

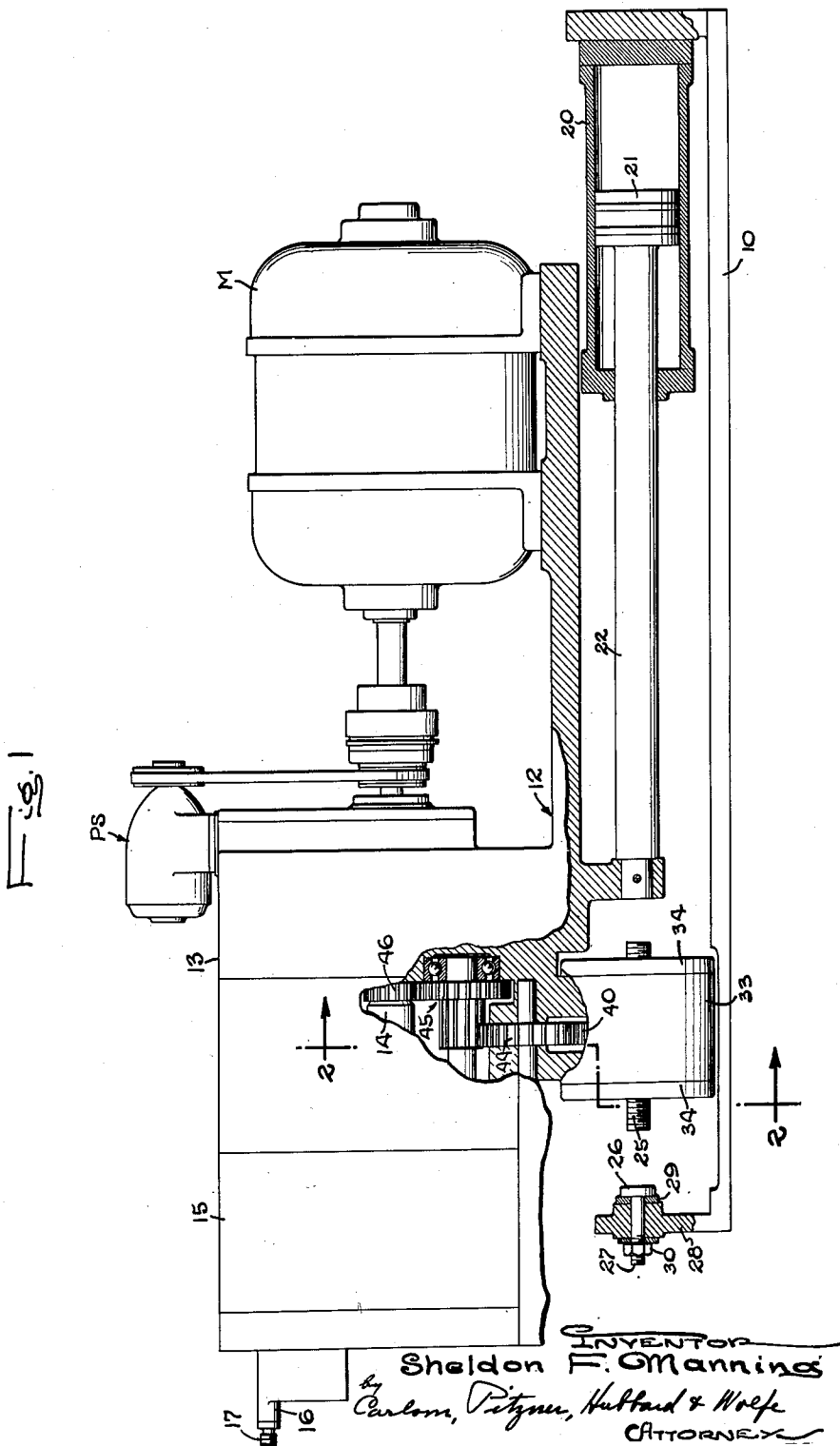
Feb. 26, 1952

S. F. MANNING
THREAD-CUTTING MACHINE HAVING RAPID TRAVERSE PLUS
POSITIVE CONTROLLED FEED

2,587,352

Filed Jan. 27, 1948

4 Sheets-Sheet 1



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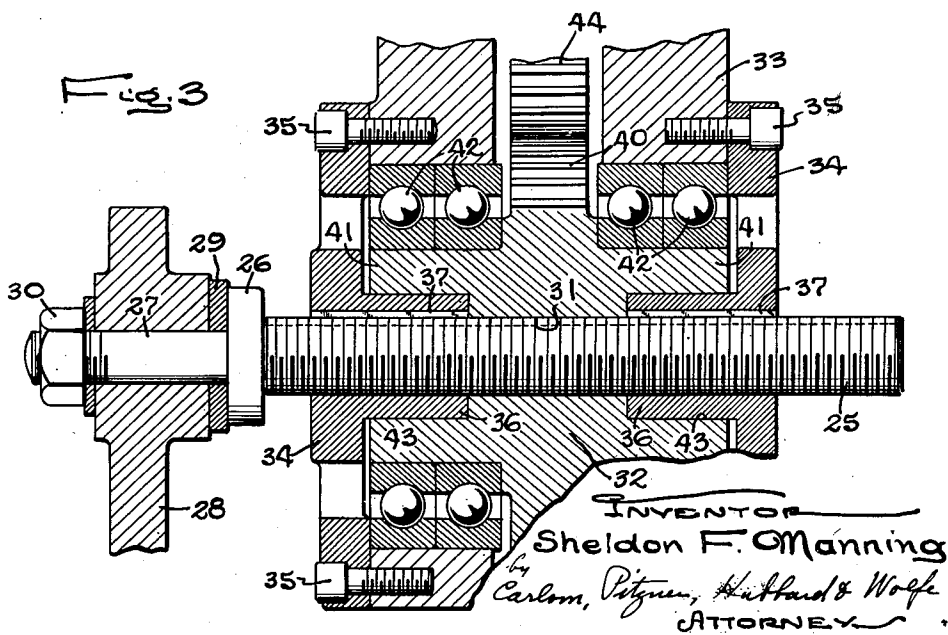
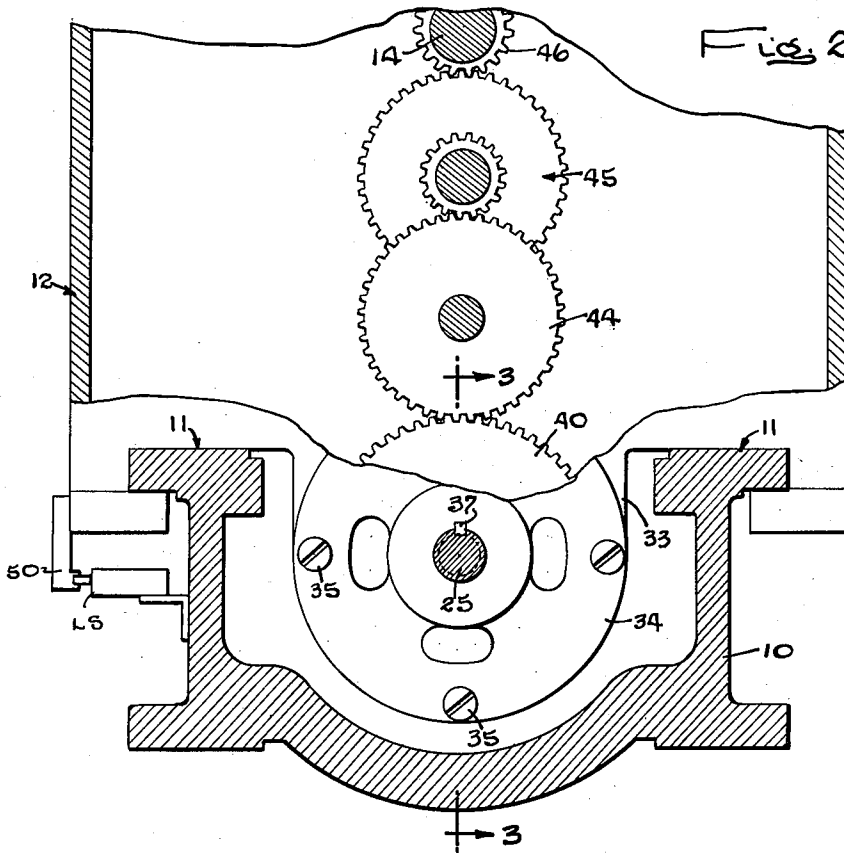
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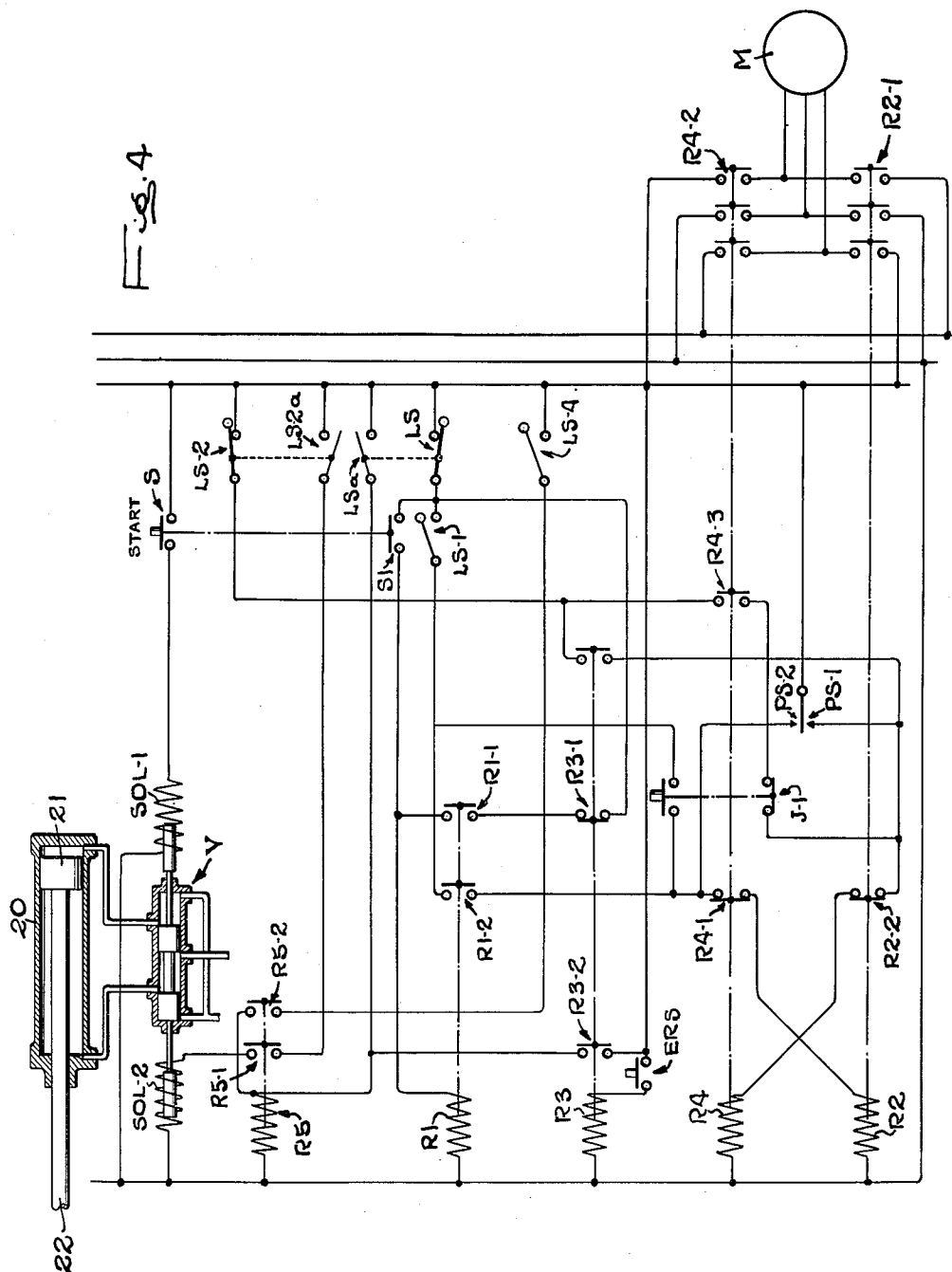
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4 Sheets-Sheet 3



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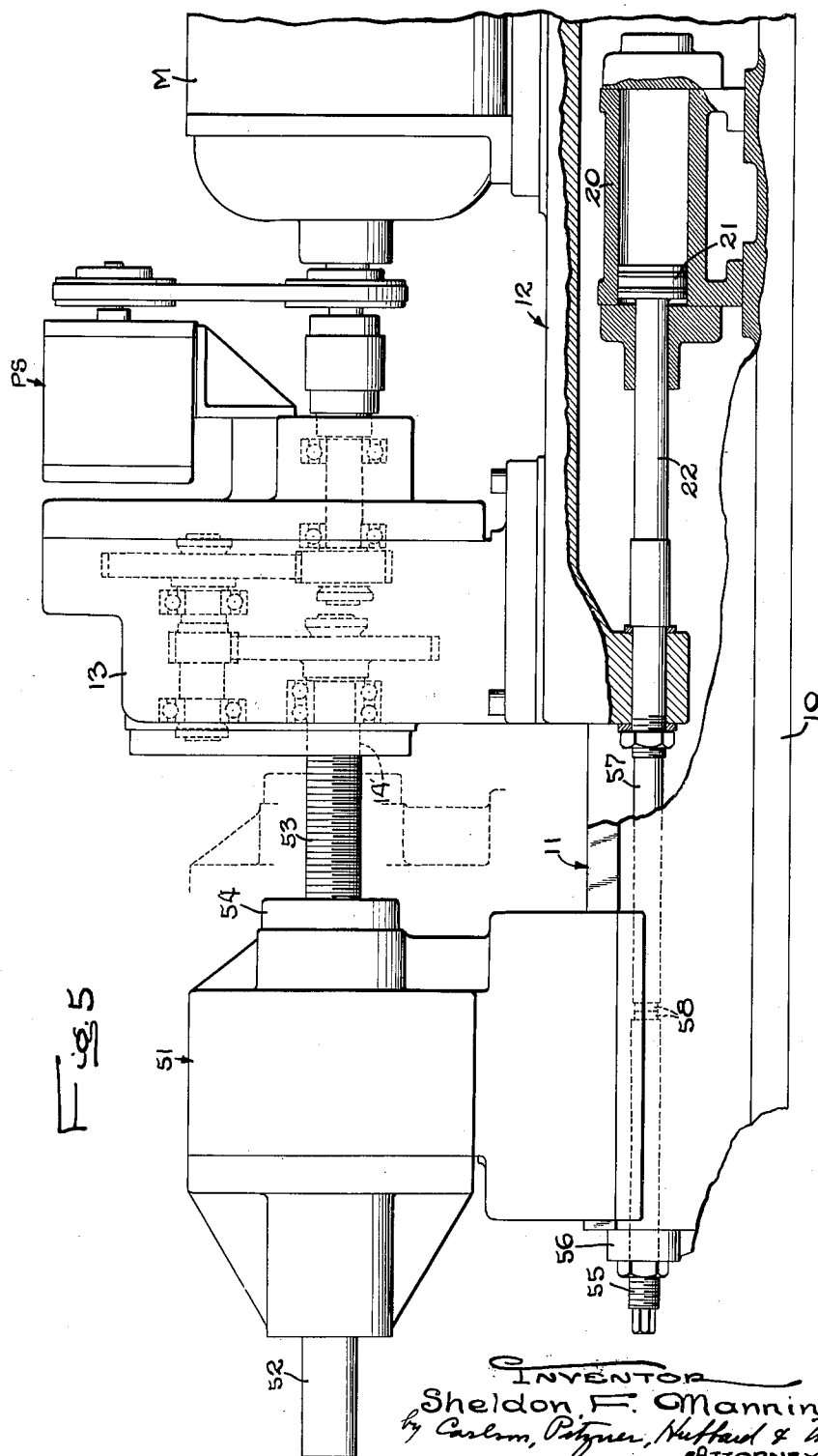
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4 Sheets-Sheet 4



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THREAD-CUTTING MACHINE HAVING RAPID TRAVERSE PLUS POSITIVE CONTROLLED FEED

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3 Claims. (Cl. 10—139)

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The invention relates to thread-cutting machines generally, and more particularly to machines adapted to cut threads by means of rotating tools such as taps or dies.

One object of the invention is to provide a machine of the above general character in which the tool is fed to and retracted from the work by a pressure fluid operated actuator and embodying novel feed control mechanism including a screw threaded stop engaging element for regulating the feed rate of the tool in accordance with the lead of the screw threads being cut.

Another object is to provide improved feed control mechanism for pressure fluid actuated thread-cutting machines which is effective only while the tool is operatively engaged with the work to effect the rate of translation of the tool, thus permitting the tool to be traversed at a rapid rate to associate it with and disassociate it from the work.

A further object is to provide a pressure fluid operated thread-cutting machine embodying improved controls which automatically insure a proper sequence of the approach, feed and return movements of the tool, thus enabling the machine to operate very efficiently and with a minimum of attention.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawings, in which:

Figure 1 is a partly sectioned side elevational view of a thread-cutting machine embodying the features of the invention.

Fig. 2 is a fragmentary transverse sectional view of the machine taken in a vertical plane substantially on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary longitudinal sectional view of the machine taken in a vertical plane substantially on the line 3—3 of Fig. 2.

Fig. 4 is a diagrammatic view of the operating and control circuits for the machine.

Fig. 5 is a partly sectioned side elevational view of a modified form of the machine.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form

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disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring to the drawings, the improved thread-cutting machine in the preferred form shown in Figs. 1-3 is of the self-contained unit type. It comprises a rigid bed 10 having spaced parallel ways 11 on its upper face for supporting and guiding a reciprocatory head 12. The head includes an upright housing 13 at its forward end in which is journaled an axially projecting tool spindle 14. The spindle 14 is rotatably driven by a reversible electric motor M supported on the head 12 at the rear of the housing 13 and connected with the spindle through the usual gearing (not shown) enclosed within the housing. A conventional plugging switch PS (Figs. 1, 4 and 5) driven from the motor shaft insures quick stopping when the motor circuit is opened.

While the spindle 14 may be provided with a suitable chuck for holding a single tool if desired, the exemplary machine has been shown as equipped with a conventional multiple spindle auxiliary head 15. The head 15 carries one or more auxiliary spindles 16 and is provided with suitable gearing whereby the auxiliary spindle or spindles may be driven in well-known manner from the main spindle 14. Each auxiliary spindle is adapted to support a conventional thread-cutting tool 17, herein shown as a tap.

Reciprocation of the head 12 on the ways 11 to advance and retract the tool with respect to a workpiece and to feed the tool into and out of the same is effected by a suitable actuator of the pressure fluid operated type. The actuator, as shown, comprises a cylinder 20 rigidly mounted on the machine bed 10 and having a working piston 21 operatively connected with the head 12 by a piston rod 22. Pressure fluid, such as compressed air, is supplied to the cylinder 20 from any suitable source under control of a reversing valve V (Fig. 4) operated between two alternate positions by solenoids SOL-1 and SOL-2, as will be explained in more detail hereinafter.

The pressure fluid operated actuator is operative to impart rapid movements to the head 12 to carry the tool 17 from a retracted position into

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engagement with the work and to return the tool to its retracted position after it has performed its thread-cutting operation and has been disassociated from the work. During the thread-cutting operations, a feeding movement is imparted to the head 12 and the tool 17 by the actuator, but the rate of such feed is regulated by novel feed control mechanism which serves to accurately coordinate the axial advance of the tool with its rotation, in accordance with the lead of the thread to be cut.

Referring to Figs. 1-3 of the drawings, the feed control mechanism in its preferred form comprises retractible stop engaging or abutment means, herein shown as an elongated screw 25 mounted on the head 12 and positioned for co-action with a fixed stop 26 on the machine bed 10. The stop 26, in this instance, comprises a disk of hardened steel or other suitable material having a shank 27 projecting from its inner face through an aperture in a cross member 28 adjacent the front end of the bed 10. The position of the stop longitudinally of the machine bed may be determined by insertion of a suitable shim or washer 29 between the stop and the cross member. A nut 30 threaded on the projecting end of the shank retains the stop in place.

The screw 25 constituting the retractible abutment is supported on the head 12 in alignment with the stop 26 with its longitudinal axis parallel to the ways 11 and with its forward end positioned for engagement with the stop when the head is advanced to a predetermined position by the pressure-fluid actuator. The free forward movement of the head is thus interrupted by the stop.

Continuation of the forward movement of the head 12 by the pressure fluid actuator is conditioned upon and regulated by the retraction of the screw 25 with reference to the stop 26. To provide for such withdrawal of the screw in timed relation to the rotation of the tool supporting spindle, the screw, in the present instance, is threaded into an axial bore 31 in a nut 32 which is supported for rotation but rigidly restrained against axial movement in a bracket 33 depending from the underside of the head 12 and which is drivingly connected with the spindle 14.

As best shown in Fig. 3, the nut 32 is disposed within a recess formed in the bracket 33 and is retained between a pair of end plates 34 secured to the bracket at opposite ends of the recess, as by machine screws 35. The end plates are formed on their inner faces with cylindrical extensions 36 apertured to receive the screw 25 with a sliding fit and the screw is held against rotation relative thereto by feather keys 37 fitted into suitable keyways in the screw and the extensions. Since the screw 25 is non-rotatable, rotation of the nut 32 is effective to shift the screw axially either forwardly or rearwardly, depending upon the direction of rotation of the nut.

In the exemplary machine, the nut 32 is formed with an integral gear element 40 disposed centrally between two cylindrical hubs 41 by which the nut is rotatably supported in antifriction bearings 42 on the bracket 33. To obtain compactness and to maintain the nut accurately aligned with the end plates 34, the hubs 41 are formed with recesses 43 for the reception of the extensions 36 of the end plates. The gear element 40 of the nut provides an operative connection with the main spindle 14 whereby the nut is driven from and in timed relation to the

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rotation of the main spindle. This driving connection, as shown, includes intermediate gears 44 and 45 (Fig. 1) journaled in the housing 13 and a pinion 46 rigid with the spindle 14.

It will be evident from the foregoing that the head 12 may be advanced freely and at high speed by the pressure-fluid actuator until the lead screw 25 meets the fixed stop 26, whereupon the advance is regulated by the rate of withdrawal of the screw 25, which in turn is dependent upon the rate of rotation of the spindle 14. As the nut 32 which effects the retraction of the screw is geared directly to the spindle 14, such retraction occurs only when the spindle is rotating in a direction to feed the thread-cutting tool 17 into the work and in timed relation to the rotative speed of the spindle and the tool. Conversely, when the spindle is rotated in the reverse direction to back the tool out of the work, the lead screw 25 is actuated so as to push the head rearwardly at the proper rate to avoid marring the threads cut in the work.

To enable the machine to operate with maximum efficiency, I provide a control system in which the sequence of operations is controlled automatically through the medium of control or limit switches actuated by suitable dogs 50 supported on and movable with the head 12. The dogs are mounted in well known manner for adjustment so that they may be set to actuate the switches to initiate each operating step at the proper point in the machine cycle, as determined by the character of the work being operated on.

The exemplary control system is arranged for single cycle operation, the cycle including a rapid advance of the head 12 from retracted position to carry the tool into operative engagement with the work, advance of the head at a feeding rate while the tool is operating on the work, retraction of the head at a feeding rate to back the tool out of the work, rapid return of the head to retracted position and stop. An operating cycle is initiated by means of a starting switch which may be actuated manually or by an associated machine element when the machine is incorporated as one unit of a multiple unit machine tool organization.

In the particular control system illustrated, the starting switch is of the manually operable push-button type and includes two sets of normally open switch contacts S and S-1 (Fig. 4). Closure of the switch contacts S completes a circuit for the solenoid SOL-1, which becomes energized and shifts the valve V to the Forward position. Pressure fluid is directed by the valve to the rear end of the cylinder 20, thereby driving the piston 21 and the head 12 forwardly.

Closure of the switch S-1 completes a circuit for a control relay R1, the circuit including a normally closed limit switch LS which is opened by one of the dogs 50 at the end of the tapping stroke of the head. Upon energization, relay R1 closes switch contacts R1-1 to complete a holding circuit for itself by way of normally closed switch contacts R3-1 of a relay R3 and the limit switch LS and closes a second set of switch contacts R1-2 to prepare an energizing circuit for a motor control relay R2.

Upon initiation of a cycle as above described, the head 12 is advanced rapidly until the stop screw 25 engages the fixed stop 26 and interrupts the free advance of the head. The screw is adjusted of course so that this occurs just as the tool is brought into a position to operate on the

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work. At the same instant one of the dogs 50 is arranged to close a normally open limit switch LS-1, thereby completing the circuit for the motor controlling relay R2 by way of the limit switch LS, switch contacts R1-2 and a normally closed switch R4-1 of a second motor control relay R4.

Relay R2 becomes energized and closes switch contacts R2-1 to complete a circuit for operating the motor M in a forward direction. This relay also opens normally closed switch contacts R2-2 to prevent premature energization of the control relay R4. The motor M now drives the tool 17 in a direction to feed it into the work and rotates the nut 32 so as to retract the stop screw 25 in timed relation to the rotation of the tool. The advance of the head 12 by the pressure fluid actuator thus continues, but the rate of such advance is now determined by the rate of retraction of the screw.

As the head 12 approaches the end of the tapping stroke, the limit switch LS is opened, thereby interrupting the holding circuit for relay R1 and the operating circuit for relay R2. The latter circuit is also opened at switch contacts R1-2 upon deenergization of relay R1 to prevent reenergization of the control relay R2 while the companion relay is energized. Relay R2 becomes deenergized and opens the motor circuit at switch contacts R2-1.

When the motor M is operating in a forward direction, contacts PS-1 of the plugging switch PS are closed. Consequently, the closure of switch contacts R2-2 completes a circuit for motor control relay R4, which closes switch contacts R4-2 to complete a circuit for operating the motor M in the reverse direction. The motor is thus brought to a quick stop and is then immediately started in operation in the reverse direction. This is for the reason that relay R4 is maintained energized independently of the plugging switch PS-1 by a holding circuit including normally closed switch contacts J-1 of a jog switch, relay switch contacts R4-3 and a normally closed limit switch LS-2. The reverse rotation of the motor M serves to back the tool 17 out of the work and to rotate the nut 32 in a direction effective to advance the screw 25 and thus push the head back at a rate conforming to the rate of withdrawal of the tool. During this withdrawal, a forward pressure is maintained on the head by the pressure fluid actuator to insure smooth retraction of the tool at the proper rate.

As the tool clears the work in its rearward movement, one of the dogs 50 opens normally closed limit switch LS-2 and closes a normally open limit switch LS-2a which, in this instance, is mechanically interconnected with the limit switch LS-2. The opening of the limit switch LS-2 opens the holding circuit for the control relay R4 which becomes deenergized and opens the motor circuit at switch contacts R4-2 and closes the switch contacts R4-1 to complete an energizing circuit for control relay R2 by way of plugging switch contacts PS-2 which are closed when the motor is running in reverse. The motor is thus plugged to a quick stop under control of the plugging switch, which opens as soon as the motor shaft stops and thus interrupts the circuit for relay R2. In this way the stop screw 25 is stopped in the precise position to begin its control functions in the next cycle of the machine.

Closure of the limit switch LS-2a completes an

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energized circuit for solenoid SOL-2 which acts to shift the valve V to Return position. Pressure fluid is thereby directed to the forward end of the cylinder 20 and the piston 21 and the head 12 are returned at a rapid rate to the retracted position. In the exemplary control system the circuit for solenoid SOL-2 includes normally open switch contacts R5-1 of a relay R5. This relay is energized in response to the closure of a limit switch LSa which is mechanically interconnected with the limit switch LS and which is therefore energized at the end of the tapping stroke of the head. To guard against accidental shifting of the valve V during the return of the head, the relay R5 is maintained energized in a holding circuit including its own switch contacts R5-2 and a limit switch LS-4 which is closed whenever the head is out of retracted position.

As the head 12 moves into its fully retracted position, the limit switch LS-4 is opened to deenergize relay R5 and the latter opens switch contacts R5-1 to interrupt the circuit for solenoid SOL-2. The machine cycle thus ends with the head 12 in fully retracted position, the motor M stopped and all of the controls in their normal rest positions.

Provision is made so that return movement of the head 12 may be initiated manually at any point in its forward travel. Such return is effected by actuation of a normally open manually operable emergency return switch ERS. Closure of this switch completes an energizing circuit for relay R3 which opens switch contacts R3-1 to interrupt the holding circuit for control relay R1, which, in turn, opens switch contacts R1-2 to interrupt the circuit for relay R2. If the tool is operating on the work at this time, motor M will be running and the deenergization of relay R2 will interrupt the forward running circuit of the motor and thus stop the advance of the tool. As explained heretofore relay R4 will become energized under control of the plugging switch to bring the motor to a quick stop and will remain energized under control of limit switch LS-2 to initiate reverse operation of the motor to withdraw the tool from the work. After such withdrawal, rapid return of the head 12 to retracted position takes place as in the normal operating cycle.

In case the emergency return switch ERS is closed during the forward movement of the slide 12 but before the tool has engaged the work, the motor M remains inactive. Relay R3 closes switch contacts R3-2 to energize relay R5 and the latter closes switch contacts R5-1 to energize the solenoid SOL-2. The solenoid shifts valve V to Return position and the head is returned to retracted position, as heretofore described.

In the modified form of the thread cutting machine shown in Fig. 5 of the drawings, the ways 11 are extended to the forward end of the bed 10 for supporting and guiding an auxiliary head 51 in front of the main head 12. The auxiliary head is provided with a rotatable axially projecting spindle 52 for supporting the thread cutting tool and is arranged to advance and return with the main head 12 during the free movements of the latter.

For feeding the tool into the work and withdrawing it therefrom, provision is made for shifting the auxiliary head independently and at a rate accurately timed with respect to the rate of rotation of the spindle 52. To this end the head 12 is equipped with a main spindle 14' which extends into the auxiliary head 51 to drive the spindle 52 through suitable gearing and which

has its intermediate portion threaded as at 53 for coaction with a nut element 54 rigid with the auxiliary head. Accordingly, rotation of the main spindle 14' in a forward direction is effective to rotate the tool supporting spindle 52 and simultaneously advance the auxiliary head 51 to feed the tool axially into the work at a rate determined by the lead of the screw threads 53. Upon reverse rotation of the spindle 14' the auxiliary spindle is turned reversely to back the tool out of the work and the auxiliary head is shifted rearwardly in timed relation thereto.

For automatic cyclic operation the modified machine is equipped with a control circuit similar to that above described. Operation of the starting switch initiates the advance of the head 12 at a rapid rate by the pressure fluid actuator. Provision is made for interrupting the advance of the head 12 when the tool is brought into operative engagement with the work and the motor M is started to rotate and feed the tool into the work. At the end of the tapping stroke the motor is reversed to back the tool out of the work, and upon disassociation of the tool from the work the motor is stopped and the valve V is shifted to Return position to cause the actuator to return the head 12 to its normal rest position.

The means for interrupting the advance of the head 12 comprises a fixed stop, herein shown as a rod 55 threaded through a nut 56 rigid with the cross member 28 of the bed and aligned axially with the piston rod 22 of the pressure fluid actuator. In the exemplary machine the piston rod 22 is constructed in two sections and the foremost section 57 is extended beyond the head to engage the stop rod 55 and thereby define the forward limit position of the head. This position may be varied by turning the stop rod 55 to screw it into or out of the nut 56. Hardened steel buttons 58 mounted on the abutting ends of the rods 55 and 57 reduce wear incident to the engagement of those elements.

It will be apparent from the foregoing that the invention provides a thread cutting machine of novel and advantageous character. Advance and retraction of the tool head to associate and disassociate the tool and the work are effected rapidly by a pressure fluid operated actuator, thus reducing idle machine time. Movements of the head while the tool is operating on the work and in its withdrawal therefrom are controlled with a high degree of accuracy to insure formation of perfect threads. The various operations are initiated automatically in proper sequence by a novel control system which is simple in construction, yet efficient and reliable in operation.

I claim as my invention:

1. In a machine tool having a reciprocable support for a rotatably driven thread cutting tool, a pressure fluid operated actuator operatively associated with and operative to advance and retract said support, a fixed stop, means for regulating the rate of advance of said support while the tool is in operative engagement with the work including a nut rotatably mounted on said support, a stop screw threaded into said nut and having one end projecting therefrom for coaction with said fixed stop when the support is advanced to a predetermined position, means restraining said screw against rotation, a reversible electric motor drivingly connected with and operative to rotate the tool and said nut in timed relation, control means operable manually to initiate the advance of said support by said actu-

ator, control means operative in response to the advance of said support to said predetermined position for starting said motor in operation in a direction to feed the tool into the work and to retract said stop screw with reference to said fixed stop, control means operative upon further advance of said support for reversing said motor to back the tool out of the work and to advance said stop screw to push the support rearwardly against the action of said actuator, and other control means operative upon the return of said support to said predetermined position for stopping said motor and for reversing said actuator to initiate rapid return of the support to retracted position.

2. In a machine tool having a frame and a support for a rotatably driven thread cutting tool reciprocable thereon, in combination, a pressure fluid operated actuator associated with an operative to advance and retract the support, means for regulating the rate of advance of the support while the tool is operating on the work including a cooperating screw and nut element and a stop element, one of said elements being mounted on the support and the other being fixedly mounted on the machine frame, said nut being restrained against axial movement and said screw being restrained against rotation whereby the screw is advanced or retracted relative to said stop element upon rotation of said nut, reversible drive means connected with and operative to rotate the tool support and said nut in timed relation, control means operable manually to initiate the advance of said support by said actuator to a predetermined position so as to associate the tool with the work and to bring said screw and stop into engagement, control means operative in response to the advance of said support to said predetermined position for initiating the operation of said drive means in a direction to feed the tool into the work and to retract said screw with reference to said stop element, control means operative upon further advance of said support for reversing said drive means to back the tool out of the work and to advance said screw to shift the support toward retracted position against the action of said actuator, and other control means operative upon the return of said support to said predetermined position for interrupting the operation of said drive means and for reversing said actuator to initiate rapid return of the support to retracted position.

3. In a machine tool having a bed, a support for a rotatably driven thread cutting tool mounted on said bed for reciprocation, in combination, a pressure fluid operated actuator associated with and operative to advance and retract the support, a fixed stop on said bed positioned in the path of said support, means for regulating the rate of advance of the support by said actuator while the tool is operating on a workpiece and for shifting the support toward retracted position independently of said actuator while the tool is being withdrawn from the workpiece, said means comprising a nut element mounted on the support and restrained against axial movement, a screw element threaded into said nut and having one end projecting therefrom for cooperation with said fixed stop when the support is advanced to a predetermined position, reversible drive means associated with and operative to rotate the tool support and one of said elements in timed relation, the other of said elements being restrained against rotation so as to retract the screw element with respect to the

fixed stop as the tool is rotated in one direction and fed into the work by said actuator, said screw being advanced to impart return movement to the support when the tool is rotated in the other direction to back it out of the work, and control means for regulating the supply of pressure fluid to said actuator so as to maintain a feed thrust on the support during such advance of the screw and withdrawal of the tool.

SHELDON F. MANNING.

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