Jan. 8, 1946. P. SCHULTZE 2,392,774

APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

Original Filed April 29, 1942 7 Sheets-Sheet 1

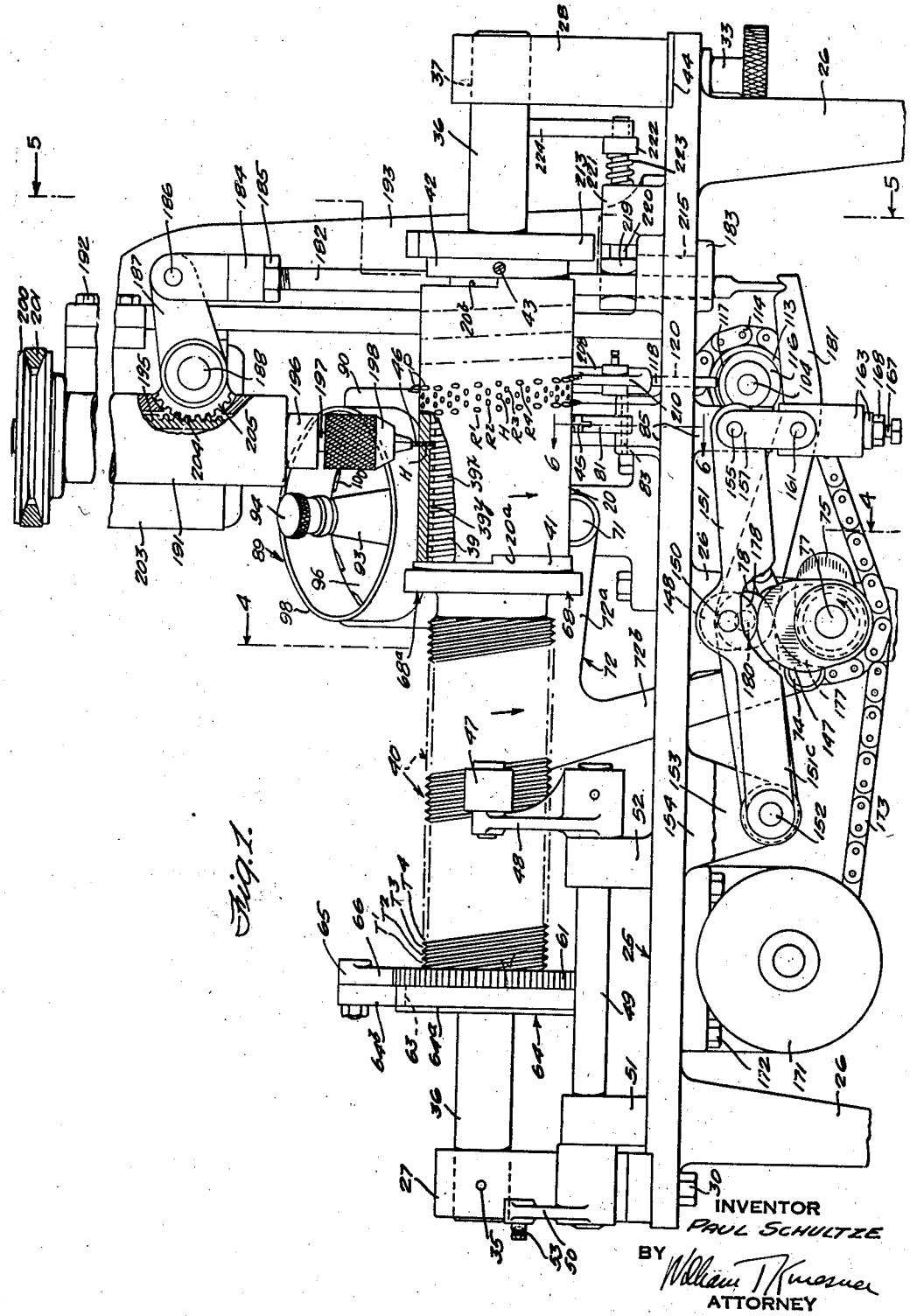


Fig. 1.

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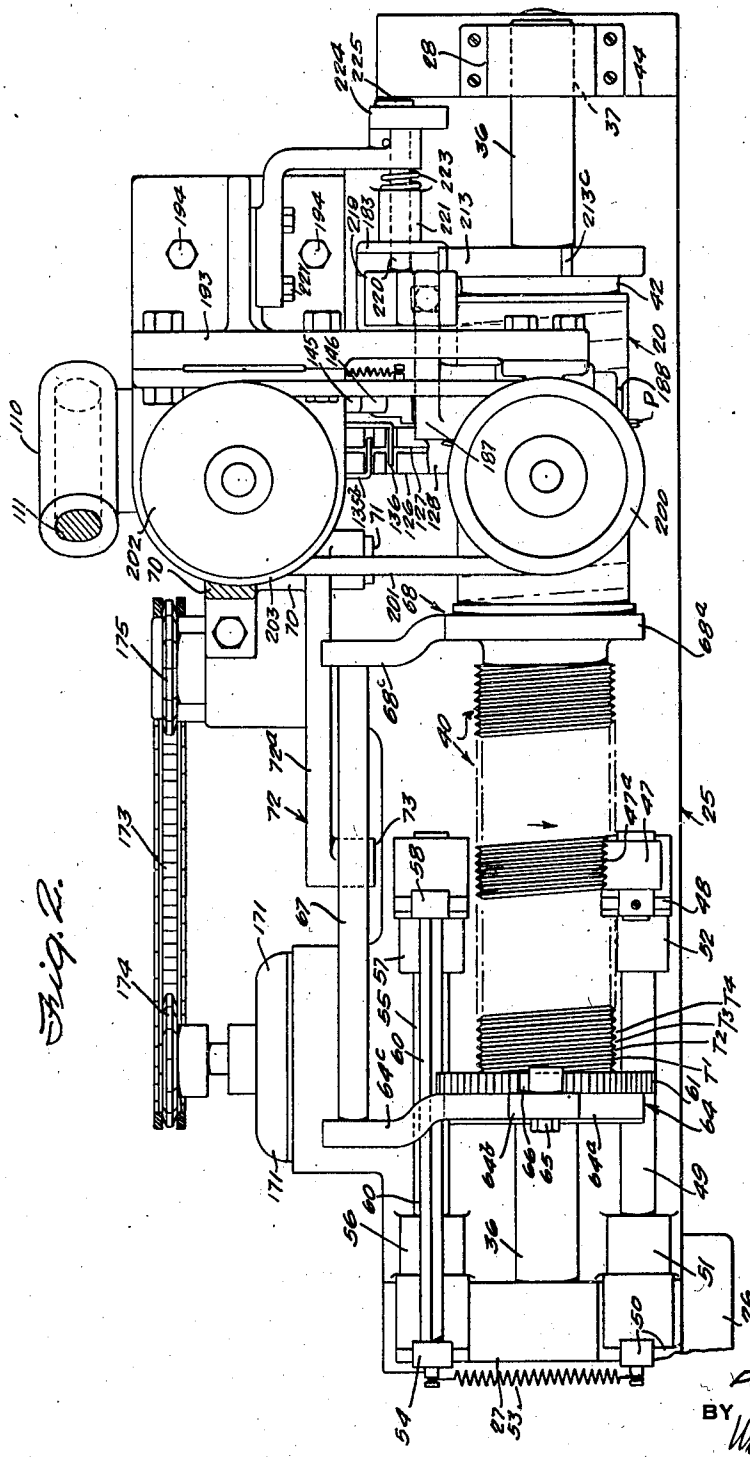


Fig. 2.

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APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

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Fig. 3.

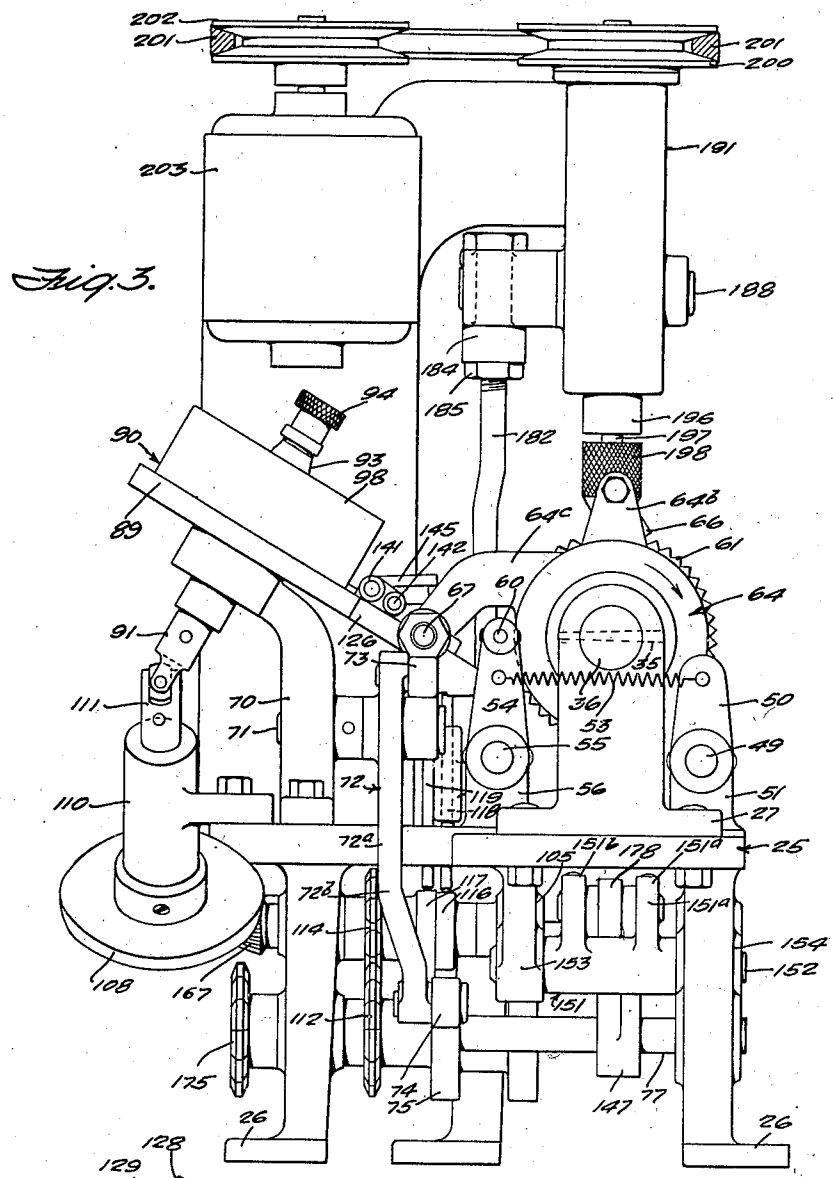
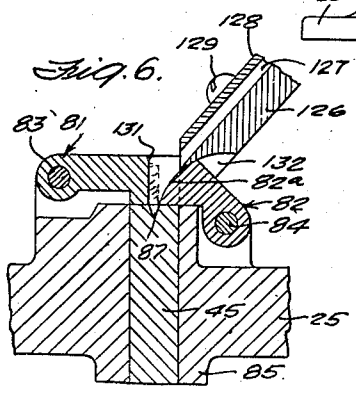


Fig. 6.



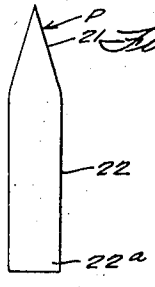


Fig. 7.

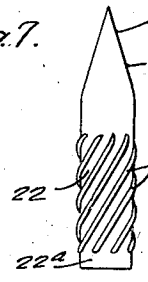


Fig. 8.

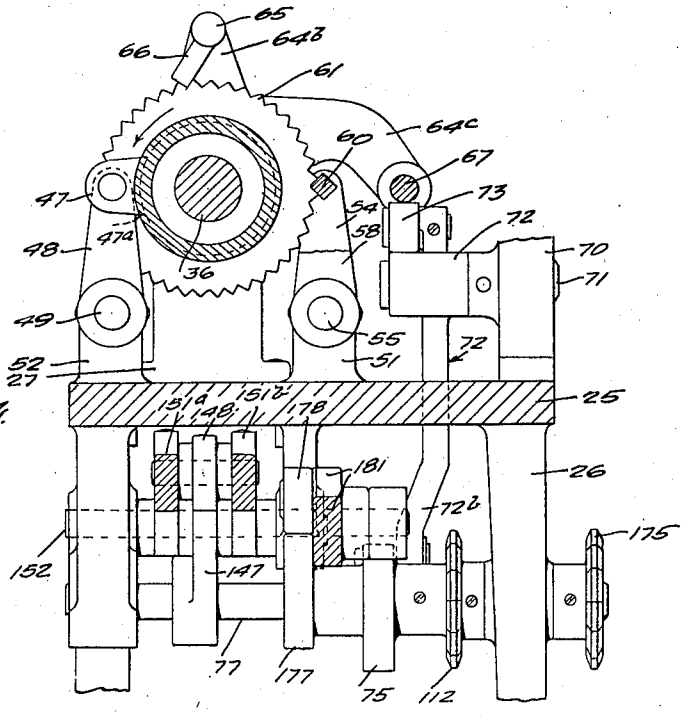
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APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

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Fig. 4.



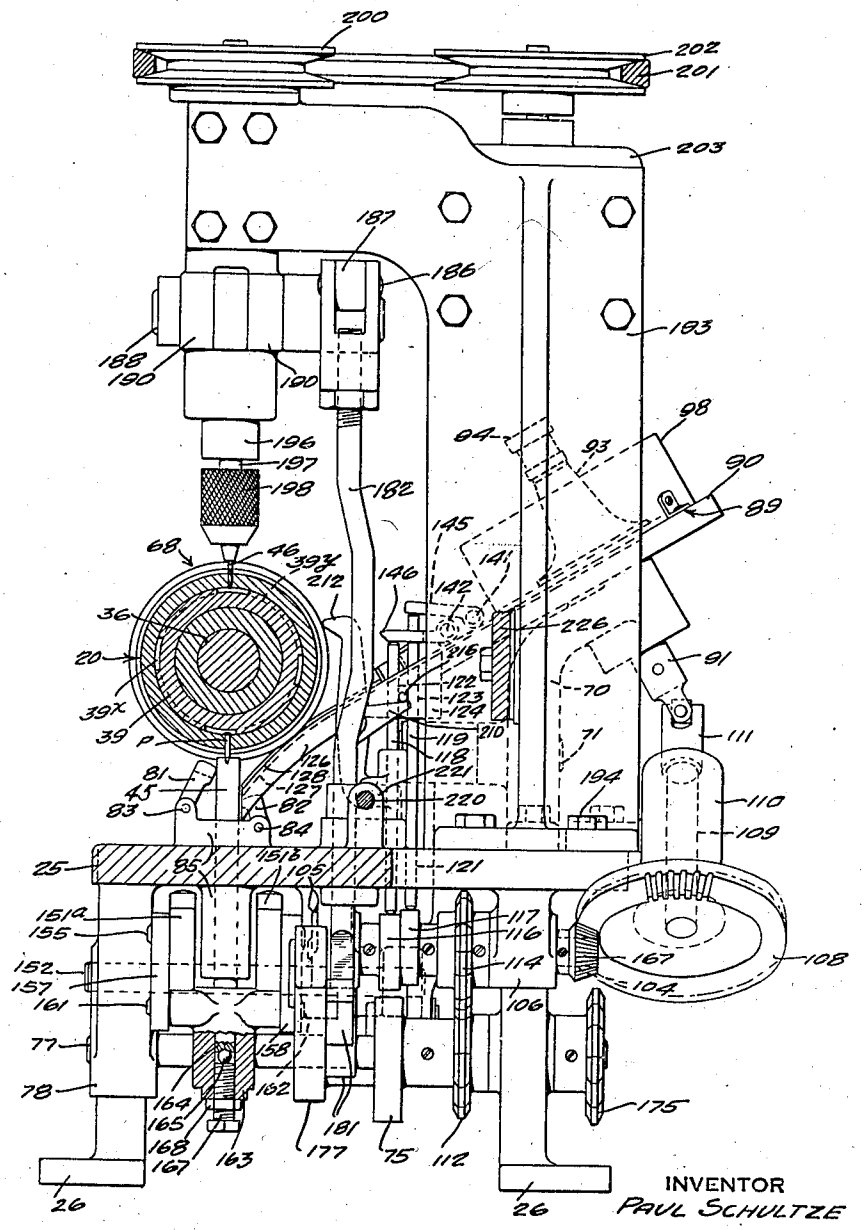
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APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

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Fig. 5.



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Fig. 9.

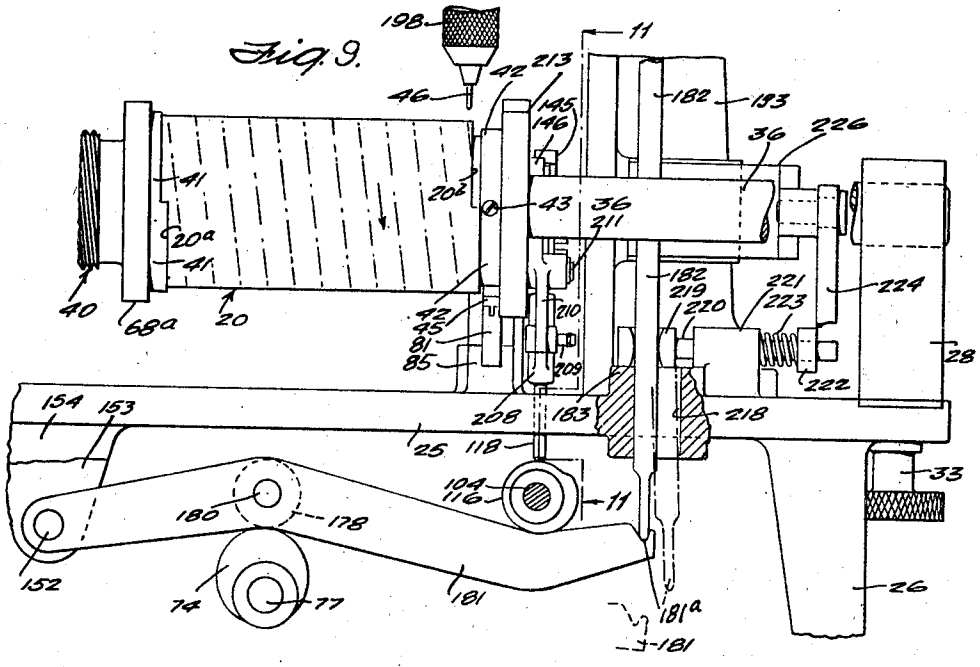
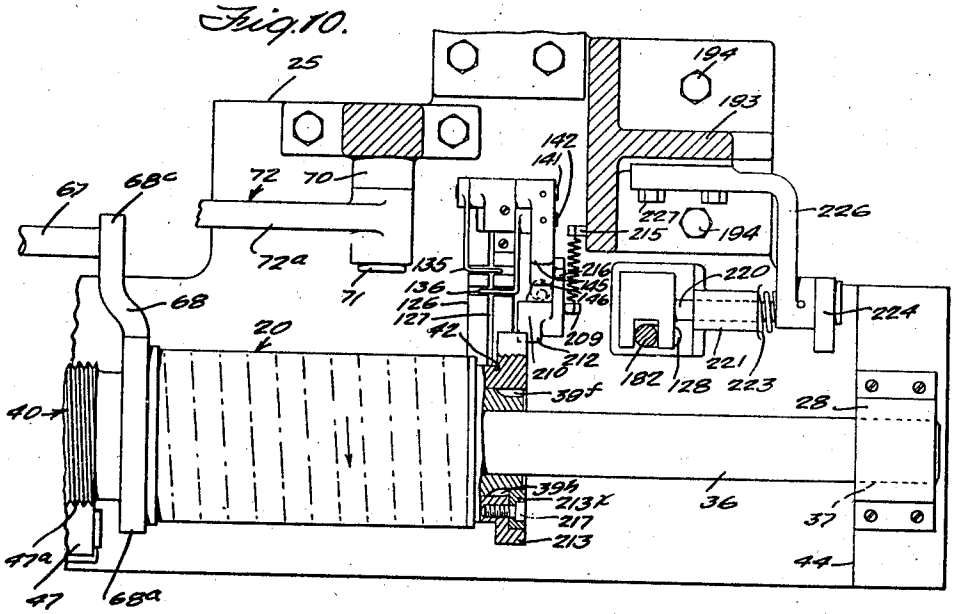


Fig. 10.



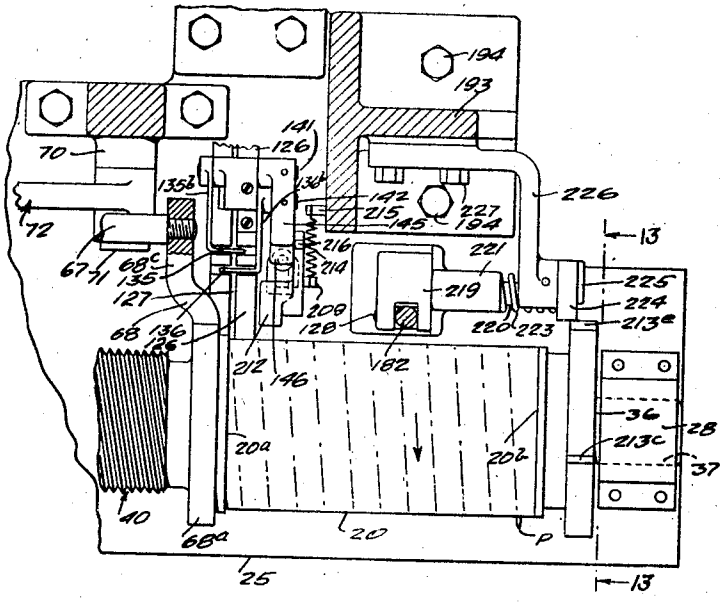
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APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

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Fig. 12.



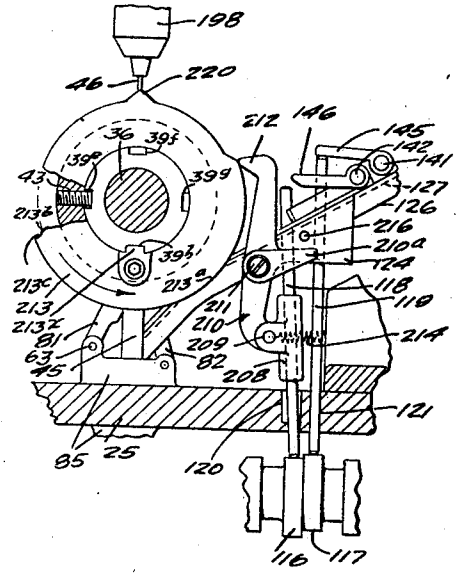


Fig. 11.

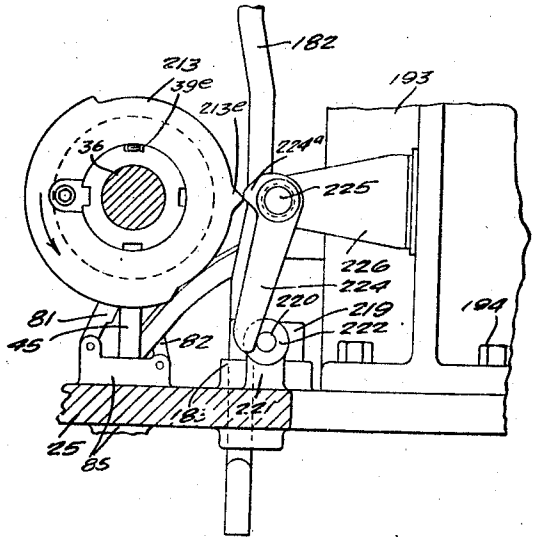


Fig. 13.

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Patented Jan. 8, 1946 2,392,774

UNITED STATES PATENT OFFICE

2,392,774

APPARATUS FOR DRILLING HOLES IN CYLINDRICAL SUPPORTS OR THE LIKE

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Original application April 29, 1942, Serial No. 441,045. Divided and this application June 14, 1944, Serial No. 540,205

19 Claims. (Cl. 77—64)

This invention relates to an apparatus for drilling holes in cylindrical supports or the like, more particularly to an apparatus for drilling successions of holes in the cylindrical supports for so-called picker rolls, and thus to prepare such supports for the reception of pins or the like.

This application is a division of my application Serial No. 441,045, filed April 29, 1942.

One of the objects of this invention is to provide a dependable and practical apparatus for rapidly and efficiently preparing the hollow cylindrical support for the reception of the picker pins and in a manner to make it possible to provide and maintain dynamic balance. Another object is to provide an efficient apparatus, capable of operating at high speed, for drilling appropriately distributed holes in the picker roll support for the reception of the picker pins.

Another object is to provide an efficient and dependable apparatus that will be capable, at relatively high speed, of drilling suitably distributed holes through the relatively thin wall of a hollow cylindrical support and with such holes having such substantial identity of distance of the centers of mass of the pins that they are ultimately to receive as will achieve dynamic balance.

Another object is to provide an apparatus of the above-mentioned character that will be of improved and compact construction, of efficient action, and well adapted to meet the varying conditions of hard practical use. Another object is in general to provide improved apparatus capable of highly efficient functioning in the art to which it pertains. Other objects will be in part obvious or in part pointed out hereinafter.

Another object is to provide an apparatus for drilling holes in the desired pattern, such as in a row or rows, and where the drilling of the holes is to be followed by putting pins therein, to provide dependable controls for the drilling operations as will be capable of effecting compensation for the time differentials at which the drilling and pin-setting operations are performed. Another object is to provide, in such an apparatus, a dependable control for halting the hole-forming operation at the completion of the pattern and capable of such interrelation with other controls as to permit continuance of the pin-assembling operation until the holes corresponding to the space differential above mentioned have had pins assembled thereto.

Another object is to provide an apparatus of the just-mentioned character that will be thoroughly practical and dependable and which will be capable of operation with minimum supervision. Another object is to provide an apparatus of the just-mentioned character in which the controls are readily adaptable to varying requirements met with in practical use.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of my invention,

Figure 1 is a front elevation of the complete apparatus;

Figure 2 is a plan view thereof with certain parts omitted or broken away to show certain other parts more clearly;

Figure 3 is an end elevation as seen from the left in Figure 1;

Figure 4 is a sectional view as seen along the line 4—4 of Figure 1, certain parts being broken away or omitted;

Figure 5 is a view as seen along the line 5—5 of Figure 1;

Figure 6 is a detached vertical sectional view as seen along the line 6—6 of Figure 1;

Figure 7 is an elevation on a larger scale showing an illustrative form of pin;

Figure 8 is an elevation on a larger scale showing another illustrative form of pin;

Figure 9 is a front elevation, like that of Figure 1, certain parts however being broken away or omitted, showing certain relationships upon setting the apparatus to drill the first hole;

Figure 10 is a plan view of the apparatus shown in Figure 9;

Figure 11 is a fragmentary view as seen along the line 11—11 of Figure 9, showing certain of the parts as they are interrelated upon drilling the first hole;

Figure 12 is a view like that of Figure 10 but shows the relationship of certain of the parts upon driving of the last pin;

Figure 13 is an end elevation of transverse section as seen along the line 13—13 of Figure 12.

Similar reference characters refer to similar parts throughout the several views of the drawings.

As conducive to a clearer understanding of certain features of this invention, it might here be noted that, in the fur felt industry, "blowing" machines are employed to effect separation from the desired fur fibres of heavier fur fibres and foreign or undesirable material, like pieces of skin, and that in such machines there are employed picker rolls that have to be driven at high rotary speeds, speeds on the order of 4,000 R. P. M., the separating action above mentioned taking place, in coaction with other elements, as a result of the higher velocity imparted to the particles by the rapidly revolving picker rolls. In such actions, the heavier or undesired particles or materials are caused to exert centrifugal

forces sufficient to discharge them tangentially away from the lighter or desired fur fibres, the latter being moved in the desired direction by air currents produced by the projecting picker pins of the high speed picker roll.

To achieve these actions requires high peripheral velocities and I have found that where the picker roll diameter is on the order of 4", a drive on the order of 4,000 R. P. M. is appropriate where the picker pins are closely set and project from the picker roll for about ¼". The pins are preferably of metal, such as steel, and where projecting ends are pointed the shanks may be plain or may have a multiple thread of large pitch thereon so as to cut their own thread when forced into the support.

At these high peripheral velocities and with the relatively substantial size or mass of the pins, there should be good dynamic balance of the picker roll and such a secure anchorage of the pins therein as to resist the centrifugal force tending to dislodge them, for loss of pins would not only diminish the action and efficiency of the picker roll but also effect unbalance. Moreover, the pins are very numerous. To provide a practical, efficient and high speed apparatus for uniformly drilling holes for the pins to facilitate subsequent assembling and anchoring of such picker pins to a rotary picker roll element is one of the dominant aims of this invention.

A preferred and illustrative form of rotary base or picker roll element for supporting and anchoring the pins comprises a tubular or sleeve-like element indicated generally by the reference character **20** in Figures 1, 2 and 5 of the drawings, being relatively thin-walled, made of a material of good tensile strength, and preferably of a moldable material such as phenolic condensation product, preferably with fibrous material such as layers of suitable fabrics embedded therein and impregnated by and bound together with the phenolic condensation product. The sleeve element, referred to in the claims also as a "support," may have an inside diameter of 2¾", an outside diameter of $3\frac{3}{16}$", making a wall thickness of $\frac{7}{32}$". Such a sleeve element, either singly or several of them axially aligned, may be mounted upon a drum-like shaft of metal onto which it snugly fits and is sleeved and suitably secured thereto, and as so mounted may function in the above-mentioned fur blowing machines.

The pins P preferably take a form like those shown in Figures 7 and 8, being preferably of metal, such as steel, and being dimensioned to have good points as at **21** and good rigidity to resist the reactions of the mechanical forces exerted in the blowing machine; thus, they may be of a thickness on the order of $\frac{1}{16}$".

They have shanks **22** preferably cylindrical in form and in the form of Figure 8 the shank is provided with threads **23** of relatively large pitch and preferably terminating short of the stub end of the pin, thus to leave a portion **22a** of the shank substantially free of threads and of a diameter on the order of the root diameter of the threads **23**.

By means later described, the sleeve **20** is drilled to provide it with holes H preferably arranged in one or more helical rows, illustratively four helical rows, one of which is indicated in Figure 1, at R^1, analogous to a multiple thread of substantial pitch, the holes, as is also indicated in Figure 5, extending completely through the wall of the sleeve **20**. They should be uniformly distributed and moreover the diameter of the holes H is somewhat less than the diameter of the shank **22** of the pins P where the latter are plain, as in Figure 7, so that the fit of the shank into a hole is analogous to a force fit, and where pins of steel pitch threads are employed as in Figure 8, the diameter of the holes is just about equal to the root diameter of the threads **23** so that the threads have to cut themselves a corresponding threaded pathway into the material of the sleeve **20**, the pin undergoing rotary movement in the process. The tough character of the material of sleeve **20** thus causes it, in either case, to securely grip and envelop the shank of the pin when the latter is forced home, the shank becoming in effect tightly embedded and securely anchored in the material. The great number of pins are to be assembled to the sleeve with a security or anchorage like that above mentioned and moreover with their centers of mass equidistant from the axis of the sleeve.

The apparatus for effecting such drilling comprises (see Figure 1) a base **25** with supports or legs **26**, and upstanding from the base **25** are standards **27** and **28** of which standard **27** is rigidly and fixedly secured as by the screws **30** and the standard **28** is detachably secured to the base as by a threaded stud **31** projecting downwardly from the standard **28** through an open-ended slot **32** in the base **25**, threaded stud **31** receiving a hand-operated clamping nut **33**. In standard **27** is rigidly anchored, as by a pin **35**, a relatively heavy and strong shaft **36** whose opposite end enters a hole **37** in the standard **28**, thus to support the right-hand end of the shaft **36**.

Shaft **36** rotatably and slidably supports a cylindrical structure of which the right-hand portion is in the form of a mandrel **39** of a length appropriate to receive thereon the sleeve **20** and of which the left-hand portion is threaded as at **40**, the portion **40** having thereon threads which in number and pitch correspond to the number and pitch of the rows of the holes H in the sleeve **20**. Thus, where the latter is to have four rows or helixes, portion **40** has four threads, T^1, T^2, T^3 and T^4.

Suitable means are provided for fixing the position of the sleeve **20** relative to the threads of element **40**. Since, in the preferred construction of the above-mentioned picker rolls, I prefer to sleeve several sleeves **20** onto the driving and supporting drum or shaft and since for that purpose I provide the peripheral ends of the sleeves with cut-outs **20a** and **20b**, preferably each of 180° extent and displaced from each other by 180° so that successive sleeves interfit and interlock at their adjacent ends, I prefer to utilize such stepped or cut-out ends of the sleeve for fixing its position relative to the threaded part **40** and hence, intermediate of the parts **39** and **40** I may provide an annular shoulder **41** presenting at its right-hand end, as viewed in Figure 1 a step or cut-out of 180° extent with which the left-hand end of sleeve **20** interfits and thus holds the sleeve **20** against rotation relative to the mandrel **39**, as is clear from Figures 1 and 2, and onto the end of mandrel **39** I may slip a collar **42** temporarily anchored as by a set screw **43** to hold the sleeve **20** against axial movement out of interlocking relation with the shoulder **41**.

By loosening up the hand nut **33**, the standard **28** may be slipped off toward the right, leaving the shaft **36** supported as a cantilever from the standard **27**, whence, after loosening the collar **42**, the collar and the sleeve **20** may be slipped off the mandrel **39** and right-hand end of shaft **36**, to be replaced by another, by a reverse sequence

of steps, it being noted that the base 25 is suitably shaped as at 44 to form a seat for the standard 28 and thereby fix the position to which it is returned.

The mandrel 39 is preferably constructed to give the relatively thin-walled sleeve 20 substantially uniformly distributed support and for that purpose I prefer to have the outside diameter of the mandrel 39 dimensioned to snugly receive thereover the sleeve 20, but externally the mandrel 39 is grooved as at 39^x to provide as many helical grooves 39^x, as there are to be helical rows of pins, illustratively four such helical grooves corresponding also in pitch to that of the four helical rows R^1, R^2, R^3 and R^4 of the above-mentioned holes H; this construction leaves the cylindrical surface sub-divided into a similar number of helixes 39^y which thus present uniformly distributed supports against which the internal face of the sleeve 20 engages. The structure 39—40 may be made hollow or tubular, if desired, excepting of course at those portions, such as the ends, where it is bored to a diameter to form a sliding and rotary fit relative to the fixed shaft 36.

The shaft 36 is of sufficient extent relative to the length of the structure 39—40 to give a range of sliding movement sufficient to traverse the entire length of the sleeve 20 relative to two points which, in order not to require extension of the range of such sliding movement, are preferably displaced in an axial direction as little as possible; one of these points is at the locus of operation of a drill 46 (Figure 1) and the other is at the locus of operation of the vertically movable pin-forcing device which includes a plunger 45. Conveniently, drill 46 and plunger 45 are diametrically opposed (Figure 5), being thus spaced 180° from each other, and to achieve the above-mentioned preferred or minimum spacing, they are axially displaced (see Figure 1) by a distance corresponding to half a turn of the equally pitched helical groove 39^x. Both drill 46 and plunger 45, having their vertical axes intersecting the axis of the mandrel 39 where the pins are to be positioned radially of the sleeve 20 are thus juxtaposed to a helical groove 39^x in the mandrel 39, drill 46 being in advance of the plunger 45 with respect to the direction of rotary movement of the mandrel and sleeve, that direction being as indicated by the arrow in Figure 1.

Coacting with the threaded element 40 is a block 47 having a face 47^a (Figure 2) that is curved and threaded to mate with the threaded surface of the part 40, being like a segment of a nut.

Block 47 is held against movement lengthwise of the guiding shaft 36 but is mounted to be moved toward or away from threaded element 40 so as to engage or disengage its thread. Conveniently, it is supported on an arm 48 fixed to a shaft 49 that has an arm 50 fixed to its other end, shaft 49 being supported in two upstanding bosses 51 and 52 in which it and the arms may oscillate as a unit and by which this unit is held against axial movement.

Suitable means are provided to hold the block 47 in engagement with the threaded part 40 and such means preferably comprise a spring 53 connected to arm 50 and to an arm 54 (Figures 2 and 3) secured to a shaft 55 supported in bosses 56 and 57 projecting upwardly from the base 25 like the bosses 51—52 that support shaft 49.

Shaft 55 can swing in the bosses 56—57 but is held against axial movement by the engagement of arm 54 with the boss 56 and by the engagement of an arm 58 at its other end with the boss 57. Arms 54 and 58 extend upwardly and in parallelism (Figures 2, 3 and 4) and in their upper ends fixedly support the ends of a holding pawl 60 which, being conveniently in the form of a square rod, presents throughout its length, which is at least equal to the traverse stroke of the structure 39—40, a single tooth-like portion for coaction with a toothed ratchet wheel 61 mounted or formed at the left-hand end of the rotary and slidable structure 39—40. Thus holding pawl 60 may coact with the ratchet wheel 61 at any point in the axial movement of the wheel 61 whose teeth are in number the same as the number of holes H desired to be provided in a single turn of the sleeve 20 or of a helical row of holes.

Spring 53 will thus be seen to bias the threaded block 47 into engagement with the threads of part 40 and to bias also the holding pawl 60 into proper coaction with the ratchet wheel 61, and normally holds each of them in its proper coacting relation. But pawl 60 may be disengaged from ratchet wheel 61 manually simply by swinging it away from the ratchet wheel and against the tension of spring 53 and in a similar way block 47 may be manually disengaged from the threaded part 40.

To the left of ratchet wheel 61, as seen in Figures 1 and 2, the structure 39—40 is constructed as at 63, to provide a bearing for the hub 64^a of a bell crank lever 64 having an upwardly directed arm 64^b by which is pivotally carried, as by the pin 65 a pawl 66 urged in any suitable way, as by its own weight, into coacting relation to the ratchet wheel 61 (see Figures 3 and 4).

The other arm 64^c of the bell crank lever 64 extends rearwardly and downwardly and has secured to it one end of a rod 67 whose other end is rigidly secured to the arm 68^c of a lever 68 whose hub 68^a has a bearing coaxial with the bearing of hub 64^a of lever 64, and this bearing is conveniently and preferably formed in the left-hand portion of the shoulder 41 (Figures 1 and 2) of the structure 39—40.

A bracket 70 secured adjacent the rear end of the base 25 carries a horizontal pin 71 (Figures 2, 3 and 4) which forms a horizontal pivot for one arm 72^a of a V-shaped lever 72 (see Figure 1) at whose apex is mounted a roller 73 which is thereby positioned underneath the rod 67, and whose other arm 72^b extends downwardly through a suitable aperture in the base 25 and has mounted on its end a roller or cam follower 74 for coaction with a cam 75.

Cam 75 is mounted upon a shaft 77 extending transversely of and below the base 25 from which extend downwardly suitable means such as an arm 78 and one of the legs 26 suitably bored or provided with bearings for the shaft 77.

By means of the rotating cam 75, the lever 72 is actuated in clockwise-direction about its pivot pin 71 (as viewed in Figure 1) and given a return stroke, once for each revolution of the cam 75 and at a suitable point in its rotation, cam follower 74 being held in coaction with the cam 75 in any suitable way as, for example, by the weight of the lever 72 and the weight of the rod 67 and the lever arms 64^c and 68^c which tend to swing downwardly or in counter-clockwise direction, as viewed in Figure 3.

Accordingly, upon the upward swing or stroke of lever 72 (Figure 4) roller 73 moves upwardly and, being in engagement with the rod 67 irrespective of the position of the structure 39—40

lengthwise of the guide shaft 36, moves the latter upwardly and thus moves the pawl 66 in counterclockwise direction to rotate the ratchet wheel 61 and hence the structure 39—40 by an amount equal to the distance between two teeth of the ratchet wheel 61, the angle of movement corresponding to the angle desired to be subtended by two successive pins in the ultimate picker roll and hence by two successive holes H to be drilled in a row of holes in the sleeve 20, the holding pawl 69 yielding toward the right as this rotary movement commences and being in effect cammed out of the space between two teeth but being entered into the next succeeding space under the bias of spring 53, thus not only to hold the structure 39—40 in its new position, but also, by bottoming in the succeeding space, accurately fixing the step of rotary movement to the above-mentioned angle.

And as that rotary movement takes place, the coaction between the threaded part 40 and the block 47 (Figure 1) effects a movement of translation of the structure 39—40 along its guiding support 36, and with the actuating pawl moving in the direction above described and with the threads on part 40 being as shown in Figure 1, that step of rotary movement is accompanied by a step of traverse of the structure 39—40 in a direction toward the right as viewed in Figure 1.

Since the drawings show the sleeve 20 and the mandrel 39 at about its halfway point of rotary and axial traverse, thus assuming that certain operations, namely, the drilling and pin-setting, as hereinafter described, have taken place throughout about one-half of one of the helixes, the completion of the above-mentioned step of conjoint rotary and axial movement of the structure 39—40 brings a blank space or portion of the sleeve 20 into juxtaposition to the locus of operation of the drill 46 and brings an already drilled hole into alignment with the plunger 45 to have a pin pressed or forced into the hole, there being a 180° arcuate extent of drilled holes between the point of operation of the plunger 45 and the point of operation of the drill 46 because these two elements happen to be spaced 180° apart as above noted.

With the halting of the sleeve 20 in this new position, the drill 46 having been held in withdrawn position during the movement as is later described, is now moved downward as seen in Figures 1 and 5 at a suitable cutting feed rate to drill a hole in the blank space of the sleeve 20, and as shown in Figure 1 the downward movement of the drill is preferably to an extent to pierce the relatively thin wall of the sleeve 20, the protruding end of the drill being accommodated in the underlying helical groove 39^x, and which is of ample width and depth for that purpose. During the drilling operation, the wall of the sleeve 20 is well supported against the pressure of the drill, by the helical mandrel faces 39^y to either side of the helical groove 39^x as seen in Figure 1, the downward pressure upon the mandrel 39 being opposed by the upward pressure thereon exerted by the plunger 45 which, during the drilling stroke of the drill is moving upwardly as viewed in Figure 1 to force-fit a pin into a hole in the sleeve 20.

Plunger 45, at the conclusion of the above-described rotary and axial movements of mandrel 39—40, is in lowermost position, a position better shown in Figure 6. Plunger 45 actuates separable throat elements which in Figures 5 and 6 are shown as comprising two members 81 and 82, pivotally mounted on pins 83 and 84 and biased toward the plunger and hence toward each other in any suitable way, as by their own weight, pins 83 and 84 being carried in spaced ears formed in the upper portion of a boss 85 preferably formed integrally with the base 25 and bored or drilled as at 86 to form an accurate guide for the cylindrical plunger 45 to guide its axis preferably in a line at right angles to, and intersecting, the axis of the mandrel 39 and hence of the sleeve 20.

The just-mentioned supply magazine and coacting mechanism are fully described in my above-mentioned parent application and, hence, only so much thereof will be briefly described herein as will aid in more readily understanding how certain controls of the drilling operations and mechanisms may be interrelated to certain controls of the pin-feeding and setting mechanisms. The magazine 89 (Figures 1 and 5) comprises a cylindrical wall 98 secured to a base plate 90 that is inclined, being an extension of the bracket 70, and having extending therethrough a shaft 91 at the upper end of which is secured, by nut 94, a conical hub 93 at the lower end of which is secured a circular plate 96, peripherally slotted as at 100, in the shape of the pins P. Upon rotation of plate 96, pins are supplied, pointed ends first, to the upper end of a channel 127 (Figure 10) which underlies tangentially the rotary path of movement of the slots 100. Channel 127 is continued in the form of a groove in an inclined member 126, preferably covered over by a strip-like plate 128 (Figure 6) throughout its lower extent, to guide pins individually, pointed end first, into the plunger recess 87, slot 131 in throat element 81 and the curved face 82^a of throat element 82 coacting, when in the positions shown in Figure 6, to guide the pin into the recess 87. Upward stroke of plunger 45 swings element 81 counterclockwise out of its path and swings member 82 clockwise, the under part of member 126 being cut away, as at 132, for that purpose.

Shaft 91 (Figure 5) has a universal joint connection 111 with a shaft 109 carried in a bearing bracket 110, a gear 108 on a shaft 109 being driven by a mating gear 107 carried by an auxiliary shaft 104 supported underneath frame 25 in bearing bosses 105, 106 (Figure 5). Shaft 104 is driven from main drive shaft 77, as by sprockets 112 and 113 and a chain 114. On shaft 104 are cams 116 and 117 (Figures 3 and 5) with which coact cam follower rods 118 and 119, respectively, being guided in vertical holes or guideways 120 and 121 in the base 25 (Figure 11) and holes 122 and 123 in a block 124 that is secured to the pin-guideway member 126 (Figure 5). Follower rods 118 and 119 actuate gates 135 and 136 (Figure 12) that are positionable transversely of the pin slot 127, member 126 being appropriately slotted for that purpose.

Gates 135 and 136 have arms 135^b and 136^b secured to shafts 141 and 142, respectively, mounted in a bearing block 143 carried by channel member 126, shafts 141 and 142 having secured thereto lever arms 145 and 146 which overlie and are engaged by the cam follower rods 119 and 118, respectively. Cams 116 and 117 effect such successive lifting of gates 135 and 136 as to release pins P one by one for sliding down the inclined channel 127 for engagement with the plunger 45 (Figure 6).

Downward stroke of the drill is preferably achieved by a cam 177 on the main drive shaft 77

(Figures 1, 3, 4, and 5), shaped as is better shown in Figure 1 and coacting with a cam follower or roller 178 rotatably supported by a pin 180 in a lever 181, the left-hand end of which is pivotally supported by a shaft or pin 152 carried by two spaced bosses 153 and 154 projecting downwardly from the base 25 and the right-hand end of which (Figure 1) extends to a point where it underlies a push-rod 182 that extends vertically through the base 25 which is formed to provide a suitable vertically-extending boss 183 to guide and aid in supporting the push-rod 182.

The upper end of push rod 182 is threaded into the lower end of a bifurcated member 184, locked as by a lock nut 185, member 184 carrying a pin 186 by which a pivotal connection is effected with an arm 187 secured to a shaft 188 rotatably supported in horizontal bearings 190 (Figures 1 and 5) formed in the vertical drill-spindle guide frame 191, the latter being secured as by screws 192 to the upper end of a standard 193 which rests upon the bed or base 25 which is secured as by screws 194.

The frame 191 is sleeve-like or elongated in form and supports therein non-rotatably but vertically slidable a sleeve-like spindle support 195 provided in any suitable way with suitable combined radial and thrust bearing, one of which is indicated at 196 for rotatably supporting the shaft or spindle 197 so that the latter may freely rotate but must partake of up and down movement with the spindle support 195.

At its lower end, the shaft 197 is provided with a suitable chuck 198 to receive the drill 46 and at its upper end the shaft 197 has a splined connection (not shown) with a pulley 200 by which it is driven at a suitable drilling speed, a belt 201 extending from pulley 200 to a pulley 202 mounted on the shaft of a motor 203 secured to the upper end of the upright standard 193.

Intermediate of the bearings 198 (Figure 5) the spindle supporting frame 190 is cut away to expose the teeth formed in the spindle support 195, thus to form a rack 204 and meshing with the rack 204 are the teeth of a sectional gear 205 rigidly secured to the shaft 188 and accommodated between the spaced bearings 190.

On shaft 77 is a cam 147 (Figures 1, 3, and 4) coacting with a cam roller 148 carried by pin 150 in the bifurcations 151ª and 151ᵇ of lever 151, the left-hand end of which 151ᶜ (Figure 1) is pivotally supported by the shaft or pin 152. Lever parts 151ª and 151ᵇ extend to either side of the boss 85 (Figure 5) and have pivotally secured to them, as by pins 155 and 156, links 157 and 158, respectively, which at their lower ends pivotally engage, as by pins or trunnions 161 and 162, a plunger-carrier 163 having a vertical bore 164 in which is received the lower end of the plunger 45, the vertical position of which may be adjusted by screw 167 (Figure 5), locked by nut 168, and where the pins P are threaded, as in Figure 8, plunger 45 may partake of rotary movement with the pin, and for this purpose I interpose a steel ball 165 between the lower end of plunger 45 and the screw 167. By setting screw 167 the plunger 45 may be set to force the pins home into the holes always to the same depth, preferably not beyond the inner face of the sleeve 20 so as not to interfere with slipping the sleeve element off the supporting mandrel.

As is better shown in Figure 1, cam 177 is shaped substantially similar to the plunger controlling cam 147 and is substantially aligned with the latter so that the rise and fall of both lever arms 151 and 181 take place substantially in synchronism or unison. The upward swing of lever 181 raises the push rod 182 and through the gearing 205—204 the drill spindle and drill 46 are lowered to an extent, and at a drilling rate to cause the drill to drill a hole in the sleeve 20, the penetrating end of the drill being accommodated in a helical groove 39ˣ; downward swing of the lever 181 reverses the movements, the drill being withdrawn, and in this connection any suitable means such as the weight of the lever 181 may be used to cause the lever faithfully to follow the cam 177 and such means as the weight of the push rod 182 and connected parts may serve to keep the push rod with the end of lever 181 and cause it faithfully to follow also the downstroke of the lever 181. Due to the substantial synchronization of the levers 151 and 181, the plunger 45 moves up as the drill moves down, and vice versa, the pressure effects of the two upon the sleeve 20 and its mandrel support being substantially counterbalanced.

With the mandrel and the sleeve 20 rotated step by step and axially advanced in the directions indicated and with the advance displacement of the locus of operation of the drill 46 from the locus of operation of the plunger 45, the drill drills the holes successively and in advance of the operation of the throat elements and plunger, thus providing the sleeve element 20 with the holes into which the other coacting mechanisms operate to set pins, and in the illustrative embodiment there is a 180° extent of drilled holes always ahead of the point where the plunger operates.

During the upward stroke of plunger 45, the drill 46 is given a steady downward stroke, and the mandrel 39 and hence sleeve 20 are held in fixed position with a previously drilled hole H of that particular helix or row presented to and fixedly held in line with the upwardly moving pin carried by the plunger, the drill meanwhile commencing the drilling operation to provide a hole 180° in advance, and as the plunger recedes and hence moves downwardly, as a result of movement of cam 147 in counterclockwise direction from the position shown in Figure 1, it being noted that the weight of the plunger 45, carrier 163 and lever 151 insure biasing of the cam follower always into engagement with the cam 147, cam 116 (Figures 1 and 5) continues to hold gate 136 closed, the cam follower 118 thereof being still on a low part of the cam, while cam 117, having opened the gate 135 (Figure 5), shortly after cam 116 has closed the gate 136, such closure having taken place shortly after release of a single pin while the plunger 45 is in its lowermost position, now moves the gate 135 in closing position, thus to hold back the row of pins P in the channel 101 to the right of the gate 135, and thus preparing for the release by gate 136 of the single pin held by the latter in advance or to the left of gate 135.

Following the withdrawal upwardly of the drill 46 and downwardly of plunger 45 from the pointed end of a pin just driven home by the plunger, cam 75 (Figures 1, 3 and 4) actuates the ratchet operating bar 67 (Figures 2, 3 and 4) in an upward stroke followed by a retrograde stroke (see the hump in cam 75 of Figure 1 displaced about 90° from the highest point of cam 147), thus to actuate the ratchet 66 to rotate the mandrel 39—40 throughout the angle subtended by two successive holes H in a row and by the coaction between the threaded block 47 and the threads of part 40 to

advance the mandrel slidably along its support 36 by the right amount, locking pawl 60 acting to lock the rotated parts accurately in their new position.

By that time the lowest portion of cam 177 holds the drill in uppermost position and the lowest portion of cam 147, that portion being of about 90° extent and of about the same radius throughout, comes into coaction with the cam follower 148, thus to hold the plunger in its lowermost position as shown in Figure 6, with the throat forming elements 81—82 restored to coacting relation with the pin receiving socket 87 in the plunger, and just about when the plunger arrives at its lowermost position, a high portion of cam 116 rides the cam follower 118 upwardly to lift the gate 136, thus releasing the single pin that had been isolated between the two gates 135 and 136, that pin quickly moving down the channel extension 127 to be entered into the plunger recess 87 as was above described.

Then the gradually rising portion in the upper left-hand quadrant, as viewed in Figure 1, of cam 147, comes into action upon cam roller 148, progressively and steadily forcing the plunger to the uppermost extreme of its upward stroke to seat and embed the pin carried by it in the sleeve 20, but just about when that movement begins or shortly thereafter, cam 116 closes the gate 136 and shortly after such closure cam 117 opens gate 135 to permit the row of pins in channel 101 to slide downwardly to be stopped by closed gate 136, and shortly thereafter cam 117 closes gate 135 in order thus to place the single pin between it and gate 136 under the sole control of gate 136. A similar gradually rising portion of the cam 177 operates substantially synchronously to steadily bring the drill 46 downwardly to perform its drilling operation.

Such sequences of steps to constitute a complete cycle thus take place during a single revolution of main drive shaft 77 and of cam shaft 104, the ratio of driving connection between the two being 1 to 1, whence the cycle repeats itself in rapid succession, illustratively at a rate to drill holes for and anchor about 60 pins per minute.

The main drive shaft may be driven in any suitable manner, conveniently by way of an electric motor 171 which may be secured to the underside of base 25 as indicated at 172 in Figure 1, whence a drive chain 173 connects the motor sprocket 174 with a sprocket 175 mounted on the rear end of shaft 77.

Where the holes H in the sleeve member 20 are to be arranged helically, the operation, after having assembled a blank sleeve to the mandrel 39, is commenced by first manually setting the structure 39—40 toward the left of the position shown in Figure 1, the drive being halted for that purpose and the thread block 47 being withdrawn from engagement with the threads of part 40 so as to permit manual sliding of the structure along the supporting shaft 36 and to permit positioning the mandrel structure in a rotary sense, locking pawl 60 being yieldably mounted while driving pawl 66 may be disengaged if necessary, to bring that portion of the sleeve 20 where the first hole of a helix is to be drilled directly underneath the drill 46. The location or point where the drill will drill the first hole of a helical row becomes definitely fixed by the inter-engagement of the thread block 47 with the threads of part 40.

Preferably, in order to forestall pin-setting action by the plunger until a suitable number of holes have been drilled by the drill, I interrupt the drive of the gate 136, and do this preferably by displacing the cam follower or push rod 118 out of engagement with the gate lever 146, as is better shown in Figure 11, where the aperture 120 in the base 25 and the aperture 122 in the block 124 are shown elongated in a direction toward the left so as to permit the push rod 118 to be tilted in counterclockwise direction from its normal or operating vertical position to a sufficient extent to bring its upper end, while maintaining its lower end in contact with the cam 116, sufficiently to the left of the free end of lever 146 so as to clear the latter during its up and down strokes of movement, the under end portion of lever 146 being tapered or cam-shaped to insure re-entry of the upper end of push rod 118 underneath the lever 146 when the driving connection is to be restored, as is later described.

About an intermediate portion of push rod 118 is an elongated sleeve 208 pivotally mounted by pin 209 at the lower end of a lever 210 that is pivotally supported by a screw stud 211 threaded into a suitable boss in the downwardly inclined channel member 126; the upper end of lever 210 is shaped as at 212 to provide a cam follower for coaction with a peripheral cam 213. This cam also controls the hole-drilling operation.

Lever 210 is biased in counterclockwise direction as viewed in Figure 11 by a spring 214 (see also Figures 10 and 12) one end of which is connected to the pivot pin 209 and the other end of which is anchored to a frame part such as the upright 193, as by pin 215. If unrestrained, the tension of spring 214 swings lever 210 counterclockwise sufficiently to tilt the push rod 118 in clockwise direction (Figure 11) to bring its upper end underneath the gate lever 146, a pin 216 projecting from the block 124 being engaged by a lug 210^a projecting from lever 210 in order to limit the extent of clockwise tilting of push rod 118 to just about its normal or vertical operating position.

Cam 213 is rotatable and movable with the mandrel structure 39—40 and is preferably mounted for adjustment with respect thereto. Preferably, as is better shown in Figures 1, 2, 10 and 11, I utilize collar 42 as a carrier for cam 213 and I may, and preferably do, form the cam 213 integral with the collar 42, and where a fixed relationship of the row or rows of holes in the sleeve member 20 is desired with respect to the fixed cut-outs 20^a (Figure 1) with which the annular shoulder 41 interfits as above described, I preferably provide suitable means for fixedly relating the cam 213, in a relative rotary sense, to the mandrel structure, and this I may achieve as by a slot 39^e in the end portion of the mandrel 39, and where the holes are to be drilled and the pins set in the pattern of a multiple helix, such as the four above-mentioned helical rows R^1, R^2, R^3 and R^4, I provide four such slots, namely, slots 39^e, 39^f, 39^g and 39^h, and provide the hub or collar element 42 of the cam with an inwardly radially extending key or projection 213^x (Figures 10 and 11) set into a suitable recess in the end face of the collar-cam structure 42—213 and fixedly secured as by a screw 217, and with the four slots equi-angularly spaced, set screw 43 and the key 213^x are spaced 90° apart as shown in Figures 11 and 13. The slots are open-ended (Figure 10), and by loosening set screw 43, the structure may be slipped onto the mandrel in an axial direction in any one of four rotary positions, each related to one of the above-mentioned desired helical rows of holes and pins.

In Figures 9, 10 and 11, the parts are shown

positioned in readiness to drill the first hole of, for example, row R1, sleeve 20 having its cut-out 20a (Figure 9) interfitted with the stepped shoulder 41 of the mandrel and key 213x being in the slot 39h with set screw 43 tightened up against the bottom of slot 39e, and in that position the high peripheral portion 213a of the cam (the part rotating in counterclockwise direction, as seen in Figure 11) has its initial portion thus brought into engagement with the lever 210 which is thereby held swung clockwise against the tension of spring 214, thus holding push rod 118 out of engagement with the gate lever 146 so that the ensuing up and down strokes of the push rod under the action of cam 116 do not actuate the gate 136. The step by step drilling commences, upon starting the apparatus, and continues, the gate 136 remaining closed until the drill has drilled enough holes corresponding to the displacement, in the illustrative embodiment 180°, between the locus of operation of the drill and the locus of operation of the pin-setting plunger 45, or in other words, until the first hole drilled by the drill 46 is in position to have the plunger 45 set a pin into it; accordingly, the high peripheral portion 213a of the cam 213 is of that arcuate extent, namely 180°, whence there is a drop to the portion 213b of the cam, that change in the cam periphery permitting lever 210 to swing in counterclockwise direction under the tension of spring 214, thus restoring push rod 118 to its position underneath the gate lever 146 whence the gate 136 is actuated, being timed as earlier above described with the other moving parts, to transfer a pin to the throat elements and to the plunger 45 for insertion into that first hole, whence step-by-step drilling, step-by-step pin transfer, and step-by-step pin-setting continue in timed relationships, as earlier above described.

As earlier above noted, the step-by-step movement of the supporting structure, such as the mandrel structure 39—40, for the sleeve 20, is a step-by-step rotary movement in the direction of the arrows shown on the drawings and a step-by-step movement in a direction toward the right as viewed in Figures 1, 2, 10, 11 and 12, where the pattern in which the holes are drilled and pins are set is helical. At the commencement of the operation, that is, when the first hole is drilled, the mandrel structure and the sleeve 20 are in their left-most position, as shown in Figures 9 and 10, and the extent in an axial direction of the cam follower 212 of the lever 210 or the axial extent of the portion 213a of the cam 213, or both, is so proportioned that, with the cam 213 moving with the mandrel structure, the cam 213 becomes displaced to the right of the cam follower 212, as viewed in Figure 10, shortly after the cam follower 212 has been tripped inwardly toward the axis at the relatively sharp step 213c (Figure 11), thereby, as the cam continues its step-by-step rotary movement and step-by-step movement toward the right (Figure 10) to avoid interference with the pin-transferring and pin-setting mechanisms during their required subsequent operations. Though the cam follower 212 is in this manner disengaged from the lower cam portion 213b, spring 214 continues to hold the push rod 118 in operative relation to the gate lever 146, lever lug 210a and pin 216 acting during this interim to fix the just-stated position of push rod 118 under the action of spring 214.

As the drilling and pin-anchoring operations continue, the point is reached where the last hole of the helix of holes is to be drilled, and at that point I provide suitable means for preventing further drilling operations by the drill, leaving the rest of the mechanism to continue so as to conclude the setting of pins in the 180° extent of holes that would at that point remain in advance of the locus of operation of the plunger. A preferred way for effecting such cessation of the drilling operation in advance (by 180°) of stopping the pin-setting operation, the latter being accomplished preferably by stopping the drive of the entire apparatus, comprises provisions for interrupting the working strokes of the drill, conveniently by shifting the push rod 182 (Figure 1), at its lower end, to the right and thus disengaging it from the lever 181. Thus the boss 183 and the base 25 have a longitudinally extending slot 218 so that the lower end of the push rod may be moved to the right in Figure 1 about the pivot pin 186 at its upper connection, as a pivot, and such movement, and subsequent restoration into coacting relation with the lever 181 may be achieved as by a yoke 219 (Figures 9, 10 and 12) suitably mounted above the upper face of the base 25.

Thus, the yoke 219, between the arms of which push rod 182 passes (Figure 10), rests slidably against the upper face of the boss 183, and is guided for movement in the direction of the slot 218 by a stud or rod 220 slidably mounted in an upstanding boss 221 formed in or secured to the base 25; at its right-hand end, the rod 220 has secured to it a collar 222 and between the collar and the fixed boss 221 is a coil spring 223 which normally biases the yoke 219 in a direction toward the right as viewed in Figures 12 and 13.

As is better shown in Figures 9 and 13, I provide a latch arm 224 for coaction with the collar 222, latch arm 224 being pivotally supported by a pin 225 mounted in a bracket 226 secured as by screws 227 to the frame upright 193.

With the push rod 182 in engagement with the lever 181, and preferably the latter is provided with a recess 181a (Figure 9) and the lower end of push rod 182 may be shaped as shown to better seat itself in the recess 181a, the slide rod 220 of the yoke 219 held in a leftward position, as shown in Figure 9, with the spring 223 compressed, by swinging the latch lever 224 in position to the right of the collar 222 to an extent permitted by the free end portion of the rod 220, as is better shown in Figure 13; thereby yoke 219 is held in position to maintain the lower end of push rod 182 in alignment with the recess 181a of the lever 181, the push rod 182 partaking of up and down strokes in response to the actuation of lever 181 from the cam 177 whose lowest portion, that is, the portion of smallest radius, is preferably such that it permits the free end of the lever 181 to assume a lowermost position to unseat the push rod 182 from the seat 181a, though re-seating takes place upon each upstroke of the lever 181 so long as the yoke 219 is held in the above-mentioned position as shown in Figure 9.

In positioning the latch lever 224 as above described (see Figure 13), a laterally projecting portion 224a of the latch lever 224 is given a position substantially like that shown in Figure 13, being substantially in the helical path of movement of a projecting portion 213e of the cam 213, related to the other portions substantially as shown in Figure 13.

As the above-mentioned cycles of drilling, pin-transferring and pin-setting are repeated, and as the drill 46 approaches the point in the step-by-

step rotary and axial movement of the mandrel and hence of the cam 213 where it is about to drill the last hole of the selected helical row of holes, the cam structure 213 reaches an axial position corresponding almost to its extreme right-hand position and hence into coacting relation to the cam follower portion 224a of the latch lever 224, the last hole is drilled, whence the next step of rotary movement of the mandrel structure and hence of the cam 213, being in counterclockwise direction as viewed in Figure 13, causes the cam part 213e to engage the latch lever part 224a and trip or swing the latch lever 224 in clockwise direction and hence out of engagement with the collar 222, thus releasing spring 223 to move the yoke 219 toward the right as viewed in Figure 9 and from the position shown in Figure 10 to the position shown in Figure 12; this action occurs during those portions of a cycle that find the lever 181 (Figure 9) in lowermost position in which the lower end of push rod 182 is out of engagement with the seat 181a of the lever, thus giving the spring 223 complete freedom to swing the push rod 182 to the right and into the dotted-line position shown in Figure 9, the subsequent upstrokes of the lever 181 being thereby ineffective to give the push rod 182 and hence the drill any working strokes.

The drilling operations are halted and the drill remains in uppermost or out-of-the-way position, whence the setting of pins in the still empty holes (of about 180° extent) continues, the drive of the apparatus being stopped when the last pin is set.

If the sleeve member 20 is to have more than one helix of pins, as was above initially assumed, the general sequence of steps above described is repeated, once for each additional helix, but only after disengaging the thread block 47 from the thread part 49 to axially and rotatably reset the mandrel and the sleeve 20 to the starting point for the second helix of holes, and then re-engaging the thread block, and resetting the rotary position of cam 213 and its carrier collar 42 by bringing the key 213x into one of the mandrel slots corresponding to the next helix and then setting the lock screw 43, as above described, but now with respect to the second helix to be drilled and pin-set.

Thus, if there are four helixes of holes to be drilled and fitted with pins, the four helixes start at equi-angularly spaced points and hence at points spaced 90° from each other, and accordingly the mandrel part 39 has the above-mentioned four slots 39e, 39f, 39g and 39h similarly spaced equi-angularly and hence by 90°, and thereby the cam structure 42—213 can be set in four different angular relationships, one for each helix.

Each such setting of the cam structure insures that, for each helical row, drilling commences at the right point, pin-setting is delayed until the space differential between the locus of operation of the drill and locus of operation of the pin-setting plunger is compensated for by the drilling of holes (illustratively, throughout 180°), in the embodiment above described, and that drilling ceases at the right point to terminate each helix at the right point, while permitting continued pin-setting operations after the last hole has been drilled, whence the apparatus may be stopped, as by opening the circuit of the driving motor by means of any suitable switch (not shown). Accordingly, with the cam structure once set for a particular helix, and the apparatus is started, it continues to function without attention until the last pin is set whence it is stopped as it has to be in order to re-set the cam 213, or to replace the sleeve member 20 by another. Thus dependable uniformity of construction throughout all of the pin-set sleeve elements can be achieved.

To remove the sleeve member, collar 42 of the mandrel 39 is released and the supporting standard 28 removed, whence the completed picker roll section is removed from mandrel 39 and another sleeve 20 slipped onto the mandrel 39 whence the collar 42 and the standard 28 are replaced, the new sleeve member 20 being properly fixed in position by the inter-locking of its left-hand end portion (Figure 1) with the annular stepped shoulder 41.

Thus it will be seen that there has been provided in this invention an apparatus in which the several objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. An apparatus for drilling holes through the wall of a hollow cylindrical support, said apparatus comprising drill means, a mandrel for supporting said hollow cylindrical support, said mandrel having a plurality of helically extending recesses therein to provide spaces for the emerging end of a drill of said drill means drilling a hole through the wall of said cylindrical support, means mounting said mandrel and said drill means to effect relative step by step movement therebetween along the line of a helix having the pitch of said helical recesses, means for selectively determining along the line of which of said plurality of helical recesses said relative step by step movement is to take place, and mechanism operating for any selected helical line determined by said last-mentioned means and operable during pauses in said movement to effect relative movement in a general radial direction between said mandrel and said drill means to effect drilling of a hole through said wall whereby the emerging drill end is always accommodated in the selected helically extending recess.

2. An apparatus for drilling holes through the wall of a hollow cylindrical support, said apparatus comprising drill means, a mandrel for supporting said hollow cylindrical support, said mandrel having a plurality of helically extending recesses therein to provide spaces for the emerging end of a drill of said drill means drilling a hole through the wall of said cylindrical support, means mounting said mandrel and said drill means to effect relative step by step movement therebetween along the line of a helix having the pitch of said helical recesses, means for selectively determining along the line of which of said plurality of helical recesses said relative step by step movement is to take place, mechanism operable during pauses in said movement to effect relative movement in a general radial direction between said mandrel and said drill means to effect drilling of a hole through said wall whereby the emerging drill end is always accommodated in the selected helically extending recess, said mechanism including means for halting

drilling actuation of said drill means, and means operating for any selected helical line determined by said selectively determining means and responsive to a succession of steps of said step by step movement for actuating said halting means.

3. An apparatus as claimed in claim 2, in which said last-mentioned responsive means comprises a member selectively positionable according to which of the plurality of the helically extending recesses is selected as the line along which said relative step by step movement is effected.

4. An apparatus as claimed in claim 1, in which said mechanism comprises a disconnectible operating connection and means responsive to a succession of steps of said step by step movement for disconnecting said operating connection and thereby halt the drilling of a succession of holes.

5. An apparatus as claimed in claim 1, in which said mechanism comprises a member having strokes of movement the cycles of which are timed with said pauses in said step by step movement, a control member having means mounting it for movement into or out of operative relation to said last-mentioned member to effect or discontinue drilling actuation during pauses, and means for controlling movement of said control member into or out of operative relation to said other member.

6. An apparatus as claimed in claim 1, in which said mechanism comprises a member having strokes of movement the cycles of which are timed with said pauses in said step by step movement, a control member having means mounting it for movement into or out of operative relation to said last-mentioned member to effect or discontinue drilling actuation during pauses, and means responsive to relative movement between said drill means and said mandrel for controlling said control member.

7. An apparatus for drilling holes through the wall of a hollow cylindrical support, said apparatus comprising a mandrel to receive said cylindrical support thereon, said mandrel being recessed to provide space for accommodating the emerging end of a drill drilling through the wall of said support and thereby leaving intervening surface portions of the mandrel to give internal support to said hollow cylindrical support, drill means, means mounting said drill means and said mandrel for relative step by step movement along the line of the recessing in said mandrel, means operating during pauses in said step by step movement to actuate said drill means to drill a hole at each pause through the wall of said hollow support, the emerging end of the drill means being thereby always accommodated in the recessing in said mandrel.

8. An apparatus for drilling holes through the wall of a hollow cylindrical support, said apparatus comprising a mandrel for supporting said hollow cylindrical support, there being rib means associated with said mandrel to provide internal support for the walls of said hollow cylindrical support and to provide spaces relative to said hollow support for the accommodation therein of the emerging end of the drill drilling a hole through the wall of said support, drill means, means mounting said mandrel and said drill means for relative step by step movement along the line of the spaces provided by said rib means, and means for actuating said drill means to drill a hole through the wall of said support as backed up by said rib means during a pause in said relative movement, the emerging end of the drill being thereby always accommodated in said spaces.

9. An apparatus for drilling a helical row of holes through the wall of a hollow cylindrical support, said apparatus comprising a mandrel for supporting and internally backing up said hollow cylindrical support, said mandrel having a helical groove therein to provide a space for accommodating the emerging end of a drill drilling through the wall of said support, drill means, means mounting said mandrel and said drill means for relative step by step movement along the line of said helical groove, and means operable during pauses in said movement for actuating said drill means to drill holes through said wall, whereby the emerging end of the drill is always accommodated in said groove.

10. An apparatus for drilling holes through the wall of a hollow cylindrical support, said apparatus comprising a mandrel for receiving said support thereover, said mandrel having a plurality of helical grooves therein to provide spaces for the emerging end of a drill and to leave intervening rib elements to support said support, drill means, means for effecting step by step relative movement between said mandrel and said drill means along a helical line of the same pitch as said helixes, means for selectively effecting such relative step by step movement along the line of any one of said helical grooves, and means for actuating said drill means and operable during pauses in said step by step movement to drill a hole through said wall at each pause whereby the emerging end of said drill is always accommodated in one of said helical grooves.

11. An apparatus for drilling holes in a cylindrical support, said apparatus comprising means for supporting said cylindrical support, drill means, means for effecting step by step rotary movement of said supporting means relative to said drill means, means operable during pauses in said movement to actuate said drill means in a general radial direction to drill a hole in said cylindrical support, cam means partaking of said rotary movement relative to said drill means, and means controlled by said cam means to prevent operation of said last-mentioned means and thereby prevent drilling by said drill means.

12. An apparatus for drilling holes in a cylindrical support, said apparatus comprising means for supporting said cylindrical support, drill means, means for effecting step by step rotary movement of said supporting means relative to said drill means, means operable during pauses in said movement to actuate said drill means in a general radial direction to drill a hole in said cylindrical support, said last-mentioned means including a disconnectible operating connection, and means responsive to said rotary movement for effecting disconnection of said operating connection.

13. An apparatus for drilling holes in a cylindrical support, said apparatus comprising means for supporting said cylindrical support, drill means, means for effecting step by step rotary movement of said supporting means relative to said drill means, mechanism operating in timed relation to said step by step movement for effecting, during pauses, a cycle of movements of said drill means in a general radial direction toward and then away from said cylindrical support to thereby drill a succession of holes therein, said mechanism including a disconnectible operating connection having manual means for controlling it and having also means actuated automatically upon the completion of drilling of a succession of holes to effect disconnection thereof.

14. An apparatus for drilling holes in a cylin-

drical support, said apparatus comprising means for supporting said cylindrical support, drill means, means mounting said supporting means and said drill means to effect relative step by step rotary and axial movements and, during pauses in said step by step movements, to effect relative movement therebetween in a generally radial direction to cause said drill means to drill a hole and withdraw the drill therefrom at each pause, an actuatable control member fixedly positioned in relation to said relative rotary and axial movements, a member partaking of the latter movements and thereby brought into operative relation to said control member, and means responsive to actuation of said control member for halting the said relative radial movement.

15. An apparatus for drilling holes in multiple helical rows in a cylindrical support, said apparatus comprising drill means, means for supporting said cylindrical support for rotary movement about its axis and for movement in the direction of its axis, all relative to said drill means, mechanism for effecting step by step rotary movement of said supporting means, means operable during pauses in said step by step rotary movement to effect relative movement in a general radial direction between said supporting means and said drill means, and means for effecting axial movement of said supporting means comprising a cylindrical element externally threaded in multiple threads corresponding to the multiple helical rows in which holes are to be drilled and a nut element coacting therewith, means mounting one of said elements to rotate synchronously with said supporting means whereby relative rotary movement between said two elements effects relative axial movement therebetween and axial movement of said supporting means, and means operable at will for selectively inter-engaging said two elements according to the desired helix along which to effect drilling of a row of holes.

16. An apparatus for drilling holes in multiple helical rows in a cylindrical support, said apparatus comprising drill means, means for supporting said cylindrical support for rotary movement about its axis and for movement in the direction of its axis, means for effecting step by step rotary movement of said supporting means, means operable during a pause in said step by step movement to actuate said drill means to drill a hole in said cylindrical support, and selectively controlled means comprising a multiple-threaded element and an element coacting therewith, said elements having means mounting them for selective interengagement according to any one of several multiple helixes, said elements operating in response to said step by step rotary movement to effect axial movement of said supporting means to traverse said cylindrical support along a helix corresponding to any selected interengagement of said elements, whereby said holes may be drilled in said cylindrical support in a plurality of helical rows.

17. In an apparatus having drill means for drilling holes, the combination comprising rotatable carrier means for receiving and holding a cylindrical support, said carrier means having an externally threaded portion and, coaxial therewith, means for holding the cylindrical support coaxially therewith, means supporting said carrier means for movement axially, a relatively fixed nut element engaging said threaded portion whereby rotary movement of said carrier means effects axial movement thereof, a ratchet wheel and a pawl for giving said carrier means step by step rotary movement, means carried by and movable axially with said carrier means for supporting and actuating said pawl relative to said ratchet wheel and having an elongated member extending lengthwise of said carrier means and movable axially therewith, and a relatively fixedly positioned actuated member relative to which said elongated member is traversed during axial movement of said carrier means for thereby communicating step by step motion to said pawl, whereby said drill means may be made effective during pauses in said step by step movement to thereby drill a succession of holes in said cylindrical support with the holes aligned substantially in a helix.

18. An apparatus for drilling holes in a cylindrical support, said apparatus comprising rotatable carrier means having an externally threaded portion and, coaxial therewith, means for holding the cylindrical support coaxially therewith, means supporting said carrier means for movement axially, a relatively fixed nut element engaging said threaded portion whereby rotary movement of said carrier means effects axial movement thereof, mechanism carried by said carrier means and axially movable therewith for giving the latter step by step rotary movement and having an elongated actuating member extending lengthwise of the direction of axial movement, mechanism including a relatively fixedly positioned periodically actuating element relative to which said elongated actuating member is traversed during axial movement for operating it throughout the extent of axial traverse of said carrier means.

19. An apparatus for drilling holes through the wall of a hollow cylindrical support that has a stepped end portion to mate with a correspondingly stepped end portion of another and coaxially arranged hollow cylindrical support, said apparatus comprising drill means, means for supporting said hollow cylindrical support and comprising a mandrel on to which said cylindrical support is sleeved, said mandrel having a plurality of helically extending recesses therein to provide spaces for the emerging end of a drill of said drill means and to leave intervening surface portions of the mandrel for backing up the cylindrical support as said drill means drills a hole through the wall of said cylindrical support, said mandrel having means interengageable with at least part of the stepped end portion of the cylindrical support whereby successive cylindrical supports received on the mandrel are related to said helically extending recesses always in the same manner, means mounting said mandrel and said drill means to effect relative step by step movement therebetween along the line of a helix having the pitch of said helical recesses, means for selectively determining along the line of which of said plurality of helical recesses said relative step by step movement is to take place, and mechanism operable during pauses in said movement to effect relative movement in a general radial direction between the mandrel and the drill means to effect drilling of a hole through said wall as the latter is supported by said intervening portions of the mandrel and whereby the emerging drill end is always accommodated in the selected helically extending recesses.

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