Nov. 27, 1945. L. ROBBINS 2,389,743

AUTOMATIC DRILLING MACHINE

Filed Dec. 21, 1942 8 Sheets-Sheet 1

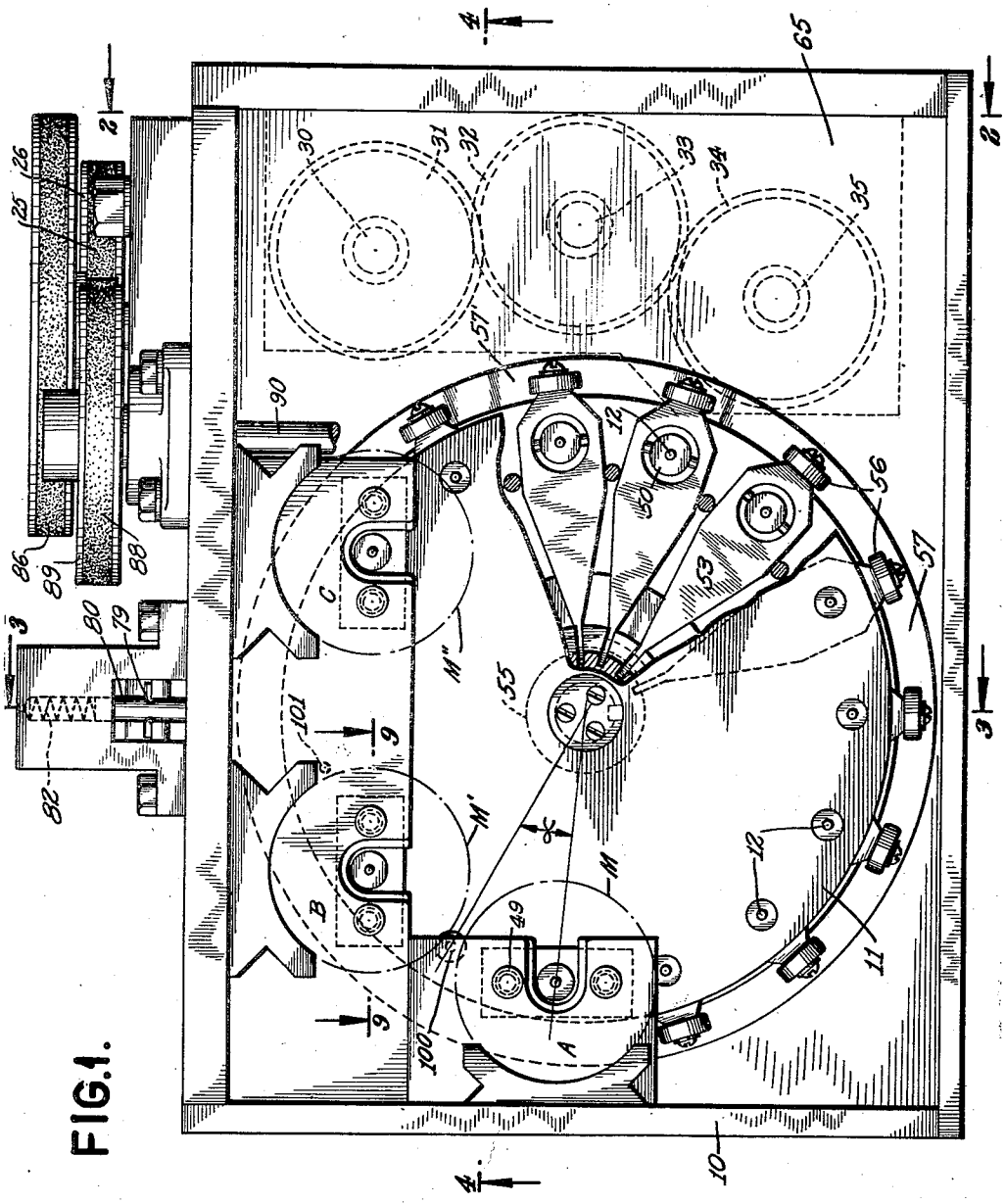

FIG.1.

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AUTOMATIC DRILLING MACHINE

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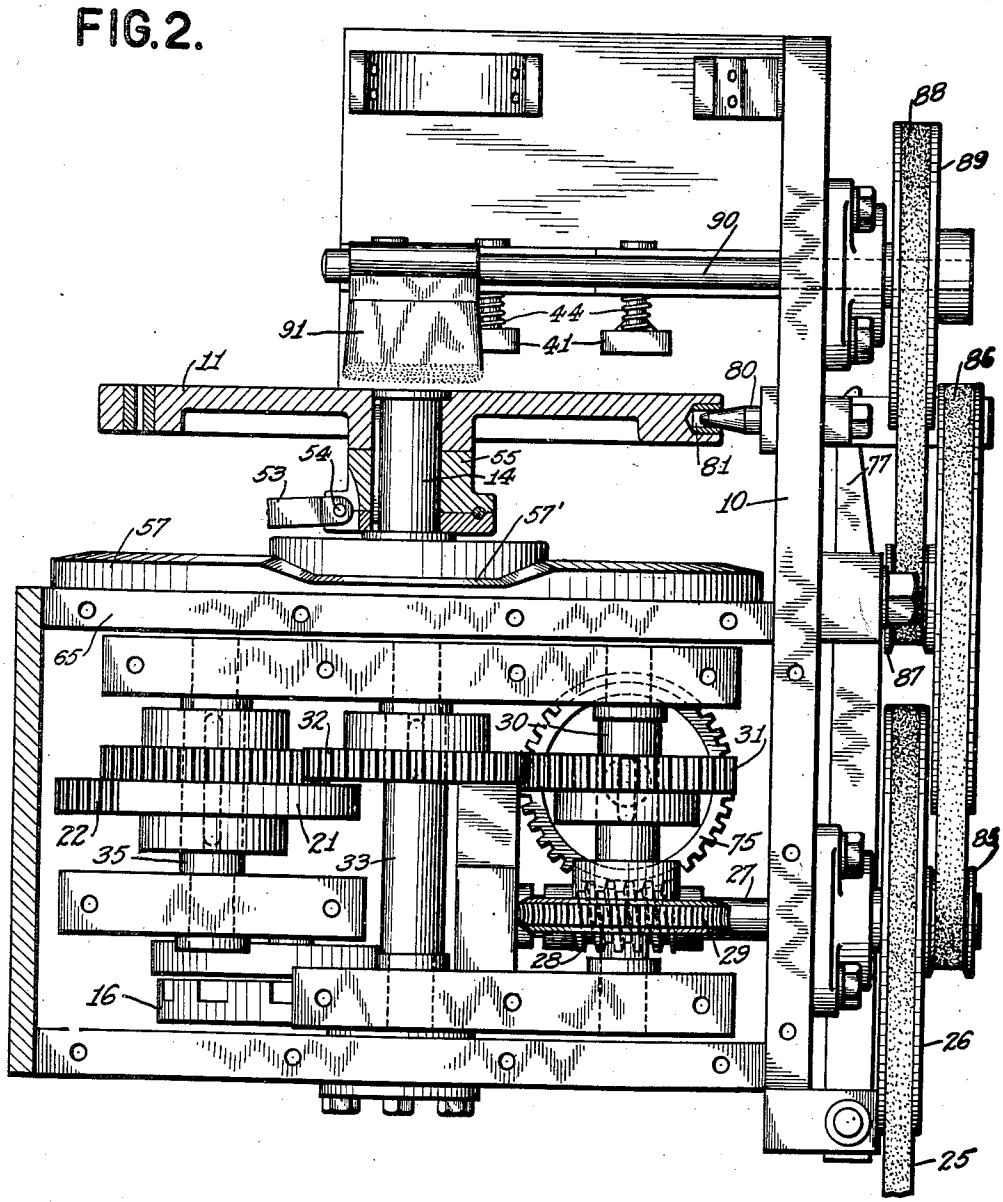
FIG. 2.



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AUTOMATIC DRILLING MACHINE

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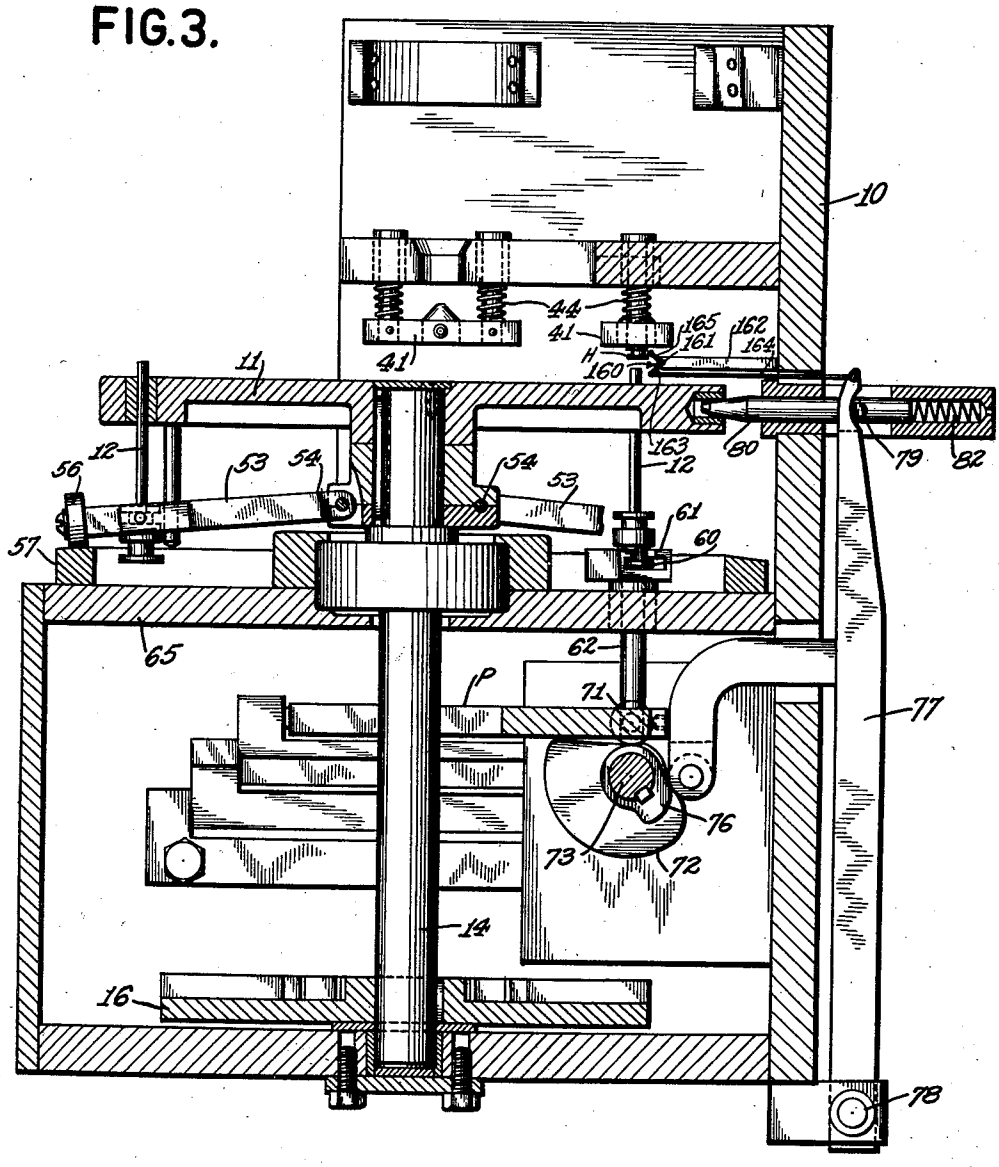
FIG. 3.



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AUTOMATIC DRILLING MACHINE

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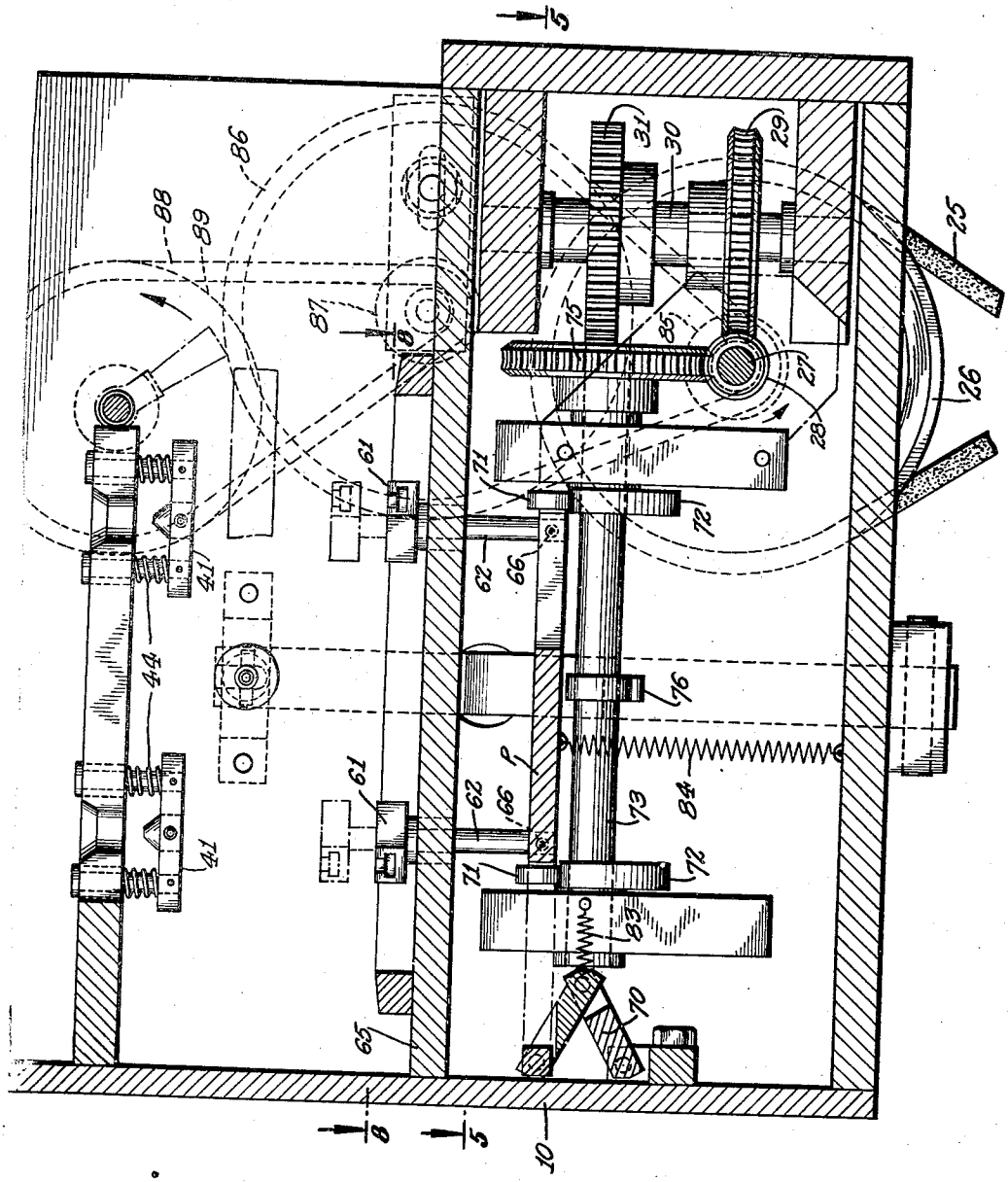

FIG. 4.

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AUTOMATIC DRILLING MACHINE

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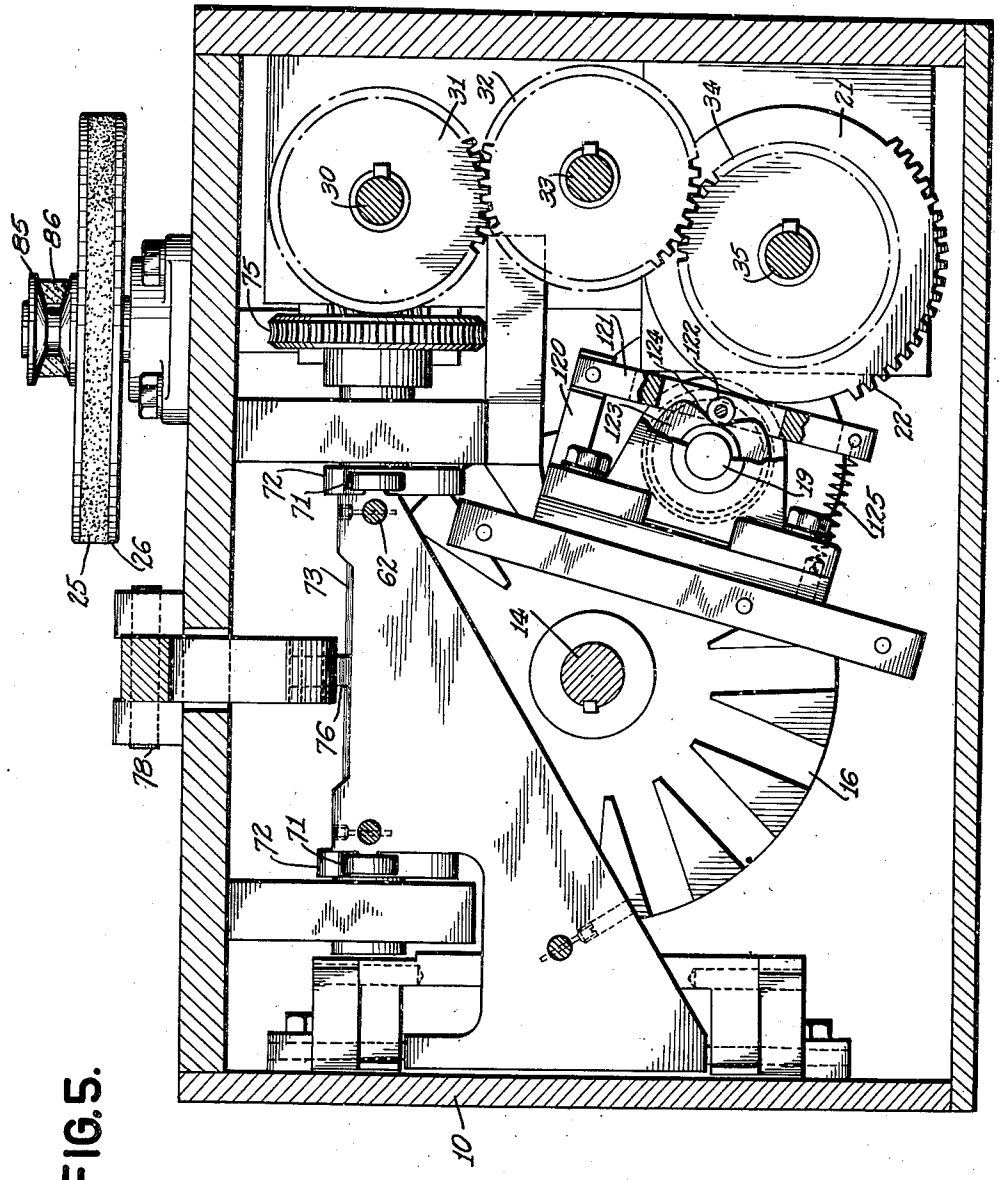

FIG. 5.

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FIG.6.

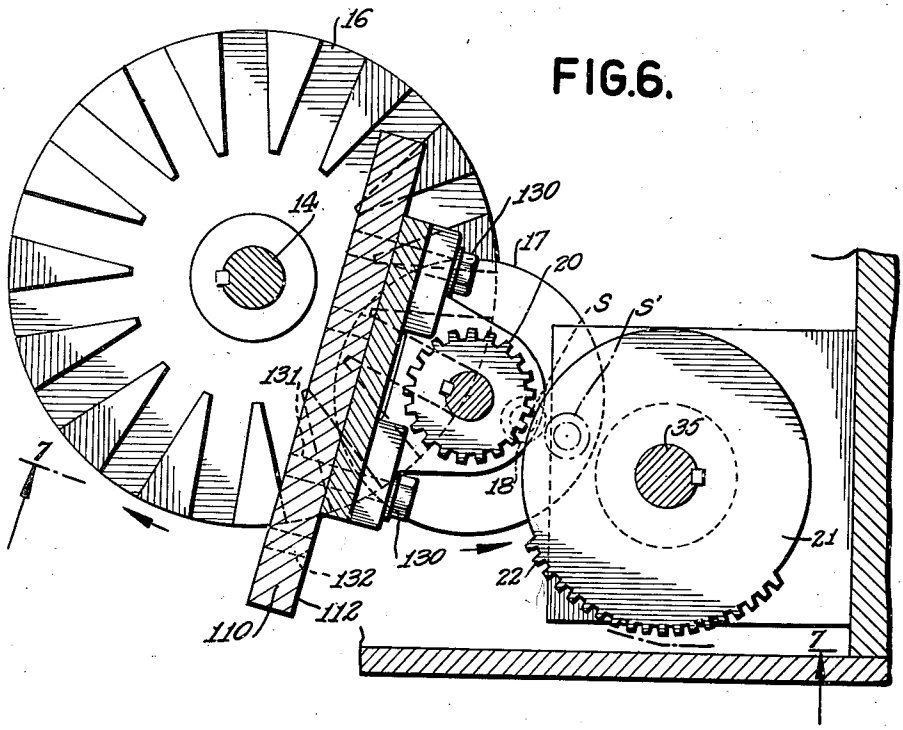

FIG.7.

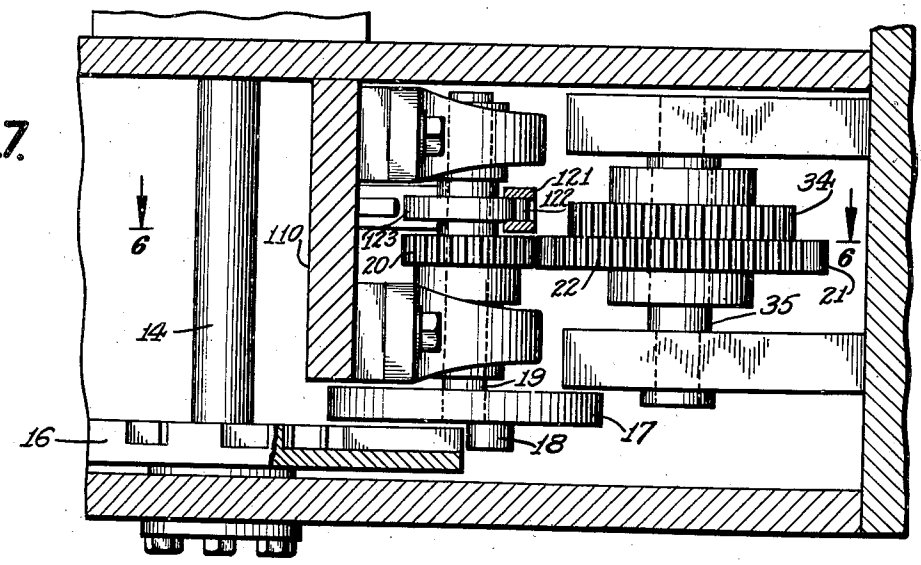

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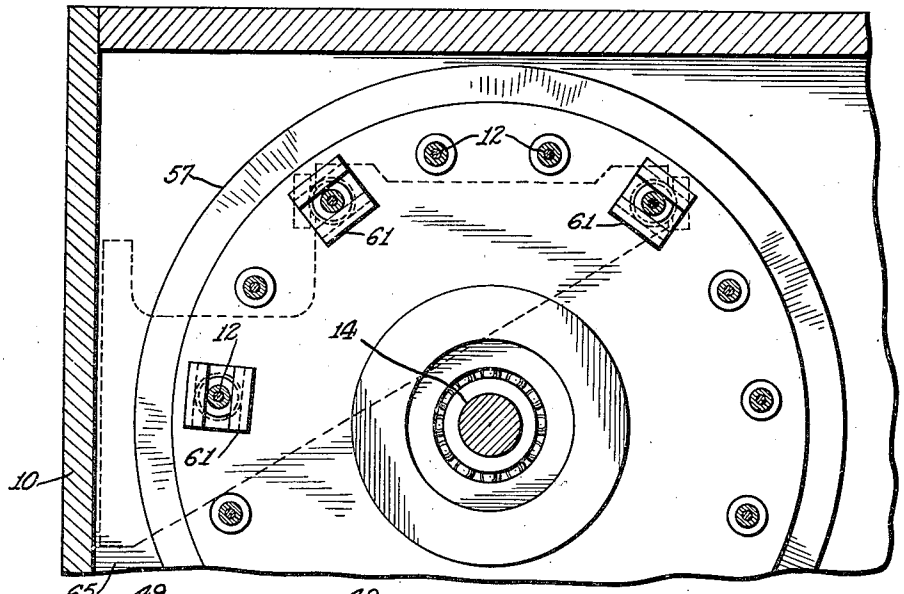
FIG. 8.



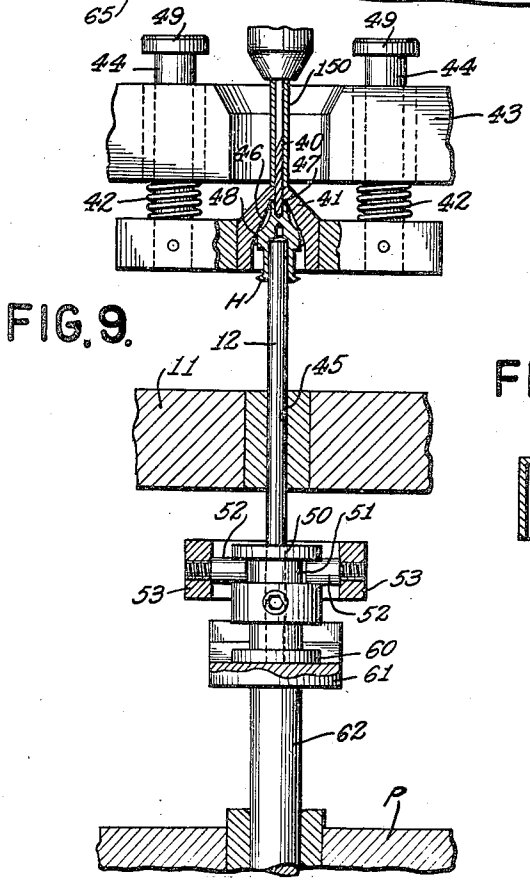


FIG. 9.

FIG. 10.

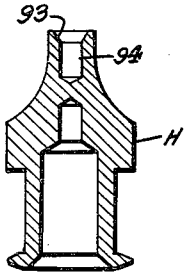


FIG. 12.

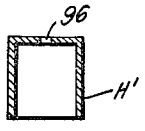
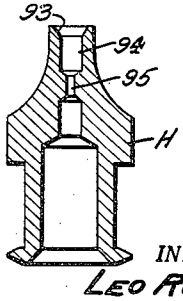


FIG. 11.



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AUTOMATIC DRILLING MACHINE

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FIG.13.

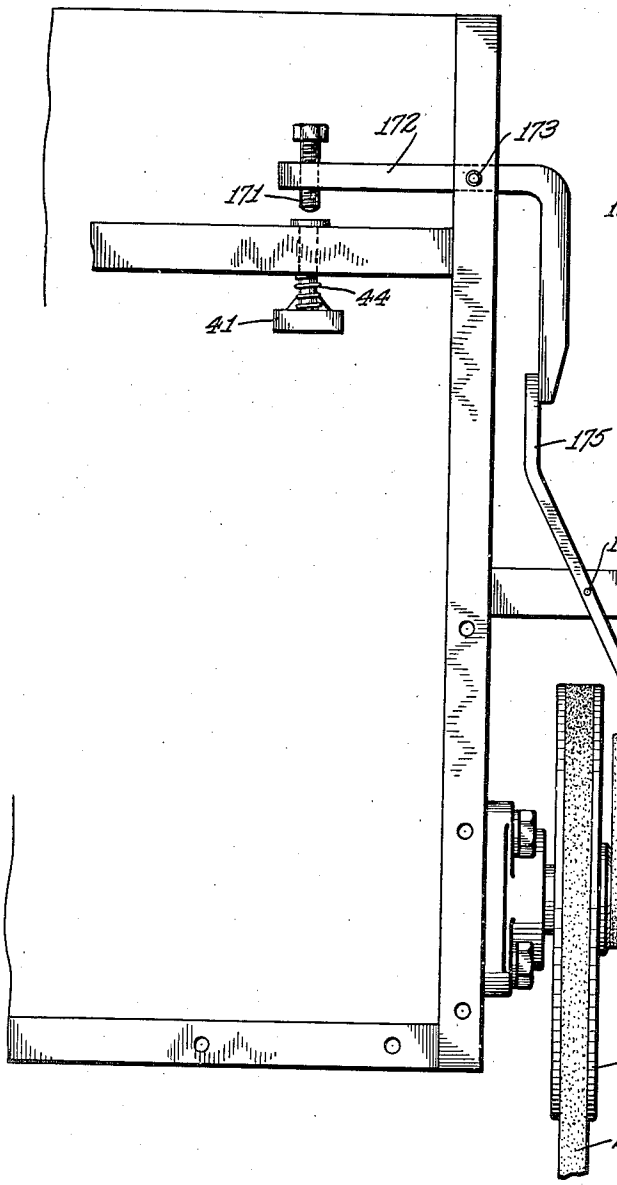
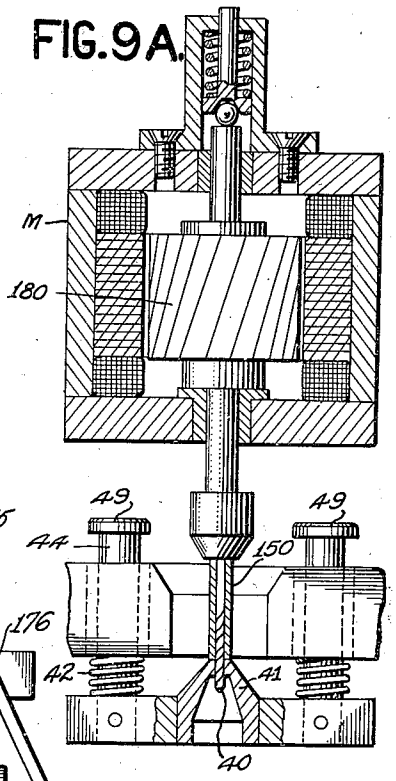


FIG.9A.



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Patented Nov. 27, 1945

2,389,743

UNITED STATES PATENT OFFICE

2,389,743

AUTOMATIC DRILLING MACHINE

Leo Robbins, New York, N. Y., assignor to Roberts Manufacturing Co., New York, N. Y.

Application December 21, 1942, Serial No. 469,685

13 Claims. (Cl. 77—23)

This invention relates to automatic drilling machines. While these machines are particularly adapted and are described herein for the purpose of drilling holes in the hubs of hypodermic injection needles, it will be understood that they are capable of being employed for drilling a wide variety of similar articles.

It is one of the principal objects of this invention to provide an automatic drilling machine which is capable of performing a plurality of successive drilling operations, each of which may be of a different variety.

It is a further object of the invention to provide a drilling machine which can not only perform a plurality of successive drilling operations but which can perform a plurality of operations simultaneously on a plurality of articles.

It is a further object of this invention to provide a machine which is capable at the will of an operator of either performing a plurality of successive drilling operations which are different in character, or performing simultaneously a plurality of similar drilling operations so as to drill a plurality of objects simultaneously in the same manner.

It is a further object of this invention to provide means for maintaining the turntable free of waste metal which has been drilled out of the articles.

Still another object of this invention is to provide means whereby a drill may drill a constant depth of hole in the article regardless of the length of the article which is fed to the drill.

Still another object of this invention is to provide means for preventing damage to the machine due to jamming of the articles to be drilled in the jig.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

In the accompanying drawings:

Fig. 1 is a plan view of the drilling machine with parts broken away.

Fig. 2 is a section taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 1.

Fig. 5 is a section taken substantially on the line 5—5 of Fig. 4.

Fig. 6 is a section taken substantially on the line 6—6 of Fig. 7.

Fig. 7 is a section taken substantially on the line 7—7 of Fig. 5.

Fig. 8 is a section taken substantially on the line 8—8 of Fig. 4.

Fig. 9 is a section taken substantially on the line 9—9 of Fig. 1.

Fig. 9A is a section through a motor and armature employed in the Fig. 9 device.

Fig. 10 is a vertical section through one type of hub adapted to be drilled and showing the countersink and large hole drilled therein.

Fig. 11 is a view similar to Fig. 10 showing the same hub with the small hole drilled therein.

Fig. 12 is a vertical section through another type of hub adapted to have but a single hole drilled therein.

Fig. 13 is a view of a detail adapted to be applied to the device shown in Fig. 3.

Referring to the drawings, and particularly to Fig. 1, it will be seen that the invention consists broadly in supporting within a frame or casing 10 a rotating table 11 having a plurality of hub supports 12 projecting therethrough. The operator places the hubs to be drilled upon the upper ends of said supports in advance of the drilling positions. The hubs may be of the types shown in Figs. 10, 11 and 12. The intermittent rotation of turntable 11 is designed to bring the hubs successively into the drilling positions beneath the drills A, B and C, after which the drilled hubs are removed from the hub supports and replaced with undrilled hubs. The mechanism for rotating the table to bring the hubs into drilling position and for effecting such drilling will now be described.

The hub supports 12 are disposed circumferentially in the table 11 and spaced equal angular distances apart. This angle is designated in Fig. 1 as the angle α. The table is then rotated step by step, each step being equal to the angular distance α to bring the supports successively into cooperation with the drill heads A, B, C which are fixedly mounted on the frame 10.

For rotating the turntable 11 intermittently through successive steps, the table may be mounted upon a shaft 14 which is driven by an intermittent or step-by-step drive. This drive is shown in Figs. 5, 6 and 7 and may comprise a star-wheel 16 with which is adapted to mesh periodically a pin 18 eccentrically mounted on a disk 17 which is supported for rotation on a shaft 19. The said shaft also carries a gear 20 adapted to mesh with a mutilated gear 21 of larger diameter so that gear 20 will rotate through only a portion of the time in which gear 21 makes a complete revolution. Gear wheel 21 is provided with substantially as many teeth 22 as are on the periphery of gear wheel 20 so that for each revolu-

tion of gear wheel 21, gear wheel 20 will make one complete revolution. (Actually the number of teeth 22 is less than the number of teeth on wheel 20 to take care of the inertia of wheel 20 and the mass driven by said wheel.)

This means that disk 17 and eccentric pin 18 will also make one complete revolution for each revolution of gear wheel 21, and since shaft 19 is eccentrically positioned with respect to shaft 14, the pin 18 will mesh with the star-wheel 16 once during each revolution of gear wheel 21 through a predetermined angular distance, at which point it will leave the star-wheel. Thus, for that fraction of a revolution of gear wheel 21 indicated by the proportion of its circumference occupied by teeth 22, the star-wheel will be moved through a step and will remain in that position throughout the time that the remainder of the periphery of gear wheel 21 which is minus gear teeth remains out of mesh with gear wheel 20. Thus the star-wheel has been given one step of rotation designed to move the succeeding hub support 12 to drilling position while moving the hub which has been drilled, out of drilling position.

The said intermittent movement may be effected from any suitable driving source such as a motor, not shown, which drives through a belt and pulley 25, 26 to a shaft 27, and thence (see Fig. 4) through a worm 28 and worm wheel 29 it will drive shaft 30 on which the worm wheel 29 is mounted. Shaft 30 carries gear wheel 31 which may mesh (see Fig. 5) with gear wheel 32 on shaft 33, said gear wheel 32 meshing with gear 34 on the same shaft 35 which carries the mutilated gear wheel 21.

Since gear teeth 22 move out of mesh with gear wheel 20 once during each revolution of shaft 35 and must again effect engagement on the next revolution, means are provided for synchronizing the position of gear wheel 20 with gear wheel 21 and gear teeth 22 during the interval that the gears are out of engagement so that said gear teeth will be in position to mesh. For this purpose there is provided a defining and holding mechanism which becomes effective as soon as gear teeth 22 move out of mesh with gear 20 and which remains effective until gear teeth 22 are almost ready to engage gear 20 again. For this purpose there is mounted on the fixed support 120 a lever 121 carrying a detent roller 122 adapted to cooperate with a disk 123 fixed upon the shaft 19. Said disk 123 is provided with the groove 124 into which the detent roller 122 is adapted to engage as soon as the gear teeth 22 move out of mesh with gear wheel 20, and thus render definite the position of the gear wheel 20 with respect to gear wheel 21 and its gear teeth 22 so that gear teeth 22 will be able to mesh with gear 20 on the next rotation. The lever 121 is normally spring pressed by spring 125 to hold the detent 122 in engagement with the periphery of disk 123. When the gear teeth 22 again mesh with gear 20 it will rotate shaft 19 and hence disk 123 to move the detent 122 and lever 121 outwardly from the groove against the action of spring 125. The defining and holding mechanism is thus released for the interval that the shaft 19 rotates, and when substantially a complete rotation of said shaft has been made and gear teeth 22 move out of engagement with gear 20, the detent 122 again falls into the groove 124 to define the meshing position of the gear wheel 20 relative to gear wheel 21 and hold it fixed in such position.

The drive described above is designed to rotate the table 11 intermittently through predetermined steps, said steps being those necessary to bring the hub supports 12 and the hubs supported on the upper ends thereof successively into drilling position. Each drill may comprise the motor M, M', M'' which drives a drill 40 extending downwardly within a jig 41. The jig is supported upon a fixed member 43 by means of pins 44 slidable in said member. Springs 42 are interposed between the jig and support 43 to hold the jig normally in lowered position until flanges 49 on pins 44 engage member 43. The hub support 12 with the hub H to be drilled supported thereon is designed to be moved up through guide opening 45 in the table 11 with sufficient force to lift the jig against the action of springs 42 to cause the drill to enter into the upper end of the hub H and drill the hole. The interior of the jig 41 may be provided with a conical surface 46 so formed as to engage the narrow upper rim 47 and the wider lower rim 48 of the hub H and thus guide the hub into the proper drilling position.

For operating the hub support 12 upwardly into the jig when the respective hub support and its hub are in drilling position, the following mechanism is provided: The hub supports 12 are slidably mounted within table 11 through openings 45 so that they may be moved vertically. Each support 12 is provided with a collar 50 having a groove 51 within which engages pins 52 carried by arms 53 (see Figs. 9 and 1). Each arm 53 is pivoted at one end at 54 (see Figs. 1 and 2) on a hub 55 fixed to the shaft 14 and is provided at its other end with a roller 56 operating on a ring cam track 57. At the bottom of each support 12 there is provided a flange 60 (see Figs. 3 and 9) which is adapted to engage within a slotted member 61 when the respective hub support has moved into drilling position. Said slotted members are carried upon the upper ends of shafts 62 which are slidable (see Fig. 4) within a fixed supporting plate 65 forming part of the fixed frame 10. The lower ends of said slotted member 62 are fixed at 66 in a vertically reciprocable plate P. The plate P is supported on the fixed frame 10 by means such as pairs of toggles 70.

It will now be apparent that if plate P is lifted vertically it will move all of the shafts 62 and their respective slotted members 61, together with the hub supports 12 which are in engagement with said slotted members, vertically upwardly. Since the axes of shafts 62 coincide with the axes of drills 40, the hub supports will be lifted vertically and the hubs moved within the jigs concentrically with the drills when the plate P is raised. This, however, implies that the plate P will maintain a parallel motion as it is lifted. To secure such parallel motion, as well as the necessary force for lifting the hub supports and the hubs into the jigs so that they may be drilled, the plate P is supported, in addition to the toggles 70, at two points by means of rollers 71 in engagement with cams 72 on a horizontal shaft 73. It will now be understood that if plate P is lifted equally by the cams 72 it will move in parallel motion by reason of the toggle supports 70 which hold it on the frame 10.

Shaft 73 and its cam 72 may be rotated to lift plate P by any suitable driving means such as the motor, not shown, which drives the belt and pulley 25, 26 which drives the shaft 27 and its worm 28 which may engage worm wheel 75 on the said shaft 73. The cams 72 are so positioned with respect to the intermittent drive hereinbefore described that they operate to lift the plate P after pin 17 has left the star-wheel 16. In other

words, the star-wheel has first been moved to the new position to bring a new hub and its hub support into drilling position and then the cams lift plate P to lift the hubs into engagement with the drill. Raising plate P raises shafts 62, the slotted member 61, and the respective hub supports 12 which are in engagement with said slotted members to move the hubs H carried by the respective hub supports into the jigs against the pressure of springs 42 to permit the drills to bore the holes. The plate P is normally biased toward lowered position by means of springs 83, 84.

It is essential that the table 11 be held in fixed position before the plate P starts its upward movement, and therefore locking and defining means are provided which become effective as soon as the table has been turned into its new position and before the plate P begins to move upwardly for locking the table in position. For this purpose an additional cam 76 is provided on shaft 73 and is adapted to engage a lever 77 pivoted on the fixed frame at 78 and at its upper end engaging a pin 79 on a pin or plunger 80 which is adapted to cooperate with openings 81 in the periphery of the table 11. Normally, the cam moves lever 77 outwardly to pull the pin 80 out of the opening 81 when the intermittent drive is about to take effect to move the table 11 to its new position. As soon, however, as the pin 17 has disengaged the star-wheel 15, that is, as soon as the table has been moved through another step to its new position, the cam 76 permits the lever 77 to move inwardly under the pressure of a spring 82 pressing against the end of plunger 80 to permit said plunger to enter the respective opening 81 in the table and hold it while plate P begins to move the hub supports 12 upwardly. When the drilling has been effected and plate P moves downwardly, the cam 76 becomes effective to move lever 77 outwardly against the action of spring 82 and thus disengage plunger 80 from opening 81 in table 11 to permit the intermittent drive to move the table to its next position. The pin 80 may be provided with a tapered point 83 so that any indefiniteness of position of table 11 will not prevent engagement with openings 81 and will correct such indefiniteness by bringing the table to the proper step position.

The full cycle of operation is apparent from the above description and may be briefly summarized as follows: The intermittent star-wheel drive rotates turntable 11 through a given angular distance to move the drilled hub out of drilling position and bring a new hub into drilling position. The table 11 is locked in this position by the action of plunger 80 under control of cam 76. Then the plate P is lifted through the action of cams 72 to lift the hubs on supports 12 into the jigs and effect drilling. The plate is then lowered, the plunger 80 withdrawn from table 11, and the star-wheel mechanism again is actuated through the next step. In the interval that table 11 is stationary, the drilled hubs are removed from the hub supports and undrilled hubs are placed thereon.

Since the drilling of the hubs produces considerable waste material which drops upon table 11 and may clog the mechanism, means are provided whereby said waste is continually removed from the surface of the table. For this purpose, the power drive which includes belt and pulley 25 and 26 may drive through further belt and pulley arrangements 85, 86, 87, 88 and 89 to rotate a horizontal shaft 90 extending inwardly over plate 11 and carrying at its inner end a brush 91 which will thus be continuously rotated about a horizontal axis. The brush is so positioned and the direction of rotation so controlled that the brush will engage the surface of the table during each revolution of the brush and move outwardly toward the circumference of the table and then upwardly. In this movement the brush also removes the drilled hubs. Thus there is a continuous brushing of waste material and drilled hubs past the outer periphery of the table. The waste material and drilled hubs are caught in a screen filter which permits the waste to pass but holds back the drilled hubs.

In order that the hub supports 12 which normally project upwardly through the turntable 11 shall not interfere with the operation of brush 91, the cam track 57 is provided with a depressed portion 57' in cooperative relation with the brush 91. The rollers 56 at the end of lever arms 53 will drop into the depression 57' carrying levers 53 downwardly and hence carrying the respective hub supports 12 downwardly until they are beneath the surface of the turntable in that portion of the table over which brush 91 operates and thus will not interfere with the brush. The drilled hubs remain on the surface of the table after the supports 12 are depressed, until the brush sweeps them off.

As shown in Fig. 1 of the drawings, a plurality of drills may be provided and these may be employed in various combinations for performing various operational sequences. Thus, for instance, to drill the hub shown in Figs. 10 and 11 which calls for drilling first a countersunk hole 93, then a large hole 94 and finally a small hole 95, three drills A, B and C may be employed. The drills A and B are positioned the angular distance 2α apart while drills B and C are positioned the angular distance 3α apart. Drill A is provided with a countersink, drill B with the large drill, while drill C is provided with the finer drill. After the hub has had the countersink drilled by drill A, it will, two steps later, have hole 94 drilled by drill B, and three steps later in the intermittent drive of plate 11 it will reach drill C where the fine hole will be drilled. It will be understood that all of the drills are operating simultaneously on the respective hubs which are in cooperative relation. During this operation the turntable 11 moves at each step through the angular distance α. However, when a hub of the type shown in Fig. 12 is to be drilled, such hub requiring but a single hole, then only drills B and C are employed and each performs the same function. In this instance, the drive is changed so that the table 11 rotates at each step through the angular distance 2α, and since drills B and C are the angular distance 3α apart, alternate hub supports will engage drill B and drill C. In other words, a support that goes under drill B and has the hole 96 drilled in the hub H' will in the next step of the table rotate the distance 2α (one step in advance of drill C) and in the next step of the table will advance another distance 2α (which is one step beyond drill C). On the other hand, the next succeeding support 12, for example the one at position 100 when the drill B is drilling a hub, will in the next step of the table advance to position 101 one step beyond drill B but two steps before drill C. Therefore on the next double step of the table the hub in position 101 will advance into position to be drilled by drill C. Thus alternate hubs on hub supports 12 will engage drill B while the hubs between those which engage drill B will engage

drill C. In this way both drills B and C will drill holes 96 in their respective hubs H' at the same time and the rate of production will be increased because at each angular double step of the table 11 two hubs will be drilled.

The above operation implies that the angular distance through which table 11 may be moved can be adjusted from movement of angle α at each step to movement of angle 2α at each step. For this purpose the following mechanism is provided: The pin 18 carried by disc 17 may occupy either one of two positions on said disc. In position S, nearer the center of the disc, the pin will engage the teeth of the star-wheel for a shorter interval to effect a smaller angular movement of the wheel than when the pin is in position S' farther removed from the center of the disc. Position S' is so determined that pin 18 in this position will effect twice the angular movement of the star-wheel for each rotation of gear 20 than when said pin is in position S.

When the pin 18 is moved to position S' from position S it may be found that it does not coincide with the center of an opening between two adjacent teeth of the star-wheel and that unless some adjustment is made the pin 18 will not enter the notch in the star-wheel freely but will strike one of the teeth. To effect the necessary adjustment without interfering with the meshing relationship of gears 20 and 22, the shaft 19 and its concentric gears and discs are mounted on the support 110 by sets of screws 130 entering openings 131 in the support. A second set of openings 132 may be provided so that the shaft 19, disc 17 and pin 18 may be moved along the plane surface 112 of support 110 to the necessary position to cause the pin 18 to cooperate with the notches in the star-wheel when the pin is moved to position S'. The axis of shaft 19 when pin 18 is in position S and the screws 130 are in openings 131 lies to one side of a normal to the plane 112 a distance equal to one-half the distance between sets of openings 131 and 132. When the shaft 19 (with its gears and discs) is moved to adjust for the screw in position S', it is moved to a position on the other side of the normal equal to one-half the distance between sets of openings 131 and 132. The distance between the axes of shafts 19 and 35 remains the same in the two positions and therefore the meshing of gears 20 and 22 is unaffected by the adjustment.

The drill motors M, M', M'' may be mounted in any suitable manner, preferably so that they may be adjusted vertically to permit boring of holes of any length in hubs of various lengths.

In drilling hubs such as H, shown in the drawings, it frequently happens that these hubs are not all of the same length and therefore holes of different lengths may be drilled because certain of the hubs will project above the hub supports for greater distances than others. To insure constant length of drill hole regardless of the length of hub, there may be provided on the armature 180 of the drill motor, a sleeve 150 which extends above the drill point a predetermined distance corresponding to the depth of hole to be drilled. The motor armature is of a resiliently mounted type. When the hub support lifts the hub into the jig 41 and against the drill, the latter will descend into the hub until the hub or jig engages sleeve 150, after which further upward movement of the hub will cause no further entrance of the drill because the sleeve and motor armature will lift, and hence the drill and hub will lift together. A constant depth of drilling is thus assured regardless of the length of the hub.

It sometimes occurs that a hub will stick in the jig after the hub support is withdrawn. The next hub support lifts its hub into the jig and attempts to complete its stroke under the pressure of the lifting plate P and the driving mechanism, despite the presence of the jammed prior hub. This creates great pressure throughout the entire system and would cause considerable damage if it were not relieved. For this purpose any suitable type of one-way overrunning clutch (not shown) may be employed in the drive system, preferably between the double pulley 26—85 and the shaft 27.

Another method of preventing damage to the machine caused by the presence of a jammed prior hub is shown in Fig. 3. This includes a bell crank 160 pivoted at 161 on a member 162 which in turn is fixed to the main frame 10 of the machine. One arm 163 of the bell crank is connected to the upper end of lever 77 through a link 164 so that when cam 76 moves lever 77 to cause pin 80 to disengage the table 11 and permit the latter to be rotated, the bell crank will be rocked about its pivot (counter-clockwise in Fig. 3). The other arm 165 of the bell crank is normally in close proximity to the hub H positioned within the jig 41. If the drilled hub H has descended with its hub support 12, then the arm 165 of the bell crank meets no opposition when the bell crank is rotated counter-clockwise, the lever 77 moves outwardly, and the table is rotated to its next step position. However, if a hub has stuck in the jig after its support 12 has descended, the arm 165 of the bell crank will strike the hub H and prevent rotation of the bell crank counter-clockwise and hence prevent lever 77 from moving outwardly. Pin 80 remains in engagement with the table 11, and since the driving mechanism continues to operate, the excess resistance will cause the overrunning clutch mentioned in the preceding paragraph to become effective to release the driving connections. Since the table cannot be turned to a new position until the hub H is removed from the jig, it is not possible to jam a second hub into the same jig before the first has been removed.

Still another solution of the above problem of preventing damage to the machine by a jammed hub is disclosed in Fig. 13. Here the distance through which pins 44 are raised is utilized to operate a safety mechanism. A single hub in the jig is raised a predetermined distance. If this hub is jammed and a second hub enters the jig before the first hub has been removed, the jig and its pin 44 will obviously be raised a greater distance than normally. Any tendency to exceed the predetermined distance through which pin 44 is raised is caused to operate safety mechanism in the form of a clutch 170 for disconnecting the driving mechanism. For this purpose the flange 49 on pin 44 is caused to engage a stop 171 carried by a lever 172 pivoted at 173 on the fixed frame 10. The stop is set at the predetermined position to which the flange 49 on pin 44 is raised for drilling one hub. If this distance is exceeded (as in the case where a hub jams and a second hub enters the same jig before the first has been removed), the flange 49 will engage stop 171 to rock the lever 172 which actuates an operating lever 175 pivoted at 176 on the fixed arm to disconnect clutch 170 against the action of a spring 177 which tends to keep the clutch in engage-

ment. This clutch, like the overrunning clutch heretofore mentioned, may be interposed between the driving mechanism and the shaft 27 which carries the double pulley 26, 85.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other equivalent means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

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

1. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable for supporting a plurality of hubs spaced apart a predetermined angular distance, a plurality of drills, and means for moving said turntable step by step, each step corresponding to twice said angular distance, said drills being spaced apart three times said angular distance whereby said drills are caused to cooperate with alternate hubs at each step of said turntable.

2. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a drill, a jig in which said drill operates, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports into cooperative relation to said drill, and means for lifting the hub support which is in cooperative relation to said drill and moving the hub carried by said support into said jig.

3. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a plurality of drills, a plurality of jigs in which said drills operate, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drills, said drills being spaced apart a distance equal to a predetermined number of said steps, and means for simultaneously lifting all of those hub supports which are in cooperative relation to said drills so as to move the hubs carried by the last named supports into said jigs.

4. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a plurality of drills, a plurality of jigs in which said drills operate, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drills, said drills being spaced apart a distance equal to a predetermined number of said steps, means adapted to engage those supports which are in cooperative relation to said drills, and means for lifting said preceding means so as to move the hubs carried by the last-named supports into said jigs.

5. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a plurality of drills, a plurality of jigs in which said drills operate, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drills, said drills being spaced apart a distance equal to a predetermined number of said steps, means adapted to engage those supports which are in cooperative relation to said drills, a plate for supporting said last named means, and means for lifting said plate with a parallel motion whereby all those hub supports which are in cooperative relation to said drills are moved into said jigs.

6. In an automatic drilling machine, a motor driven drill having an armature mounted for linear movement along the axis of rotation thereof, said armature supporting said drill for rotation about said axis, a member carried by said armature and extending downwardly along said drill to within a predetermined distance from the point of the drill, said distance corresponding to the depth of hole to be drilled, a jig in which said drill and said member operate, means for moving articles to be drilled into said jig to engage said drill, said article being engaged by said member after said drill has penetrated to said predetermined distance whereby further movement of said article axially relative to said drill will lift said armature and said drill and cause no further penetration of said drill into said article.

7. In an automatic drilling machine, a motor driven drill having an armature mounted for linear movement along the axis of rotation thereof, said armature supporting said drill for rotation about said axis, a member carried by said armature and extending downwardly along said drill to within a predetermined distance from the point of the drill, said distance corresponding to the depth of hole to be drilled, a jig in which said drill and said member operate, a turntable for supporting a plurality of hypodermic needle hubs or similar articles, said hubs varying in length, means for driving said turntable step by step to bring said hubs successively into cooperative relation to said drill, and means for moving the hub which is in cooperative relation to the drill into the jig, the said hub engaging said member after said drill has penetrated to said predetermined distance, whereby further movement of said hub into said jig will lift said armature and said drill and cause no further penetration of said drill into the hub regardless of the length of the hub.

8. In an automatic drilling machine, a drill, a jig in which said drill operates, a turntable for supporting a plurality of articles to be drilled, means for driving said turntable step by step to bring said articles successively into cooperative relation to said drill, said drill being positioned on one side of said turntable and means cooperating with the other side of said turntable for removing drill waste from the turntable and the drilled hubs therefrom, said last-named means comprising a brush and means for continuously rotating said brush, said brush being so mounted as to engage the turntable once during each rota-

tion of the brush, the direction of rotation being such as to cause the brush to move with respect to said table outwardly toward the periphery thereof.

9. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a plurality of drills, a plurality of jigs in which said drills operate, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drills, said drills being spaced apart a distance equal to a predetermined number of said steps, means for simultaneously lifting all of those hub supports which are in cooperative relation to said drills so as to move the hubs carried by the last named supports into said jigs, a cam upon which the outer ends of said levers operate, said cam being so formed that said levers and their supports are depressed after passing all of said drills so that said supports are below the surface of the turntable, and means cooperating with the portion of the turntable in which the supports are below the surface for removing drill waste and the drilled hubs from said turntable.

10. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a drill, a jig in which said drill operates, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drill, means for lifting the hub support which is in cooperative relation to said drill so as to move the hub into said jig and lower the support after the hub is drilled, a source of power for operating said turntable and said lifting means, a releasing means between said source of power and the mechanisms operated thereby, and means whereby said releasing means is rendered effective when the hub in drilling position remains in the jig after its support has been lowered.

11. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a drill, a jig in which said drill operates, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drill, means for lifting the hub support which is in cooperative relation to said drill so as to move the hub into said jig and lower the support after the hub is drilled, a source of power for operating said turntable and said lifting means, a releasing means between said source of power and the mechanisms operated thereby, and means whereby said releasing means is rendered effective when the pressure between the lifting means and the jig exceeds a predetermined pressure.

12. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a drill, a jig in which said drill operates, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drill, means for locking said turntable in position at each step and releasing the same after a hub has been drilled, means for lifting the hub support which is in cooperative relation to said drill so as to move the hub into said jig and lower the support after the hub is drilled, a source of power for operating said turntable and said lifting means, a releasing means between said source of power and the mechanisms operated thereby, and means whereby said releasing means is rendered effective when the hub in drilling position remains in the jig after its support has been lowered, said last-named means comprising means adapted to engage the hub in the jig when the turntable releasing means is rendered effective for preventing release of said turntable.

13. In an automatic drilling machine for hypodermic needle hubs and similar articles, a turntable, a drill, a jig in which said drill operates, a shaft for supporting said turntable, a plurality of levers pivotally connected to said shaft, a plurality of hub supports slidably mounted in said turntable, each of said supports being carried by one of said levers, means for moving said turntable step by step to bring successive hub supports successively into cooperative relation to said drill, means for lifting the hub support which is in cooperative relation to said drill so as to move the hub into said jig and lower the support after the hub is drilled, said jig being lifted a predetermined degree by the insertion of a hub therein, a source of power for operating said turntable and said lifting means, a releasing means between said source of power and the mechanisms operated thereby, and means whereby said releasing means is rendered effective when the hub in drilling position remains in the jig after its support has been lowered, said last-named means comprising an operating member for actuating said releasing means, and means whereby said operating member is adapted to be engaged by said jig when said jig is lifted in excess of said predetermined degree by the engagement of a second hub with said jig before the first hub has been released.

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