiple carriage movement cycles.

19. In an automatically operated mechanism, a pattern, means to rotate a work piece, a carriage movable lengthwise of the pattern in a work movement and in a return movement, a slide mounted on the carriage and movable toward and from the pattern, a power mechanism to move the carriage in the work movement and said power mechanism adapted to automatically provide reduction of speed of carriage movement with increase of resistance to its movement, a power means to move the slide, a tool carried by the slide and positioned for a rough-cut operation on the work piece, a tracer carried by the slide and controlled by the pattern to control movements of the slide in both directions and to control movement of the carriage only in the work movement to effect the rough-cut operation on the work piece, automatically operated reversing means for the carriage return movement, automatically operated means to provide a finish-cut position for the tool, and automatically operated means to effect the finish-cut operation on the work piece in a second tracer controlled work movement of the carriage.

20. In combination, a rotary work support, a member movable by power for relative feeding and return movements, a pattern, a tracer having a deflectable element controlled by the pattern to control only the feeding movement of the member, means controlled by the tracer to reverse the direction of movement of the member for return to the tracer control starting position, and control means moving with the tracer but independent of the deflectable element to contact the pattern during the return movement to stop the reverse movement of the member.

21. In combination, a pattern having a retraction extension carried at one end and a stop extension at the other, a member movable by power toward and from the pattern and lengthwise thereof in a work movement and in a return movement, a tracer carried by the member and controlled by the pattern to control movements toward and from the pattern and to control only the work lengthwise movement and said tracer operative by contact with the retraction extension to move the tracer away from the pattern to provide clearance between them in the return movement, means automatically operated to reverse the member and to control its return movement, and a control moving with the member to contact the stop extension to stop the reverse movement and to provide another tracer controlled work movement of the member.

22. In combination, a pattern, a member movable by power toward and from the pattern and also lengthwise thereof in a work movement and in a return movement, a tool carried by the member for operation in the work movement, a tracer carried by the member and controlled by the pattern to control movements of the member toward and from the pattern and to control only the lengthwise work movement and said tracer adapted to contact the pattern during the period that the tool is operative in the work movement, and a control device having escapement movement and automatically operative to vary the relative adjustment of the tool and the tracer in its control contact with the pattern.

23. In combination, a pattern, a member movable by power toward and from the pattern and lengthwise thereof in a work movement and in a return movement, a tool carried by the member for operation in the work movement, a tracer carried by the member and controlled by the pattern to control the movements of the member toward and from the pattern and to control only its work lengthwise movement and said tracer having an overlapping of control elements to permit simultaneous control of the work movement and at least one direction of movement toward and from the pattern, and a control operative by movement of the member to provide a variation in adjustment of the tool relative to the tracer control contact with the pattern.

24. In combination, a pattern, means to rotate a work piece, a member movable by power toward and from the pattern and lengthwise thereof in a work movement and in a return movement, work producing means carried by the member, a tracer carried by the member and controlled by the pattern to control movements of the member toward and from the pattern and to control only the work lengthwise movement of the member, means operative by movement of the member to withdraw the tracer from the pattern for the return movement, automatically operated reversing means to control the return movement of the member, a control device operative by movement of the member to determine the adjustment of the work producing means relative to tracer control contact with the pattern, means controlled by movement of the member to provide another tracer controlled work movement of the member, and manually operated means to reset the control device to its starting position.

25. In combination, a support, a carriage movable by power mounted on the support for relative movement, a workpiece, a pattern positioned with reference to the support and to the work piece and having a reference line corresponding to the outline to be formed on the work, a slide movable by power mounted on the carriage and movable toward and from the pattern at an angle relative to the carriage movement, a tool carried by the slide and operable upon the workpiece while the carriage is moving in a predetermined direction, and a tracer mounted to move with the tool and having a control element to contact the pattern to control the power means, said tool and said control element being of predetermined different size in their effective operating portions, and said control element being variably deflected to a predetermined extent from a common position to provide the control action required to position the tool to form the outline on the work, and said pattern having control surfaces that vary from the reference line to an extent and in a direction determined by the deflection of the tracer element from its common position but modified by any variation in the relative size of the effective portions of the tool and the tracer element to form the outline on the workpiece to correspond exactly to the reference line on the pattern when the tool is operatively moved in the predetermined direction of carriage movement under control of the tracer.

26. In a machine tool, a support, a pattern, a member carried by the support and adapted for traverse movement relative to the pattern, power means to move the member, a deflectable device adapted to control the power means for movement of the member in one direction, a second deflectable device to control the power means for movement of the member in the reverse direction, means to normally hold the devices inoperative, a tracer controlled by the pattern and adapted to control deflection of the first said device for control of the movement of the member in the one direction, and a reversing mechanism adapted to deflect the second said device to move the member in the reverse direction and acting to return the first said device to its inoperative position and to maintain it in that position in the reverse movement.

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