Feb. 7, 1933. C. T. RAULE 1,896,752

REVERSING MECHANISM FOR MACHINE TOOLS

Filed Oct. 7, 1926 5 Sheets-Sheet 1

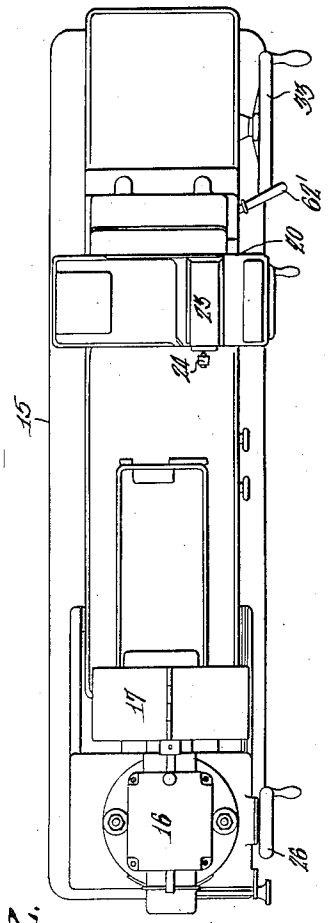

Fig. 2.

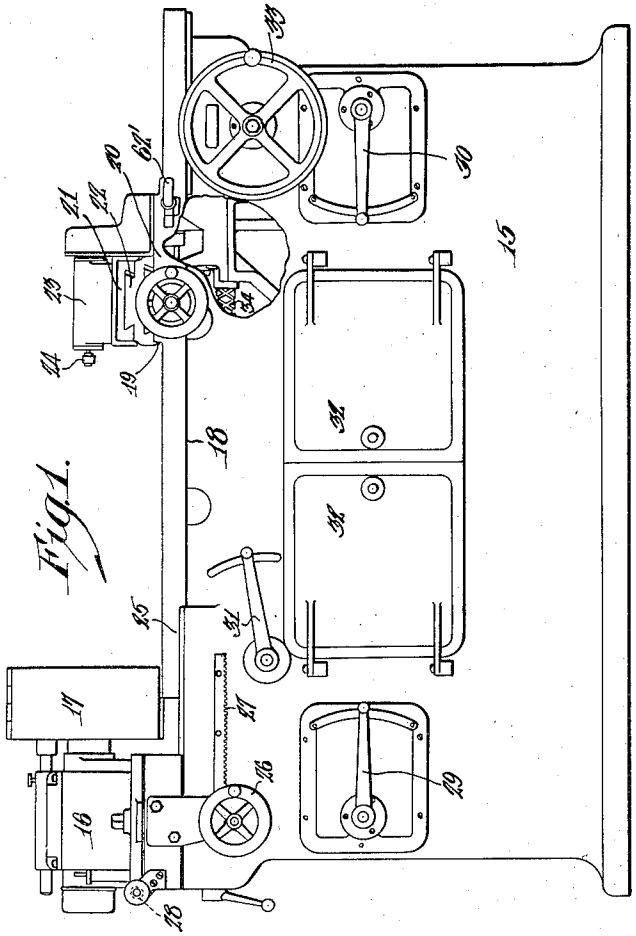

Fig. 1.

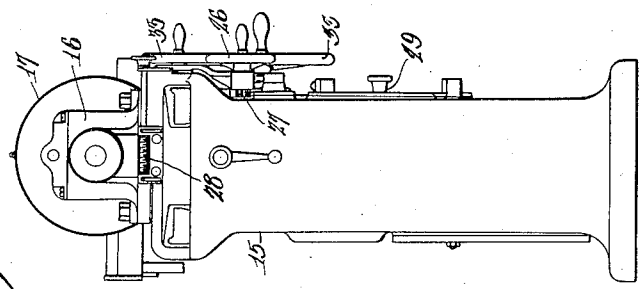

Fig. 3.

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REVERSING MECHANISM FOR MACHINE TOOLS

Filed Oct. 7, 1926 5 Sheets-Sheet 2

Fig. 4.

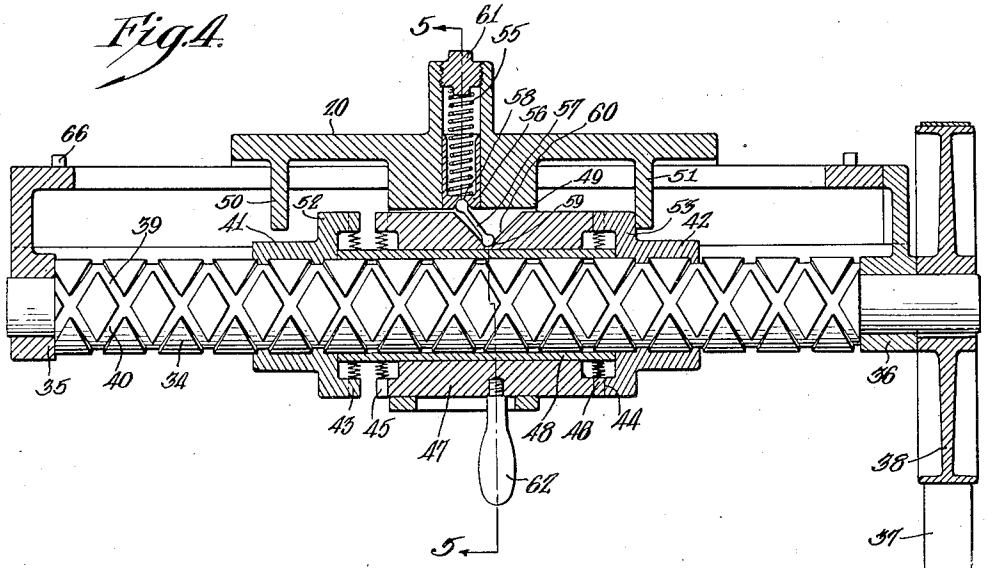


Fig. 5.

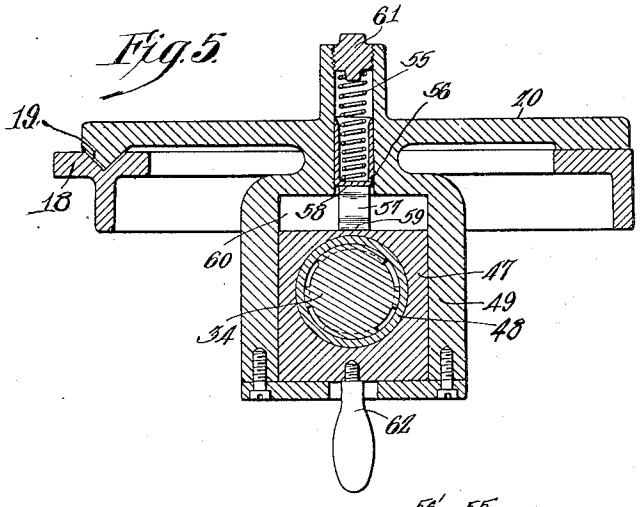
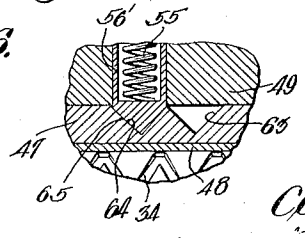


Fig. 6.



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REVERSING MECHANISM FOR MACHINE TOOLS

Filed Oct. 7, 1926 5 Sheets-Sheet 3

Fig. 8.

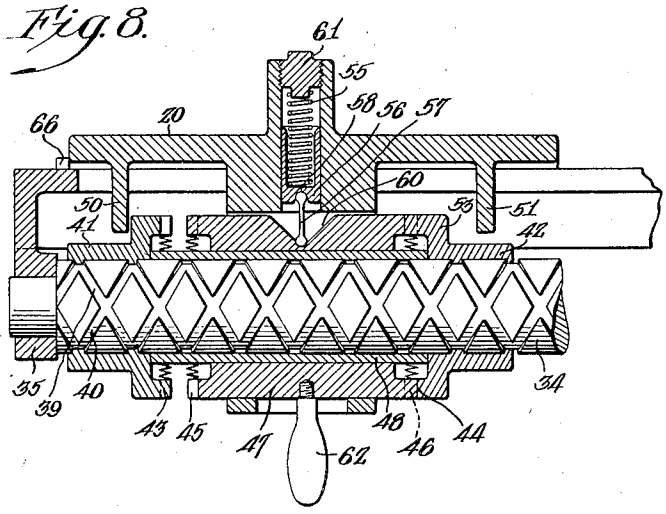


Fig. 9.

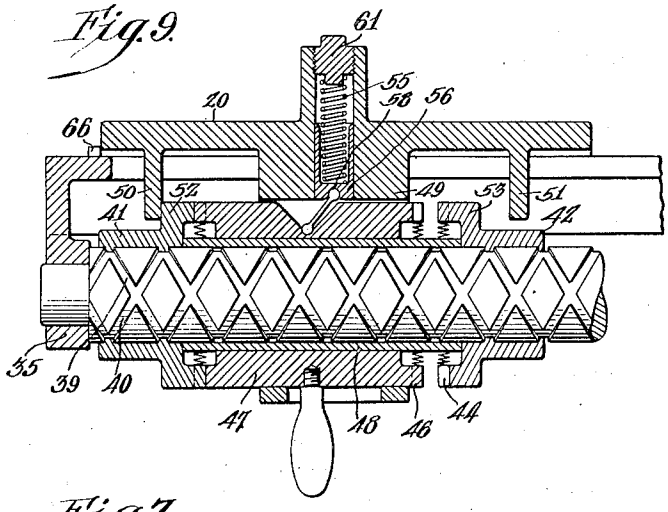
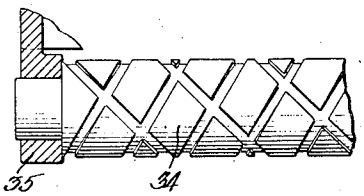


Fig. 7.



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REVERSING MECHANISM FOR MACHINE TOOLS

Filed Oct. 7, 1926 5 Sheets-Sheet 4

Fig. 11.

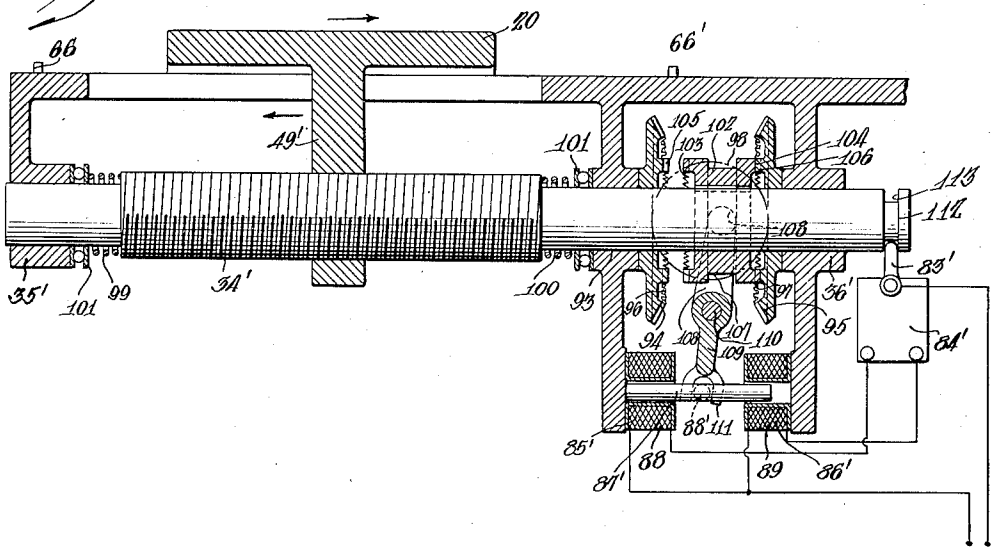


Fig. 10.

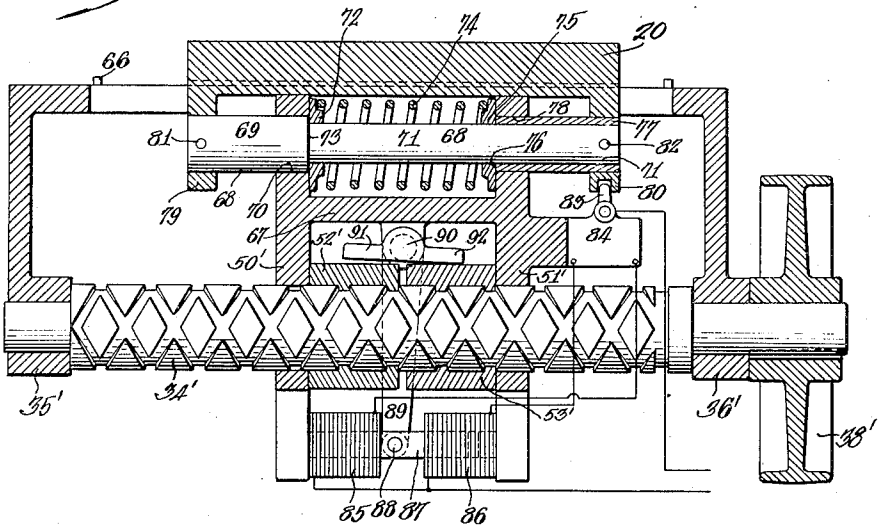
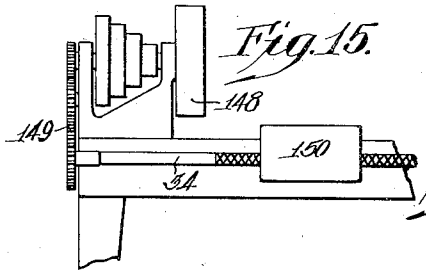


Fig. 15.



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REVERSING MECHANISM FOR MACHINE TOOLS

Filed Oct. 7, 1926 5 Sheets-Sheet 5

Fig. 12.

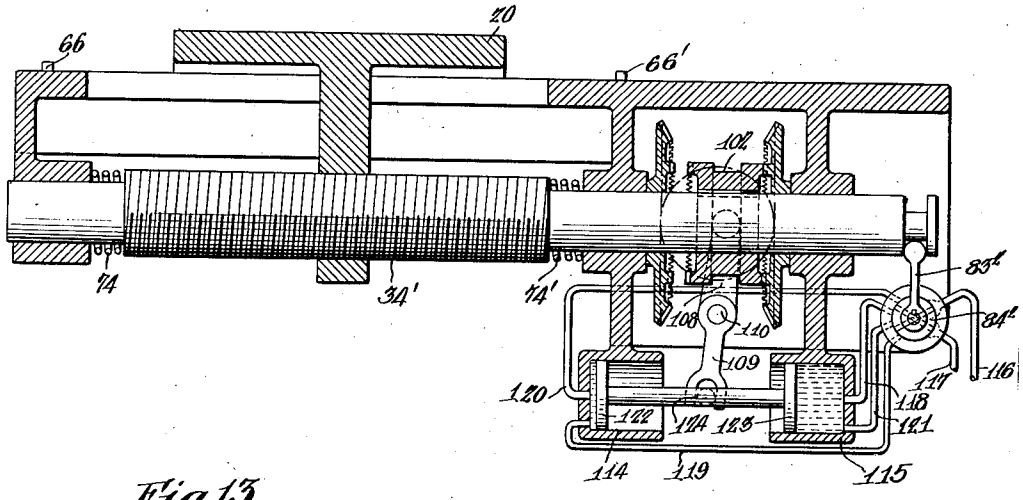


Fig. 13.

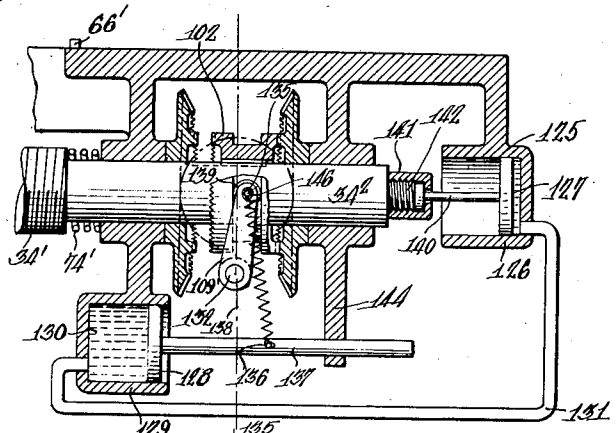
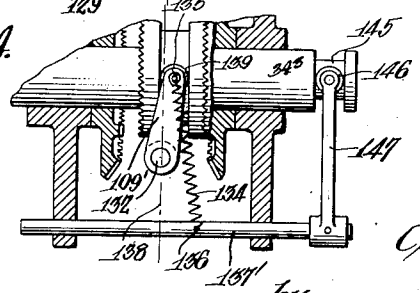


Fig. 14.



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UNITED STATES PATENT OFFICE

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REVERSING MECHANISM FOR MACHINE TOOLS

Application filed October 7, 1926. Serial No. 140,035.

My invention relates to the traverse reversing mechanisms such as are used to reverse the feed of a grinding machine, lathe, boring bar, planer, shaper or other tool having repeated strokes over the same work.

The purpose of my invention is to cause the reversal by the stoppage of a carriage carrying the work, the tool or other traversely movable part.

A further purpose is to cause the feeding mechanism of a machine to throw the reversing mechanism after the carriage has stopped, shifting the feeding mechanism bodily or not as preferred.

A further purpose is to utilize a quick throw or full-stroke mechanism or an outside force to cause the final engagement of the parts.

A further purpose is to adapt my reversing mechanism to application by mechanical, electrical, hydraulic or pneumatic means.

A further purpose is to utilize reversely cut threads upon the same lead screw to operate driving mechanisms with which the carriage is caused to engage alternately.

A further purpose is to move a lead screw bodily by its own operation to cause a reversal in its rotation or a shift in the clutch mechanism engaging it.

A further purpose is to operate a carriage in reverse directions from a lead screw reversing it in direction of rotation by clutch mechanisms operated by the lead screw.

A further purpose is to provide a separate driving motor for a lead screw to control the direction of rotation of the driving motor by stoppage of the carriage.

Further purposes will appear in the specification and in the claims.

Figure 1 is a side elevation, partly broken away, of an internal grinding machine in which my invention is well suited to operate.

Figures 2 and 3 are top plan view and end elevation respectively of the structure seen in Figure 1.

Figures 4, 10, 11, 12, 13 and 14 are fragmentary longitudinal sections showing a variety of structures by which my invention can be carried out.

Figure 5 is a section of Figure 4 upon line 5—5.

Figure 6 is a fragmentary section showing a modification of the structure of Figure 4.

Figure 7 is a fragmentary section of a modified thread.

Figures 8 and 9 are sections corresponding to Figure 4 but with the parts in different positions.

Figure 15 is a fragmentary side elevation of a portion of a lathe.

In the drawings similar numerals indicate like parts.

I have preferred to illustrate my invention by a few only of the many forms in which it may be carried out, selecting forms with a view to showing respectively mechanical, electrical, hydraulic and pneumatic mechanisms, not from the standpoint of attempting to show all the different forms, but to illustrate merely the fact that the invention may appear in a variety of quite diverse forms.

I have selected the forms with a view to illustration of the principles involved to the best advantage.

The frame 15 of the grinding machine presents no novelty in its application to the invention in hand. It carries a work head 16 carrying the guard 17 within which the work is mounted, also bed 18 and guides 19 upon which a carriage travels. The carriage 20 is shown as provided with two transverse slides 21 and 22, upon the upper one of which is mounted the wheel head 23. The wheel 24 is driven by a motor not shown. As this invention has to do with the reversing mechanism it is not concerned with the character of these devices.

Travel of the work head longitudinally on guides 25 is controlled by a hand wheel 26, rack 27 and gear not shown. The work head may be shifted for taper work by screw 28 and the exterior of the mechanism shows rheostat controls 29 and 30 for the motors, a head clutch lever 31 and doors 32 by which access is had to the interior of the mechanism.

The wheel 33 provides for hand feed supplemental to the automatic feed and reverse with which this case is concerned.

In Figures 1–3 the reversing mechanism is placed for convenience upon the inside of the frame. This is not essential and the mechanism has been shown with its location outside in Figure 15. Some of the structure, particularly the hand-reversing structure shown in Figures 4 and 5, bases its utility partly upon accessibility of this mechanism. It has been convenient to illustrate it in connection with devices of these figures independently of whether they be easily accessible or not.

The construction of Figure 4 has been selected for illustration because of its simplicity and in order to compare the character of snap movement in it with that shown in Figure 6, as will later appear. Anti-friction bearings and other constructional refinements have been omitted in order not to divert from the illustration of the new structure involved.

The carriage 20 is movable back and forward along the guides of the tool upon which it is mounted so as to provide for the length of travel required. Beneath it is located a lead screw 34 mounted in bearings 35, 36. It is driven by any suitable gearing which I have shown in the form of a belt 37 and pulley 38.

This lead screw 34 is provided with right and left-hand threads 39, 40 which consequently cut each other as shown, and which, as hereinafter described advance and retract right and left nuts 41, 42, respectively. When one is driving the carriage the other is pushed ahead and thus rotated upon the shaft in the direction of shaft rotation by a sleeve as later described. A direction of rotation of the shaft has been arbitrarily assumed to be that shown by the head and tail at the right of the figure.

The screw may be single, double or other multiple thread as described and a multiple thread is in fact illustrated. In some uses of my invention I plan the use of a steeper pitch for the return feed than for the working feed. (See Fig. 7.)

Obviously my broad invention is not affected by these questions of the pitch or whether the pitch of the thread is the same for feed as for reverse.

The nuts 41 and 42 are provided with oppositely facing clutch members 43, 44, here shown as teeth, adapted for engagement with opposing clutch members 45 and 46, here also teeth, upon a block 47 surrounding the lead screw. Between the lead screw and the block I place a spacing sleeve 48.

The block 47 is prevented from rotation by any convenient means, here by the simple expedient of making it non-circular and enclosing it within a non-circular housing 49, rigid with the carriage and by which the block is prevented from turning.

The spacing of the two nuts with respect to the block is such that there is not only enough room for the clutch members (teeth) of the block and one nut to disengage fully before the other clutch and the block engage, but there is sufficient additional space between the brackets by which the nuts are held to their duty to permit relative movement of the unit (including the nuts) and the carriage to throw a quick stroke mechanism.

By any convenient means I control the outward limits of the positions of the two nuts from the carriage. This is most easily done by brackets 50 and 51 extending downwardly from the carriage to engage the nuts and to limit their movement. In the position shown in Figure 4, where the parts are engaged for movement of the carriage to the left with the direction of rotation indicated it will be noticed that there is not only space between the teeth of clutch members 43 and 45 but that there is space between the bracket 50 and the shoulder 52 of the nut 41. There would be corresponding space at the opposite side from shoulder 53 with drive in the opposite direction.

The block 47 has thus a limited movement with respect to the carriage longitudinally of the feed screw for the purpose of providing the neutral position or of having its clutch faces engage with the clutch faces of the nuts 41 and 42 to drive alternately in the two directions. At the same time the brackets 50 and 51 insure that the nuts cannot back away and disengage from the clutches of the block while driving. They also prevent the disengaged nut from whirling beyond the block too far for proper engaging position when reversal takes place.

In this form shown I provide a quick-throw mechanism by which the carriage and block are controlled. The block which normally drives the carriage may slide with the two nuts within the carriage when the carriage is stopped. The carriage may be stopped either by normal stop mechanism or by any foreign object in its path exerting a pressure in excess of the pre-determined pressure necessary to drive the carriage. The quick-throw mechanism allows the block to feed forwardly with respect to the motion of the carriage in the direction of last preceding carriage motion up to the point where the quick-throw becomes operative and from that point to jump forward to release the block from the clutch by which it has been driven and to engage it with the clutch at the opposite end for reverse feeding.

The quick throw mechanism is, of course, capable of wide variation and may appear in a valve- or switch-controlled outside force. I have illustrated two forms suitable for plain mechanical structures seen in Figures 4 and 6. The one in Figure 4 comprises a spring 55 pressing a plunger 56 downwardly upon a toggle member 57 which

has a seat at 58 in the bottom of the plunger and a second seat at 59 in a recess 60 in the block. Because of the diagonal direction of this toggle member the driving force of the block through it against the carriage is greatest in the full stroke position shown and gradually reduces when the carriage is stopped while the block moves forwardly in the carriage in the direction of last carriage movement. The plunger spring is held in place by a plug 61.

The pressure of the spring can be adjusted by screwing the plug in or out until the desired degree of pressure is attained. This adjustment controls the pressure which must be exerted against the carriage to reverse it, and reversal pressure will vary widely according to existing needs, being very great for example if the reversing mechanism be applied to a planer, while when applied to some types of grinders it may be small as to cause reversal by engagement across an electric light bulb without breaking the bulb.

Obviously the angle at which the toggle member 57 is sloped in normal driving use will greatly affect the resistance necessary for stoppage of the carriage and reversal even when using the same strength of spring in the plunger mechanism. For example, in mechanism such as a planer where heavy driving pressure and heavy reverse resistance are desirable the toggle member would be more nearly horizontal, whereas in grinding mechanism or in a lathe or other lighter tool the toggle member would be given a high angle such as illustrated.

At the lower side of Figure 4 is shown a hand-reversing mechanism whose utility would depend upon the accessibility of the structure. It would be suitable, therefore, rather for an exposed reversing mechanism or for lever operation than for direct operation upon enclosed mechanism such as is shown in the grinding machine. The handle 62 is shown connected with the block. By this the block can be thrown from one extremity of its movement to the other.

In Figures 1 and 2 a handle 62′ is connected to the block by a leverage system not shown for hand-operation of the block, corresponding with movement of the block by handle 62.

In Figure 6, I have shown a more simple form of snap actuation or full stroke mechanism in a pair of V notches 63 and 64 within the block in which the V end 65 of plunger 56′ is adapted to fit. The rest of the structure is the same as in Figure 4.

In operation, with the parts in the position shown in Figure 4 and the lead screw rotating in the direction shown by the arrows, the nut 42 engaging with the left-hand thread upon the lead screw intermeshes with the clutch member 46 so that the nut can not turn. It is consequently driven bodily to the left and drives with it the block 47.

Through the toggle member 57 and the plunger 56, the block pushes the carriage to a point at which the carriage meets such a resistance to movement as overcomes the thrust of this spring-pressed toggle member. The nut 42 through sleeve 48 presses the nut 41 continuously to the left so that this nut travels backward upon the right hand thread, rotating.

Since the right-hand thread would tend to advance the nut 41 to the right, while the nut 42 is actually moving upon the screw to the left, the nut 41 must rotate at a greater speed relatively than the speed of travel of the screw. If the right and left-hand screws be of equal pitch it must rotate with respect to the lead screw at a speed twice as great as the speed of the lead screw. In Figure 7 I have shown the pitch of the return thread in excess of that of the feed thread on this screw in which case when nut 42 is driving the nut 41 would have to rotate at a much lower rate of speed. On the other hand when nut 41 is driving the nut 42 as it is pushed ahead will rotate at a much higher rate of speed. In these forms of Figures 1′ to 9 the thread must be steep enough pitch for either of the nuts to be "backed off" when the other is driving. The steeper pitch of Figure 7 is permissible for reverse movement of the parts because there is no duty other than returning the carriage or body and would be highly desirable in the feeding mechanism of a planer or screw machine, to both of which this invention is adapted.

When the carriage meets with an obstruction offering it sufficient resistance so that the carriage stops, continued movement of the nut 42 and block compresses the spring and rocks the thrust bar 57 (Fig. 4) about its upper pivot point or slides the V point (Fig. 6) up toward the top of the slope of the notch by which driving contact has been made. When the thrust bar slightly passes vertical position or when the V point of the plunger passes the edge between the two notches pressure of the spring thrusts the block rapidly to the left along the sleeve 48. The first effect of this movement of the block is to release the teeth at the right hand of the block from the teeth of nut 42. Subsequently the teeth 45 at the left hand end of the block engage with teeth 43 of nut 41.

Evidently the block can be thrown by handle 62 or the handle 62′ to produce the same effect or reversal can be effected by shoving the carriage in the opposite direction.

Figure 8 shows the parts in position with the carriage blocked by a stop 66—typical of any adjustable stop or obstruction—and the thrust bar in vertical position ready with a slight movement of the block to the left to cause reversal of the clutch engagement of

the block. In Figure 9 the carriage is shown in the same position but the block has jumped into clutch engagement with the nut 41.

It will be noted that the position of the parts in Figure 9 is the reverse of that in Figure 4, having clutch engagement at the opposite ends of the block, one as compared with the other, and having spacing between the other clutch elements likewise at opposite ends.

In Figure 9 the nut 42 is about to be driven ahead of the sleeve at a speed higher than the speed of rotation of the screw, just as the nut 41 is driven ahead of the sleeve at a higher rate than the rate of rotation of the screw in the form shown in Figure 4.

It will be obvious that the snap actuations or quick throw movements in Figures 4 and 6 are closely comparable being based both of them upon purely mechanical snaps.

The reversing mechanism depends for its operation upon stopping the carriage and effecting reversal of application of the feed by continued operation of the feed to be reversed. In these two forms a member movable relatively to the carriage is located between the driving mechanism and the carriage so that continued movement of the driving mechanism operates the movable member directly. It may cause direct engagement of contacts, the throwing of a mechanical or electrical switch or lever or direct or indirect action through fluid means to reverse the connections. During the time the reversal is being effected the carriage may be stationary. Whatever the lost motion mechanism used it can be applied to mechanical, electrical or fluid reversing mechanisms of any type.

The lost motion can be between slides or other relatively movable parts of the carriage, as, for example, between the feed screw nuts and the carriage itself, in separated parts of the feed screw or by providing for relative movement of the feed screw bodily in a direction reverse to that of the feed and in any of the forms supplemental operating means may be used. Thus, with bodily movement of all or of any part of the feed screw the movable operating member may, as in the other forms, make contacts, throw a lever, operate a valve or act as or operate a piston to cause fluid movement.

The movement of the feeding force after the carriage stops may be resiliently pressed or spring controlled as in Figures 4 and 6 so as to give always the same extent of compression of the carriage against its stop. It need not be spring nor mechanical but can be the magnetic flux from a magnet or compression of air or gravity-operated.

With the form shown in Figures 1 to 4, 8 and 9 wonderful accuracy of reversal has been obtained, the carriage stopping at the same point reliably within much less than 1/1000″. The length of the stroke between reversals has also proved to be capable of very exact determination. It is not only adapted to reverse on very short strokes—as of one or a few thousandths of an inch but may be set to operate to successively throw the reversing mechanisms where there is no measurable movement of the carriage. The machine is capable of adjustment to reverse on extremely light pressures and with no measurable movement of the carriage. With the form shown in Figures 1 to 5, 7 and 8, the reaction between the carriage and the reversing mechanism movable relatively to it is greatest when the carriage is first stopped and reduces as the thrust connection between it and the spring compressed by this thrust approaches perpendicular position.

With the form of Figure 6 the reaction is uniform. It may be varied by the selection of the type of quick thrust mechanism.

In the form shown in Figures 10 and 11 the snap actuation is electro-magnetic and is obtained by throwing an electric switch by which the electric current is cut off from one solenoid winding and passed through another to throw the clutch. These two forms well illustrate the fact, true of all the forms that the lead screw may be movable longitudinally or not as preferred.

In Figure 10 the lead screw 34′ is of the same general character as the lead screw in the earlier figures, having right and left hand threads upon the same shaft and having right and left nuts 52′ and 53′ engaging them. In this form the nut which is operating the carriage is the forward nut of the pair as distinguished from the rear nut of the pair in Figures 1 to 9. The trailing nut is therefore carried by the flanges 50′, 51′ respectively and is not backed off by any such mechanism as shown in Figures 1 to 9. Obviously, however, the trailing nut could shove the nut ahead of it if desired.

The casing 67 here corresponds generally with the block 47 in that it is resiliently connected with the carriage 20 and is adapted to be driven alternatively by the nut 52′ or by the nut 53′.

The resilient connection between the casing and the carriage includes and is assembled about a pin 68 secured in the carriage. The end 69 is enlarged to form a head and the larger end rests in an opening 70. Upon the reduced portion 71 I place a collar 72 which is pressed against the shoulder 73 by a spring 74. At the other end the spring presses against a collar 75 which at the limit of its movement engages a shoulder 76 formed by fastening a sleeve 77 upon the reduced portion 71.

The sleeve 77 passes through an opening 78 corresponding with the opening 70. The enlargement of the pin at 69 and the sleeve 77 permit movement of the casing and carriage relatively to each other in either direc-

tion between the limits of flanges 79 and 80 of the carriage. The pin is held within flange 79 by any suitable key 81, and within the sleeve 77 by any suitable key 82.

One of the parts rigid with respect to the carriage is used to throw the snap actuation lever 83 for electrically snapping switch 84 to energize either of the electro-magnets 85 or 86. The solenoid windings embrace core 87 pivoted at 88 to the reversing lever 89. Throwing of this reversing lever 89 about its pivot 90 to either of the two extremes of its stroke reverses the clutch so as to cause engagement of the clutch lever arms, 91, or 92, as the case may be, with the nuts, 52′ or 53′.

A standard form of electrical reversing switch is available which contains a quick stroke mechanism and reverses the switch connections without reversal of the position of the lever through which this has been accomplished.

In operation, rotation of the lead screw in one direction causes movement of the carriage in the direction which is controlled by the nut with which engagement is made by the clutch mechanism including lever 89. This continues in the same direction until the carriage is stopped, at which time continuing movement of the lead screw, through the operation of the same nut which has been doing the driving previously, causes relative movement between the frame and the carriage. This compresses spring 74. The compression continues until the relative movement of the carriage with respect to the casing throws the switch lever 83 and thus throws the snap actuated switch within the electrical switching mechanism 84, reversing the electric current and passing the electric current through that solenoid winding from which the current was previously cut off. This throws the lever 89 pivoted at 90 reversing the clutching mechanism by which the nuts are gripped one at a time and causing the arms 91 and 92, one to grip the nut which has been inactive and the other to release the previously active nut.

The electro-magnetic snap actuated mechanism thus causes the same character of operation and the same character of reversal control by reason of stoppage of the carriage as in the other forms.

In the form shown in Figure 11 I illustrate another electro-magnetic reversing mechanism having a single lead screw operated to rotate in different directions for reversal of feed and capable of longitudinal movement of the lead screw with respect to the bed of the machine tool to cause reversal of the direction of rotation of the lead screw and to thereby reverse the direction of feed.

I accomplish this by means of a shaft 34′ which is threaded through and therefore directly operates the carriage member 49′. The floating shaft is mounted in bearings 35′, 36′ and 93 within or carried by the frame work of the machine. The shaft carries opposed gears 94 and 95 which are loose upon it and both of which, through teeth 96 and 97 are driven, though in opposite directions, by a gear 98.

The shaft 34′ is a floating shaft in that it has play axially and is centered longitudinally within the play allowed by springs 99 and 100 which, in order to reduce friction engage against thrust bearings 101.

Upon the shaft 34′ and between the gears 94 and 95 is mounted a clutch 102 splined to the shaft and having oppositely directed clutch faces 103, 104 adapted to engage with corresponding clutch faces 105, 106 upon gears 94 and 95. The clutch 102 is grooved at 107 to receive the yoke end 108 of a rocker arm 109 pivoted at 110. The yoke engages with the clutch to shift it in opposite directions. The other end of this rocker arm is yoked also, at 111 to engage with a pin 88′ in an armature 87′ movable within solenoidal windings 85′ and 86′ energized alternately by a switch 84′. This switch is of the snap actuated type in which the snap actuation is started in opposite directions by lever 83′ operated from any exposed part 112 of the shaft 34′. It is here operated by the walls of a groove 113 in the shaft, into which groove the lever 83′ fits.

In operation, with the parts set as shown, let us assume a direction of clutch rotation as shown by the point and tail of the arrows, such that the carriage is moving to the left in the figure, that the carriage engages any stop or obstruction 66 and that the shaft continues to rotate in the same direction. When the carriage stops the shaft will continue to turn in clockwise direction as viewed from the right causing the shaft to move bodily toward the right of this Figure 11 snapping the electrical switch and electrifying the solenoid 89 while cutting off the solenoid 88. The result is an immediate and quick throw of the rocker arm 109 so as to throw the clutch from the position shown to a position at the left thereof with its left clutch face engaging the clutch members upon gear 94. In whatever direction gear 95 had previously driven this shaft gear 94 will rotate it in the opposite direction, first taking up the displaced movement of the shaft lengthwise and bringing it back to neutral. With the direction which we have assumed, gear 94 will bring the shaft back to its balanced position and will then begin to drive the carriage toward the right in Figure 11. This movement of the carriage will continue until the carriage meets an obstruction such as 66′ which will stop it and again reverse the connection and the direction of travel.

It will be apparent that in all of these

forms as in the other forms shown by me, the strength of the resistance which must be met to stop the carriage is measured by the spring or other resilient pressure which must be overcome to cause relative movement between the parts, i. e., in the present cases by the spring which must be compressed and in the form of Figures 1–9, also by the component of pressure which is effective in compressing the spring. In grinding machines the reversal may be effected with a very slight pressure, too little to crush a finger, but in machines such as lathes and planers in which the tool must be pushed forward to effect the feed or make the cut the resistance to movement of the carriage necessary to cause reversal must be greater than anything which is to be encountered in taking the normal cut, suiting the invention more to machines taking light cuts than to machines taking heavy cuts.

That the means of effecting the actual reversal is broad and is not confined to mechanical and electrical means but may include any other is illustrated still further by the fluid actuation of the reversing mechanism in Figures 12 and 13, showing the application of outside fluid pressure in Figure 12 and showing the fluid merely to transient motion in Figure 13.

Figure 12 is intended to correspond with Figure 11 in all particulars except that fluid pressure is used to perform the function performed by the solenoidal form of Figure 11. Instead of the snap actuated electrical switch or valve 84′, thrown in opposite directions by the lead screw through arm 83′ I provide a snap actuated switch or valve 84^2 thrown by an arm 83^2 and controlling the path of inlet and exhaust to cylinders 114, 115 from fluid pressure inlet and exhaust 116, 117. In the position shown, corresponding to that in Figure 11 the pressure inlet is connected with cylinder 115 through pipe 118 and cylinder 114 is connected through pipe 119 with the exhaust 117.

When the carriage, considered now as moving to the left in the figure, strikes an obstruction and the shaft 34′ subsequently shifts to the right, the valve 84^2 is rotated a short distance before the snap actuation takes place and it is then thrown to position to admit liquid under pressure to pipe 120 in cylinder 114 and to connect cylinder 115 to exhaust through pipe 121. This throws piston 122 to the left, sweeping out the water in front of piston 123, throwing the rod or stem 124 which occupies the position of the armature 87 or 87′. The rest of the construction acts as in Figure 12 to shift the clutch so that the shaft is driven by gear 94 instead of by gear 95.

In Figure 13, the illustration generally parallels that in Figures 11 and 12 except that, as compared with both of them, the direction of rotation of the shaft 34′ is reversed in the position of the clutch shown, rotating in counter-clockwise direction as viewed from the right, as shown by the arrow point and tail in the figure, and in that, as compared with Figure 12, the liquid is a mere means of transmitting motion and not an outside liquid pressure.

Because of the change in the direction of rotation the carriage will be moved in the opposite direction from that of the carriage in Figures 11 and 12 and will engage stop 66′ instead of stop 66, causing the lead screw, with continued rotation to move to the left instead of to the right as in Figures 11 and 12 and compressing the spring 74 at the left end of the shaft (not shown in the figure) instead of 74′ near the right end of the shaft as in the other figures.

As a result of this movement to the left, the piston 125 in cylinder 126 will be moved to the left, tending to produce a vacuum in the space 127. The unbalanced normal air pressure upon the outer surface of piston 128 in cylinder 129 will then force this piston in, causing the liquid to flow from space 130 through pipe 131 into the space 127.

The quick throw in this case is obtained by means of a snap-actuated lever 109′ of U-shape pivoted to swing about the middle of the U, the axis of the shaft 132 upon which its two arms 133 (one only shown) are mounted. The lever is actuated by a spring 134 connected at one end at 135 to one of the arms and at its other end at 136 to piston rod 137. This point of attachment 136 is thrown from a position on one side of a line 138 through point 135 and the shaft axis to a point on the other side of this line in order to "snap" the clutch one way or the other.

At the position shown the attachment point 136 is at the right of this line 138 but the movement of the piston and its rod to the left will throw it to the left of this line. The spring, whose tension will be increased during the shifting of the pivot, will snap the lever over to a position at the left of that shown in the figure, carrying the clutch 102 with the lever. The lever carries a roller 139 upon each arm to engage the walls within the groove in the clutch.

Because the lead screw will be rotating and it is undesirable to rotate the piston 125 the piston is slip-connected with the shaft. The connection shown is by a rod 140 terminating in a collar 141 which is free to rotate but has slight longitudinal movement only between a threaded projection 142 carried by the shaft and a cap 143 secured upon the projection.

The rod or stem 137 is shown as guided in a bracket 144.

With the reversal of the clutch position the direction of rotation of the feed screw is reversed so that the carriage (not shown) will move to the left until it engages some stop. Movement of the lead screw bodily toward

the right will then begin and will force the liquid out of cylinder 126 into cylinder 129, again throwing the attachment point of the spring beyond the line 138 to snap-actuate the clutch into the position shown in Figure 13.

Figure 14 has the same direction of rotation of the lead screw and therefore the direction of movement of the carriage for the position shown as in Figure 13, the reverse from those seen in Figures 11 and 12.

All of the forms of reversing mechanism operate equally well with drive in either direction.

It has the same snap-actuation as Figure 13 but secures the snap actuation by direct movement of a rod or stem 137′ instead of by fluid actuation of the fastening point of the spring. This is accomplished in Figure 14 by means of a groove 145 in the end of the lead screw, into which groove a roller 146 extends. The roller is carried by an arm 147 connected with the rod 137′ so that movement of the arm 147 and of the rod 137′ to the left with movement of the lead screw 34^3 to the left will cause the attachment point of the spring to throw beyond the line 138 and the spring will shift the clutch.

At the end of the reversed movement a second reversal takes place and the lead screw is shifted bodily to the right causing the clutch to be thrown to the position shown in Figure 14.

In Figure 15 I have shown a conventional form of lathe with a live head 148 and gearing 149 connecting with a lead screw 34 upon which a feed reversing gear 150 is mounted which may be any of the types of feed gear reversing mechanisms. This view is shown for the purpose merely of indicating in the drawing one other type of machine tool than the grinding tool to which my invention may be applied, in order to negative the idea that my invention is intended for grinding machines only. As previously stated my invention can be applied to a variety of machines, suiting best those in which the feed resistance to carriage movement is low.

I have made no attempt to show with completeness from any standpoint the various applications of my invention but have selected samples only, selecting diverse means by which the reversal may be accomplished in order to make clear that the invention is of great breadth and can be practiced in many different ways.

I have no doubt that a great variety of other forms and means of securing all or a part of the advantage of my process and mechanism will occur to those skilled in the art, in view of my disclosure herein, and I therefore purpose covering herein all such forms and changes as come within the reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a reversing mechanism for machine tools, a carriage, a feeding mechanism therefor, including a lead screw and a quick throw connection having lost motion between part of the feed mechanism and the carriage providing for continued rotation of the lead screw to accumulate energy applied to the quick throw connection when the carriage has been stopped to terminate feed in one direction, and reversing devices operated by the quick throw mechanism through taking up the lost motion to reverse the driving connection.

2. In reversing mechanism for machine tools, a movable carriage, a feed screw having right and left threads upon it, means for continuously rotating the feed screw, right and left nuts spaced upon the feed screw, movable axially of the nuts with and also with respect to the carriage, a block between the nuts having faces engaging them alternatively and lost motion snap actuation for the block forming operating connection between it and the carriage.

3. In reversing mechanism for machine tools, a movable carriage, a feed screw having right and left threads upon it, means for continuously rotating the feed screw, right and left nuts spaced upon the feed screw, movable axially of the nuts with and also with respect to the carriage, a member between the nuts having faces alternatively engaging them, slip motion snap actuation connecting the member and the carriage operated by the feed screw when the carriage is stopped and a spacer between the nuts adapted to back one nut off from the member with advances of the other nut.

4. In reversing mechanism for machine tools, a movable carriage, a feed screw having right and left threads upon it, means for continuously rotating the feed screw, right and left nuts spaced upon the feed screw, movable axially of the nuts with and also with respect to the carriage, a sleeve surrounding the right and left screw and adapted to keep the nuts spaced upon the screw, a block about the sleeve having faces for alternatively engaging one or the other of the nuts and spring pressed operating connections between the block and carriage adapted to allow loose motion between them and to snap over to throw the block free from engagement with one nut and into engagement with the other.

5. In reversing mechanism for machine tools, a movable carriage, a feed screw having right and left threads upon it, means for continuously rotating the feed screw, right and left nuts spaced upon the feed screw, movable axially of the nuts with and also with respect to the carriage, a spacer between the nuts adapted to back one as the other ad-

vances, a block between the nuts adapted to engage them alternatively, a spring pressed sloping thrust connection between the block and the carriage adapted to permit movement of the block with respect to the carriage when one nut is driving and, with stoppage of the carriage, to snap over to throw the block free from the one nut and into engagement with the other to provide drive by the other nut.

6. In a reversing mechanism for machine tool feeds, a machine tool having a tool or work carriage, a feed screw for the carriage, driving connections for the feed screw, a reversing mechanism for the screw, a lost motion connection located in the train between the driving mechanism and the carriage providing for continued rotation of the screw after the carriage has been stopped and a quick operating device for the reversing mechanism operated by said continued movement of the screw.

7. In a reversing mechanism for machine tool feeds, a machine tool having a tool or work carriage, a feed screw for the carriage, driving connections for the feed screw, turning the screw continuously in the same direction, a reversing mechanism, a lost motion connection located in the train between the driving mechanism and the carriage providing for continued rotation of the screw after the carriage has been stopped and a quick operating device for the reversing mechanism controlled by said continued movement of the screw.

8. In a machine tool, a tool or work carriage, a traversing means for the carriage and a stop for the carriage in combination with driving means for operating the traversing means, and means actuated by the continued movement of the traversing means after the carriage has engaged the stop to reverse the direction of movement of said carriage.

9. In a machine tool, a tool or work carriage, mechanism for causing traverse of the carriage, a stop for the carriage, means for driving the traversing mechanism, lost motion connections between the driving means and the carriage adapted to continue to operate the traversing mechanism after the carriage has stopped, and means actuated by the traversing mechanism during the time the carriage is stopped for reversing the direction of traverse effected by said traverse means.

10. In a machine tool, a tool or work carriage, mechanism for causing traverse of the carriage, a stop for the carriage, means for driving the traversing mechanism, a resiliently retarded lost motion connection between the traversing mechanism and the carriage, driving means for the traversing mechanism and reversing connections for the carriage operated through the lost motion connection by continued movement of the traversing mechanism.

11. In a machine tool, a tool or work carriage, a traversing screw therefor, means for operating the screw, lost motion connections in the train between the operating means and the carriage whereby the traversing screw with continued operation takes up the lost motion and means effected through the taking up of the lost motion for reversing the direction of traverse of the carriage.

12. In a machine tool, a tool or work carriage, a stop therefor, a continuously rotatable right and left thread traversing screw, a nut located in each thread, a clutch carried by each nut, means located between the two clutches having clutches adapted to cooperate alternatively with the two clutches carried by the nuts and a resiliently retarded quick throw device between the carriage and said last means, whereby continued rotation of the screw after the carriage has stopped operates the quick-throw device and changes the clutch connection.

13. In a machine tool, a tool or work carriage, traversing means for causing the carriage to move along the length of the machine, lost motion connections in the train between the traversing means and the carriage whereby with continued operation of the traversing means the lost motion is taken up and means effected through the taking up of the lost motion for reversing the direction of traverse of the carriage.

14. In operation of a reversing mechanism embodying a carriage, a feed screw therefor and connections between the feed screw and carriage for operating the carriage in opposite directions, the novelty which consists in resiliently opposing bodily movement of the connections between the screw and carriage when the carriage is stopped and the feed screw continues to rotate and in utilizing this resilient opposition to quickly reverse the connections.

15. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therein and bodily movable in an axial direction, spring means opposing movement in each direction, facing gears upon the shaft constantly driven in opposite directions, a clutch between the gears and movable axially of the shaft, and snap actuation for the clutch thrown by movement of the shaft in reaction against the carriage when the carriage engages a stop.

16. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therewith and bodily movable in an axial direction, spring means opposing movement in each direction, facing gears upon the shaft, constantly driven in opposite directions, a clutch between the gears and movable axially of the shaft, snap actuation for the clutch and fluid operating connections from

the movable shaft to set the snap actuating mechanism.

17. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therewith and bodily movable in an axial direction, spring means opposing movement in each direction, facing gears upon the shaft constantly driven in opposite directions, a clutch between the gears and movable axially with the shaft, snap actuation for outside setting force for the snap actuation and valve control for said outside force movable by the movable shaft.

18. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therewith and bodily movable in an axial direction, spring means opposing movement in each direction, facing gears upon the shaft, a constantly driven clutch between the gears and movable axially of the shaft, snap actuation for an outside actuating force applicable to the movement of the clutch and means for applying the outside force with movement of the shaft.

19. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therewith and bodily movable in an axial direction, spring means opposing movement in each direction, facing gears upon the shaft constantly driven in opposite directions, a clutch between the gears and movable axially with the shaft and a snap actuated control set by movement of the lead screw for throwing the clutch.

20. In feeding and reversing mechanism for machine tools, a carriage, a lead screw engaged therewith and bodily movable in an axial direction, spring means opposing movement in each direction, driving means for turning the screw in opposite directions, a clutch movable axially of the shaft to engage the driving means, snap actuation mechanism for throwing the clutch and connections between the shaft and the snap actuating mechanism for setting and tripping the same.

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