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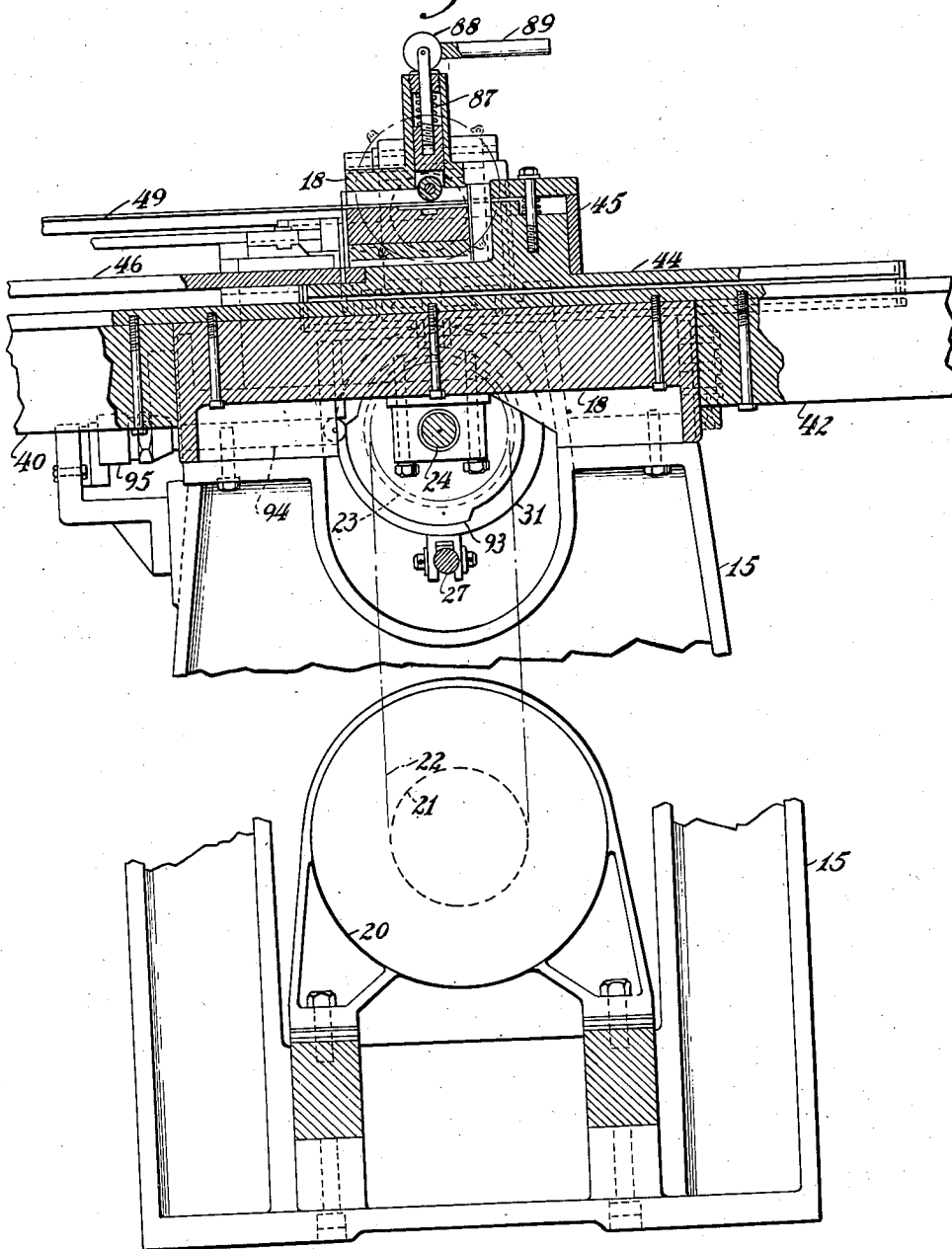
E. L. HAMILTON ET AL
DRILLING AND COUNTERSINKING MACHINE

2,300,253

Filed June 24, 1941

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Fig. 1



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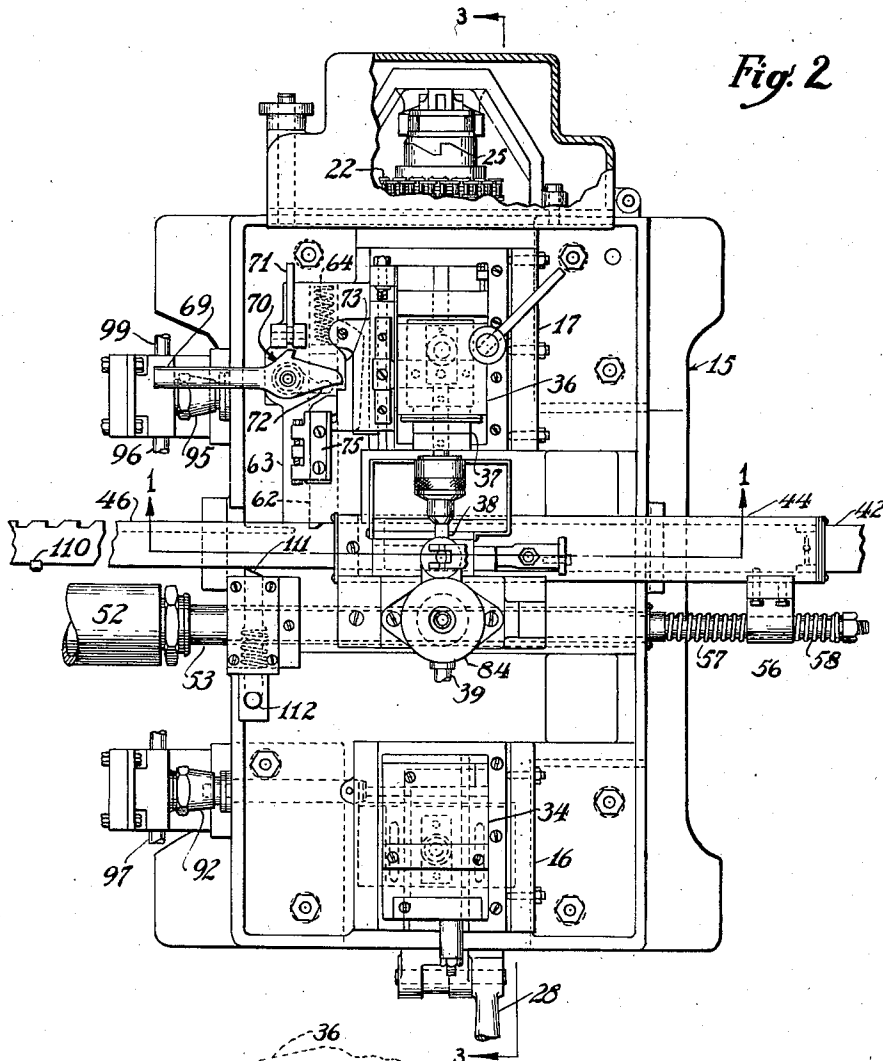
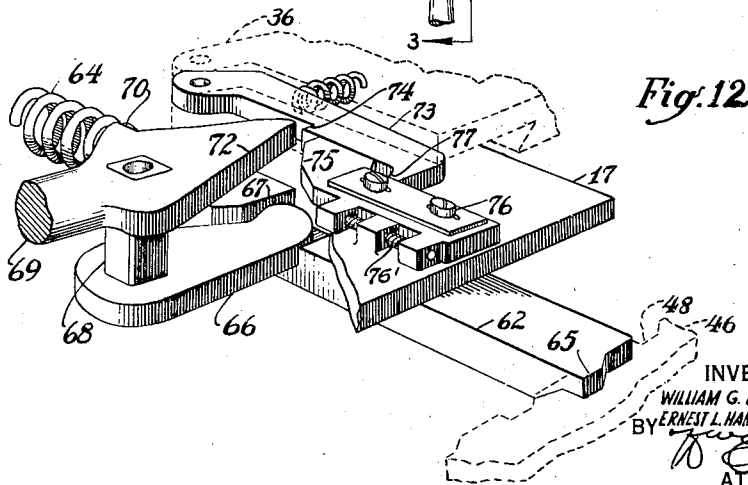
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DRILLING AND COUNTERSINKING MACHINE

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Fig. 3

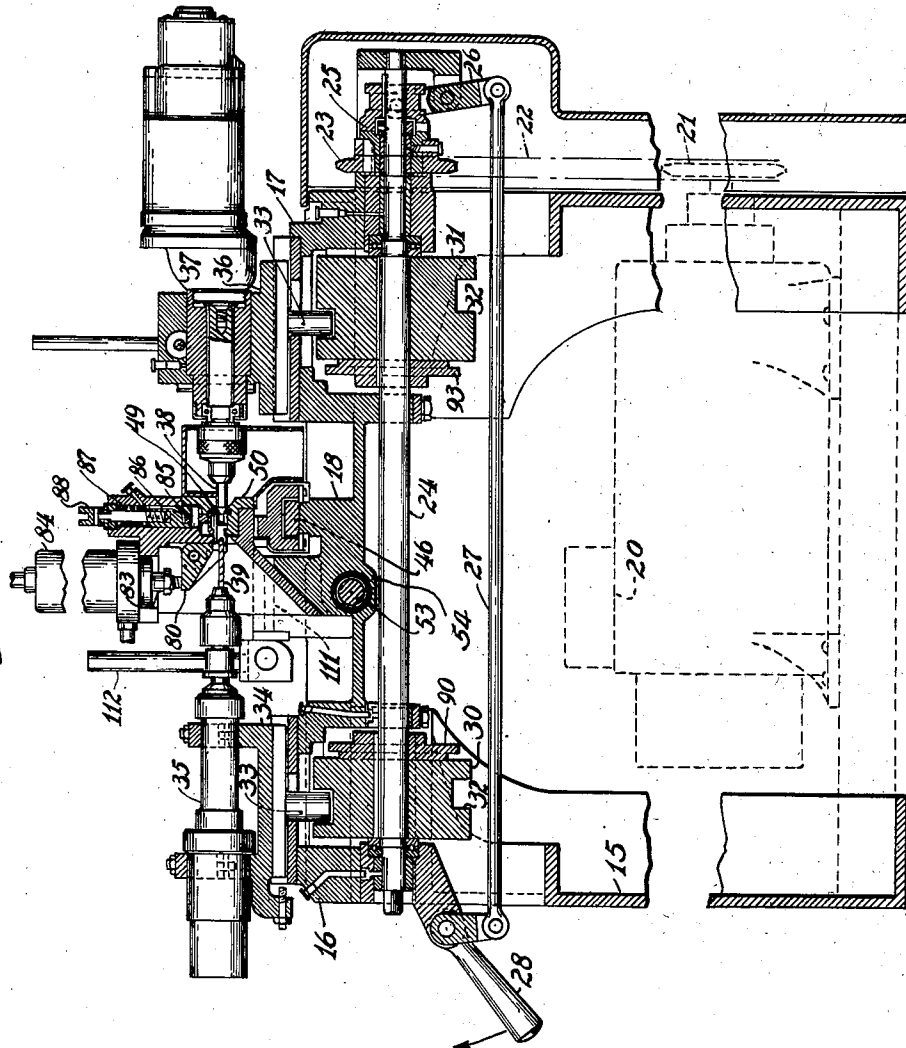
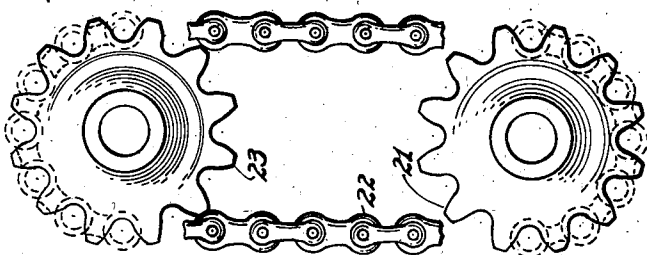


Fig. 11



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DRILLING AND COUNTERSINKING MACHINE

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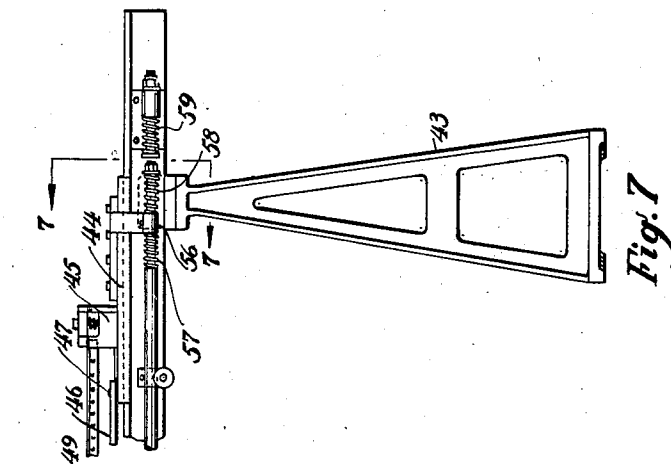
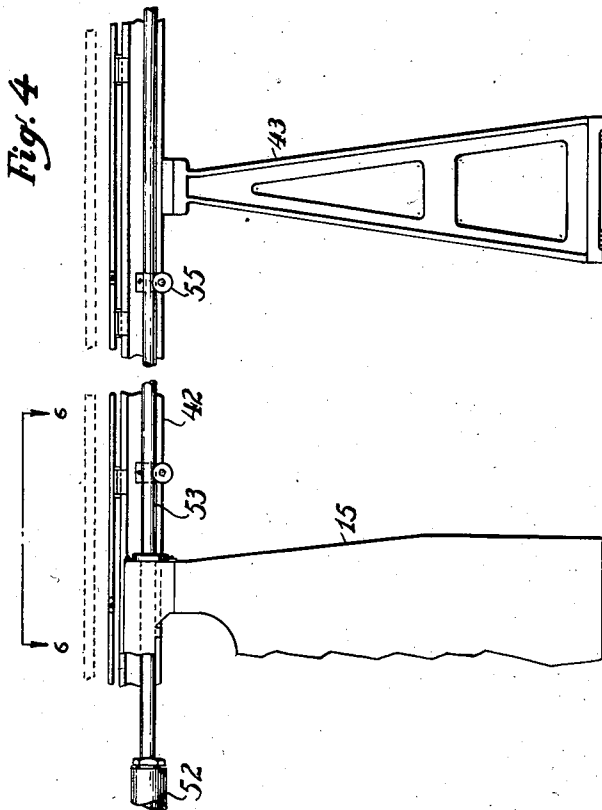
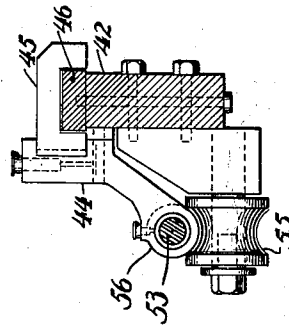
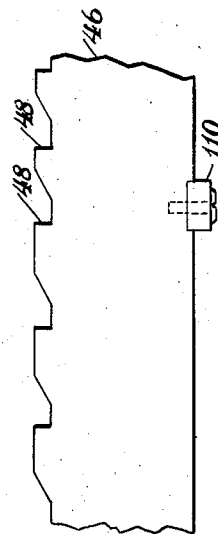


Fig. 4

Fig. 6



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Fig. 5

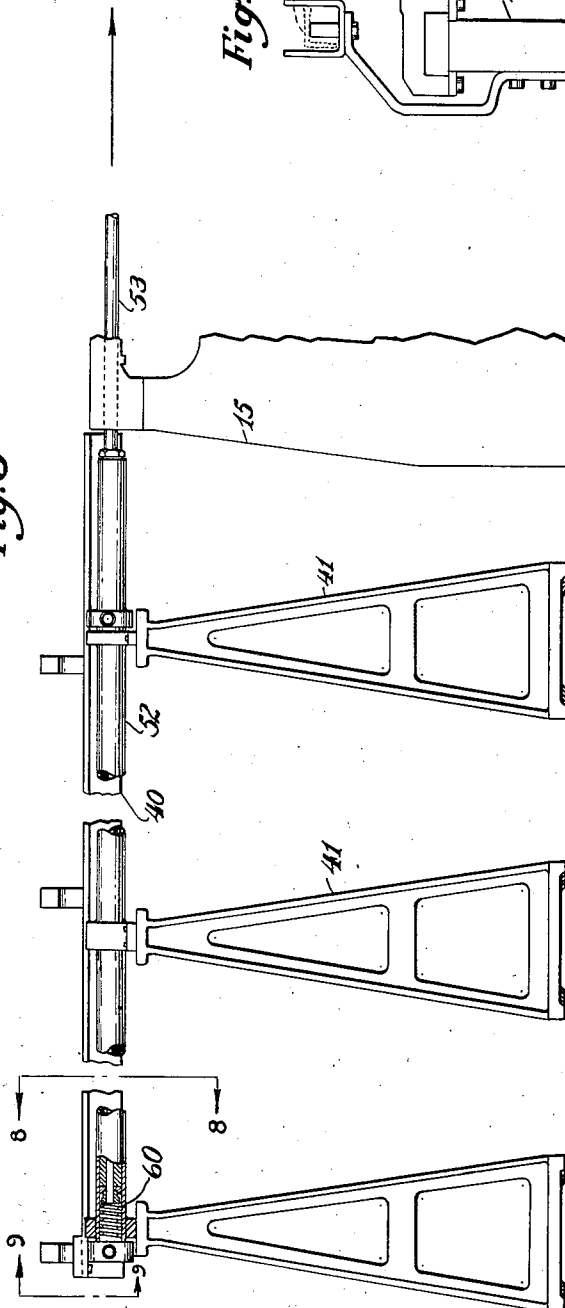


Fig. 9

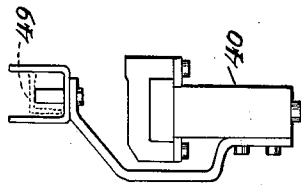


Fig. 10

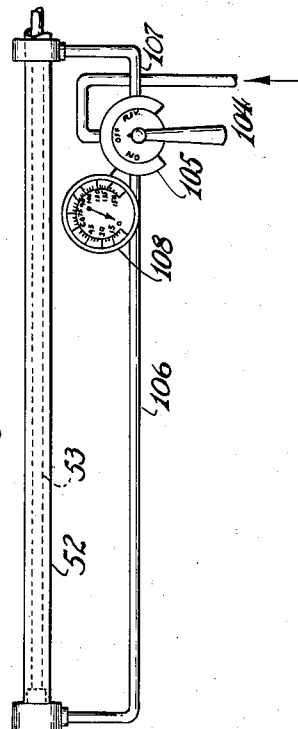
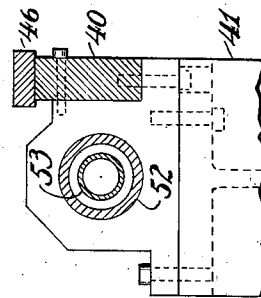


Fig. 8



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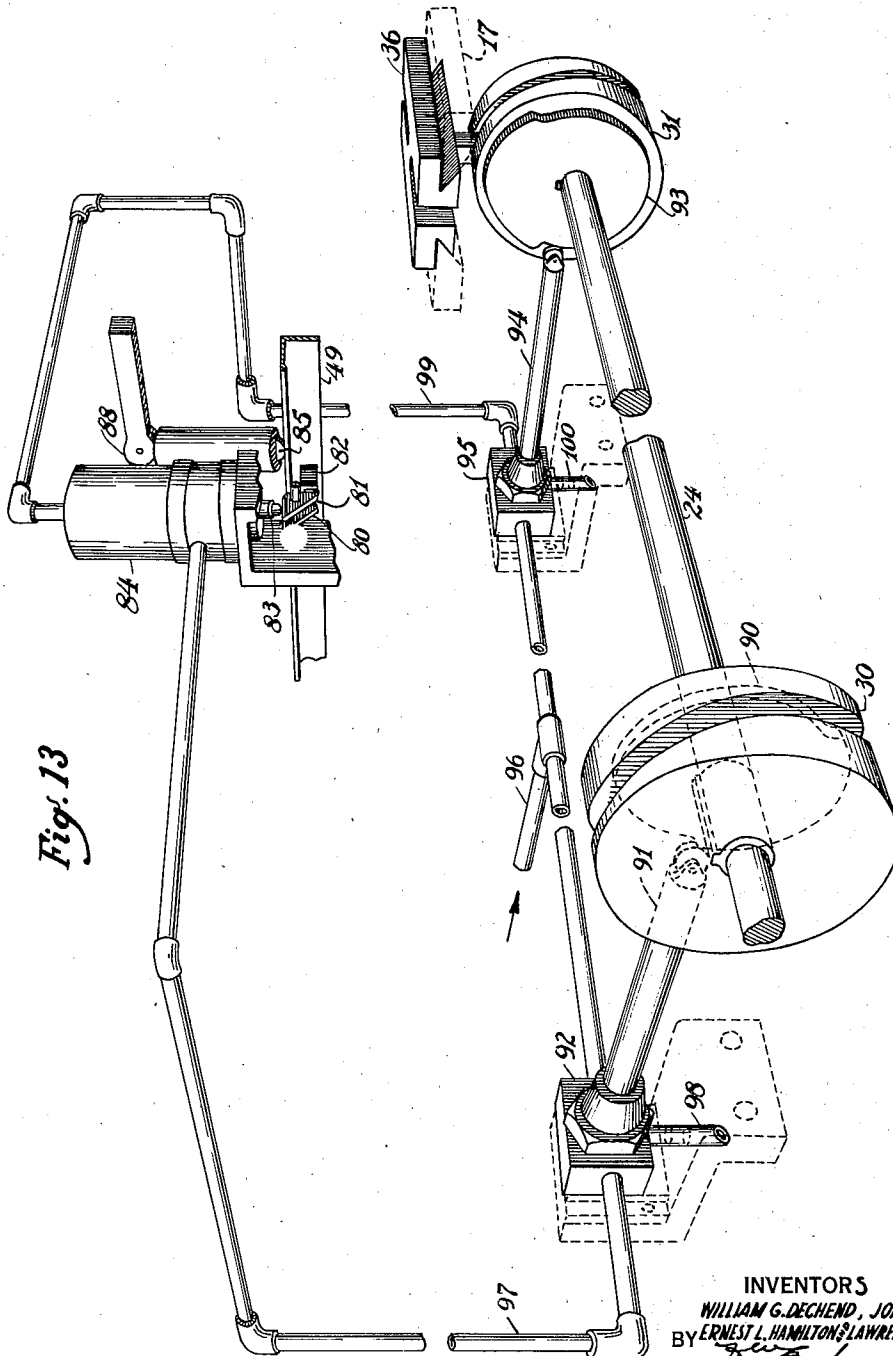
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DRILLING AND COUNTERSINKING MACHINE

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Fig. 14

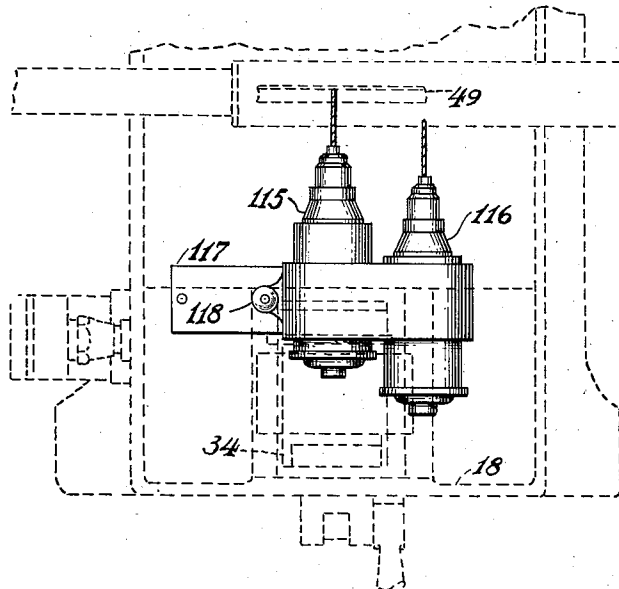
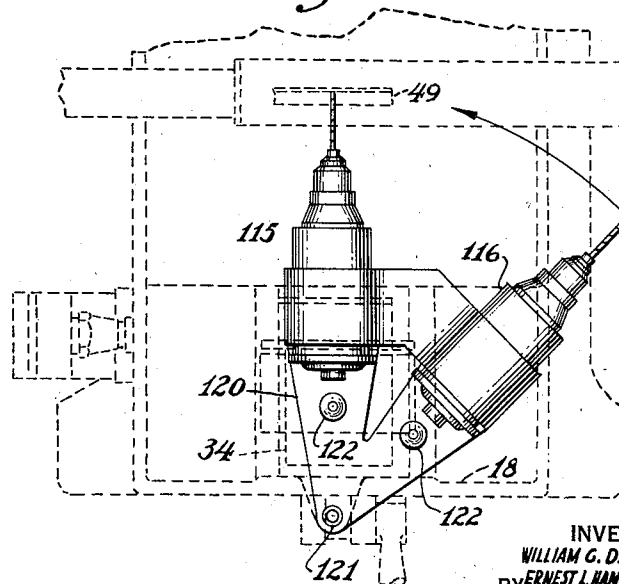


Fig. 15



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UNITED STATES PATENT OFFICE

2,300,253

DRILLING AND COUNTERSINKING
MACHINE

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Application June 24, 1941, Serial No. 399,438

18 Claims. (Cl. 77—21)

This invention relates to machines for processing metal components, and is particularly concerned with an automatic machine for drilling a plurality of spaced holes in long slender metal strips.

In the construction of modern aircraft, mono-coque body and wing structures are used in which many stiffeners are incorporated, these taking the form of channels or angles to which the metallic aircraft skin is secured by a large number of rivets. The drilling of the large number of necessary holes in the slender stiffener elements is obviously an arduous and time consuming task when the holes are drilled by hand or on conventional machines—templates for the spaced holes can be used but they are not particularly satisfactory.

An object of this invention is to provide an automatic drilling machine in which spacing of drilled holes may be afforded by indexing a member extending parallel to the work-piece and movable therewith with respect to a drill spindle, said member being indexed automatically in the intervals when the drill shank is not engaged with the work-piece. A further object is to provide a machine which will progressively drill and countersink a plurality of holes in a work-piece. A further object is to provide a machine which will minimize the formation of burrs or rough edges on the work-piece to avoid the necessity for additional hand working after the holes have been drilled. A further object is to provide a machine which, when once set up to drill a plurality of spaced holes in a long slender work-piece, will function automatically after starting until all desired holes have been drilled. Still another object is to provide a machine in which work is accomplished upon a work-piece upon both sides thereof; that is, a drill is passed through the work-piece from one side subsequent to which a countersink is engaged with the work from the opposite side. Further objects of the invention consist in the co-ordination and timing of speeds of operation by which minimum operator attention is necessary in causing the machine to function properly.

Other objects of the invention will become apparent in reading the annexed detailed description in connection with the drawings, in which:

Fig. 1 is a front elevation of a central part of the machine, partly in section, and comprises a section on the line 1—1 of Fig. 2;

Fig. 2 is a plan of the central part of the machine;

Fig. 3 is a section on the line 3—3 of Fig. 2; Figs. 4 and 5 are respectively front elevations of the right and left hand portions of the machine;

Fig. 6 is a plan on the line 6—6 of Fig. 4; Fig. 7 is a section on the line 7—7 of Fig. 4; Fig. 8 is a section on the line 8—8 of Fig. 5; Fig. 9 is a side elevation taken on the line 9—9 of Fig. 5;

Fig. 10 is a plan of part of the control system; Fig. 11 is an enlarged detail of part of the driving system;

Fig. 12 is an enlarged perspective view of a part of the feed control mechanism;

Fig. 13 is a fragmentary perspective view of part of the control, feed, and clamping mechanisms; and

Figs. 14 and 15 are plan views of alternate arrangements of drilling units.

Referring first to Figs. 1 to 5, the machine comprises a central standard 15 having, at its upper end, front and rear tables 16 and 17 with a work-piece support 18 therebetween. The lower part of the standard 15 carries a motor 20 having a built-in reduction gear which drives a sprocket 21, driving through a chain 22 to a sprocket 23 rearward of the table 17. The sprocket 23 drives a shaft 24 through a dog clutch 25 selectively engageable or disengageable through a lever 26 connected by a push-pull rod 27 to an operating handle 28 at the front of the machine. The shaft 24 is journaled in the standard 15 and carries a forward cam drum 30, beneath the table 16, and a rearward cam drum 31, beneath the table 17. The periphery of each drum is formed with an axially waved groove 32 within which a follower pin 33 is engaged. Upon the table 16 is a reciprocable tool carrier 34 upon which one said pin 33 is rigidly mounted, the carrier 34 having secured therein a power drill 35 having a drill bit 39. The table 17 has a reciprocably mounted tool carrier 36, said carrier having the other pin 33 rigid therewith, and having secured thereto an independently operated power drill 37 in whose chuck a countersink bit 38 is secured.

When the shaft 24 is driven, the cam drums 31 will cause the slides 34 and 36 to reciprocate from front to rear in timed relation in accordance with the profile of the cam grooves 32.

Referring to Figs. 4, 5, 6, and 7, it will be seen that a work supporting rail 40 extends from the left of the standard 15 and is supported by horses 41, while a work supporting rail 42 is secured to

the right-hand side of the standard 15 and is supported by horses 43. A slide 44 is movable along the rail 42 and carries a work-piece anchor 45 to which an undrilled work-piece is clamped, with the slide 44 in its leftwardmost position adjacent the standard 15. Also, to the slide 44 a notched bar 46 is secured by a screw 47, this bar being substantially coextensive in length with the work-piece and having formed in its rearward edge, as shown in Fig. 6, a plurality of longitudinally spaced notches 48 whose purpose will be disclosed shortly. As shown in Fig. 3, the notched bar 46 passes through a suitable slot in the work support 18, while the work-piece, indicated in the figures at 49, runs along an anvil 50 secured to the work carrier.

Secured to the horses 41, as shown in Fig. 5, is a cylinder 52 which extends nearly to the standard 15. Within the cylinder, a plunger 53 is telescoped, this plunger passing through the standard 15 as at 54 in Fig. 3 and extending to the right, along support rollers 55 secured to the rail 42. The righthand end of the plunger 53 is secured to a bracket 56 on the slide 44 and has an elastic coupling therewith through the medium of springs 57 and 58 and an additional impulse spring 59. The lefthand end of the cylinder 52 is fed with compressed air, as will be described shortly, so that, assuming the plunger 53 is initially telescoped within the cylinder, it will be continually urged to the right under the influence of the compressed air. Incidentally, a buffer spring 60 is inserted in the left-hand, closed, end of the cylinder 52 to take up the shock when the plunger reaches the end of its leftward travel in the cylinder.

Upon a side face of the rear table 17 on the standard (refer to Figs. 2 and 12) a bolt 62 is mounted in a slide 63 for fore-and-aft reciprocation, said bolt being urged by a spring 64 into engagement with the notched bar 46, said bolt having a tip 65 for engagement with one or another of the notches 48. A bolt operating lug 66 engages a cut-out 67 in the bolt 62 and is turnable about the axis of its shaft 68 to retract the bolt from engagement with the notched bar 46. A lever 69 is secured to the shaft 68 to afford manual retraction of the bolt, which lever carries an abutment 70 against which may be manually slid a detent 71 when an operator desires to hold the bolt 62 in a disengaged position with respect to the bar 46. The handle 69 is further provided with an extension 72, substantially pointed at its end, which may be engaged by a latch 73 hinged to the tool carrier 36. Said latch includes a face 74 engageable with a face of the extension 72 so that, when the tool carrier 36 moves rearwardly, the latch 73 rotates the extension 72 in a counter-clockwise direction as viewed in the figures to withdraw the bolt 62 from bar engagement. A cam 75 is adjustably secured by clamp screws 76 and an adjusting screw 76' to the table 17 which engages a cam follower 77 on the latch 73 to afford disengagement of the face 74 from the extension 72 at the instant when the bolt 62 has been disengaged from the bar 46, during rearward movement of the tool carrier 36. Thereupon, the spring 64 urges the bolt 62 against the bar 46 permitting it to engage an adjacent notch 48 of the bar as the bar is urged to the right under the influence of the piston-cylinder assembly 52, 53.

It is apparent that the instantaneous stopping

of travel of the bar 46 would impose considerable shock on the system and it is for this reason that the springs 57, 58 and 59 are assembled at the righthand end of the plunger 53 to absorb the momentum of the plunger.

It will be apparent that the bar 46 is allowed to traverse during rearward movement of the tool carrier 36, the latter being arranged so that its tool is disengaged from the work-piece 49 to allow free traverse of the work-piece to the rest position established by the bar notch 48. It will also be apparent that the spacing of the bar notches 48 establishes the locations of the work-piece 49 on its anvil 50 to allow of the drilling or counter-sinking of holes by the bits 39 and 38. When the spacing of holes in work-pieces is to be changed, it is merely necessary to substitute an appropriate notched bar 46 for the work intended. In practice, where the machine is to be used for a number of different component work-pieces, a number of notched bars would be prepared with a notch spacing appropriate to the several components.

In order to secure the work-piece rigidly while either one of the bits 39 or 38 are engaged therewith, clamping means are provided as shown in Figs. 3 and 13 consisting of a bellcrank 80 hinged to the work holder 10 so that its side face 81 bears on a spacer 82 which in turn bears on the front face of the work-piece 49. The top face of the bellcrank 80 is engaged by a plunger 83 slidable in a cylinder 84 which is supplied with compressed air at such time as the work-piece is stationary. The compressed air supply is relieved from the plunger 83 during those intervals when lateral feeding movement of the work-piece is being accomplished. Further securing of the work-piece is afforded by a roller 85 carried in a slide 86 which is pressed downwardly toward the work-piece by a spring 87. While unloading or loading the machine with work-pieces, the roller 85 is retracted from the work holder by a cam 88 provided with a handle 89, said cam bearing upon the top of the work holder.

Referring again to Fig. 13, it will be seen that the cam drum 39 is also provided with a peripheral cam 90 engaged by a cam follower 91 which operates an air valve 92. Similarly, the cam drive 31 is provided with a peripheral cam 93 engaged by a cam follower 94 which operates an air valve 95. The valves 92 and 95 are fed from a pressure supply line 96. The valve 92, when the cam follower 91 is depressed, delivers air from the supply line 96 to a line 97 leading to the bottom of the work clamping cylinder 84. As the cam rotates, air is supplied to the cylinder bottom during part of the rotation of the cam 90 while during another part of its rotation, the compressed air in the cylinder and in the line 97 is allowed to exhaust through a vent 98. The valve 95 in a similar manner is adjustable, in accordance with the position of the cam 93, to feed compressed air to the top of the cylinder 84 through a line 99 or alternately, to discharge compressed air from the top of the cylinder through a vent 100. The supply of air to the top of the cylinder 84 obviously causes clamping of the work-piece 49, during which interval, the bottom of the cylinder is vented at 98. In the other part of the cycle, the piston 83 is retracted from the work-piece by the supply of air to the cylinder bottom and during clamping, air pressure is relieved from the cylinder bottom.

Fig. 10 shows the air control for the cylinder

52. An air supply line 104 leads to a valve 105 having three positions of adjustment. The "on" position directs compressed air through a line 106 to the lefthand end of the cylinder 52, at the same time venting a line 107 leading to the righthand end of the cylinder 52. When the valve 105 is in the "off" position, the air line 104 is shut off. When the valve 105 is in the "reverse" position, compressed air is valved to the line 107 while the line 106 is vented in order to retract the plunger 53 within the cylinder 52 to prepare the machine for reception of a new work-piece to be drilled. A pressure gauge 108 connected with the line 106 or 104 assures the operator of adequate air pressure for operation of the work traversing system.

It is believed that, from the foregoing, the mode of operation of the drilling machine will be fairly obvious. To summarize however, the following steps are followed: With the slide 44 moved all the way to the left, by actuation of the valve 105 to the reverse position, an appropriate notched bar 46 is clamped to the slide 44 and likewise, a fresh blank 49 is clamped at 45 to the slide. The motor 20 is started (while declutched by the handle 28) and the drilling tools 35 and 37 are started, and the valve 105 is moved to the "on" position causing movement of the work-piece and the notched bar to the right until the first notch of the bar is engaged by the bolt 62. Engagement of the clutch 25 is then effected by the handle 28 whereupon cyclic forward and rearward movement of the drilling devices 35 and 37 is initiated with concurrent traversing of the notched bar and work-piece during those intervals in the cycle of the drilling devices when the tool bits are clear of the work-piece. Simultaneously, cyclic operation of the work clamping bellcrank 80 is accomplished, the clamping dwell of such bellcrank lasting from the time when the bolt 62 engages a bar notch until shortly before the bolt 62 is withdrawn from the bar notch. The machine proceeds in this fashion until all of the bar notches have been engaged sequentially by the bolt 62 whereupon stoppage of further bar traverse is accomplished by the engagement of an abutment 110 toward the left end of the bar (Fig. 2) with a mating abutment 111 secured to the work table 16. Said abutment 111 may be retracted for bar replacement by a handle 112 shown in Figs. 2 and 3.

At times, the work-piece 49 may require holes of different size in the series to be drilled in one setup of the drilling machine. Rather than stop the machine to change drills, we provide arrangements as shown in Fig. 14 or 15, wherein the tool carrier 34 has a pair of power drills 115 and 116 mounted thereon, each having a drill of appropriate size.

In Fig. 14, the power drills 115 and 116 are secured in axially parallel relation to a cross slide 117 movable crosswise of the carrier 34 so that either may be aligned with the work station. The cross slide is secured in either position by a pin 118 which also locks the appropriate power drill in the proper axial working position.

In Fig. 15, the power drills 115 and 116 are secured to a bracket 120 in angular relation, the bracket being pivoted to the tool carrier 34 at 121 and being swingable so that either power drill may be aligned with the work station. Push pins 122 in the bracket are adapted to engage a suitable hole in the tool carrier for securing either power drill in position.

While we have described our invention in de-

tail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding our invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. We aim in the appended claims to cover all such modifications and changes.

We claim as our invention:

1. In apparatus for alternately and progressively drilling and countersinking holes in a work-piece, a support, means for intermittently feeding the work-piece across the support, a drill movable into and out of engagement with said work-piece, a countersink tool coaxial with the drill likewise movable into and out of engagement with the work-piece, and means to alternately move the drill and countersink tool in timed relation into and out of work piece engagement while the work piece is stationary relative to the support.

2. In apparatus for alternately and progressively drilling and countersinking holes in a work-piece, a support, means for intermittently feeding the work-piece across the support, a drill movable into and out of engagement with said work-piece, a countersink tool likewise movable into and out of engagement with the work-piece, and means to alternately move the drill and countersink tool in timed relation into and out of work piece engagement while the work piece is stationary relative to the support, said drill and countersink tool being coaxial and disposed on opposite sides of said work-piece.

3. In apparatus for alternately and progressively drilling and countersinking holes in a work-piece, a support, means for intermittently moving the work-piece across the support, means for intermittently clamping the work-piece to the support, a drill movable into and out of engagement with said work-piece, a countersink tool movable into and out of engagement with the work-piece, and means to alternately move said work-piece, said drill, said countersink tool and said work-piece clamping means in timed relation.

4. In apparatus for alternately and progressively drilling and countersinking holes in a work-piece, a support, means for feeding the work-piece across the support, means for intermittently stopping the work-piece, means for intermittently releasing said stop means, a drill movable into and out of engagement with said work-piece, a countersink tool likewise movable into and out of engagement with the work-piece, said feeding means, said stop means, said releasing means, said drill and said countersink tool all being actuated in timed relation.

5. Apparatus for alternately and progressively drilling and countersinking holes comprising, in combination, a frame, reciprocating means mounted on said frame, a table fixed to said frame, a drilling unit movably mounted on said table and actuated by said reciprocating means, a countersinking unit movably mounted on said table and actuated by said reciprocating means, a guide rail fixed to said supporting table, a work carrier movably mounted on said rail, means for holding the work-piece to said work-carrier, an indexing bar fixed to said work-carrier and adapted to move along said rail, means adjacent said rail for moving said work-carrier and said indexing bar along the rail, a stop member mounted on said supporting table and adapted to engage said indexing bar, and means for actuating said stop member.

6. Apparatus for alternately and progressively drilling and countersinking holes in long lengths of materials comprising, in combination, a frame, a rotary means journaled in said frame, said means having cams, a supporting table fixed to said frame, a sliding member transversely mounted toward one end of said table, a drilling device mounted on said sliding member, means connecting said sliding member to one cam to cause a reciprocating motion to said sliding member and hence the drilling device, a second sliding member transversely mounted on the opposite end of said table, a countersinking device mounted to said second sliding member, means connecting last said sliding member to the other cam to cause a reciprocating motion to said last sliding member and hence the countersinking device, said countersinking device facing and being in axial alignment with said drilling device, a guide rail passing across and extending longitudinally from either side of said supporting table, support means for the outer ends of said guide rail, a work carrier slidably mounted on said rail, clamping means fixed to said work-carrier for clamping one end of the material to be drilled and countersunk, a stationary support member fixed to said table in axial alignment with and between said drilling and countersinking means, a clamp in said support means for holding said material while being worked, an indexing bar having notches removably attached to said work-carrier and adapted to move along said rail, said notches being spaced to meet the requirements of hole spacing, a stop adapted to engage said notches, said stop being actuated by transverse movement of said countersinking device sliding member, work-carrier actuating means, said means consisting of a cylinder and plunger, said means being mounted adjacent to and substantially parallel with said guide rail, one end of said plunger being fixed to said work-carrier, and fluid means for actuating said plunger and hence said carrier.

7. In apparatus for forming spaced holes in a long slender work-piece, a work table, a hole forming device slidable across the work table, means to clamp the work-piece to the table while the device is forming a hole, means to locate the work-piece along the table, and means actuated by sliding of the device away from the work-piece to release said clamp and to traverse the work-piece along the table.

8. In apparatus for forming spaced holes in a long slender work-piece, a work table along which the work-piece may be moved, a hole forming device reciprocable across said table toward and away from the work-piece, means to clamp the work-piece to the table when the device is engaging the work-piece for a hole forming operation, and means to move the work-piece along the table while the device is out of engagement with the work-piece.

9. In apparatus for forming spaced holes in a long slender work-piece, a work table along which the work-piece may be moved, a hole forming device reciprocable across said table toward and away from the work-piece, means to clamp the work-piece to the table when the device is engaging the work-piece for a hole forming operation, a notched bar movable along the table to which said work-piece is secured, means to urge said bar along the table, a detent urged toward engagement with the bar notches to arrest work-piece movement along the table, and

means responsive to reciprocation of the hole forming device while remote from the work-piece to trip said detent from a notch with which it has been engaged to allow movement of the work-piece until said detent engages the next notch of the notched bar.

10. In a machine tool including a work station across which a blank is adapted to pass, means at the station for performing an operation on the blank, a blank carrier comprising a notched bar, means continually and elastically urging the blank and carrier across said work station, and means at the work station engageable with the notches of said bar to arrest bar movement, and disengageable from the notches to allow bar movement.

11. In a machine tool including a work station across which a blank is adapted to pass, means at the station for performing an operation on the blank, a blank carrier comprising a notched bar, means continually and elastically urging the blank and carrier across said work station, a bolt at the work station engageable sequentially with the bar notches to hold the bar against movement, and means to trip said bolt periodically from a notch with which it is engaged to allow traverse of the bar until the bolt engages the next bar notch.

12. In a machine tool including a work station across which a blank is adapted to pass, means at the station cyclically operable to perform an operation on the blank, a clamp movable relative to the work station, and power means to engage the clamp with the blank at the same cyclic frequency as the first said means, said clamping engagement having a dwell longer than the dwell of the operation performed on the blank.

13. In a machine tool including a work station across which a blank is adapted to pass, means at the station cyclically operable to perform an operation on the blank, a clamp movable relative to the work station, power means to engage the clamp with the blank at the same cyclic frequency as the first said means, said clamping engagement having a dwell longer than the dwell of the operation performed on the blank, and means to move the blank across the work station when said clamp is disengaged from the work.

14. In a hole forming machine, a track for blank material, reciprocable bit-carrying rotating spindles at opposite sides of the blank, said spindles being coaxial, power operated cam means to move first one and then the other spindle bit into and out of engagement with the blank, and means to traverse the work along the track while the spindle bits are clear of the work.

15. In a hole forming machine, a track for blank material, reciprocable bit-carrying rotating spindles at opposite sides of the blank, said spindles being coaxial, power operated cam means to move first one and then the other spindle bit into and out of engagement with the blank, means to traverse the work along the track while the spindle bits are clear of the work, and means to clamp the blank to the track during the interval when said bits are engaged with the blank.

16. In a machine tool feed system, a blank carrier, a pneumatic ram for moving said carrier in the direction of feed, and power means intermittently engageable with the blank carrier to arrest its movement.

17. In a machine tool feed system, a blank car-

rier, a pneumatic ram for moving said carrier in the direction of feed, power means intermittently engageable with the blank carrier to arrest its movement, a pneumatic ram intermittently operable to clamp the blank in the machine tool, and means to energize said ram at a time when movement of the blank carrier is arrested.

18. In apparatus for alternately and progressively performing two successive machining operations on a work piece, a support, means for intermittently feeding the work piece across the

support, a first machine tool movable into and out of engagement with said work piece, a second machine tool coaxial with said first tool and likewise movable into and out of engagement with the work piece, and means to alternately move said tools in timed relation into and out of work piece engagement while the work piece is stationary relative to the support.

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