May 25, 1954 N. T. SAWDEY 2,679,057

AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 1

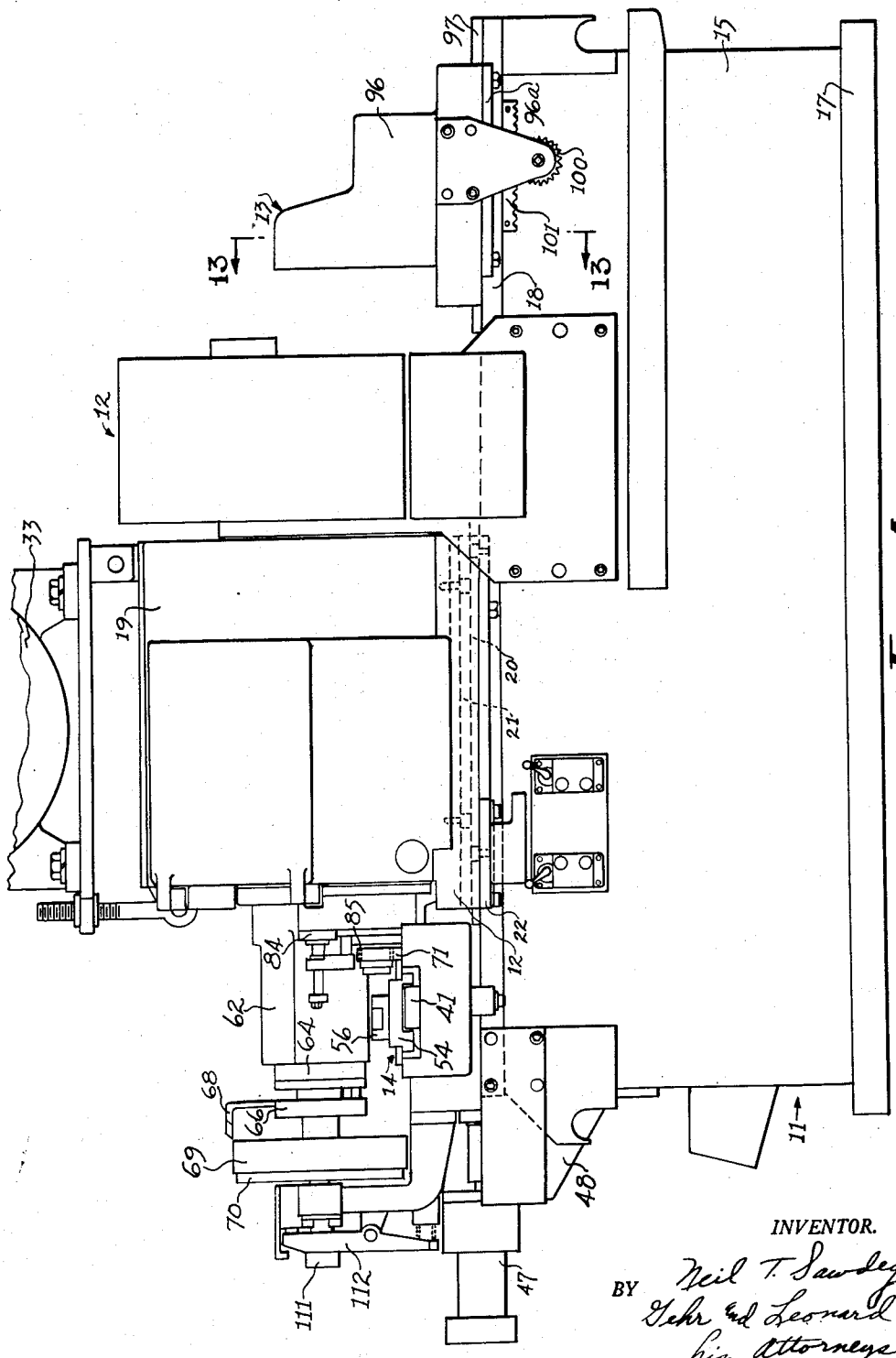

Fig. 1

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AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 2

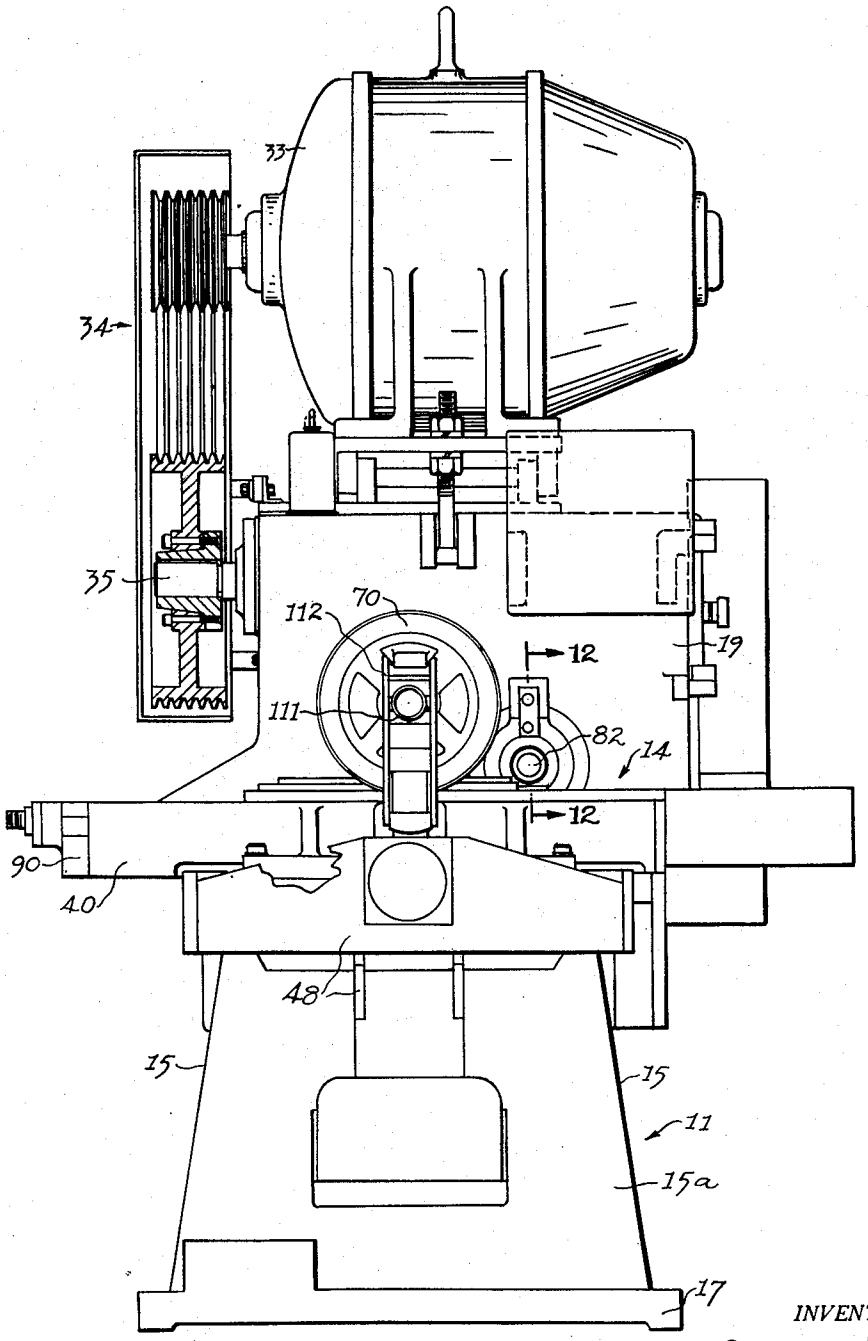

Fig. 2

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AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 3

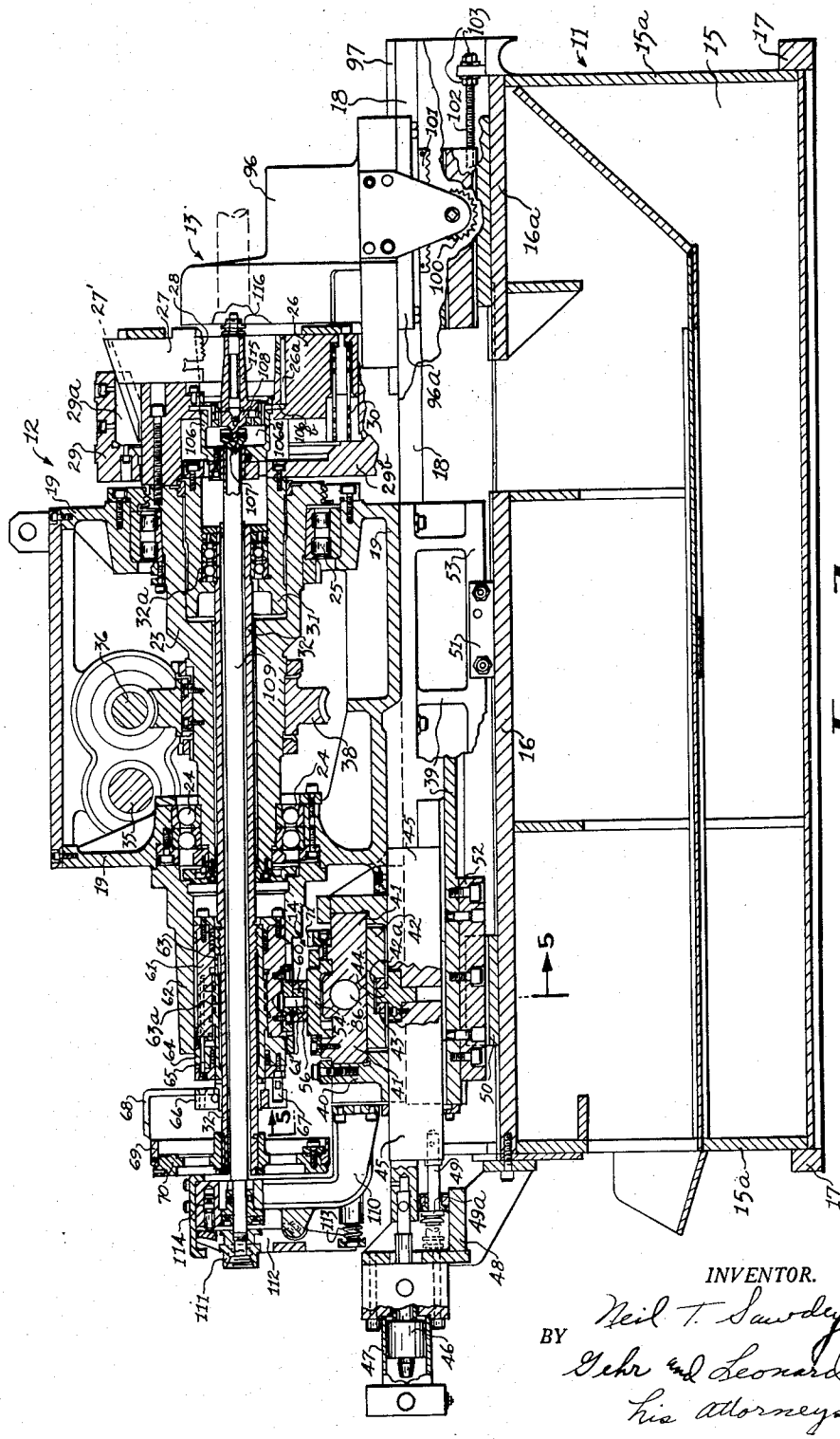

Fig. 3

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AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 4

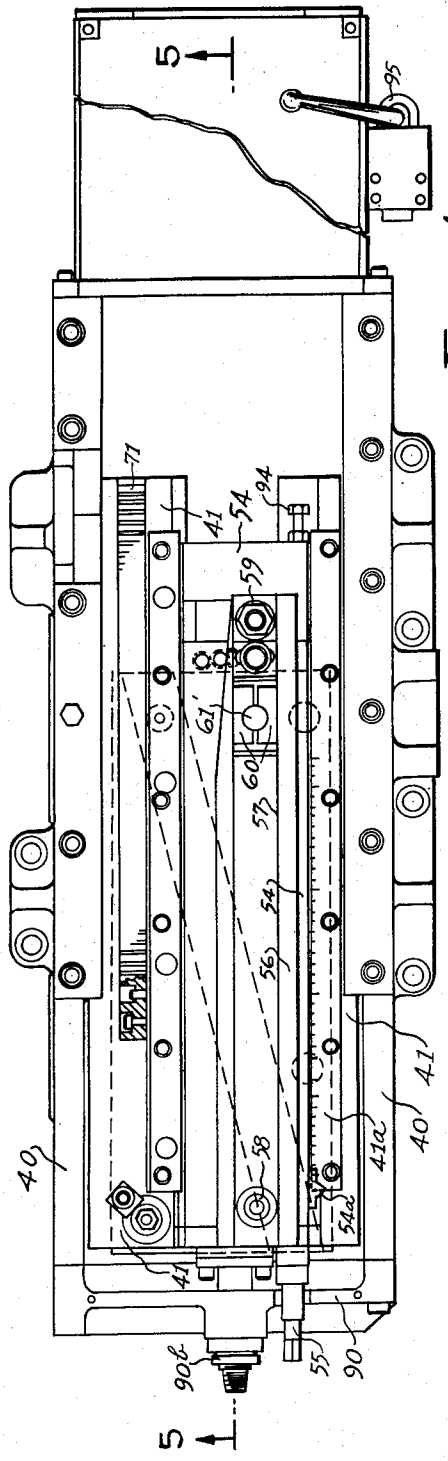

Fig. 4

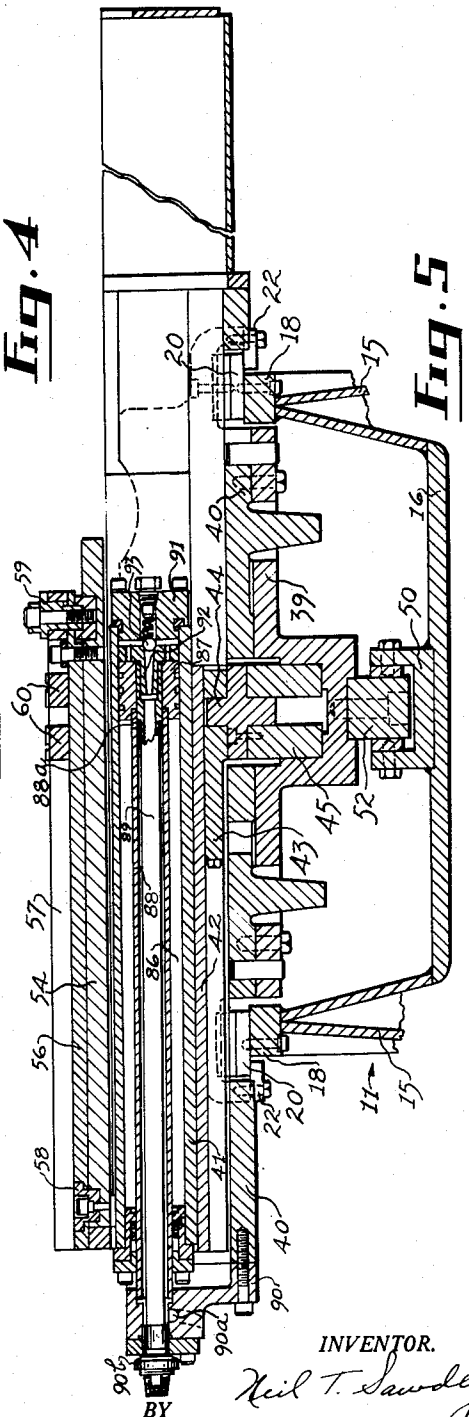

Fig. 5

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May 25, 1954 N. T. SAWDEY 2,679,057

AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 5

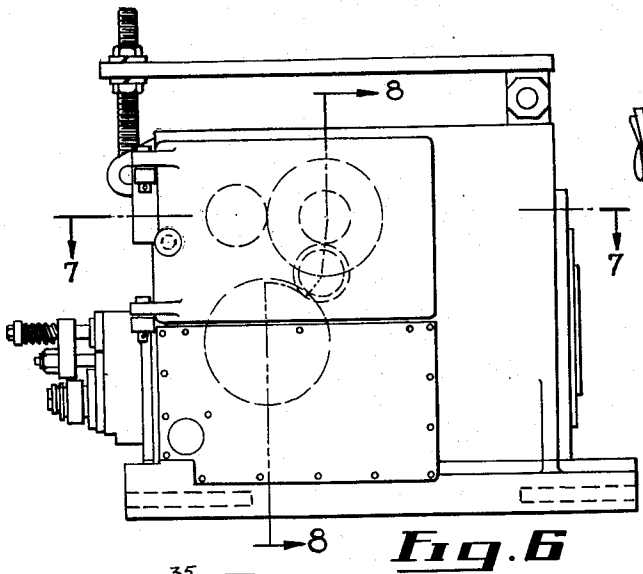

Fig. 6

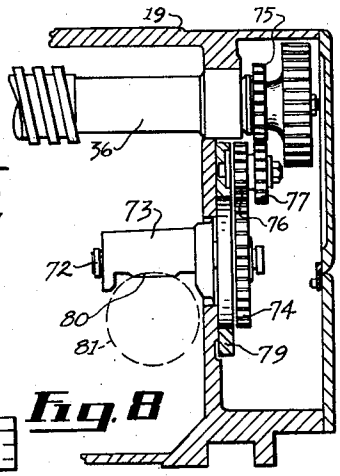

Fig. 8

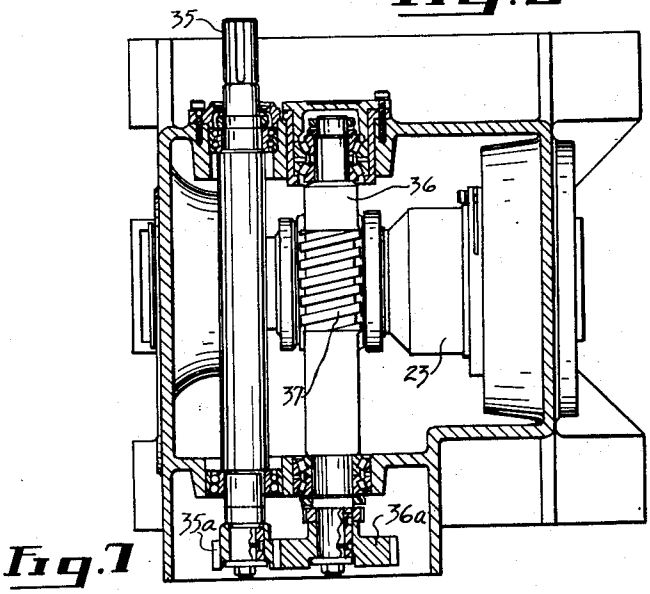

Fig. 7

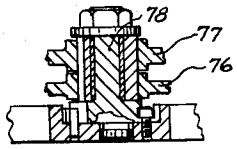

Fig. 9

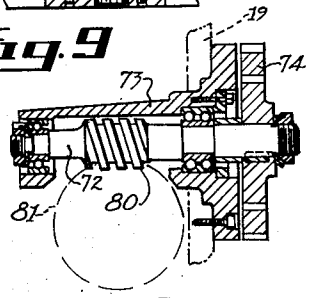

Fig. 10

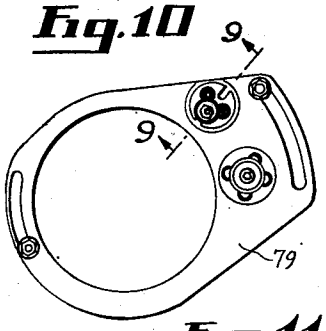

Fig. 11

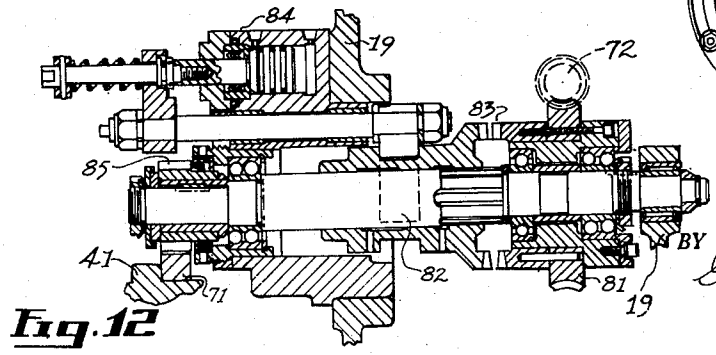

Fig. 12

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May 25, 1954 N. T. SAWDEY 2,679,057

AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 6

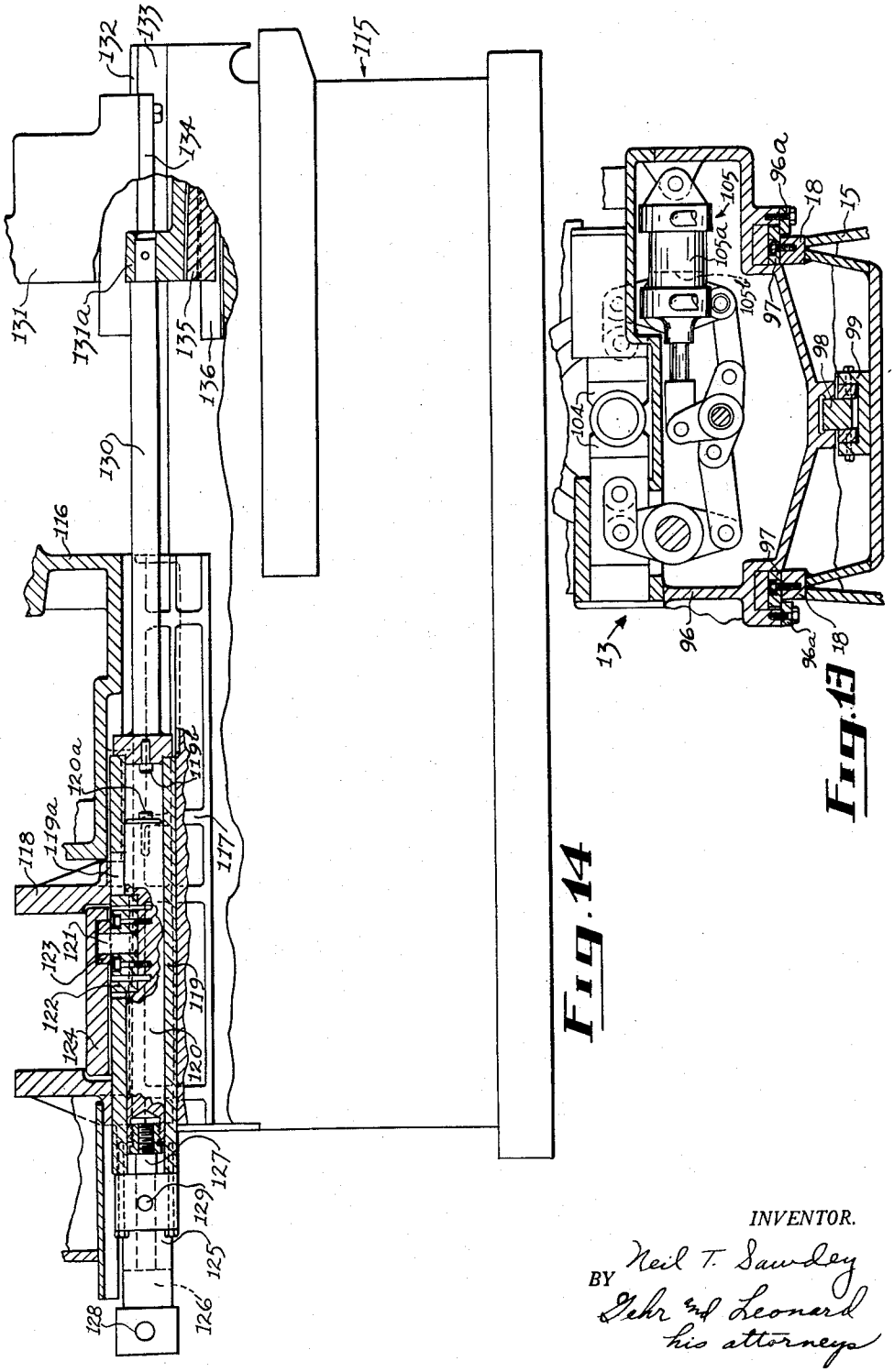

Fig. 14

Fig. 13

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May 25, 1954 N. T. SAWDEY 2,679,057

AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 7

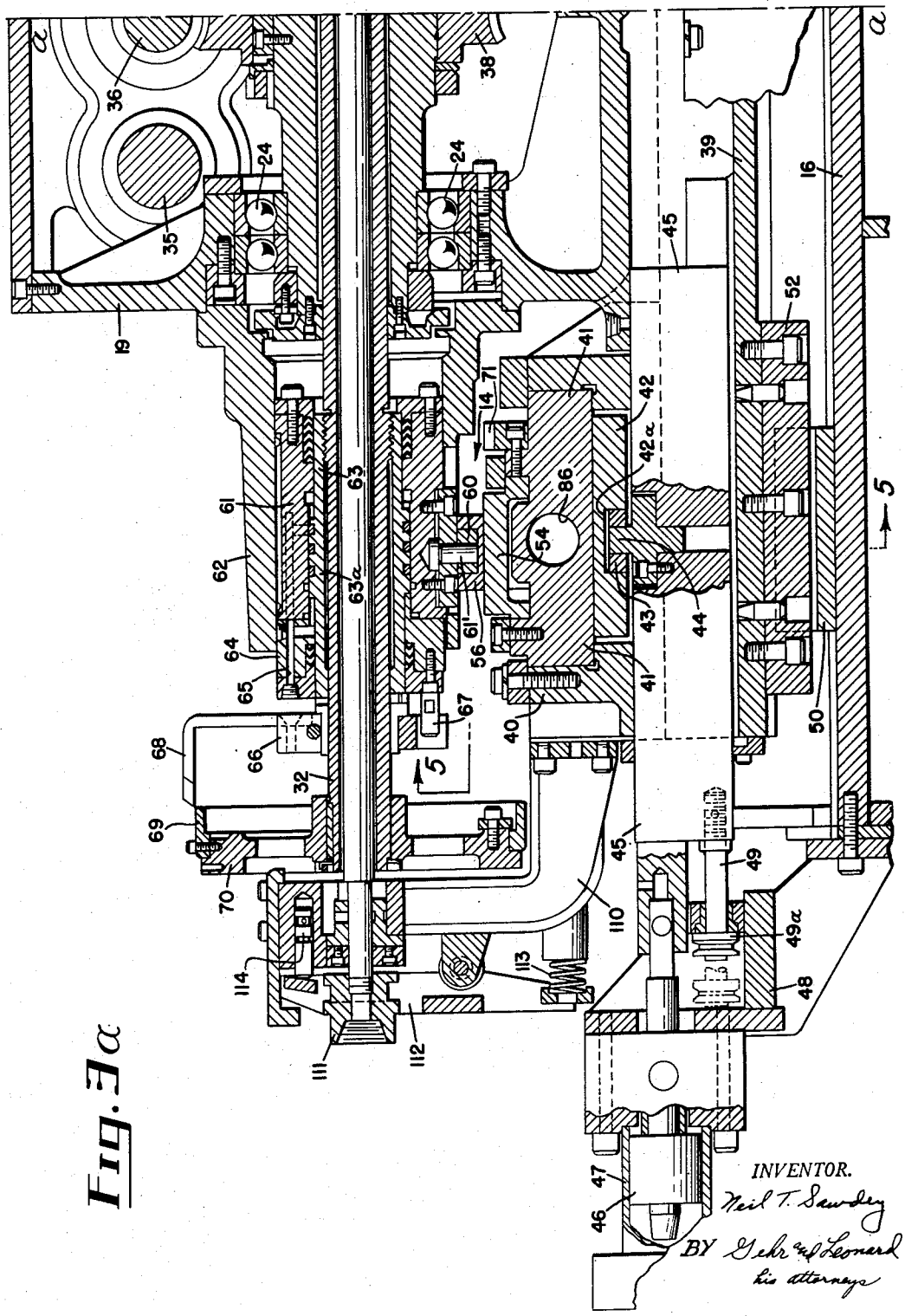

Fig. 5a

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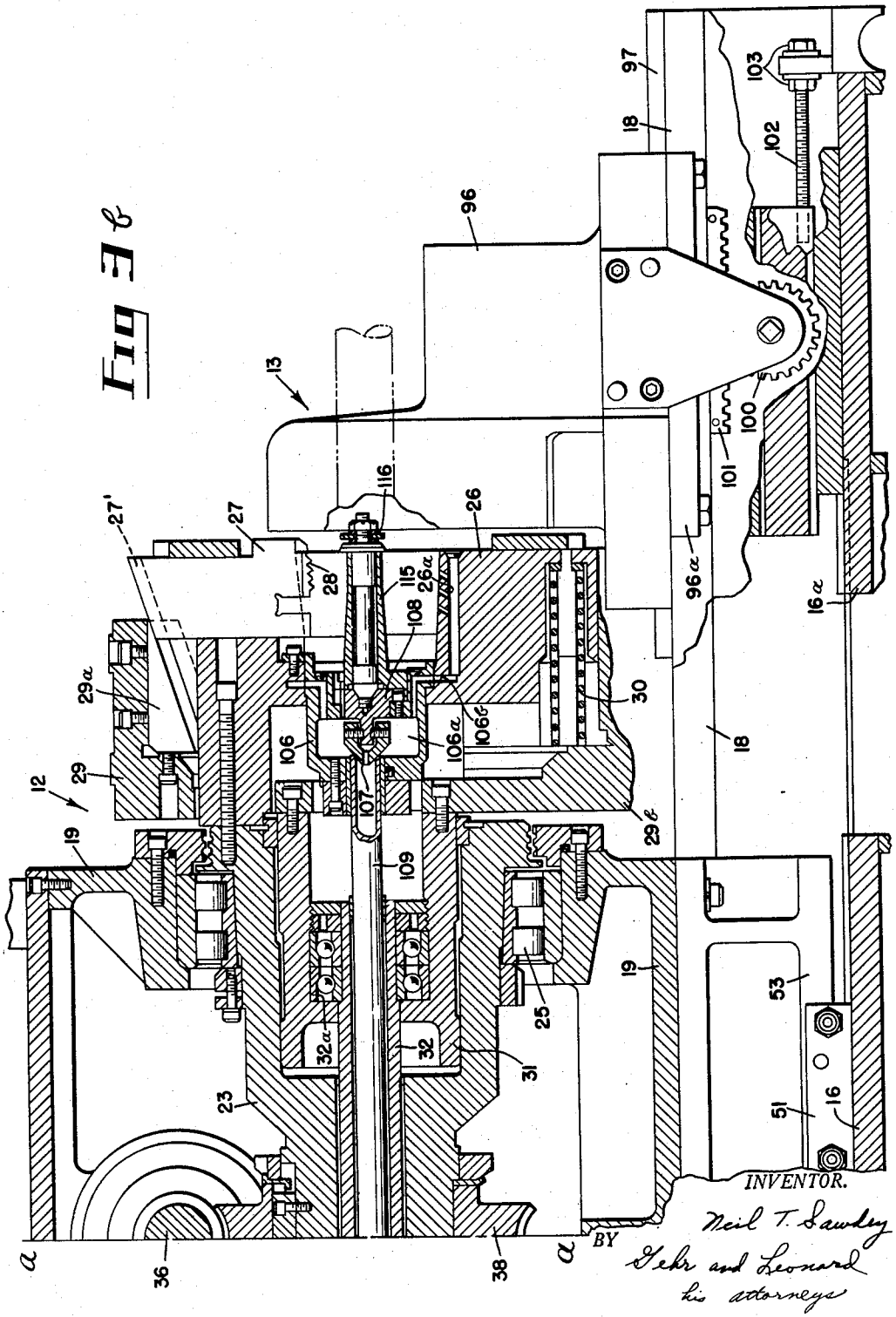
AUTOMATIC TAPER THREAD FORMING MACHINE

Filed Sept. 28, 1949 8 Sheets-Sheet 8

Fig 8b



Patented May 25, 1954

2,679,057

UNITED STATES PATENT OFFICE

2,679,057

AUTOMATIC TAPER THREAD FORMING MACHINE

Neil T. Sawdey, Shaker Heights, Ohio, assignor to The Pipe Machinery Company, Cleveland, Ohio, a corporation of Ohio

Application September 28, 1949, Serial No. 118,397

13 Claims. (Cl. 10—96)

1

The invention relates to various improvements in machines for forming screw threads, the nature of which can best be explained in connection with specific embodiments which are hereinafter described.

The general object of the invention is to provide a machine capable of forming either straight or taper threads of various pitches and taper threads of various lengths and diameters which is characterized by structural simplicity and ruggedness, high accuracy of threads formed by it, high speed of operation, ease with which the machine can be adjusted for particular threading jobs and ease with which the machine can be disassembled and reassembled for inspection or repairs in case of need.

Another object of the invention is to provide a threading machine having improved means for effecting relative axial movement of the chasers and the work in synchronism with their relative rotational movement.

A further object of the invention is to provide a threading machine of the receding chaser type having improved means for effecting the gradual receding movement of the chaser in synchronism with the relative rotational and relative axial movements of the chasers and the work.

Another object of the invention is to provide a threading machine in which recession of chasers and relative axial movement of chasers and work are effected by cam means characterized by cam surfaces of flat form and great area and length.

Another object of the invention is to provide a collapsible chaser threading machine having positive, and preferably fluid pressure, means for effecting collapse of the chasers and preferably also such positive means for resetting the chasers, to the end that increased speed of operation of the machine may reliably be attained.

A further object of the invention is to provide a threading machine in which the relative axial movements of the chasers and the work to effect rapid advance and retraction movements are carried out positively and preferably by fluid pressure power means.

In carrying out the invention its main features can be embodied in various forms of construction, suited to form male threads or female threads, with the axis of the machine horizontal or vertical, with the relative axial movements of cutters and work effected either by moving the cutter mechanism or the work, and certain of the improvements can be used without use of others or all may be combined in the same machine.

2

Accordingly, language hereinafter used in describing and explaining particular embodiments of the invention is not to be construed as limiting.

For purposes of explanation and illustration two forms of die threading machines of the horizontal type will be described as shown in the accompanying drawings and thereafter the invention will be particularly pointed out in the appended claims.

In the drawings,

Fig. 1 is a side elevation of a threading machine embodying the invention.

Fig. 2 is a rear elevation of the machine.

Fig. 3 is a longitudinal vertical section through the spindle axis of the machine.

Figs. 3a and 3b are enlarged views of the left end and right end portions, respectively, of Fig. 3.

Fig. 4 is an enlarged plan view of the sine bar mechanism employed in carrying out the invention, the same being detached from the remainder of the machine.

Fig. 5 is a similarly enlarged vertical section taken on the line 5—5 of Figs. 3 and 4 and showing the sine bar mechanism and some of the upper parts of the bed frame of the machine.

Fig. 6 is a front side elevation of the cutter mechanism housing structure detached from the bed frame of the machine.

Fig. 7 is a horizontal section on the line 7, 7 of Fig. 6.

Fig. 8 is a fragmentary sectional view on the broken line 8, 8 of Fig. 6.

Fig. 9 is a fragmentary section on the line 9, 9 of Fig. 11.

Fig. 10 is an enlarged vertical sectional view of a portion of the gearing shown in Fig. 8.

Fig. 11 is an enlarged front elevation of a supporting member of the gearing shown in Fig. 8.

Fig. 12 is an enlarged sectional view of the clutch mechanism of the machine, the section being taken on the line 12, 12 of Fig. 2.

Fig. 13 is a sectional view of the chuck mechanism of the machine, the section being taken on the line 13, 13 of Fig. 1.

Fig. 14 is an enlarged front side elevation, partly in vertical section, of a modified form of machine in accordance with the invention.

The machine shown in Figs. 1–13 comprises an elongated bed frame, generally designated by the numeral 11, a rotary-spindle cutter mechanism, generally designated by the numeral 12 and having a spindle housing or frame slidably supported on the bed frame intermediate the ends thereof, a work-holding chuck, generally designated by the numeral 13 and mounted on the bed frame

in front of the spindle mechanism, and a sine bar mechanism, generally designated by the numeral 14, which is supported from the spindle housing and disposed to the rear thereof with the sine bar parts arranged for reciprocation transversely of the bed frame.

Bed frame

The bed frame 11 as shown is of the welded wrought metal type of construction and comprises side walls 15 and end walls 15*a* with various transverse members including horizontally extending plates 16, 16*a*. The side and end walls are fitted with bottom rails 17 and at their tops the side walls carry parallel top rails 18.

Cutter mechanism

The cutter mechanism 12 comprises a housing and frame structure 19 which is slidably mounted on the top rails of the bed frame intermediate the ends thereof, with interposed wear strips 20, 21, respectively attached to the bed frame and the housing. Hold-down strips 22 bolted to the housing 19 engage wear strips 20 and prevent vertical displacement of the cutter mechanism.

A horizontally disposed tubular spindle 23 is rotatably supported by ball bearings 24 and roller bearings 25 in the housing 19 and a cutter head 26 of well known construction is bolted to the front end of the spindle. A series of radially disposed chaser blocks 27 carrying chasers 28 at their inner ends are slidably mounted in the front of the cutter head 26. On the periphery of the cutter head is slidably mounted a cam ring 29 carrying cam blocks 29*a* which are grooved to engage splines 27′ of the chaser blocks, the arrangement being such that rearward movement of ring 29 will control receding of the chasers radially outward to provide for the cutting of tapered threads. Cam ring 29 is constantly pressed rearward by a series of springs 30 interposed between the ring and cutter head 26. The cam ring 29 is formed with a series of inwardly extending arms 29*b* which pass through slots in the cutter head 26 and are connected at their inner ends to a cylindrical side 31 which is slidably mounted in the major bore of the spindle 23. Slide 31 is in turn connected to tubular rod 32 which extends through the minor bore of spindle 23 and projects from the rear end thereof. The connection between slide 31 and rod 32 is effected by a ball bearing 32*a* which is adapted to transmit thrust of either of the connected parts to the other while permitting necessary rotation of the slide with spindle 23 and head 26 in relation to the rod 32 which, as will later appear, is held against rotation.

The spindle 23 of the cutter mechanism is driven by an electric motor 33 which is adjustably mounted on top of housing 19. The motor is connected by pulley and V-belt drive means, generally designated by the numeral 34, to a jack-shaft 35 mounted in the upper part of housing 19 and connected to drive a parallel worm shaft 36 by means of gears 35*a*, 36*a*. Shaft 36 carries a worm 37 which meshes with a worm wheel 38 keyed on spindle 23.

Sine bar mechanism

The slidable mounting of the cutter mechanism on the bed frame contemplates axial movement of the mechanism during the threading operation to effect the necessary axial feed movement of the cutters in relation to the work. This latter movement is carried out by means of sine bar devices which are believed to be of novel construction and arrangement. A horizontally disposed frame 39 is rigidly bolted to the underside of the spindle housing 19 and projects well to the rear thereof to carry a sine bar supporting frame 40 which is formed with ways to slidably support a sine bar carrier 41 for movement transversely of the bed frame. Separate drive means, which will later be described, are provided, one to cause the working stroke or movement of the carrier in synchronism with the rotation of spindle 23 and the other to effect a rapid return movement of the carrier and corresponding movement of the cutter mechanism on the bed frame. A bottom sine bar 42 formed with a cam slot 42*a* is fixedly attached to the under side of carrier 41 by suitable means permitting a nice angular adjustment of the cam slot in relation to the supporting ways of the carrier. A follower block or shoe 43 engages the slot 42*a* and also operatively engages a pin 44 attached to a plunger 45 which is slidably mounted in frame 39 for endwise movement lengthwise of the machine. Plunger 45 is connected to the rod of piston 46 which is mounted in cylinder 47 carried by a bracket 48 on the rear end of bed frame 11. By admitting pressure fluid to the rear end of cylinder 47 plunger 45 can be moved forward in relation to the bed frame while fluid pressure admitted to the front end of the cylinder causes a reverse movement of the plunger. Forward movement of the plunger is definitely limited by stop bolt 49 having nuts 49*a* arranged to engage a stop on the bracket 48. When plunger 45 is held by fluid pressure in its extreme forward position it is in effect a rigid part of the bed frame of the machine. Furthermore the coupling between the cam of the sine bar and its follower is non-overhauling. Consequently when the plunger is locked by the fluid pressure, endwise movement of the sine bar 42 by its carrier 41 must effect a corresponding forward or rearward movement of the sine bar frame 40, frame 39 and housing 19 on the bed frame 11. Such movement on the bed frame is guided laterally by guideway blocks 50 and 51 which are attached to plate 16 of the bed frame and cooperate with guide bars 52 and 53, respectively, carried by frame 39.

On the upper side of the sine bar carrier 41 an elongated slide 54 is slidably mounted for endwise adjustment which may be effected by means of a long screw 55 (Fig. 4) which is rotatably supported by carrier 41 and has its threads in engagement with female threads in slide 54. The purpose of the adjustment is to vary the length of the thread cut (in a manner which will later appear) and the carrier 41 is provided with a scale 41*a* suitably graduated to indicate, in conjunction with a pointer 54*a* on part 54, a considerable range of thread lengths. A top sine bar 56 having a cam groove 57 is mounted on slide 54, being pivotally attached thereto at one end by pivot member 58 while its other end is adjustably secured to the carrier slide by the eccentric means 59 so that the angle of the cam groove of bar 56 can be adjusted in relation to the path of its movement.

The purpose of the top sine bar 56 is to control the gradual receding of the chasers during the cutting of taper threads. To this end the follower block 60 of the sine bar 56 is connected to a tubular slide 61, by means of pin 61′ secured to the slide and engaging an aperture in block 60, and the said slide is operatively connected to the tubular rod 32 which receives and transmits the rearward thrust of the cam ring 29 incident to the pressure of springs 30, so that the outward

receding movement of the chasers is effected by the cam ring subject to the control of the sine bar. Slide 61 is carried by the cylindrical support 62 which is rigidly bolted to the rear wall of housing 19. Connection of the slide 61 to tube 32 is effected by means of a tube 63 which has threaded engagement with tube 32 and is formed intermediate its ends with an annular piston enlargement 63a disposed in a corresponding cylinder enlargement of the bore of slide 61. The rear end of the so-formed cylinder chamber is closed by the annular head member 64 which is bolted to the slide. Suitable passages for admission and exhaust of fluid pressure to and from the cylinder chamber at the front and rear sides, respectively, of the piston 63a are formed in the head 64 and slide 61, some of such passages being shown at 65. Flexible supply and exhaust conduits (not shown) for these passages are connected to the cylinder head 64 and accommodate the necessary movement of slide 61. A clamp 66 on the rear end of piston tube 63 engages an anchor pin 67 carried by cylinder head 64 so that the piston tube is prevented from rotating in slide 61. Clamp 66 carries an upstanding pointer 68 arranged to cooperate with a suitably graduated and marked rim 69 carried by hand wheel 70 which is keyed on the rear end of the rod 32. By rotation of hand wheel 70 rod 32 is rotated and by reason of the threaded connection of the bar with the piston tube 63 endwise adjustment of rod 32 can be effected to vary the radial positions of the chasers and, consequently, the diameter of the threads cut.

In receding chaser thread cutters it is desirable that the chasers be given a rapid collapsing movement at the end of the cutting operation. Such movement, in addition to quickly clearing the chasers from the work in the operation of the machine, also provides for the convenient radial separation of the chasers for purposes of inspection, removal and replacement. A reverse movement of the chasers is of course, necessary to reset them in position for the next cutting operation. In the present machine these collapsing and resetting movements are carried out rapidly and effectively by the piston 63a. On admission of pressure fluid on the front side of the piston at the end of the thread cutting operation the chasers are fully withdrawn by the actuation of rod 32. Similarly by admission of pressure fluid to the rear side of piston 63a the chasers are given a resetting movement.

Sine bar drive means

To effect the necessary feeding movement of the chasers relative to the work and their simultaneous receding movement, it is necessary to provide for the longitudinal movement of the sine bar carrier and its two sine bars in synchronism with the rotation of the cutter driving spindle; and it is also necessary to provide for the return movement of the sine bar parts preparatory to the next cutting operation. In the present machine two separate drive means are provided for these purposes.

To effect the stated synchronous movement of the sine bars the carrier 41 is provided with an elongated rack 71 (Figs. 3 and 4) and suitable drive gearing is interposed between the worm shaft 36 and the rack. Such gearing comprises a second worm shaft 72 which is disposed below and somewhat to the rear of the worm shaft 36 and in parallel relation to it. Shaft 72 is mounted in a flanged carrier 73 which is bolted to the front side wall of the housing 19 with the shaft 72 projecting well into the housing. The two worm shafts are operatively connected by gears 74 on the shaft 72, gear 75 on the worm shaft 36, and a pair of interposed gears 76 and 77 which are separately formed but are splined to a sleeve for rotation together on stud shaft 78. This stud shaft is mounted on a carrier plate 79 bolted to the front wall of the housing 19 in a manner permitting it to be angularly adjusted about the axis of worm shaft 72 so that change gears of various diameters can be substituted for the gear 77. A worm 80 on shaft 72 drives a worm wheel 81 on shaft 82 which is rotatably supported in bearings carried by the housing 19. Worm wheel 81 is loose on shaft 83 but may be made fast thereon by a toothed clutch 83, one element of which is attached to the worm wheel while the other is splined on the shaft. A fluid pressure motor 84 of the reciprocating piston type serves to open or close the clutch. A pinion 85 fastened on the rear end of shaft 82 meshes with the rack 71 and serves to reciprocate the rack and the sine bar assembly in synchronism with the rotation of the spindle 23 when the clutch 83 is closed.

Fluid pressure operated means is provided to effect rapid return movement of the sine bar assembly. For this purpose the sine bar carrier 41 is formed with an elongated cylinder chamber 86 in which is arranged a piston 87 which is fixedly secured against movement in relation to the bed frame of the machine by tubular piston rod 88 and a second smaller tubular rod 89 disposed within the rod 88 with an intervening space between the rods. The rear ends of the piston rods are connected to a bracket 90 which is attached to the sine bar frame 40 and serves to anchor the piston. The front end of the cylinder bore 86 is closed by a head 91 which is fitted with a tapered nipple 92 disposed to enter the front end of the inner piston rod 89 when the sine bar assembly approaches its fully retracted position. The cylinder head 91 is also formed with passages that serve to connect the bore of the nipple 92 with the cylinder space in front of the piston 87 subject to control of a spring-pressed check valve 93. The annular space between the inner piston rod and the outer one is in continuous communication with the cylinder bore 86 through apertures 88a in the outer rod. The rear end of this annular space communicates with a passage 90a formed in the bracket 90 and this passage 90a by suitable solenoid valve means (not shown) may be connected, alternatively, with a source of fluid pressure and an exhaust or drain chamber. The rear end of the inner piston rod 89 is in constant communication through fitting 90b with an exhaust or drain chamber.

In the operation of the fluid pressure return means, when fluid pressure is admitted through passage 90a at the end of the forward feeding movement of the sine bar assembly, the pressure fluid entering the cylinder chamber 86 serves to return the sine bar assembly to the position shown in Fig. 5. As that position is approached the entry of the tapered nipple 92 into the end of the inner piston rod 89 serves to check the return movement. Thereafter, at the beginning of the next feeding movement of the sine bar assembly the check valve 93 opens to permit entry of exhaust pressure fluid behind the piston 87 so that the feeding movement is not unduly resisted.

The sine bar carrier 41 is provided at its front end with an adjusted actuator 94 arranged to

operate a suitable limit switch (such as is indicated at 95) at the end of the feeding movement of the machine.

Chuck mechanism

In the operation of the machine the chuck mechanism 13 is fixed on the bed frame. It comprises a housing 96 which is carried by the rails 18 of the bed frame with interposed strips 97, 97 attached to the tops of the rails. Hold down strips 96a engage the under sides of strips 97. The housing 96 is fitted with a depending shoe 98 which engages a longitudinal guide 99 on the bed frame. To permit axial adjustment of the chuck on the bed frame the housing 96 carries a manually operable pinion 100 arranged to cooperate with a rack 101 attached to the bed frame. Threaded rod 102 attached to shoe 98 has lock nuts 103 arranged to engage a bed frame bracket and lock the chuck in adjusted position.

The chuck housing 96 provides supporting slideways for horizontally disposed gripper jaws 104, the housing being upwardly open in the zone between the oppositely disposed guideways so that the end of the pipe section to be threaded can be lowered into position between the gripper jaws. To permit automatic power operation of the chuck the housing is fitted with a fluid pressure motor 105 comprising a cylinder 105a and a piston 105b which is operatively connected to the gripper jaws by conventional crank, link, and lever parts shown so as to move the gripper jaws equally in opposite directions and support the pipe section in line with the axis of the cutter mechanism.

By having the chuck mechanism fixed on the bed frame in the operation of the machine, the machine is well adapted for use in conjunction with automatic pipe handling and feeding mechanism of a commercially available type disclosed in the application of Benninghoff and Thompson, Serial No. 737,500, filed March 27, 1947. As will presently more fully appear, the present machine is itself adapted for high speed automatic operation and when combined with pipe handling and feeding apparatus of the character referred to is capable of turning out a large volume of work.

Coolant system

As is shown in Fig. 3, the cutter head 26 carries an axially arranged chambered coolant distributor 106. This distributor has a main chamber 106a and a series of passages 106b which communicate with passages 26a formed in the cutter head 26 and disposed to discharge coolant liquid on the chasers and the work during a cutting operation. A conical-faced valve 107 is pivotally supported in the chamber 106a on a carrier 108 mounted in the distributor 106. To conduct coolant liquid to the chamber of the distributor 106, a pipe 109 is mounted for endwise movement within the tubular rod 32 of the machine, the front end of the pipe 109 being slidably supported in the hub of the distributor 106 in position to have its end cooperate as seat with the conical face of the valve 107 while the rear end of the pipe projects from the rear end of rod 32 and is slidably supported in a bracket 110 attached to the sine bar frame. The rear end of pipe 109 carries a pipe fitting 111 which is peripherally grooved to cooperate with lugs on a lever 112 which is pivotally mounted intermediate its ends on bracket 110 and has its upper end biased in a forward direction by coil spring 113 which engages its lower end. At the point opposite the upper end of lever 112 the bracket 110 is bored out to form a fluid pressure cylinder for a plunger 114 by the movement of which the lever can be moved to effect rearward movement of pipe 109 to open its front end to the chamber of distributor 106. By thus admitting coolant liquid to said chamber at the beginning of a threading operation and cutting off fluid pressure from plunger 114 at the end of the operation, coolant can be supplied to the chasers and work only during the cutting operation.

The distributor 106 carries a forwardly projecting tubular support 115 to receive the shank of a pipe seal 116 which is thus supported in position to enter and close the end of a pipe being threaded, thus reducing wastage of coolant that would otherwise enter the pipes and be lost from the machine.

It is to be understood that the machine shown and described is in practice provided with suitable means for continuously supplying lubricant to bearing surfaces and that suitable means, such as pump, accumulator and filter devices, are provided for supplying the various fluid pressure motors which have been described with liquid under pressure and for draining such liquid, when exhausted, back to the source of supply.

Control devices

Reference has been made to automatic operation of the machine. To secure such operation use may be made of conventional control devices (for the most part not shown) including electrical limit switches and solenoid valves for controlling admission and exhaust of working fluid to and from the fluid pressure motors of the machine. Such electric control devices for the machine and for the cooperating pipe handling and feeding mechanism can be combined and coordinated in known manner in a unitary system such as is shown in the aforesaid application Serial No. 737,500. The provision of such a system is assumed in the description which follows.

Operation

It will be appreciated by those familiar with threading apparatus of the class in question that preliminary to operation of the apparatus for the production of screw threads of specified diameter, length, pitch and taper, suitable adjustment of various parts of the mechanism must be made. In the present machine the adjustment for diameter is secured by rotational adjustment of the hand wheel 70 in relation to pointer 68 in accordance with the marking on the graduated rim 69 of the wheel. This adjustment moves rod 32 in relation to piston 63a and effects the required initial positioning of the chasers radially to produce threads of the desired nominal diameter.

The desired length of the thread cut is secured by rotation of the adjusting screw 55 to effect endwise adjustment of the upper sine bar slide 54. The effect is to adjust the contact member 94, carried by slide 54, toward, or away from, the limit switch 95, thus determining the length of the sine bar movement before actuation of the control switch occurs. Of course the adjustment also moves the follower shoe of the upper sine bar and changes the positions of the chasers to correspond to the length of thread indicated by the graduated scale 41a.

The pitch of the thread to be cut is determined by the number of teeth in the change gear **77** and a suitable gear may be selected to give a particular pitch.

Finally, the desired taper of the thread to be cut is secured by suitable angular adjustment of the sine bar **56** by means of the eccentric means **59**.

For readier understanding of the operation in the case of conjoint use with the threader of the automatic pipe feeding and discharging apparatus previously mentioned, it is here noted that the said apparatus operates intermittently, under automatic control, to advance the pipe sections laterally in parallelism with the axis of the threading machine through a series of stations including a first or receiving station, a second station where the pipe section is adjusted endwise, a third or chucking station where the pipe section is lowered between the jaws of the chuck to be gripped and held for the threading operation, and a fourth or discharge station. On each actuation of the pipe-handling apparatus the pipe sections in the first three stations are each advanced to the next station.

With the necessary adjustments made and electric motor **33** running, the operating cycle of the threader may be traced, starting with the deposit in the chuck of the endwise-adjusted pipe to be threaded. This deposit of the pipe section closes a limit switch to energize two solenoid valves that respectively supply working fluid to the chuck motor and to the rear side of piston **63***a*, thus closing the chuck and setting the chasers in initial cutting position. The completion of the latter of these actions closes another limit switch that causes admission of working fluid to the rear of piston **46** with resultant rapid advance of plunger **45** and the entire cutting mechanism in relation to the bed frame and chuck. After this rapid advance the fluid pressure is held back of piston **46** so that plunger **45** is rigidly locked to the bed frame.

Completion of the rapid advance movement actuates a limit switch to energize a solenoid valve that admits working fluid to clutch motor **84** to close the machine clutch and also admits working fluid in front of piston **114** to move tube **109** rearward and start the flow of coolant to the chasers. At the same time the end of the rapid advance actuates another limit switch to energize a valve that releases fluid pressure in the sine bar return cylinder, thus freeing the sine bar carrier for advance movement.

The closing of the machine clutch starts the rack-and-pinion drive of the sine bars in synchronism with the rotation of the machine spindle, the lower sine bar effecting the mutual relative feed movement of the work and chasers while the upper sine bar controls the receding of the chasers. At the end of the thread-cutting operation the contact **94** on the sine bar carrier contacts a limit switch (**95** in Fig. 4) controlling appropriate solenoids to effect sudden collapse of the chasers by shift of fluid pressure from the rear to the front side of piston **63***a* and to open the machine clutch by similar shift of fluid pressure in its motor, the latter shift serving also to release fluid pressure on piston **114** and permit forward movement of tube **109** by spring **113** to stop flow of coolant liquid.

The opening of the clutch effects movement of the solenoid valve controlling the rapid advance motor to shift fluid pressure from the rear to the front side of its piston **46** and start rapid return of the cutter mechanism on the bed frame. At the same time the solenoid valve controlling admission of pressure fluid to the rear side of fixed piston **87** is opened to start retraction of the sine bars. The start of this movement, in a manner previously explained, is facilitated by check valve **93** which opens to permit low pressure fluid to pass through nipple **92** to the front side of piston **87**.

As the rapid return movement and the retraction of the sine bars are completed the valve controlling the chuck motor is shifted to start opening of the chuck, and the completion of such opening starts the transfer mechanism to discharge the threaded pipe section from the chuck to the discharge station and, in the same movement, to advance pipe sections in stations one and two. This deposits another pipe in the chuck. Simultaneously with the start of the transfer mechanism fluid pressure is shifted from the front to the rear side of piston **63***a* to reset the chasers again, so that, with the deposit of another pipe section in the chuck, the threader is ready to repeat the operating cycle which has been described.

In connection with the described operation of the machine it is to be noted that all movements essential to the machine operation, aside from the accurately synchronous movements during the thread-cutting operation, are carried out by positive hydraulic pressure means having ample power capacity for rapid and reliable movement of the actuated parts. The reciprocating piston motors employed for such movements lend themselves to the holding of related parts firmly in predetermined positions by simply maintaining fluid pressure in the respective motor cylinders. This is notably true in the case of the piston **46** which holds the plunger **45** in predetermined position in relation to the bed frame of the machine and of piston **63***a* which serves to position the chasers accurately in their initial cutting positions. Such accurate positioning of parts is thus attained by relatively simple mechanical means capable of continuous reliable operation.

The advantages incident to the multiple sine bar construction which is herein disclosed will be apparent. Both the feed and the chaser receding movement are carried out synchronously with the spindle rotation by the use of a single sine bar carrier. Furthermore the arrangement of the sine bar mechanism transversely of the bed frame and entirely outside the housing of the spindle mechanism permits the use of sine bars and carrier of relatively great length and ruggedness, which favors highly accurate and reliable operation. It also favors the maintenance of accurate operation throughout a relatively long life because of the low rate of wear of the relatively large sine bar cam surfaces. Furthermore when inevitable substantial wear finally comes the simple, flat forms of the wear surfaces permits their renewal by very simple grinding operations. Such arrangement of the sine bar mechanism also facilitates the employment of the hydraulic motor means for effecting both the rapid advance and return movements of the machine, the setting and resetting of the chasers and the return movement of the sine bars.

Modification construction

For some classes of work it may be desirable that the relative axial feeding movement of the work and the cutters be effected by movement of the chuck in relation to the bed frame, with the frame or housing of the cutter mechanism

mounted immovably on the bed frame. This can be accomplished in carrying out the present invention with relatively little modification of the construction already described, and such a modified construction is shown in Fig. 14 which will now be described, it being understood that the upper parts of the machine which are broken away or omitted in Fig. 14 are structurally the same as in the first described form of the machine.

In the second construction the bed frame 115 has the spindle housing 116 fixedly secured on the rails of the bed frame. The frame 117 which is rigidly bolted to the underside of the spindle housing and extends rearward therefrom is generally similar to the frame 39 of the first described construction and the sine bar supporting frame 118 also is similar to that of the first construction. However, both of the frames 117 and 118 are slightly modified to accommodate an elongated, two-part slide structure comprising a slide 119 which is rectangular in cross-section and bored out lengthwise to receive a cylindrical slide 120. Slide 120 has a portion of its top side cut away and the resulting flat surface carries a welded structure consisting of a pin 121 and a rectangular block 122 which is of a width to slidably engage the sides of a slot 119*a* cut in the top of slide 119. Pin 121 engages the shoe 123 that in turn slidably engages the cam slot of the bottom sine bar 124. This sine bar has its cam slot disposed at an angle such that endwise movement of the sine bar toward the front side of the machine will cause rearward movement of slide 120.

A hydraulic cylinder 125 is attached to the rear end of outer slide 119 and accommodates a piston 126 having its rod 127 attached to the rear end of inner slide 120. Cylinder 125 has ports 128, 129 for admitting and discharging pressure fluid to effect relative movement of the cylinder and piston. Such relative movement is limited by stops 119*b* and 120*a* carried by the slides 119 and 120, respectively. Admission and discharge of working fluid for the cylinder 125 can conveniently be controlled by solenoid valve means as in the first described construction.

The front end of the outer slide 119 is connected by a rod 130 to the frame or housing 131 of the work-holding chuck. This housing is slidably supported on wear strips 132 attached to the top rails 133 of the bed frame 115 and carries suitable hold-down strips 134. The housing also carries a depending slide or shoe 135 which engages a lateral guide 136 on the bed frame, as in the first described chuck, so that the axis of the chuck is maintained in alignment with the axis of the cutter head of the machine.

It will be apparent that the operation of the modified form of the machine is generally similar to that first described, so that it will suffice here to mention simply the operating features incident to the rapid advance and retraction mechanism of the modified construction and particularly the telescoping two-part character of the slide structure with one part connected to the follower shoe of the bottom sine bar and the other part connected to the movable chuck of the machine, while the two parts are hydraulically connected together by the motor cylinder 125 and piston 126.

With this modified construction, following the closing of the chuck and the setting of the chasers, fluid pressure is admitted behind piston 126 and, since the piston is held in fixed position by the non-overhauling connection with the lower sine bar, the cylinder 125 and outer slide 119 are moved rearward by the hydraulic pressure to effect the rapid advance movement of the chuck in relation to the cutter mechanism. The rapid advance movement is terminated by the mutual engagement of the stops 119*b*, 120*a* and the resulting relative positions of the outer and inner slides is maintained by holding the fluid pressure on the rear side of the piston 126.

As in the first form of construction, the completion of the rapid advance movement is followed by the closing of the machine clutch and the starting of the coolant flow and other stages of the operation follow as in the first form of construction until the rapid return movement of the chuck is reached. At this point the shifting of the hydraulic pressure from the rear side of piston 126 to the front side thereof results in forward movement of the cylinder 125 to effect the rapid retraction of the chuck. In connection with both the rapid advance and rapid retraction movements of the chuck it will be borne in mind that the inner slide 120 is anchored to the bottom sine bar and the sine bar carrier which, of course, in turn is secured against movement longitudinally of the bed frame of the machine.

It will be understood that the principles underlying the present invention are susceptible of broad application, as, for example, to tap threaders and to vertical types of machines, and are not limited to die threaders or to the horizontal type of machines which have been chosen for the preferred forms of construction herein disclosed for purposes of explanation. Hence many modifications of the machines shown and described can be made without departing from the invention as defined in the appended claims.

What is claimed is:

1. In apparatus for forming taper threads, the combination of a bed frame; thread cutting mechanism supported by the bed frame and comprising a rotatably mounted power driven hollow spindle, cutters mounted on one end of the spindle for inward and outward movement relative to the spindle axis, and endwise movable rod extending longitudinally through the hollow spindle, cam connecting means between the rod and the cutters for converting endwise movements of the rod to inward and outward movements of the cutters, a sine bar supported independently of the spindle at the end thereof remote from the cutters for endwise movement transversely of the spindle, a follower operatively engaging the sine bar, means connecting the follower to the aforesaid rod, and means operatively connected with the spindle for moving the sine bar endwise in timed relation to the rotation of the spindle; work-holding chuck mechanism supported by the bed frame adjacent the cutter end of the rotatable spindle, one of the said chuck and cutter mechanisms comprising a carriage frame mounted for feed movement on the bed frame longitudinally of the cutter spindle; and means operatively connected with the spindle for effecting mutual relative feed movement of the cutter and chuck mechanisms in timed relation to the rotation of the spindle and the movement of the sine bar.

2. Apparatus as claimed in claim 1 in which the sine bar follower is connected to the cutter-moving rod by power means comprising a cylinder connected to the said follower and supported for movement parallel to the spindle axis and a

piston in the cylinder connected to the said rod.

3. Apparatus as claimed in claim 2 in which the power piston is adjustably connected to the cutter-moving rod to vary the diameter of the thread cut.

4. Apparatus as claimed in claim 2 in which the power piston has an adjustable screw thread connection to the cutter-moving rod.

5. Apparatus as claimed in claim 2 in which the cutter-moving rod is rotatable about its longitudinal axis and has a screw thread connection with the power piston and extends axially through the power piston and the cylinder.

6. Apparatus as claimed in claim 1 in which the means for connecting the sine bar follower to the cutter-moving rod is adjustable to control the diameter of the thread cut.

7. Apparatus as claimed in claim 1 in which the means for effecting relative feed movement of the cutter and chuck mechanisms comprises a sine bar rigidly connected to the cutter-actuating sine bar for longitudinal movement with the latter and a follower connected to one of the bed frame and carriage frame structures.

8. Apparatus as claimed in claim 4 in which the carriage frame constitutes a part of the cutter mechanism, the two sine bars are movably supported on the carriage frame, and the follower of the carriage-actuating sine bar is connected to the bed frame.

9. Apparatus as claimed in claim 4 in which the carriage frame constitutes a part of the cutter mechanism, the two sine bars are movably supported on the carriage frame, and the follower of the carriage-actuating sine bar is connected to the bed frame through a fluid pressure motor comprising cylinder and piston parts one of which is connected to the said follower and the other to the bed frame.

10. Apparatus as claimed in claim 4 in which the carriage frame constitutes a part of the chuck mechanism, the two sine bars are movably supported on the bed frame, and the follower of the carriage-actuating sine bar is connected to the carriage through a fluid pressure motor comprising cylinder and piston parts one of which is connected to the said follower and the other to the carriage frame.

11. In apparatus for forming threads, the combination of a bed frame; thread-cutting mechanism supported by the bed frame comprising a rotatably supported power-driven horizontally disposed hollow spindle and cutters mounted on the front end of the spindle for outward and inward movement relative to the spindle axis; a work-holding chuck mechanism comprising a frame structure slidably supported by the base frame in front of the cutter mechanism; and means for effecting simultaneous movement of the cutters relative to the spindle and movement of the chuck mechanism longitudinally of the spindle both in timed relation to the power rotation of the spindle, said means comprising a pair of sine bars rigidly connected together and mounted at the rear of the cutter mechanism for endwise sliding movement transversely of the cutter spindle and driving connections between one of the sine bars and the cutters and between the other sine bar and the chuck mechanism, each of the last named connections comprising a fluid pressure motor of the cylinder and piston reciprocating type having one of its cylinder and piston parts cam-connected to its sine bar and its other part operatively connected in the one case to the cutters and in the other case to the chuck mechanism.

12. In apparatus for forming taper threads, the combination of a bed frame; a carriage frame movable on the bed frame; cutter mechanism comprising a rotary spindle, cutters mounted on the spindle for inward and outward movement relative to the spindle axis and cutter-moving means including a sine bar supported for endwise movement transversely of the bed frame, the cutter mechanism being mounted on one of the two frames; chuck mechanism mounted on the other frame; means for effecting feed movement of the carriage comprising a second sine bar rigidly connected to the first-named sine bar for endwise movement with the latter; and operative connections between the spindle and the two sine bars for causing endwise movement of the sine bars in timed relation with the rotary movement of the spindle.

13. In apparatus for forming taper threads, the combination of a frame structure; a rotatable spindle supported by the frame structure; cutters mounted on the spindle for movement inward and outward relative to the spindle axis; means for effecting such movement of the cutters comprising an endwise movable sine bar supported independently of the spindle by the frame structure, a follower for the sine bar operatively connected with the cutters and disengageable driving means interconnecting the spindle and the sine bar to effect movement of the latter in one direction in timed relation to the rotation of the spindle; and fluid pressure-operated means for effecting rapid return movement of the sine bar when the said driving means is disconnected.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,040,583	Saunders et al.	Oct. 8, 1912
1,967,508	Hibbard	July 24, 1934
2,017,764	Mathias	Oct. 15, 1935
2,054,028	Benninghoff	Sept. 8, 1936
2,054,029	Benninghoff	Sept. 8, 1936
2,116,639	Protin	May 10, 1938
2,130,181	Hogg	Sept. 13, 1938
2,219,316	Hogg	Oct. 29, 1940
2,249,395	Reese	July 15, 1941
2,250,349	Berquist	July 22, 1941
2,551,517	Webb	May 1, 1951