Aug. 15, 1961 L. D. KLING ET AL 2,995,805

ATTACHMENT FOR TURRET LATHE

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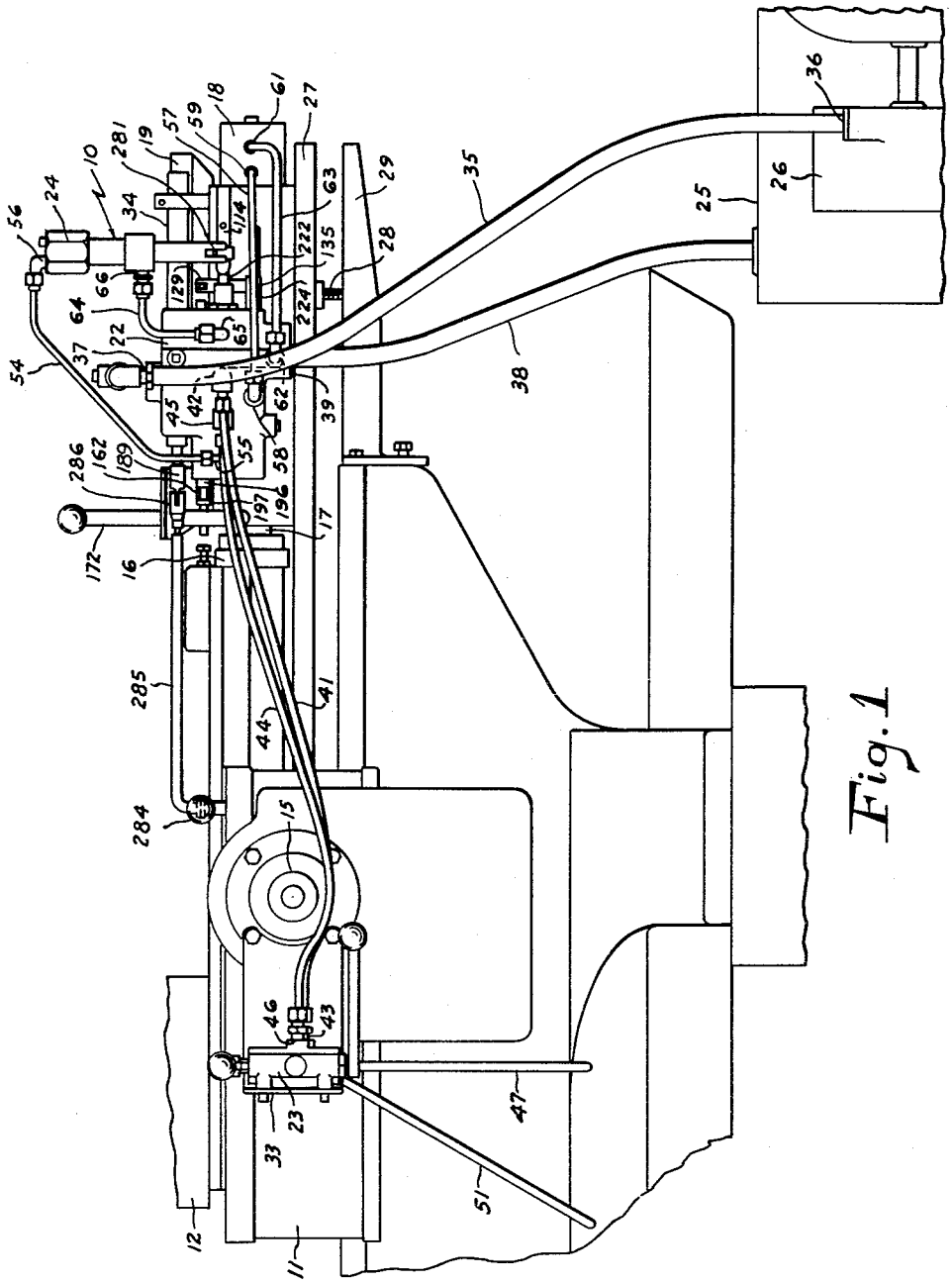


Fig. 1

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

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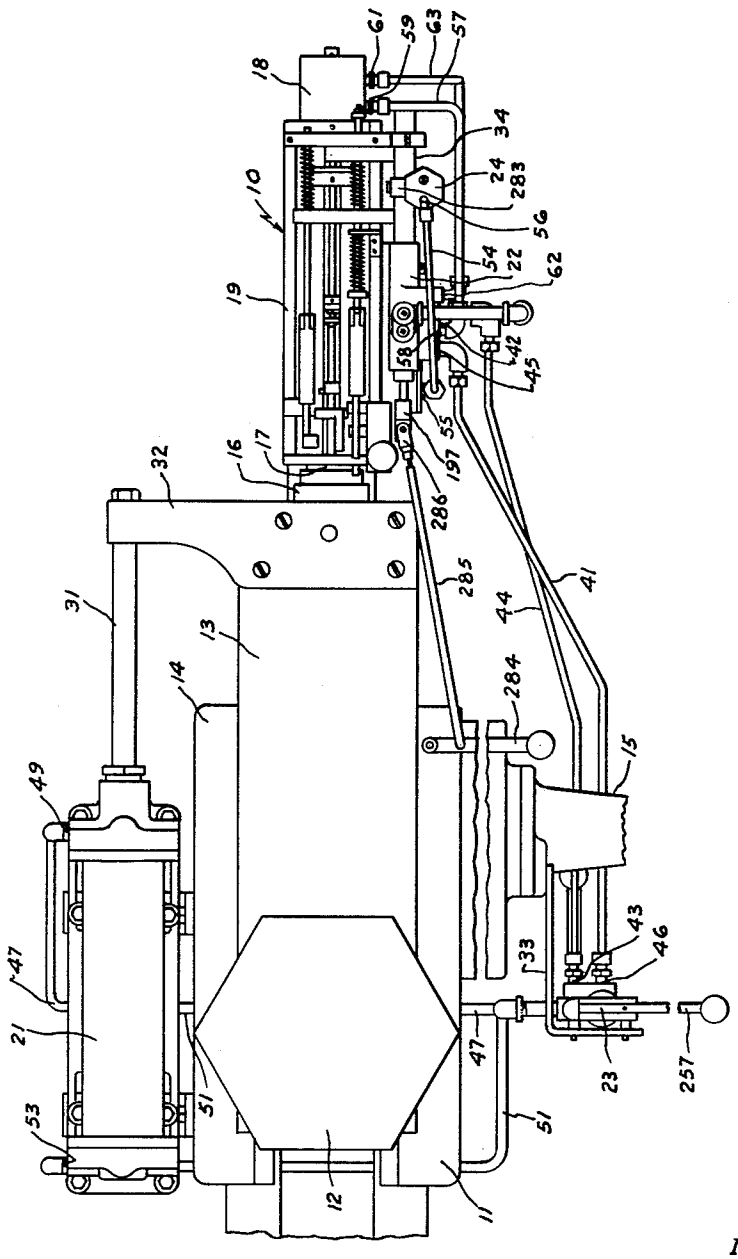


Fig. 2

INVENTOR.
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

Aug. 15, 1961 L. D. KLING ET AL 2,995,805

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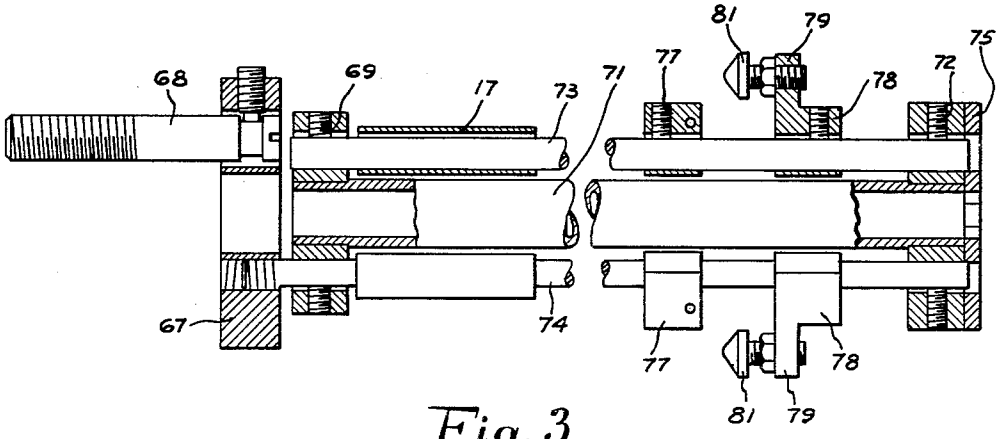


Fig. 3

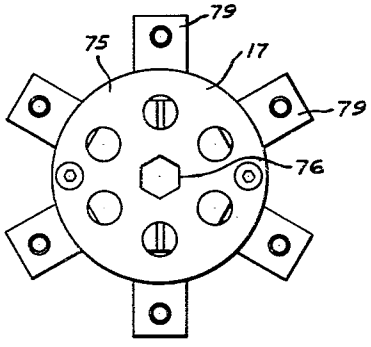


Fig. 4

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

Aug. 15, 1961 L. D. KLING ET AL 2,995,805

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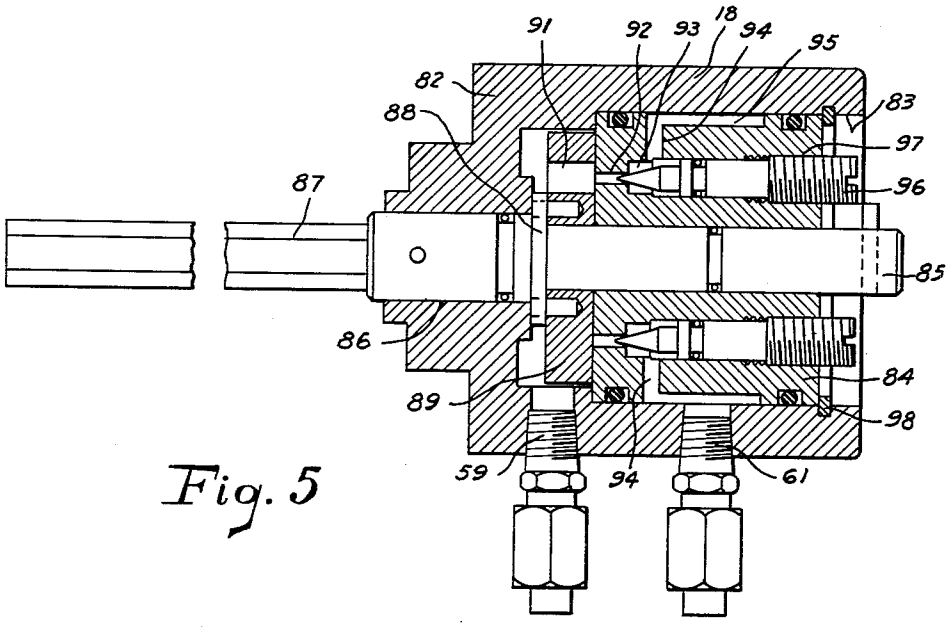


Fig. 5

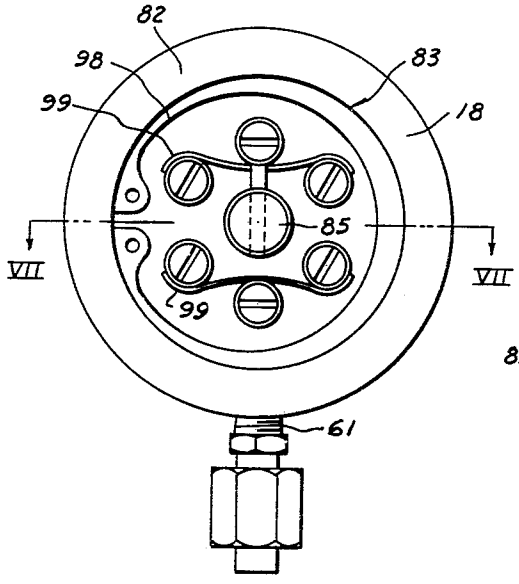


Fig. 6

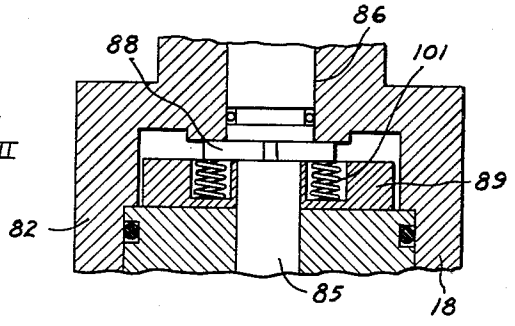


Fig. 7

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

Aug. 15, 1961 L. D. KLING ET AL 2,995,805

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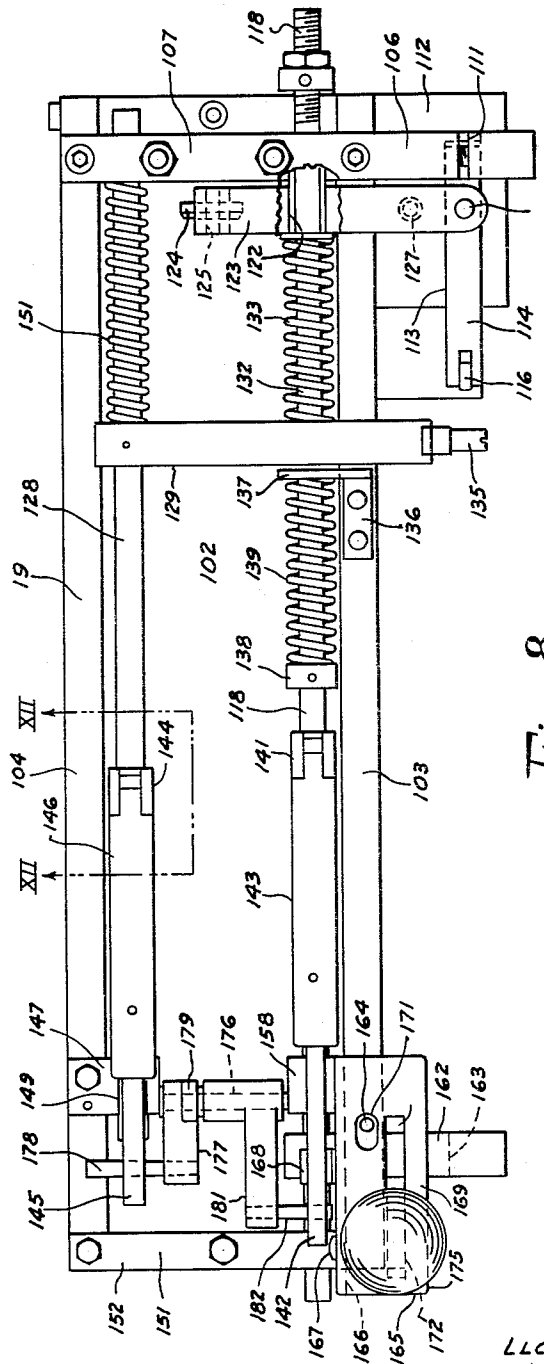


Fig. 8

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

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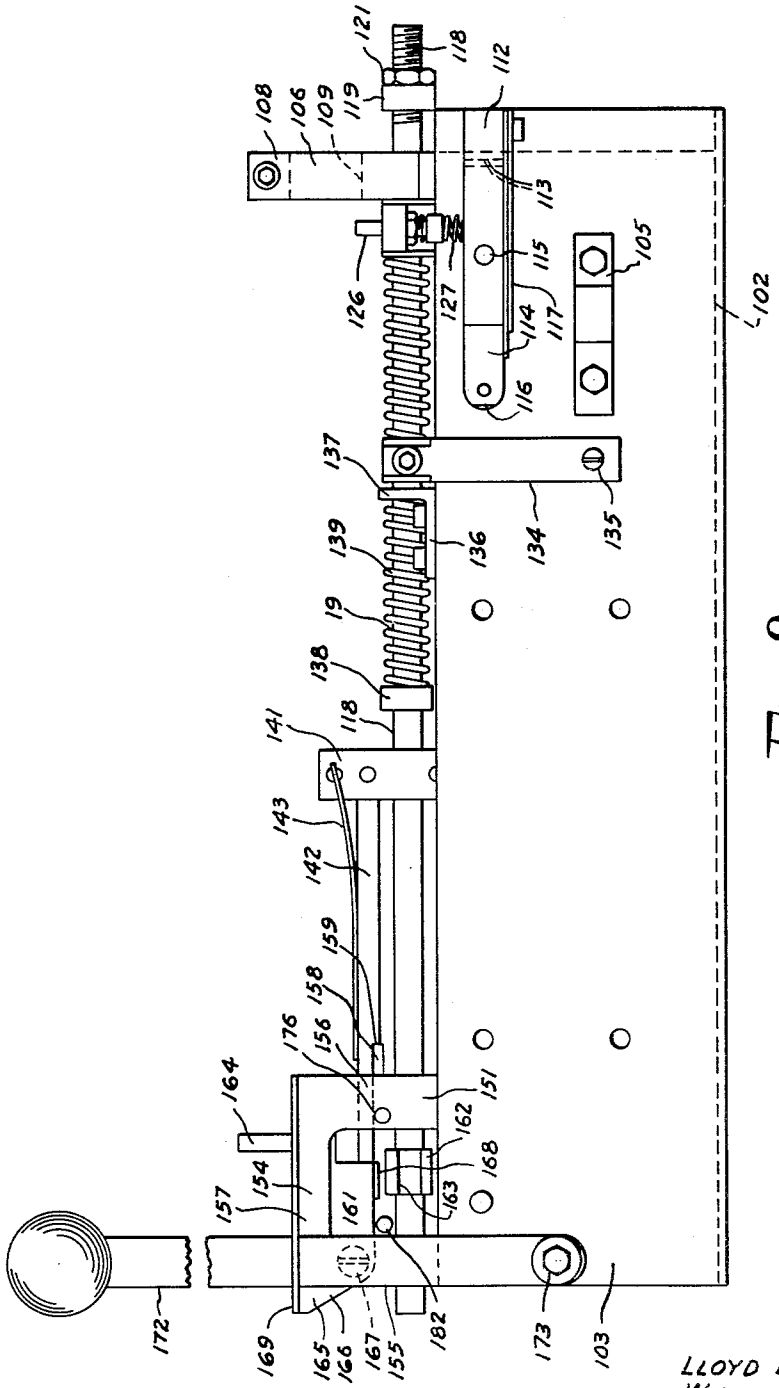


Fig. 9

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

Aug. 15, 1961 L. D. KLING ET AL 2,995,805

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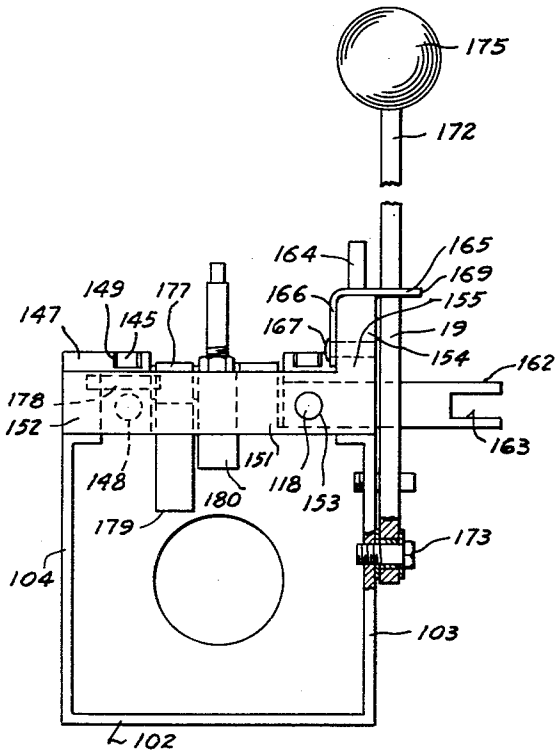


Fig. 10

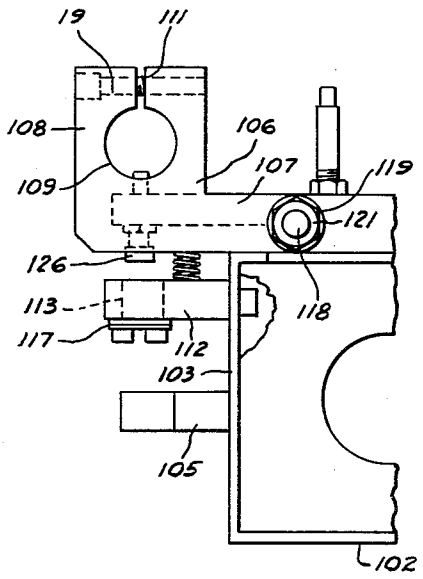


Fig. 11

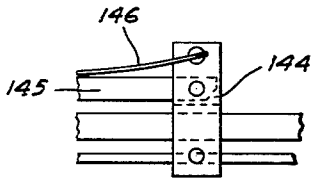


Fig. 12

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

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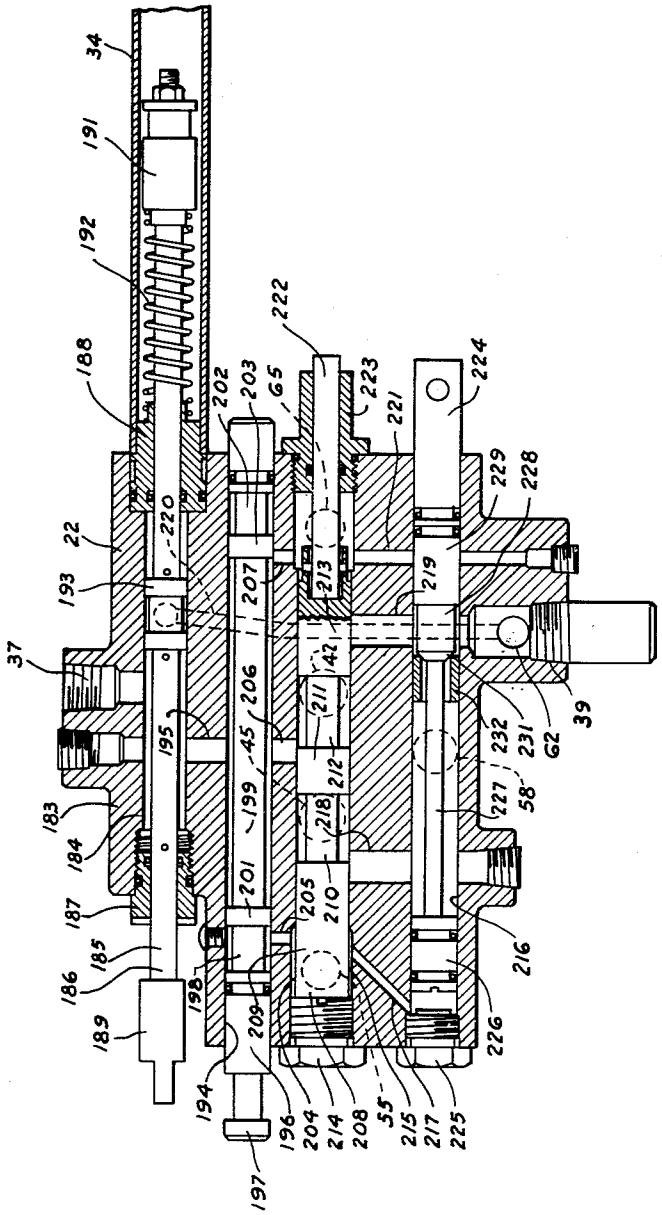


Fig. 13

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

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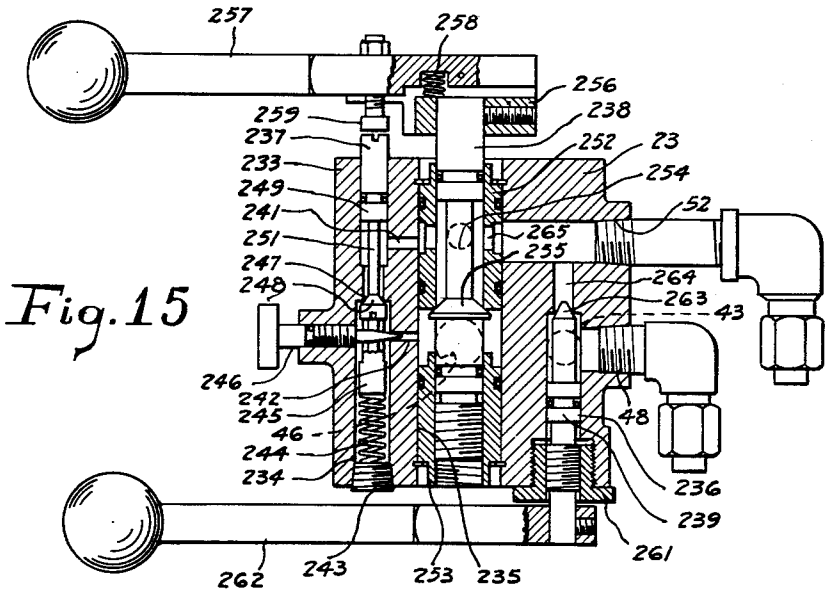


Fig. 15

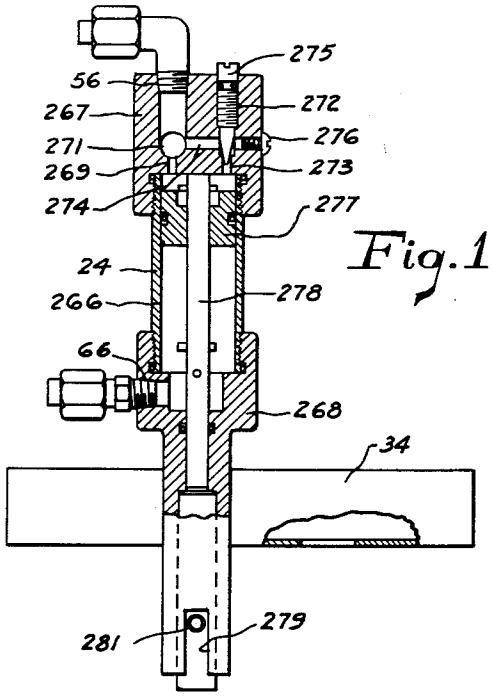


Fig. 14

INVENTORS
LLOYD D. KLING
BY WILLIAM S. MATTINGLEY
Norman S. Blodgett

United States Patent Office 2,995,805 Patented Aug. 15, 1961

2,995,805

ATTACHMENT FOR TURRET LATHE

Lloyd D. Kling, Los Angeles, Calif., and William Stanley Mattingley, Springfield, Ill., assignors to A. W. Cash Co., Decatur, Ill., a corporation of Illinois

Filed May 3, 1956, Ser. No. 582,514
3 Claims. (Cl. 29—42)

This invention relates to an attachment for turret lathe, and, more particularly, to apparatus for converting a ram-type manually-operated turret lathe to semi-automatic operation.

In the past, many attempts have been made to convert ram-type turret lathes into semi-automatic lathes with only limited success. Generally speaking, in these prior art devices, the actuation of the turret ram has been accomplished by use of a hydraulic cylinder with suitable valving and power source. However, no apparatus of this kind has been entirely satisfactory, since they have failed to provide adequately for different and adjustable feed rates at different stations of the turret, among other things. Also, the machines of this type constructed in the past have been complicated, expensive, dangerous, and have required extensive maintenance. These and other deficiencies of the previously-known devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide an attachment for turret lathe, which attachment will complete automatically the entire cycle of the turret.

Another object of this invention is the provision of a turret lathe attachment which will provide a different, adjustable feed rate for each station of the turret.

It is a still further object of the instant invention to provide an attachment for converting a ram-type turret lathe to semi-automatic operation, which attachment is rugged and dependable, is inexpensive to manufacture, can be constructed from readily-obtainable materials, and can be adapted to a lathe by an ordinary mechanic.

Another object of the invention is the provision of a turret lathe attachment which renders the lathe capable of increasing production by increasing tool life, which reduces the cycling time by synchronizing cross slide work with an automatic turret, produces machine finishes which are the equivalent of ground finishes because of infinite hydraulic feed selections, maintains tolerances of a thousandth of an inch, in which the operator can still use a hand feed if he desires, in which the rate of feed at any station of the turret can be pre-selected, and which can be adapted to any ram-type turret without disturbing the present equipment, which provides a continuous and uninterrupted cycle rapid traverse and dwell on all stations of the turret, with which the operator can stand by during the entire cycle and be checking the last workpiece, and which does not add appreciably to the length of the lathe.

Another object of the invention is the provision of an attachment for turret lathe by the use of which successive workpieces are finished in exactly the same way with the same divisions and tolerances, because the removal of differences due to the human element.

A still further object of the invention is the provision of an attachment for rendering a turret lathe capable of semi-automatic operation without rendering the lathe incapable of the usual manual operation and without disturbing the usual star wheel.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which:

FIG. 1 is an elevational view of an attachment constructed according to the teachings of the present invention,

FIG. 2 is a plan view of the attachment,

FIG. 3 is a side view of a reel forming part of the attachment,

FIG. 4 is an end view of the reel,

FIG. 5 is a longitudinal sectional view of a feed valve forming a part of the attachment,

FIG. 6 is an end view of the feed valve,

FIG. 7 is a sectional view of the feed valve taken on the line VII—VII of FIG. 6,

FIG. 8 is a plan view of a reel housing forming a part of the attachment,

FIG. 9 is a side elevational view of the latching assembly,

FIG. 10 is an end view of the latching assembly as viewed from the left in FIG. 9,

FIG. 11 is an end view of the latching assembly as viewed from the right in FIG. 9,

FIG. 12 is a view of a portion of the latching attachment taken on the line XII—XII of FIG. 8,

FIG. 13 is a sectional view through a master control valve forming a part of the attachment,

FIG. 14 is a sectional view of a dwell cylinder forming a part of the attachment, and

FIG. 15 is a sectional view of a hand control valve forming a part of the invention.

For the purposes of this specification, the term "longitudinal" will be used to indicate a direction parallel to the ways of the lathe and to the axis of rotation of the head stock, while the expression "transverse" will be used to denote a direction at a right angle to the ways. Also, the words "right" and "left" will be used to indicate the directions as the attachment appears to an operator facing the machine as shown in FIG. 1.

Referring first to FIGS. 1 and 2, wherein is best shown the general features of the invention, the attachment, designated generally by the reference numeral **10**, is shown in use with a turret lathe **11** of the well-known type having a turret **12** and a ram **13** slidably mounted on a base **14**. A post **15** extends laterally from the ram and has mounted at its outer end a hand wheel, not shown. When such a turret lathe is operated manually, the operator turns the hand wheel to traverse the ram and the turret to the right; at the end of the traverse the turrent automatically indexes to the next station. Accepted practice is to use a six-station turret, so that the turret indexes 60° to bring the next tool into alignment with the axis of the head stock on which the workpiece is mounted for driven rotation. At the right of the ram **13** is fastened a stop plate **16** which indexes 60° about a longitudinal axis when the turret indexes; six threaded holes are grouped about the axis and pass completely through the plate. Ordinarily six threaded rods would be mounted in these holes to determine the depth of cut into the workpiece for each station of the turret. When the attachment is used, however, these rods are removed and the threaded holes are used to mount a part of the attachment, as will be explained hereinafter. The operator turns the hand wheel to the left to advance the turret and its tool toward the work; jus before the tool makes contact with the work, the operator throws a feed lever, not shown, and the machine feeds the tool into the work until one of the threaded rods associated with the stop plate **16** strikes a dog and terminates the feed. The operator then rotates the hand wheel to the right, so that the ram and turret traverse to the right and the turret is indexed to the next station to begin the cycle again.

The turret lathe to which the attachment **10** is connected is in condition to operate in the manner described above, except that the threaded stop rods are removed, as has been stated. In a general way, the attachment **10** consists of a reel **17**, a feed valve **18**, a latching assembly **19**, an hydraulic linear actuator such as a power cylinder **21**, a master control valve **22**, a hand control valve **23**, a dwell cylinder **24**, an oil reservoir **25**, and a motor-driven pump **26**.

The reel **17** is mounted, as has been stated, on the stop plate **16** at the right end of the ram **13**. The reel lies within the latching assembly **19** which is mounted on a table **27** bolted at one end to a vertical surface of the base. The table underlies the ram **13** in its retracted position and extends to the right in cantilever fashion. The right end of the table rests on a vertical adjusting screw **28** extending upwardly from a support **29** bolted to the base **14** of the lathe. The table **27** is sufficiently flexible to permit leveling by means of the screw **28**. The feed valve **18** is mounted at the right hand end of the latching assembly **19** for engagement by the reel **17**. The power cylinder **21** is bolted to the base of the lathe laterally of the ram and has a piston rod **31** which is bolted to a transversely-extending connecting arm **32**, the other end of which is bolted to the ram **13**. The master control valve **22** is mounted on the operator's side of the latching assembly. The hand control valve **23** is mounted by means of an L-shaped bracket **33** to the base of the lathe adjacent the wheel post **15**. The dwell cylinder is mounted on a supporting tube **34** extending horizontally and longitudinally from the master control valve **22**. The oil reservoir **25** and the pump **26** are situated on the floor of the shop at the bottom of the base **14** of the lathe, preferably underlying the support **29**, although this placement is not critical.

The various components of the attachment are connected hydraulically by a system of conduits. A flexible conduit **35** connects the outlet port **36** of the pump **26** to an inlet port **37** of the master control valve **22**, while a similar flexible conduit **38** connects an outlet port **39** of the valve **22** to the oil reservoir **25**. A semi-rigid conduit **41** connects a port **42** of the valve **22** to a port **43** of the hand control valve **23** and a similar conduit **44** connects a port **45** of the valve **22** to a port **46** of the manual control valve **23**. A semi-rigid conduit **47** connects a port **48** of the manual control valve **23** to a port **49** at one side of the piston of the power cylinder **21**, while a similar conduit **51** connects a port **52** of the valve **23** to a port **53** at the other side of the power cylinder. In addition, a semi-rigid conduit **54** connects a port **55** on the master control valve **22** with a port **56** on the dwell cylinder **24**. A semi-rigid conduit **57** joints a port **58** on the master control valve **22** to a port **59** on the feed valve **18**, while another port **61** on the valve **18** is joined to a port **62** by a semi-rigid conduit **63**. Furthermore, a conduit **64** joins a port **65** of the master control valve **22** to a port **66** of the dwell cylinder **24**.

Referring to FIGS. 3 and 4, the reel **17** consists of an attaching plate **67** which is adapted to be fastened to the stop plate **16** of the lathe by means of bolts such as bolt **68**. Adjacent the attaching plate is an end block **69** joined by a center tube **71** to another end block **72**. The end blocks are joined by longitudinal rods **73** which lie in bores in the end blocks and are held therein by set screws; there are three of these rods equally spaced around the center tube. Between each pair of rods is located a rod **74** which extends beyond the end block **69** and is threaded into the attaching plate **67**. In this way there are six rods spaced 60° apart around the center tube. An end plate **75** is bolted over the end block **72** and a hexagon aperture **76** extends therethrough in general alignment with the centerline of the center tube **71**. Each rod has slidably mounted thereon a feed block **77** which can be fixed in a selected position by a set screw contacting the rod. In addition, each rod is provided with a reverse block **78** slidably mounted on the rod and held in a selected position on the rod by a set screw; each reverse block has a finger **79** extending radially of the reel, each finger having a threaded longitudinal bore in which is threadedly fastened a cap screw **81** having a conical head and a locking nut.

Referring next to FIGS. 5, 6 and 7, the feed valve **18** comprises a housing **82** of generally cylindrical external configuration which is fastened to the right hand end of the latching assembly **19**. This means that the valve housing **82** is connected to the base of the lathe and does not move. The valve housing is provided with an axial bore **83** opening at one end only of the housing in which is fixedly mounted an insert **84**. The inlet port **59** extends through the wall into the bore and the outlet port **61** extends in a similar manner at a position axially spaced from the inlet port. The insert **84** is carried on a shaft **85** which extends axially through the bore **83** and is rotatably mounted in a small axial bore **86** in the closed end of the valve housing. Externally of the housing the shaft is provided with an elongated hexagonal portion **87** adapted to fit closely in the hexagonal aperture **76** in the end plate **75** of the reel **17**. The shaft **85** is formed with a circular flange **88** which rests against the bottom of the bore **83**. Pinned to the flange for longitudinal but non-rotative movement relative thereto is a distributor disk **89** having a single longitudinal aperture **91** extending therethrough at a substantial distance from the common axis of the insert and the shaft. One end face of the insert **84** contacts the distributor disk and has six small bores **92** extending axially therein; these bores are arranged on a pitch circle concentric with the shaft axis having a radius equal to the distance from the shaft axis to the centerline of the bore **91**. The bores **92** are spaced equally every 60° on their pitch circle and each terminates inwardly in a small cylindrical chamber **93** of larger diameter than the bore. A passage **94** extends radially outwardly from each chamber and all the passages terminate in an annular relief groove **95**. The outlet port **61** also opens into the groove **95**. Into each chamber **93** extends a metering screw **96** which is mounted coaxially with its chamber **93** and its bore **92** by threaded engagement with a threaded bore **97** in the insert **84**. The metering screw is provided with a conical head which resides in the chamber **93** and partly in the bore **92**; the other end of the screw is provided with a slot for engagement by a screwdriver for adjustment purposes. A locking ring **98** retains the insert in the bore **83** and prevents rotation and an O-ring is situated on each side of the groove **95**. Suitable O-rings are provided throughout the valve to prevent leakage and by-passing of hydraulic fluid. Leaf springs **99** contact the portions of the metering screws which extend out of the end of insert to lock them in a preselected adjustment. As is evident in FIG. 7, coil springs **101** reside in suitable recesses in the distributor disk **89** and, by pressing against the flange **88**, assure tight sliding contact of the disk with the face of the insert **84**.

FIGS. 8, 9, 10, 11 and 12 show the details of construction of the latching assembly **19** which is, as has been explained, fastened to the table **27** and supported through the adjusting screw **28** by the support **29**. It is thus, fixed to the base of the lathe. The assembly comprises an upwardly-opening housing formed by a bottom wall **102**, a front wall **103**, and a rear wall **104**; the upper edges of the front and rear walls are provided with a small inwardly-directed horizontal flange. A rapid traverse stop **105** is fastened to the outer surface of the front wall **103** at the right side. A support bracket **106** of generally L-shaped configuration has a horizontal leg **107** bolted to the upper edges of the front and rear walls transversely thereof at the extreme right hand end of the housing, while the other leg **108** extends vertically in a position somewhat forwardly of the front wall. The leg **108** is provided with a longitudinal bore **109**

and a slot 111 whereby it may be clamped to the supporting tube 34 which extends longitudinally from the master control valve 22. A supporting block 112 is bolted to the front wall 103 at the extreme right end of the housing in a position overlying the stop 105. The block 112 is provided with a wide vertical slot 113 in which resides a lever 114 centrally pivoted on a transverse horizontal pin 115. A roller 116 is mounted for rotation about a transverse horizontal axis at the left hand end of the lever. A leaf spring 117 is fastened to the lower surface of the supporting block at the right hand end, and this spring presses upwardly on the lower surface of the lever 114 so that it is resiliently biased to occupy a horizontal position entirely within the slot 113. A reverse rod 118 extends through the leg 107 of the support bracket 106 and extends parallel and adjacent to the upper edge of the front wall 103; its right hand end is threaded and is provided with a stop collar 119 fixed in place on the rod by a set screw and a jam nut 121. A bushing 122 surrounds the rod and provides for longitudinal sliding within the leg 107; the bushing extends a considerable distance away from the leg and on it is pivotally mounted a cycle stop latch 123. The latch is elongated in form and is pivoted on the rod and bushing at a position intermediate of its ends. It resides in a generally horizontal aspect and has a roller 124 mounted on a horizontal longitudinal pin 125 at its rearward end. The roller is provided with a generous bevel at its left side and is located midway between the front and rear walls of the housing, as is evident in FIG. 8. The forward end of the latch 123 is provided with a vertical contact pin 126 which is threaded into the latch for vertical adjustment and is provided with a lock nut. The latch is normally maintained in a horizontal position by a coil spring 127 which extends between the latch and the supporting block 112. The contact pin 126 overlies the lever 114 at a position slightly to the right of the pivot pin 115 but is normally maintained out of contact with the lever by the action of the spring 127.

A feed rod 128 also passes through the leg 107 of the support bracket 106 and extends parallel and adjacent to the upper edge of the rear wall 104 of the housing. An elongated push bar 129 lies generally horizontally across the housing somewhat to the left of the roller 116. Its rearward end has the rod 128 passing through it and the bar and rod are fastened together by a set screw. A coil spring 131 surrounds the rod 128 and extends between the bar 129 and the leg 107 of the bracket 106. The rod 118 passes through the bar 129 and a sleeve 132 surrounds this rod and lies between it and the surface of the bore in the bar through which the rod passes. A coil spring 133 surrounds the sleeve and rod and extends between the bar 129 and the latch 123. The forward end of the push bar 129 lies some distance forward of the front wall of the housing and is provided with a rigidly-attached, downwardly-extending arm 134 having a transverse horizontal pin 135 at its lower end.

A spring bracket 136 is bolted to the upper edge of the front wall of the housing and is formed with a finger 137 which extends rearwardly and through which the sleeve 132 and the rod 118 pass. A spring stop 138 is adjustably mounted on the reverse rod 118 and is fixed in a selected position thereon by a set screw. A coil spring 139 surrounds the sleeve and rod and extends between the spring stop 138 and the spring bracket 136. Fastened to the reverse rod 118 to the left of the spring stop 138 by set screw means is a reverse latch clamp 141 which extends upwardly and has a reverse latch 142 pivotally connected to its intermediate portion. The latch 142 is elongated and extends longitudinally over the rod. A leaf spring 143 overlies the latch, is fastened at one end to the latch, and is pivotally attached at the other end to the upper end of the clamp 141. A feed latch clamp 144 is fixed to the intermediate portion of the feed rod 128 and extends vertically upwardly therefrom. To the intermediate portion of the clamp is hingedly attached an elongated feed latch 145 that overlies the rod 128. A leaf spring 146 is fastened to the intermediate portion of the latch and is loosely attached to the upper end of the clamp 144. A block 147 is bolted to the upper edge of the rear wall of the housing and is provided with a bore 148 in which the left hand end of the feed rod 128 is slidably supported. The upper surface of the block is provided with a longitudinal groove 149 in which the latch 145 may reside on occasion. The latch 145 is provided on its under surface with a shoulder which engages the right hand surface of the block when the latch lies in the groove 149; this effectively prevents movement of the latch and the rod to the left under the influence of the coil spring 131 when the shoulder so engages the block.

A frame 151 has a horizontal leg 152 which is bolted to the upper edges of the front and rear walls of the housing at the extreme left thereof and is formed with a bore 153 to slidably support the left hand end of the reverse rod 118. Extending from the forward end of the leg 152 is a longitudinal bridge section 154 having a vertical left leg 155, a vertical right leg 156 and a connecting section 157. The right leg is bolted at its lower end to the upper edge of the front wall of the housing; extending rearwardly from the right leg is a latch stop 158. The lower surface of the reverse latch 142 is formed with a vertical shoulder 159 which engages the stop 158 when the latch 142 rests on the upper surface of the stop; this effectively prevents the latch 142 and the reverse rod 118 from moving to the left under the influence of the coil spring 139. A window 161 is defined by the legs and connecting sections of the bridge section of the frame and through this window extends a reset bar 162. The bar 162 extends horizontally and transversely and the reverse rod 118 extends through its rearward end and is fixed thereto by a set screw. The forward end of the bar is situated well forward of the front wall of the housing and is formed with a horizontal slot 163. From the upper surface of the connecting portion 154 of the bridge section of the frame extends a vertical stop pin 164.

A latch fulcrum 165 is pivotally attached to the intermediate portion of the left leg 155. The fulcrum is provided with a vertical portion 166 which is connected to the rearward surface of the leg by a horizontal cap screw 167 in order to permit the pivotal movement. The vertical portion is provided with a horizontal, rearwardly-directed finger 168 which underlies the reverse latch 142. The fulcrum is provided with a horizontal forwardly-directed flange 169 which normally rests on the upper surface of the bridge section of the frame; when the flange so rests, the finger 168 permits the latch 142 to rest on the upper surface of the latch stop 158. The flange 169 is formed with a longitudinally-elongated slot 171 through which the pin 164 extends. A vertically-extending lever 172 is pivotally connected at its lower end to the front wall of the housing by means of a horizontal transverse cap screw 173. The lever extends through a longitudinally-elongated slot 174 formed in the flange 169 of the fulcrum 165 and is provided at its upper end with a spherical knob 175.

Extending transversely between the right leg 156 of the frame and the block 147 and mounted at its ends therein is a rocker arm shaft 176. Rotatably mounted at one end to the shaft adjacent the block 147 is a feed rocker arm 177. Mounted in the other end of the rocker arm is a pin 178 which underlies the feed latch 145. Also, fastened to the rocker arm 177 is a contact arm 179 which extends downwardly when the pin 178 underlies the latch 145 without lifting it from the groove 149. A reverse rocker arm 181 is rotatably mounted at one end to the shaft 176 and has a horizontal transverse pin 182 mounted

therein with a dependent integral contact arm **180**. When the contact arm **180** is vertical, the pin underlies the reverse latch **142** without lifting it from the latch stop **158**.

Referring to FIG. 13, the master control valve **22** is shown as having a body **183** in which are formed an upwardly-opening inlet port **37**, a downwardly-opening outlet port **39**, as well as forwardly-opening ports **55, 45, 42, 65, 58** and **62**. These ports all open into horizontal bores in which are located valving pungers. The inlet port **37** opens into the center of a bore **184** in which resides a hand control plunger **185** having a shaft **186**. The shaft **186** is mounted in a guide **187** at one end of the bore and a guide **188** at the other end. The left hand end of the shaft is provided with a coupling **189**, while the other end has fixed to it a plug **191** slidable within the supporting tube **34**. A coil spring **192** surrounds the shaft and extends between the guide **188** and the plug **191**, thus maintaining the plunger in a position to the right. Within the bore **184** and fixed to the shaft **186** is a spool **193** which normally resides to the right of the port **37**. Below the bore **184** is a bore **194** and the two bores are connected by a passage **195** located a distance to the left of the port **37**. A pilot valve plunger **196** resides in the bore **194**; the left end of the plunger is provided with a button **197**. The plunger is formed with a reduced portion **198** and a reduced portion **199** with an enlarged portion **201** therebetween. Another reduced portion **202** is separated from the reduced portion **199** by an enlarged portion **203**. A bore **204** underlies the bore **194** and is joined to it by a passage **205** at the left end, a passage **206** in the middle and a passage **207** at the right end. The enlarged portions **201** and **203** are located so that when the passage **205** lies within the reduced portion **198**, the passage **207** lies within the reduced portion **199**; the passage **206** lies within the reduced portion **199** at all times. Within the bore **204** resides a dwell control plunger **208** having an enlarged portion **209**, a reduced portion **210**, an enlarged portion **211**, a reduced portion **212** and an enlarged portion **213**. The left hand end of the bore **204** is closed by a plug **214**, while adjacent thereto an annular recess **215** is formed in the bore and has the passage **205** opening onto it. A bore **216** underlies the bore **204** and passages **217, 218, 219** and **221** extend therebetween. The passage **217** opens into the annular recess **215**, so that it communicates with the passage **205** at all times irrespective of the position of the plunger **208**. When the plunger **208** is in the left position, the port **45** communicates with the passage **218** through the reduced portion **210** and the passage **206** communicates with the port **42**; at the same time the port **65** is in communication with the passages **207** and **221**. When the plunger is in the right hand position, the passage **218** is blocked off by the enlarged portion **209**, the port **45** is in communication with the passage **206**, the port **42** is in communication with the passage **219** and passages **207** and **221** are closed by the enlarged portion **213**. Pivotally connected to the right hand end of the enlarged portion **213** is a rod **222** which extends outwardly of the valve through a guide **223**. Located in the bore **216** is a rapid traverse plunger **224** which extends outwardly of the valve on the right hand side. The left hand side of the bore is closed by a plug **225** and the passage **217** enters the bore adjacent this plug. The plunger **224** consists of a spool **226** connected by a rod **227** to a reduced portion **228** and an enlarged portion **229**. When the plunger **224** is in the left hand position, as shown in FIG. 13, the passage **218** is in communication with the port **58**, the passage **219** is operatively connected by the reduced portion **228** to the port **62** and the outlet port **39**, while the passage **221** is closed by the enlarged portion **229**. Communication between the passages **219** and ports **39** and **62**, on the one hand, with the port **58**, on the other hand, is prevented by the contact of a conical end face **231** with a sleeve **232** fixed in the bore **216**. When the plunger is in the right hand position, however, the passage **218** is closed by the spool **226**, and the port **58**, the passage **219**, the port **62**, the port **39** and the passage **221** are in communication with one another. An external passage **220** joins the bore **184** with the drain port **39** when the plunger **185** is in the left hand position.

FIG. 15 shows the details of construction of the hand control valve **23**. The valve is provided with a body **233** having vertical bores **234, 235** and **236** containing, respectively, plungers **237, 238** and **239**. The port **46** opens into the intermediate portion of the bore **235**, the port **52** communicates with upper end of the bore **236**, as do the ports **48** and **43**. A passage **241** joins the upper portions of the bores **234** and **235** and a passage **242** join them in their intermediate portions. The lower end of the bore **234** is closed by a plug **243** and a coil spring **244** extends between the plug and the lower end of the plunger **237**. The plunger is provided with a cage portion **245**. A metering screw **246** is threaded into the body **233** of the valve and has a conical head which extends across the bore through the cage portion of the plunger into the passage **242**. The bore **234** is formed with a shoulder **247** which is engaged by a conical portion **248** of the plunger. An enlarged portion **249** is joined to the conical portion by a rod **251**. The plunger **237** extends upwardly from the valve for a short distance. When the plunger is in its normal uppermost position, the passage opens into the port of the bore surrounding the rod **251**; as the plunger is moved downwardly, the conical portion **248** moves away from the shoulder **247** and communication is afforded from the passage **241** to the passage **242**, the effective entrance to which is determined by the setting of the metering screw **246**. The bore **235** is provided with an upper sleeve **252** and a lower sleeve **253** which are fixed in place within the bore; the plunger **238** is slidably and rotatably mounted within these sleeves. The lower end of the plunger is threaded into the lower sleeve **253** and the upper end extends out of the valve body a considerable distance. The plunger **238** is formed with a reduced portion **254** and the passage **241** and the port **52** both open into the space around the reduced portion **254**. At the lower end of the reduced portion the plunger is formed with a conical portion **255** which is adapted to engage the lower end of the upper sleeve **252**. The port **46** opens into the space between the sleeve **252** and **253**. When the plunger is rotated it moves downwardly, thus carrying the conical portion **255** away from the lower end of the sleeve and permitting communication between the passage **233** and the port **52** on the one hand and the port **46** on the other hand. Fixedly attached to the upper end of the plunger **238** is a block **256** to which is pivotally attached one end of a handle **257**; a coil spring **258** extends between the block and handle and causes the handle to be normally biased outwardly to retain an adjustable contact head **259** away from the upper end of the plunger **237**. The handle **257** is, therefore, capable of either moving the plunger **237** downwardly against the force of the spring **244** by use of the contact head **259** or rotating the plunger **238**. The plunger **239** is threadedly mounted in a guide **261** and its downwardly-extending end has a bypass handle **262** fixed thereto to rotate it and move a conical portion **263** toward or away from a restricted passage **264** leading from the upper end of the bore **236** to the port **52** and a passage **265** leading from the port **52** to the space around the reduced portion **254** of the plunger **238**. Such communication with the upper part of the bore **236** gives similar access to the ports **43** and **48**.

Referring next to FIG. 14, wherein is best shown the specific constructional details of the dwell cylinder **24**, the cylinder consists of a tube **266** having an upper head **267** and a lower head **268**. The port **56** consists of a vertical bore which enters the top of the head **267** and has communication with the upper end of the tube **266** through a small passage **269**; the upper end of the pas-

sage 269 is normally closed by a check ball 271 which is capable of moving vertically within the port 56. A bore 272 enters the top of the head 267 and has communication with the upper part of the tube 266 through a restricted coaxial passage 273. A horizontal passage 274 joins the lower parts of the port 56 and the bore 272. A metering needle 275 is threadedly mounted in the bore 272 with a conical point extending into the passage 273 to regulate the size of its entrance. A locking screw 276 extends laterally into the bore 272 and makes contact with the metering needle. A piston 277 is slidably mounted in the tube 266 and is provided with a piston rod 278. The piston rod extends downwardly through the lower head 268 and extends outwardly thereof at the lower end. The lower head is provided with a slot 279 and a pin 281 extends through the rod within the slot. The outlet port 66 communicates with the lower end of the tube 266. The lower head 268 is attached to the supporting tube 34, which extends from the main control valve 22, by use of a ring clamp 283, shown in FIG. 1.

A description of some of the connections and relationships of the parts of the invention will now be readily understood, referring particularly to FIGS. 1 and 2. A lever 284 is pivotally attached at one end to the base of the lathe and the intermediate part of the lever is connected by a rod 285 through a pivoted clevis 286 to the coupling 189 at the left end of the hand control plunger 185 of the master control valve. The head 197 at the left end of the pilot valve plunger 196 lies to the left of the slot 163 of the reset bar 162, so that the plunger moves longitudinally with the bar. The pin 222 of the dwell control plunger 208 is in position to be engaged by the roller 116 of the lever 114. The right hand end of the rapid traverse plunger 224 is provided with a transverse bore 287 in which lies the pin 135 of the push bar 129. The pin 281 at the bottom of the piston rod 278 of the dwell cylinder 24 overlies the lever 114 at the left of the pivot pin 126. The contact pin 126 of the cycle stop latch 123 overlies the lever 114 at the right of the pivot pin 126.

The operation of the invention will be readily understood in view of the above description. For an automatic cycle of operations with the turret the work is mounted in the headstock and the lathe is set in motion. Assuming that the ram and turret are at the extreme right of the base of the lathe and that the pump 36 is operating, the operator starts the cycle by moving the handle 257 from the "closed" position shown in FIG. 1 to the "open" position shown in dotted line. This moves the plunger 238 downwardly, thus moving the conical portion 255 away from the sleeve 252. This opens a path from the port 46 to the port 52; the port 43 and the port 48 are, of course, always in communication. Oil under pressure leaves the discharge port 36 of the pump and travels through the conduit to the inlet port 37 of the master control valve 22. The hand control plunger 185, the pilot valve plunger 196, and the dwell control plunger 222 are in the condition shown in FIG. 13, so the oil passes from the port 37 through the passage 195 and the passage 206 to the port 42. From there it passes through the conduit 41 to the port 43 of the hand control valve 23. From the port 43 the oil passes out through the port 48 and along the conduit 47 to the port 49 of the power cylinder 21 at the right side of the power piston. This moves the piston rod 31 and the turret ram toward the headstock of the lathe. The oil residing in the left side of the power piston is forced out through the port 53 through the conduit 51 to the port 52 of the hand control valve 23. The oil flows from the port 52 to the port 46 and through the conduit 44 to the port 45 of the master control valve 22. The rapid traverse plunger 224 is held in the right hand position by the push bar acting through the pin 135; this means that the conical portion 231 is removed from the sleeve 232. Therefore, the oil flows from the port 45 through the passage 218 around the reduced portion 228 of the plunger 224 to the port 39. From the port 39, the oil flows through the conduit 38 to the reservoir 25. The result is that the ram and turret are moving toward the work on rapid traverse. The rate of motion is relatively rapid because there is no substantial restriction to the flow of oil in the circuit just described.

As the turret bearing its tool approaches the work, the reel 17, which travels longitudinally with the turret ram and which has been passing through the latching assembly 19, reaches a position where the uppermost feed block 77 strikes the contact arm 179 and raises it. This rotates the rocker arm 177 on the shaft 176 so that it moves upwardly carrying its pin 178 with it. The pin 178 lifts the feed latch 145 upwardly against the resistance of the leaf spring 146, thus releasing the shoulder on its lower surface from the edge of the block 147. The feed rod 128 is permitted to move to the left under the influence of the coil spring 131 carrying the push arm 129 and the pin 135 with it. The net effect, then, is that the rapid traverse plunger 224 is moved to the left until the conical portion 231 strikes the sleeve 232. When this has been accomplished, the oil flow is similar to that described above for the rapid traverse travel of the turret toward the work, with the exception that the oil can no longer flow directly from the port 45 of the master control valve 22 to the outlet port 39. Another path of flow is available, however, and that is from the port 45 through the passage 218 to the port 58 and from the port 58 through the conduit 57 to the port 59 of the feed valve 18. Within the valve 18, the oil flows from the port 59 through the space surrounding the flange 88, through the passage 91, through the passage 92 which is aligned at that time with the passage 91, through the pre-selected restriction formed by the passage 91 and the metering screw 96, and through the passage 94 into the annular groove 95 which drains into the port 61. From the port 61 the oil flows through the conduit 63 to the port 62 of the main control valve 22. When the oil flows from the port 62 the oil flows easily to the port 39 and then to the reservoir. The restriction introduced into the circuit by the metering screw 96 of the feed valve 18 causes the power cylinder 21 to move the turret and tool slowly into the work; this slow motion is necessary for proper cutting. The rate of feed at any station is, of course, adjustable by advancing or retracting the metering screw 96. The turret continues to advance to the left, carrying the reel 17 with it. Eventually, the finger 81 of the feed block 79 on the uppermost rod 73 strikes the contact arm 180 and carries it upward. The rest of the rocker arm 181 moves upwardly also with its pin 182; eventually, the pin strikes the latch 142 and lifts against the resistance of the leaf spring 143. When the latch is lifted, the shoulder 159 is released from the stop 158, so that the reverse rod 118 moves to the left under the influence of the coil spring 139. The rod carries the reset bar 162 to the left, so that the pilot valve plunger 185 moves to the left also. The movement of the plunger to the left permits flow of oil from the inlet port 37, through the passage 195 and into the passage 205. From there, the oil flows into the relief groove 204 and to the left of the dwell control plunger 222. Now, during the metered feed portion of the cycle, described above, oil has been flowing under the piston 277 of the dwell cylinder 24 from the inlet port 37 of the master control valve by way of the passage 195, the passage 207, the port 65, the conduit 64, and the port 66 of the dwell cylinder. Any oil above the piston was forced back to the reservoir by way of the passage 269, the check ball 271, the port 56, the conduit 54, the port 55 of the master control valve, and the relief groove 204. The upward movement of the piston 277 and its piston rod 278 causes its pin 281 to permit the left end of the lever 114 to move upwardly, so that the roller 116 aligns itself with the dwell control plunger 222. The plunger is forced to the right under the influence of the

oil pressure that has appeared at its left due to the movement to the left of the pilot valve plunger **196**. With the plunger **222** at its neutral position, against the roller, no oil flows to or from the power cylinder **21**, since the ports **45** and **42** of the master control valve have no access either to input oil or to drain. Oil is permitted, however, to flow to the top of the piston **277** of the dwell cylinder **24** from the inlet port **37** of the master control valve by way of the passage **195**, the passage **205**, the relief groove **204**, the port **55**, the conduit **54**, the port **56** of the dwell cylinder, the passage **269**, and the restriction formed by the metering screw **272** and the passage **273**. The downward movement of the piston **277** is dependent on the size of the said restriction, which is adjustable to permit a desired length of dwell. The dwell is used, for example, to permit a drill to polish the hole it has just made in the work. Eventually, the piston rod **278** carries the pin **281** downwardly so that it forces the left end of the lever **114** downwardly so that the roller **116** resides well below the dwell control plunger **222**. In its unrestricted condition, the plunger moves further to its extreme right position; this brings about the reversal of flow to the power cylinder. Now the oil passes from the inlet port **37** of the master control valve to the port **45** for transmittal to the left side of the power piston by way of the passage **195** and the passage **206**. Oil is returned to the reservoir from the right side of the power piston to the port **42** of the master control valve, and from there to the reservoir by way of the passage **219** and the port **39**. Since there is no substantial restriction to the flow of oil toward or away from the power cylinder, the reverse traverse movement will be at a high rate of speed.

As the ram and the turret approach the extreme right position, the internal mechanism of the lathe indexes the turret 60° so that the next tool is ready for its operation. This indexing action causes the stop plate **16** to rotate 60° also, carrying the reel **17** with it. A new feed rod **73** is presented to the uppermost central position in the reel and a new feed block **77** and reverse block **79** are also presented for control purposes. As the reel rotates through 60° the finger **81** of the reverse block **79** contacts the roller **124** at the rearward end of the cycle stop latch **123**. The forward end of the latch moves downwardly, carrying the contact pin **126**. The pin strikes the lever **114** and rotates it back into a level position again, so that the roller **116** strikes the end of the dwell control plunger **222** and this, combined with the appearance of oil pressure at the right hand end thereof, forces the plunger back to its extreme left position again, as shown in FIG. 13.

Oil pressure behind the left end of the rapid traverse plunger **224** forces it to the right carrying the push bar **129** with it. This carries the feed rod **128** and the reverse rod **118** to the right with it against the resistance of their springs and permits the left springs **146** and **143** to press their respective latches **145** and **192** into latching position on the block **147** and the stop **158**, respectively. The movement of the rod **118** carries the reset bar **162** with it, thus moving the pilot valve plunger **196** to its right hand position. The plungers of the master control valve are now in the condition described at the beginning of the cycle. The cycle is repeated with each of the stations of the turret, until six operations have been performed on the workpiece. At the end of the sixth cycle, with the ram and turret to the right, the operator moves the control handle **257** to the "closed" position and the attachment stops operating. The operator may perform some cross-slide work and then replace the workpiece with one that is to be machined.

If, during one of the operations with the turret, the operator desires to produce a slow turret movement for a short time, particularly in the reverse direction, he may do so by proper manipulation of the handle **257**. This might be necessary, for instance, for retracting the feed during the cut of a tap, since the rapid traverse reverse speed would not be suitable. The handle **257** is returned to the "closed" position, which stops the feed. Then, he presses downwardly on the handle so that the contact head **257** strikes the plunger **237** and moves the conical portion **248** away from the shoulder **247**. Fluid then flows to the left side of the cylinder for reverse feed, but goes from the port **46** to the port **52** by way of the restriction afforded by the metering screw **246**, which produces a pre-selected slow speed.

The lower handle **262** may be used to bypass the power cylinder by providing communication directly between the port **52** and the port **43**. This changes the rate of fluid flow to the power cylinder as may be necessary during certain operations and gives control of traverse and feed rate at any time.

Actuation of the lever **284** causes movement of the hand control plunger **185** to the left, thus stopping the machine and causing a bypass through the passage. By moving the lever **172** to the left, the fulcrum will be rotated and the reverse latch released, so that the attachment immediately puts the ram and turret into rapid reverse traverse.

While certain novel features of the invention have been shown and described, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and its operation may be made by those skilled in the art without departing from the spirit of the invention.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. An attachment for the semi-automatic operation of a ram-type turret lathe having an indexing mechanism, comprising a hydraulic linear actuator, a pump serving as a source of hydraulic fluid under pressure, a reservoir serving as a source of fluid storage, a hydraulic circuit joining the pump, actuator and reservoir in operative relationship, a reel carried by the ram of the lathe and connected to the indexing mechanism for rotative movement therewith, a feed valve having a plurality of adjustable orifices adapted to be placed one at a time in the hydraulic circuit for regulation of the flow of hydraulic fluid, a housing adapted to be mounted on the lathe and having a latching mechanism operative with movement of the ram to regulate the flow of hydraulic fluid, a master control valve inserted in the hydraulic circuit having means for reversing the flow of fluid to the actuator, for producing a high rate of flow on occasion and for producing a stoppage of flow on occasion, and a dwell cylinder inserted in the hydraulic circuit and acting after a predetermined length of time to terminate a period when no fluid flows to the actuator.

2. An attachment for a turret lathe having a ram and an indexing turret for operation through a cycle of movement of the turret including a rapid forward traverse, a feed, a dwell and a rapid reverse traverse, comprising a hydraulic linear actuator, a pump serving as a source of hydraulic fluid under pressure, a reservoir serving as a source of fluid storage, a hydraulic circuit joining the pump, actuator and reservoir in operative relationship, a reel carried by the ram of the lathe and connected to the turret for indexing movement therewith, a feed valve connected to the reel having a plurality of adjustable orifices adapted to be placed one at a time in the hydraulic circuit by the reel for regulation of the flow of hydraulic fluid during the feed portion of the cycle, a latching mechanism operative with movement of the ram to start the feed and the reverse portions of the cycle, a master control valve inserted in the hydraulic circuit having means producing the reverse rapid traverse or dwell portions of the cycle, and a dwell cylinder connected to the master control valve inserted in the hydraulic circuit and acting after a predetermined length of time to determine the length of the dwell period.

3. An attachment for a turret lathe having a ram and an indexing turret with a plurality of stations for operation through a cycle of longitudinal movement of the ram and turret including a period of rapid forward traverse, a period of feed, a period of dwell and a period of rapid reverse traverse, comprising: a hydraulic linear actuator connected to drive the ram, a pump serving as a source of hydraulic fluid under pressure, a reservoir, means connecting the actuator, the pump and the reservoir in a series circuit, a reel having the same number of stations as the turret connected for rotational indexing movement in response to the said indexing of the turret and for longitudinal movement with the ram, a latching mechanism operated by a reel station during the said longitudinal movement of the reel to terminate the period of rapid forward traverse, to begin and end the period of feed and to begin the period of dwell, a feed valve having adjustable orifices corresponding in

number to the turret stations adapted to be placed in the said series circuit one at a time in response to the said rotational movement of the reel for the regulation of the flow of fluid to the actuator during the said period of feed, a master control valve inserted in the hydraulic circuit having means for reversing the flow of fluid to the actuator, and a dwell cylinder inserted in the hydraulic circuit and acting after a predetermined length of time to terminate a period when no fluid flows to the actuator.

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