

April 20, 1954

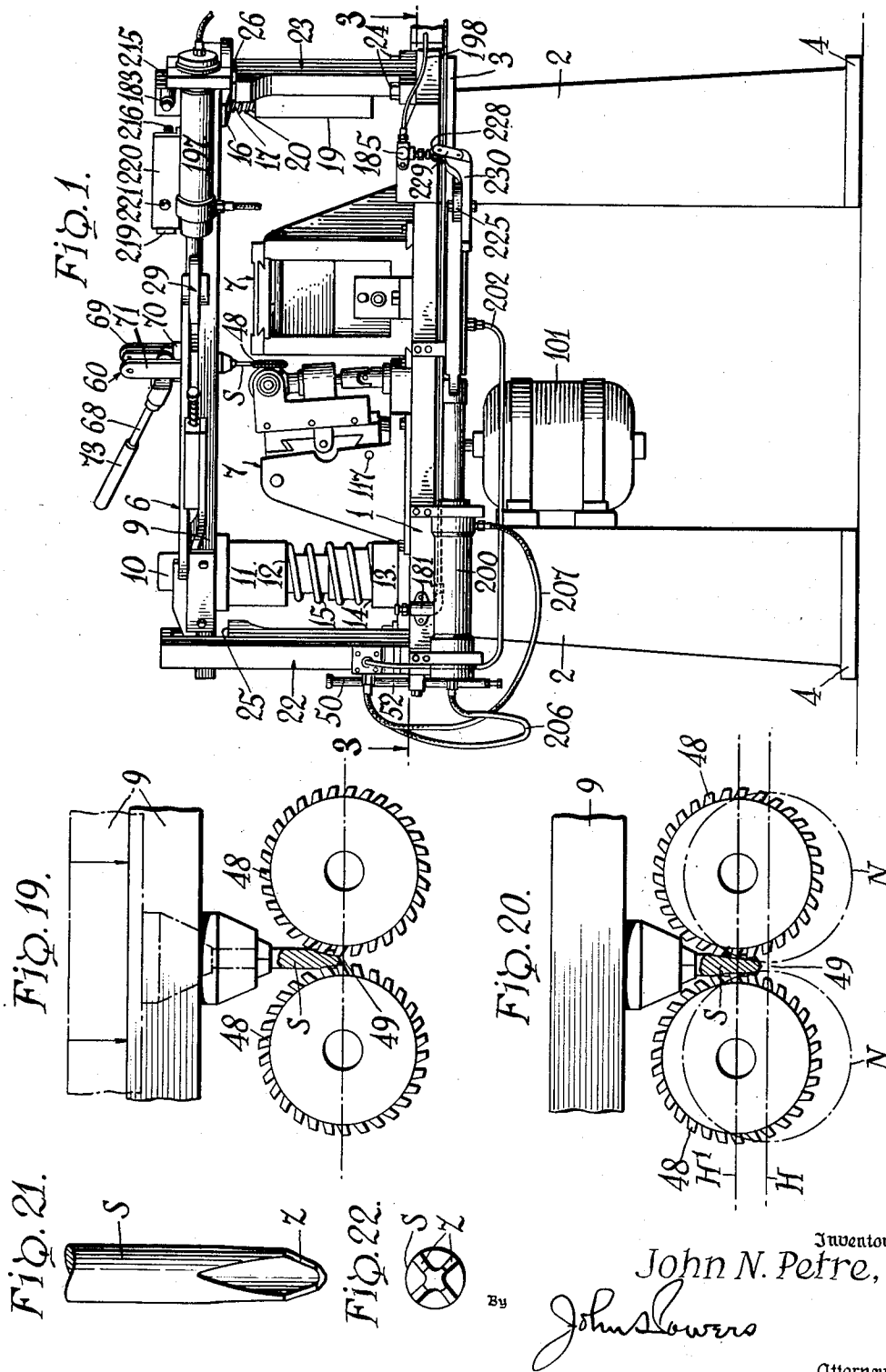
J. N. PETRE

2,675,742

METHOD FOR FORMING FLUTED BITS UPON AN END
OF A SHANK OF A SCREW DRIVER

Original Filed Feb. 1, 1951

8 Sheets-Sheet 1



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J. N. PETRE

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FIG. 2.

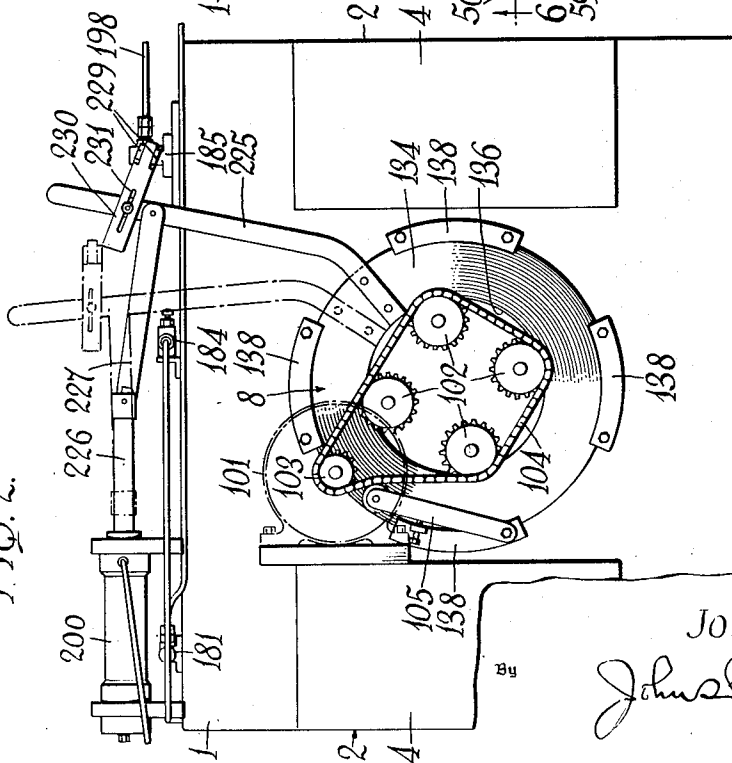
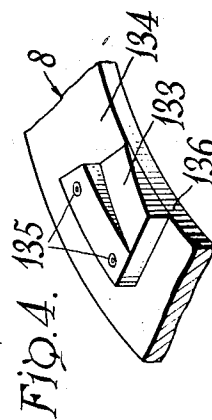
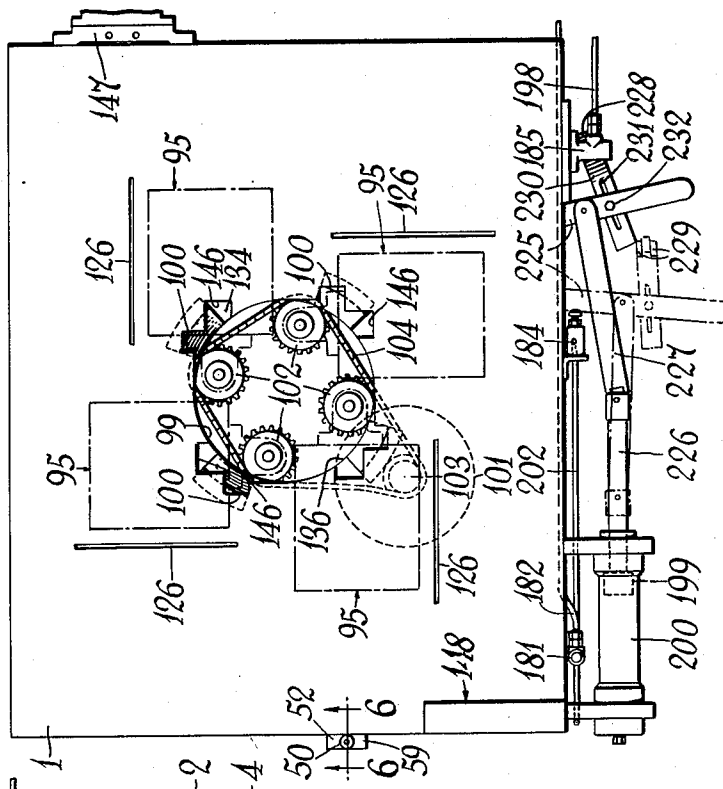


FIG. 3.



Inventor
John N. Petre,

By
John Lowers

Attorney

April 20, 1954

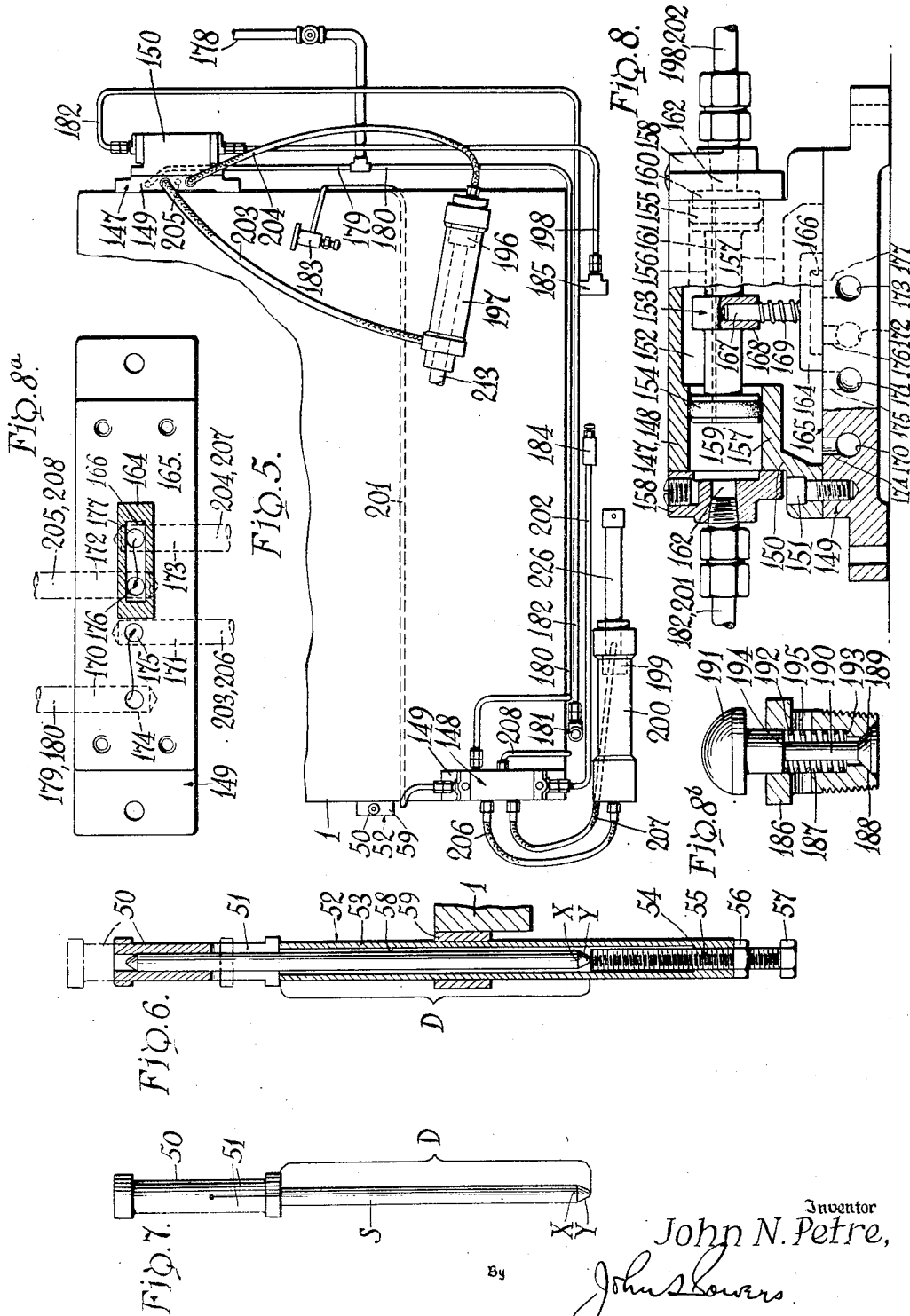
J. N. PETRE

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By

Inventor
John N. Petre,
John Showers
Attorney

April 20, 1954

J. N. PETRE

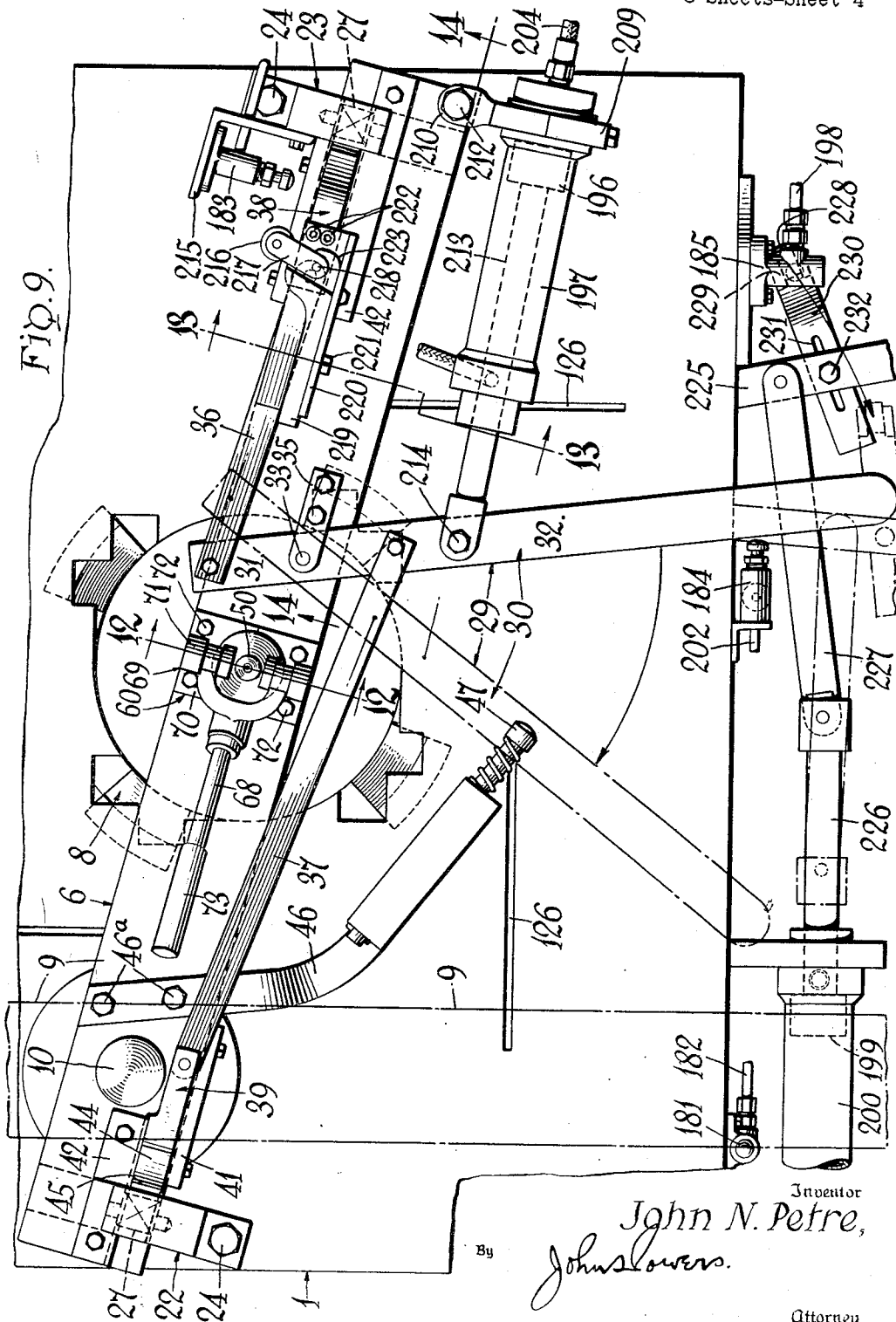
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METHOD FOR FORMING FLUTED BITS UPON AN END
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FIG. 9.



By

Inventor
John N. Petre,
John Lowers.

Attorney

April 20, 1954

J. N. PETRE

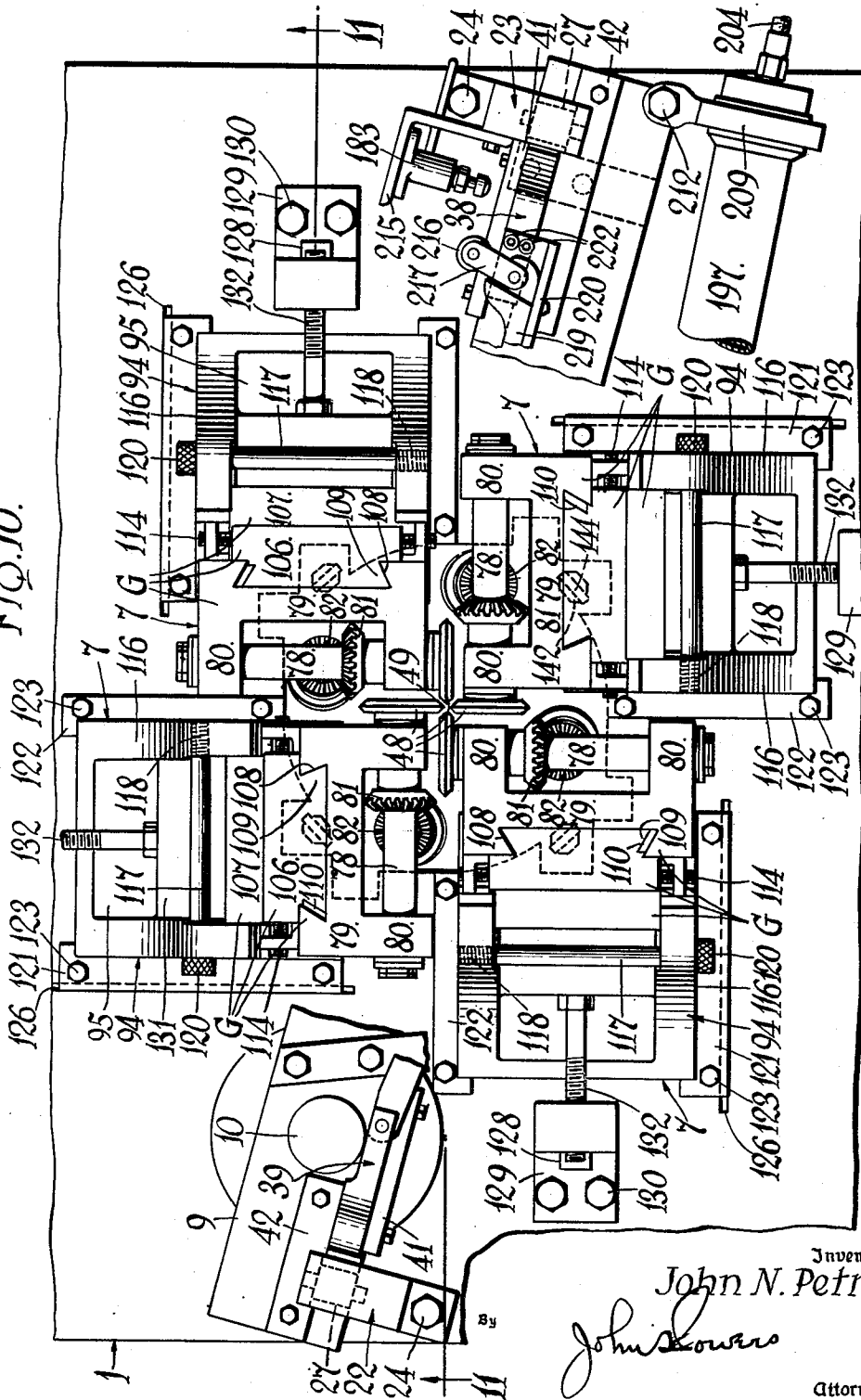
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METHOD FOR FORMING FLUTED BITS UPON AN END
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FIG. 10.



Inventor
John N. Petre,
John N. Petre
Attorney

April 20, 1954

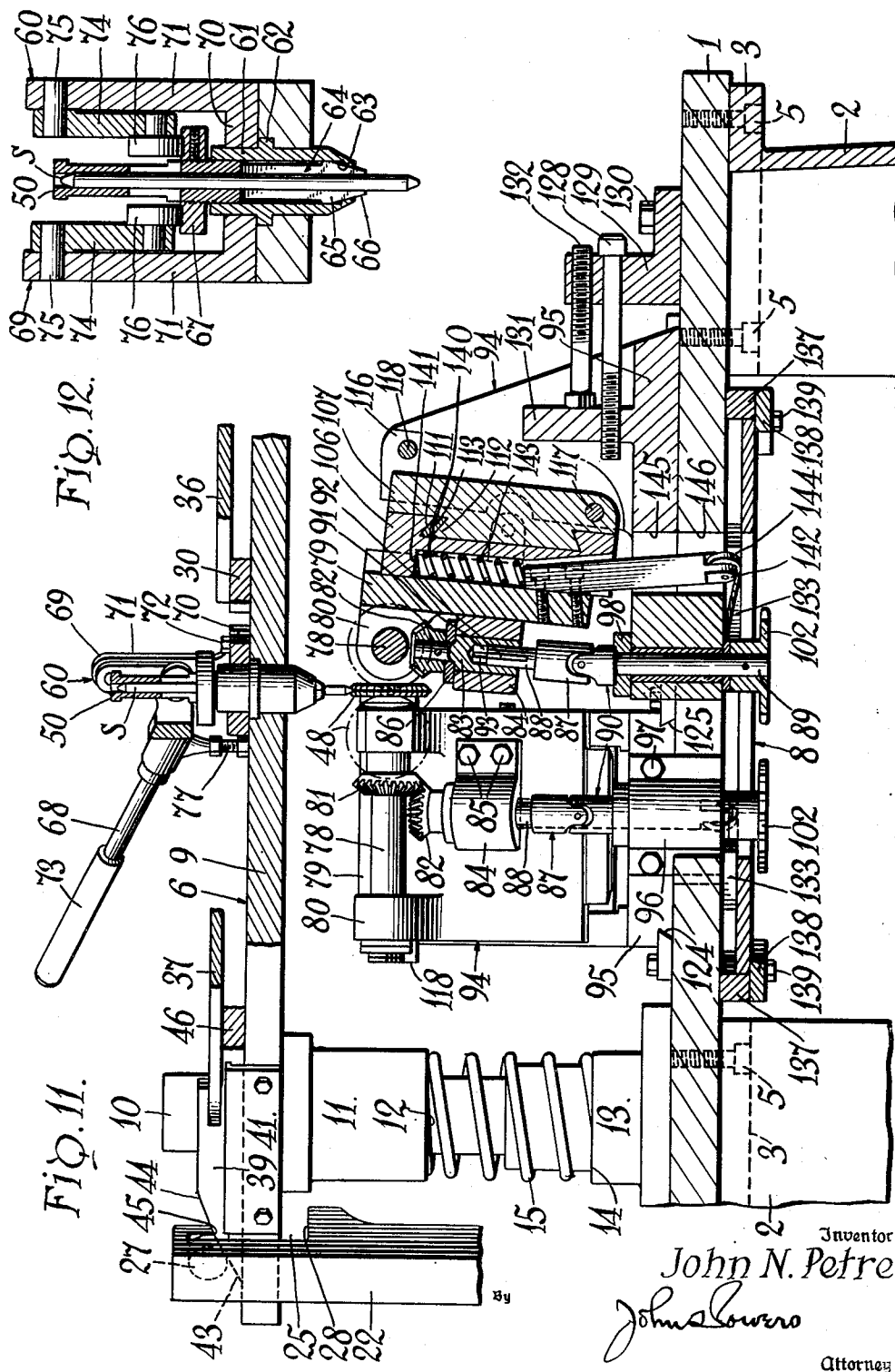
J. N. PETRE

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METHOD FOR FORMING FLUTED BITS UPON AN END
OF A SHANK OF A SCREW DRIVER

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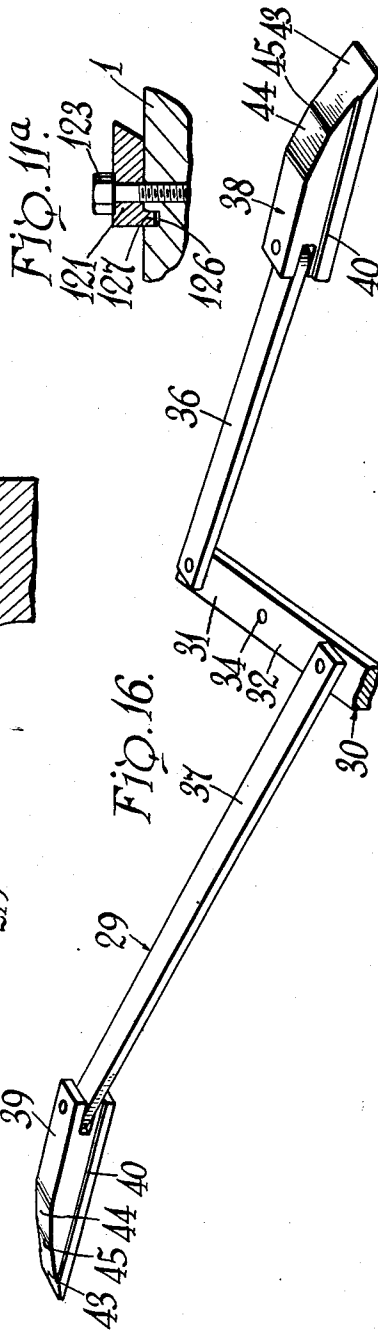
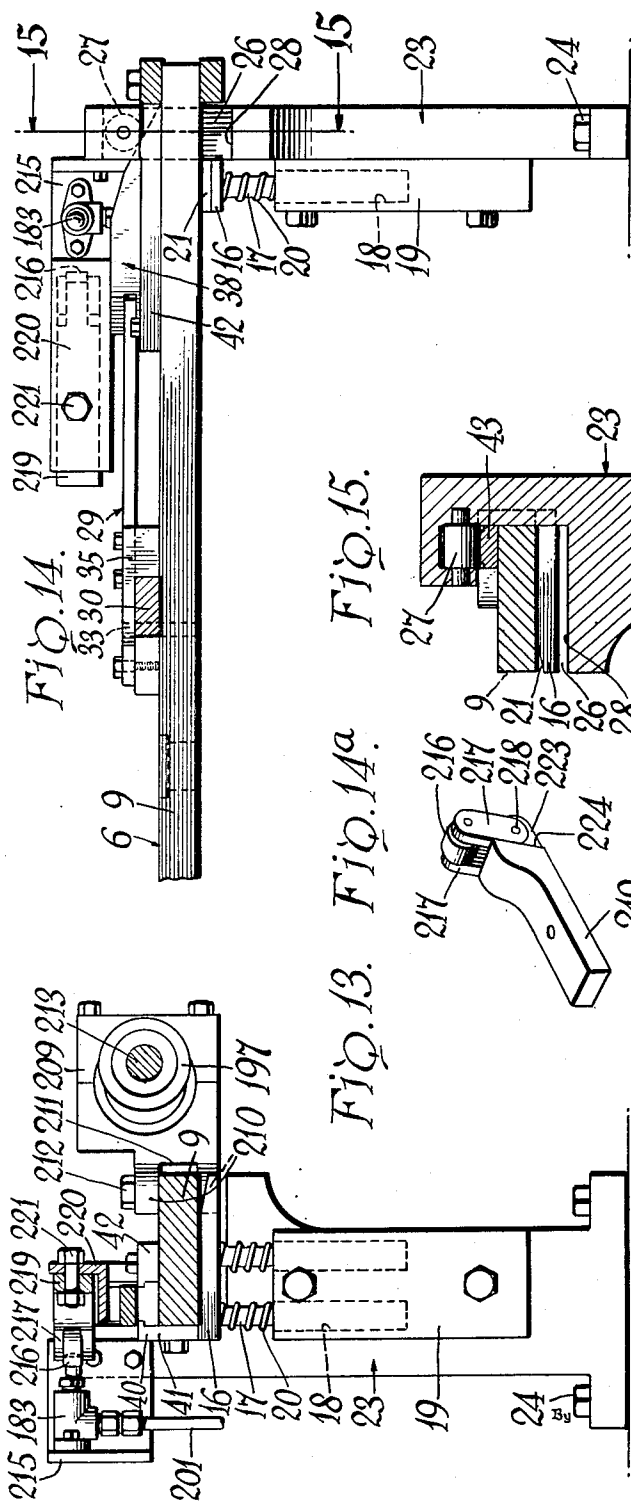
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J. N. PETRE
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Inventor
John N. Petre,
John N. Petre
Attorney

April 20, 1954

J. N. PETRE

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METHOD FOR FORMING FLUTED BITS UPON AN END
OF A SHANK OF A SCREW DRIVER

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FIG. 18.

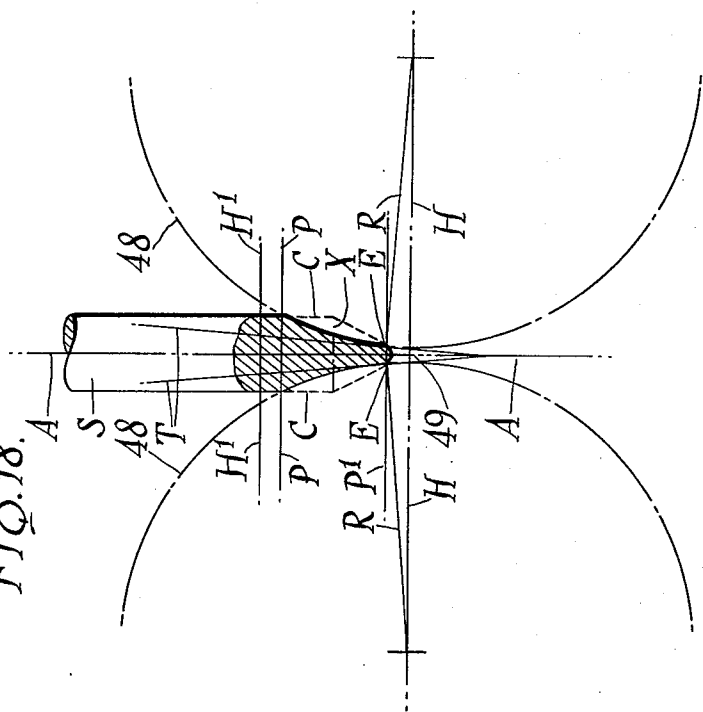
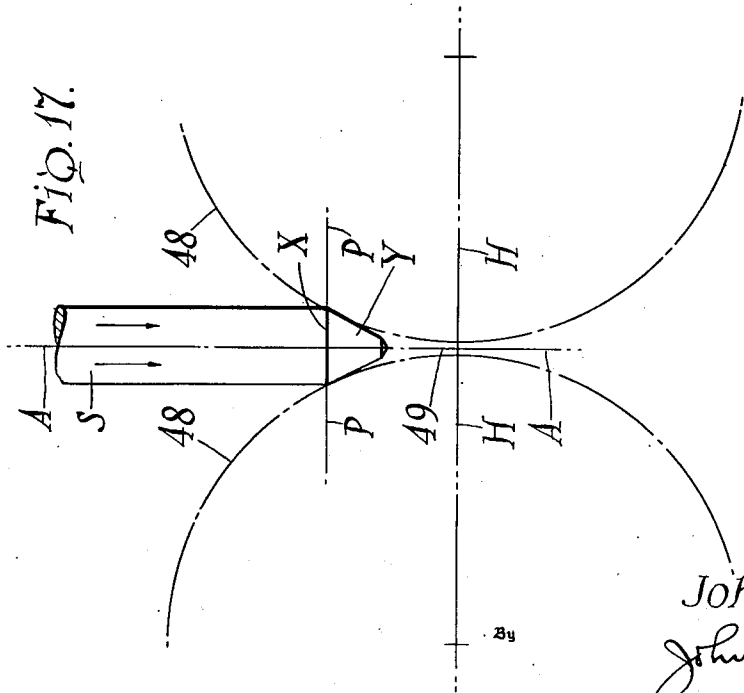


FIG. 17.



Inventor
John N. Petre,
John N. Petre
Attorney

UNITED STATES PATENT OFFICE

2,675,742

METHOD FOR FORMING FLUTED BITS UPON
AN END OF A SHANK OF A SCREW DRIVERJohn N. Petre, Orchard Park, N. Y., assignor to
Xcelite, Incorporated, a corporation of New
YorkOriginal application February 1, 1951, Serial No.
208,877. Divided and this application March
8, 1952, Serial No. 275,620

3 Claims. (Cl. 90—11)

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This invention relates to a method for forming fluted bits upon an end of the shank of a screw driver. The subject matter herein claimed is disclosed in an application filed by me for a machine for forming screw driver bits of the fluted type, said application being Serial No. 208,877 and having been filed February 1, 1951, and the present application being a division thereof.

Screw drivers of the fluted bit type are known in the trade as "Phillips" screw drivers and are of the substantial construction shown and described in the Phillips patent, No. 2,046,837, and the Phillips and Fitzpatrick patent, No. 2,046,840, both of which were issued on July 7, 1936. Such screw drivers are cooperative with screws of the particular type which are known in the trade as "Phillips" screws. These screws are of the substantial construction shown and described in the Phillips Patent No. 2,046,837 and the Phillips and Fitzpatrick patent, No. 2,046,839, also issued on July 7, 1936, and are characterized by sockets of special form in their heads. These sockets provide webs which, in relation to the vertical or longitudinal axes of the sockets, are of re-entrant angular contour and have rather sharp apices which extend downward from the upper face of the screw head. The webs are separated and delimited by recesses which extend radially in relation to the vertical or longitudinal axes of the socket.

The fluted bits are generally polygonal in cross section and conform generally in cross sectional contour to the cross sectional contour of the sockets in the heads of the "Phillips" screws. The conforming cross sectional contours of the bits and the sockets in the screw heads may be varied as shown, for example, on Sheet 2 of the drawings of the Phillips Patent No. 2,046,837. In practice, however, the bits and cooperating screw head recesses have been made of general cruciform outline.

The method of the invention is available for the production of fluted bits of various cross sectional contours. For a clear understanding of the method it is deemed advisable to show and describe in this application a machine by which the method is practiced. As herein disclosed the machine is designed for the production of fluted bits of the general cruciform outline which accords with standard usage.

In the construction which has become standard the flutes of the bits are separated by equidistantly spaced vanes which provide the flute side walls and the side walls of each flute extend inward in converging relation and meet along a line located in a central longitudinal plane of the shank. This line may be said to be the base of the flute and extends upward and outward from

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the terminal of the bit. Thus the flute bases have an upwardly diverging mutual relation. When the bit is fitted in the socket of the screw head the bases of the flutes engage the upper ends of the apices of the re-entrant screw head webs with wedging effect, the vanes conformably fit within the recesses of the socket with keying effect (that is to say for the purpose of rotation they positively couple the bit as wedged in the socket to the screw head) and the "core" of the bit is located within the central portion of the socket, i. e., the portion of the socket bounded by the apices of the webs. The flutes are formed by rotary cutters and their bases have an incidental concave curvature in lineal outline, this curvature being so gentle or, more exactly, about such a long radius, that it does not interfere with the proper, i. e. functioning, angularity of the base of the flute. The angularity of the bases of the flutes with reference to the longitudinal axis of the bit is of quite small degree and in practice, according to circumstances, may be varied within narrow limits. Generally speaking the angularity of the bases of the flutes is of the order of from five to ten degrees. It will, of course, be understood that such angularity and the longitudinal and transverse dimensions of the bits will be varied in accordance with the varying dimensions of the screw heads and their sockets within the range of manufacturing sizes. In other words each bit is especially designed for coordination in use with a screw head socket of some particular longitudinal and transverse dimension.

In the machine heretofore used for the formation of the fluted bit of a "Phillips" screw driver the flutes are cut, one at a time, in successive operations. For this purpose a single rotary milling cutter is provided and the shank, suitably mounted to secure the requisite angularity of the longitudinal cut which provides the flute, is fitted in a rotatable index feature. Four separate and successive cutting operations are required. Thus the shank is advanced toward the cutter for the first cut and is then withdrawn; utilizing the index feature it is then turned about its axis to the appropriate number of degrees, i. e., ninety degrees for a bit of cruciform cross section, and is again advanced toward the cutter for the second cut and again withdrawn. These operations are continued until four cuts have been made. In connection with the repetition of these operations the angularity of the shank must be appropriately changed for each successive cut in order to insure the appropriate angularity of the base of the flute. The cutter exercises lateral pressure upon the terminal portion of the shank. In some machines special provision is made for opposing such lateral pressure. In many machines the lateral pressure is unopposed. Unopposed lateral pres-

sure, particularly where the shanks are relatively thin, frequently results in the distortion of the terminal portion of the shank during the cutting operation as a consequence of which the flutes will be of improper formation, or relation. When this happens the shank must be discarded.

The prior machines, because they can cut only one flute at a time, impose the necessity of separate and successive cutting operations, the intermediate operations of the index feature, and the intermediate changes in the position of the shank in order to insure the proper angularity of the base of the flute. It follows that the formation of the flute bit requires an extravagant period of time and the production capacity of the machine is relatively low. In prior machines where the cutter exercises unopposed lateral pressure upon the shank an additional factor which lowers the production capacity is thereby introduced, not to mention the waste represented by shanks that are necessarily discarded.

The invention accomplishes the following broadly stated objects, viz.: a series of simultaneously produced preliminary cuts, one for each flute, followed by the cutting of all of the flutes simultaneously; the neutralization of lateral pressures exercised upon the shanks during the cutting operations; the planishing of the flutes upon the completion of the cuts; and provision for predeterminedly varying the angularity of the flute bases and the lineal and cross sectional dimensions of the flutes as circumstances may require. By virtue of these objects, the following substantial advantages are achieved, viz.: without increase of labor the production capacity of the machine is several times greater than the production capacity of the prior machines, i. e., between three and four times greater; thus whereas the prior machines have an average production capacity of six hundred fluted bits per day, the invention enables the production of twenty-two hundred fluted bits per day; the flutes are cut with the greatest possible speed; all liability of distortion of the shanks during the flute cutting operation is avoided and uniform and perfectly formed flutes are always produced; expensive waste, represented by malformed flutes and discarded shanks, is eliminated; without any separate operations or separate operating features the flutes are effectively planished and freed from all burrs or surface irregularities; and bits may be produced to conform to "Phillips" screws as varied throughout the manufacturing range.

The invention consists in the novel steps and conditions of the method.

In the accompanying drawings:

Figure 1 is a front elevation of a machine for carrying out the method of the invention and which is constructed to form fluted bits for general cruciform outline, the machine being of the construction which forms the subject of my co-pending parent application, Serial No. 208,877.

Figure 2 is a bottom plan view of the machine.

Figure 3 is a horizontal sectional view on the line 3—3 of Figure 1, looking in the direction of the arrows, various openings in the table for cooperation with sundry attachment bolts or screws being omitted.

Figure 4 is a perspective view of a portion of a cam ring with an attached cam, this being one of a series of similar cams mounted on the ring and used for raising and lowering the several cutters.

Figure 5 is a top plan view wherein the table

of the machine is partly broken away, this view being limited to the showing of sundry features of a pneumatic system for controlling the operation of various parts of the machine.

Figure 6 is a cross section on the line 6—6 of Figure 3 showing a gage for insuring the proper initial location of the shank relatively to the cutters which form the flutes and also showing a collet which is fitted upon the shank and by means of which the shank is properly positioned in the machine, this collet, as a matter of convenience, being referred to as a "locational" collet.

Figure 7 is a side elevation of the shank and the locational collet applied thereto, this figure assuming the previous use of the gage shown in Figure 6.

Figure 8 is a view partly in longitudinal section and partly in side elevation of one of two similar automatically operative pneumatic valves of the four-way type for the operation and control of certain mechanisms incorporated in the machine.

Figure 8a is a plan view of the base plate of the automatic valve shown in Figure 8, a plate valve which forms a part of the automatic valve being shown in horizontal section.

Figure 8b is a central longitudinal section of a bleeder valve, several of which of similar construction are incorporated in the pneumatic operating and controlling system which includes the two four-way valves of the construction shown in Figure 8.

Figure 9 is an enlarged partial top plan view of the machine showing the carriage for the shank and sundry mechanical features associated with the carriage together with parts of the cams shown in Figure 4 and the ring upon which the cams are mounted, the cutter units being omitted from this figure in order to promote clarity of illustration.

Figure 10 is an enlarged partial top plan view of the machine showing the arrangement of the cutter units and the gearing for the operation of the cutters, the carriage for the shank being partly broken away in order to promote clarity of the illustration.

Figure 11 is a vertical sectional view on the line 11—11 of Figure 10, looking in the direction of the arrows.

Figure 11a is a fragmentary sectional view in the same plane as Figure 11 and showing on a larger scale certain details of a guide bar and its mounting.

Figure 12 is a vertical sectional view on the line 12—12 of Figure 9, looking in the direction of the arrows.

Figure 13 is a vertical sectional view on the line 13—13 of Figure 9, looking in the direction of the arrows.

Figure 14 is a vertical sectional view on the line 14—14 of Figure 9, looking in the direction of the arrows.

Figure 14a is a perspective view of a block which carries an operating arm for a bleeder valve.

Figure 15 is a detail vertical sectional view on the line 15—15 of Figure 14, looking in the direction of the arrows.

Figure 16 is a perspective view of the cam mechanism for effecting and controlling the movements of the carriage for the shank.

Figures 17 to 20 illustrate the method.

Figure 17 is a diagrammatic view showing the shank in the course of its downward movement relatively to the cutters as having reached the

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position wherein the preliminary cutting action is initiated.

Figure 18 is a diagrammatic view showing the relation of the shank and the cutters at the beginning of the flute cutting operation.

Figures 19 to 22 appear on Sheet 1.

Figure 19 is a diagrammatic view, corresponding to the diagram of Figure 18, showing the shank as completely moved into operative relation to the cutters and in a relative position wherein the preliminary cuts have been completed and the cutting of the flutes is initiated, the axes of the cutters at such time being in their normal or lower common horizontal plane.

Figure 20 is a similar diagrammatic view showing the relation between the cutters and the shank at the completion of the formation of the bit, the cutters having been moved to a position wherein their axes are in a common horizontal plane above their normal horizontal plane.

Figure 21 is a side elevation of a terminal portion of the shank upon which the fluted bit has been formed.

Figure 22 is an end elevation of the bit shown in Figure 21.

The various parts of the machine are supported by a horizontal table 1 mounted upon legs 2 which are preferably of channel cross section and are provided at their upper ends with horizontal flanges 3 and at their lower ends with horizontal plates 4 (Figures 1, 2 and 11). The legs 2 are arranged adjacent the ends of the table 1. The flanges 3 provide direct support for the table and are secured to the table in any suitable manner, e. g. as by screws 5. The plates 4 rest upon the floor and provide floor engaging surfaces of suitable extent to insure the stability of the machine.

The principal elements of the machine are a carriage designated generally as 6 for holding the screw driver shank S (Figures 11 and 12), a series of milling cutter units designated generally as 7 (Figures 10 and 11), and a mechanism designated generally as 8 (Figures 2, 4, 9 and 11) for effecting the upward and downward movements of the milling cutters.

The shank holding carriage

The shank holding carriage 6 includes a horizontal bar 9 supported for positively guided rectilinear movement above the milling cutter units and having two positions, viz., a normal upper or "distant" position and an operative lower or "near" position. Adjacent one end (its left end, Figures 1, 11 and 12 being considered) the bar 9 is mounted for vertical sliding movement upon a vertical post 10. On its lower face the bar 9 carries a collar 11 slidably surrounding the post 10 and providing a shoulder 12. The post 10 is carried by and extends upright from a suitably formed bracket 13 attached to the table 1 and providing an annular shoulder 14. An expansive helical spring 15 surrounds the post 10 and is located between and reacts against the shoulders 12 and 14. Adjacent its opposite end (its right end, Figures 1, 13, 14 and 15 being considered) the bar 9 rests upon a spring supported horizontal plate 16 suitably mounted for vertical movement and positively guided in its movements. As shown, the plate 16 is connected to the upper ends of a pair of vertical posts 17 which fit slidably in sockets 18 in a fixed block 19 (conveniently attached to the standard 23 to be later described). An expansive helical spring 20 surrounds each post 17 and is located between and reacts against the base of the socket 18 and the under face of the plate 16. The upper face of the plate 16 has

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a terminal bevel formation 21 adjacent an edge face (Figures 13 and 15) which is utilized when the bar 9 is swung about the post 10 as a pivot from an inoperative position (dot and dash lines in Figure 9) to its normal position in the upper plane (Figures 13 and 14 and, broken lines, Figure 19).

The table 1 carries a pair of upright standards 22 and 23 (Figures 1, 9 and 10) secured by bolt fastenings 24. The standard 22 is formed with a recess 25 open to a vertical face. The standard 23 is formed with a similar recess 26. The recesses 25 and 26 are presented in opposite directions, i. e., the standard 22 at the left end of the machine (Figure 1) has its recess 25 open to its rear face and the standard 23 at the right end of the machine has its recess 26 open to its front face. Each of the recesses 25 and 26 (Figures 14 and 15) provides outer and inner shoulders. Corresponding shoulders are at corresponding locations on the standards and their planes are therefore parallel. As herein disclosed the shoulders are in upper and lower relation. The outer shoulder is preferably in the form of a horizontal anti-friction roller 27 having trunnions mounted in opposed vertical walls of the recess. The roller 27, with its lower side exposed in the recess, overhangs the flat horizontal inner shoulder 28 which is preferably coextensive with the width of the bar 9. The rollers 27 limit the upward movement of the bar 9 as effected by the springs 15 and 20 and the shoulders 28 limit the downward movement of the bar 9 and provide stable rests for the bar 9 in its lower position.

The mechanism for operating the shank holding carriage

The rollers 27 also cooperate with the mechanism, indicated generally at 29 (Figures 1, 9 and 16), for effecting the movement of the bar 9 from its upper position to its lower position. This mechanism includes a straight horizontal operating lever 30 having two alining arms 31 and 32 which may be said to be delimited by a pivotal connection 33 between the lever 30 and the bar 9. The pivot 33 extends through a suitably located opening 34 in the lever 30 and is fitted in or to the bar 9 and also in a bracket 35 (Figures 9 and 14) secured to the bar 9 and overhanging the lever 30. The arm 31 projects in a rearward direction beyond the pivot 33 and the arm 32 projects in a forward direction. The arm 31 is pivotally connected near its outer end to a horizontal link 36 and the arm 32 is similarly pivotally connected to a horizontal link 37. The links 36 and 37 extend in opposite directions from the lever 30, the link 36 extending to the right (Figures 9 and 16 of the drawing being considered) and the link 37 extending to the left. The link 36 is pivotally connected at its outer end to a horizontally extending cam member 38 of the slidable wedge type and the link 37 is pivotally connected at its outer end to a horizontally extending cam member 39 similar in all respects to the member 38. The members 38 and 39 have flat bottom faces and rest directly upon the bar 9. Their movements in either direction, as directly effected by the links to which they are connected, are longitudinally of the bar 9 and they are positively guided in such movements. For this purpose the members 38 and 39 are formed adjacent their bottom faces and at each side with laterally projecting straight longitudinal flanges 40 and are slidable in ways provided by guides 41 and 42, the guide 41 being attached to the front face of

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the bar 9 and the guide 42 being attached to its upper face. The guides 41 and 42, as shown in Figure 13, are formed for overhanging engagement with the flanges 40 and thereby confine the cam members in the guide ways. The upper faces of the members 38 and 39 are fashioned to provide the cam action and, for a purpose to be later described, have a two-stage inclination. The first stage is provided by an inclined face 43 and the second stage is provided by an inclined face 44. The inclined face 43, which may be called the outer cam face, terminates at the outer end of the cam member and the inclined face 44, which may be called the inner cam face, extends between the face 43 and the upper face of the cam member. The face 43 has a greater degree of inclination than the face 44. Thereby the face 43 effects a relatively quick action and the face 44 effects a suitably slower action. In the operation of the mechanism power is applied to the arm 32, the length of which is such that if occasion should require it may be used as a handle for the manual operation of the mechanism. In the normal relation of the parts as shown in Figures 1 and 11 the bar 9 is in its upper position (which corresponds to the position shown in broken lines in Figure 19) and the wedge members are interposed to some extent between the rollers 27 and the upper face of the bar 9, the rollers 27 at such time resting upon the outer cam faces 43. With the parts in this relation the lever 30, by the application of power to its arm 32, is moved about the pivot 33 in order to effect outward movements of the links 36 and 37 and of the cam members 38 and 39. Figure 9 of the drawing being considered, this movement of the arm 32 is to the left and is continued until the lever reaches the position shown in broken lines. This movement of the lever 30 causes the cam faces 43 and 44 to react successively against the rollers 27 with the result that the bar 9 is given rectilinear downward movement in opposition to the pressure of the springs 15 and 20. At the completion of the outward movements of the cam members 38 and 39 the rollers 27 engage their upper flat faces and thereby positively hold the bar 9 in its lower position as shown in full lines in Figure 19. The downward movement of the bar 9 caused by the reaction of the outer cam faces 43 against the rollers 27 is at a more rapid rate than the continued downward movement of the bar 9 caused by the reaction of the inner cam faces 44 against the rollers 27. The transverse lines 45 at which the cam faces 43 and 44 adjoin substantially correspond in location to the horizontal plane P (Figure 17) in which the shank initially engages the teeth of the cutters, this being the plane in which the later described preliminary cutting action is initiated. In aid of speed of operation it is desirable that the initial downward movement of the shank, i. e., its movement prior to its engagement with the cutters, be quite rapid and the inclination of the outer cam faces 43 is determined with this consideration in mind. In order to prevent injury to the shank or the cutters it is desirable that the downward movement of the shank immediately following its engagement with the cutters be not too rapid. It is for this reason that the inner cam faces 44 have less inclination than the outer cam faces 43. The above described movement of the lever 30 which results in the downward movement of the bar 9 is positively limited. This is accomplished by a bumper arm 46 located below the link 37 and secured by fastenings 46a to the bar 9, the arm 46

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projecting forwardly and inwardly from the bar. As an additional factor in the prevention of injury to the cutters or to the shank the arm 46 carries at its outer end a slidably mounted spring biased projecting bumper head 47 which is engaged by the arm 32 at a suitable point in its movement, i. e. a point substantially corresponding to the initial points of engagement of the inner cam surfaces 44 with the rollers 27, to cause the lowering of the bar 9 at a slower rate, and which retards and progressively cushions the continued operative movement of this arm.

The method

The milling cutters 48 are of the same diameter and are arranged in angular and equally spaced relation with their axes of rotation in a common plane H (Figure 18) which is horizontal in the embodiment disclosed. In this plane the peripheries of the cutters are spaced to delimit a passage 49 of symmetrical contour (Figures 10, 19 and 20). Figure 18 shows a shank S properly positioned for the cutting of the flutes. In the practice of the method the shank S, which has a diameter suitably greater than the minimum sectional dimension of the passage 49, is moved in the direction of its vertical axis A and in a direction normal to the plane H into the passage, the axis A being in alinement with the axial center of the passage 49. The movement of the shank is continued to a point at which the lower ends of the bases of the flutes at the initiation of the cutting of the flutes will lie within a horizontal plane P'. This plane is located below the plane P and may be in substantial coincidence with the plane H or it may, as herein shown, be slightly above it. The plane P' prescribes the points E at which the succeeding step, namely the cutting of the flutes, commences, these points coinciding with the lower ends of the bases of the flutes. The angle of the bases of the flutes to the axis A of the shank is in any case less than the angle of the bases of the preliminary cuts C (Figure 18) to the axis A. The location of the plane P' is such that the points E will lie within upwardly diverging lines T tangential to the cutters and at an angle to the axis A which substantially corresponds to the general angle of the bases of the flutes to the axis A. In Figure 18 it may be assumed that the bases of the flutes are to extend at an angle of the order of seven degrees to the perpendicular, i. e., the axis A, in which case the tangent lines T will extend at an angle of seven degrees to the axis A. The tangent lines T extend at right angles to lines R which extend to the points E and are radii of the cutters. The angle of the lines R to the plane H is the same as the angle of the lines T to the axis A. For example if the angle of the lines T to the axis A be assumed as seven degrees the angle of the lines R to the plane H will be seven degrees.

When the shank S is moved into the passage 49 to the position determined by the plane P (as shown in Figure 17) the cutters 48, during the final stage of the downward movement of the shank, will make preliminary cuts in the end of the shank, these conforming in basal lineal outline to the curvature of the cutters and facilitating the cutting of the flutes. The terminal portion of the shank (upon which the bit is to be formed) is of an outline which tapers to a point as shown at Y in Figure 17 from an annular line X at the cylindrical surface of the shank, a standard pointing machine being used for this

purpose. The taper Y provides the socket engaging terminal portion Z of the bit (Figure 21), the taper of which conforms to the taper of the socket in the screw head. The preliminary cutting commences during the downward movement of the shank when the line X of the shank substantially coincides with the plane P. This relation is shown in Figure 17. The preliminary cuts are completed when their lower ends coincide with the points E in the plane P'. Figure 18 shows the preliminary cuts as completed, their outline and extent, both above and below the line X of the shank, being indicated by broken lines C. The flutes are cut from points quite near the lower end of the shank to points on its cylindrical surface, these latter points being the upper ends of the bases of the flutes. The cutting of the flutes is accomplished by holding the shank stationary and at the same time effecting simultaneous coextensive movements of the cutters in angular directions having components opposite to the direction of movement of the shank and outward components of the same degree of angularity. In the embodiment disclosed these movements are upward and outward. Figure 20 assumes the complete cutting of the flutes. The tangent lines T conform in angularity to the movements of the cutters. Thus for the step of cutting the flutes the cutters are moved angularly upward from their normal positions N (broken lines) to or through raised positions (full lines) wherein their horizontal axes are in a common plane H' parallel to the plane H and coincident with the upper ends of the bases of the flutes. Hence, the elevation of the plane H', indicated arbitrarily in Figure 18, will accord with the prede- with the upper ends of the bases of the flutes. When the axes of the cutters reach the plane H' the cutting of the flutes is completed and thereupon, the shank being held stationary the while, the cutters are returned to their normal position, represented by the plane H, by an inward and downward movement along the same paths as their upward movement during which the cutters act with planishing effect upon the flutes. After the cutters 40 have been returned to their normal lower positions the bar 9 is returned to its normal upper position. This is accomplished by the application of power to the arm 32 whereby to move it back into its normal position shown in full lines in Figure 9. At such time the cam members 38 and 39 are withdrawn and the springs 15 and 20 raise the bar 9 until its movement is arrested by the rollers 27.

The gage for determining the position of the locational collet

For the satisfactory use of the screw drivers accuracy, approaching precision, is required in the formation of the bits. For this purpose the bit must be accurately located in the machine. This is accomplished by a locational collet 50 (Figures 6 and 7) which is preferably in the form of an open ended sleeve split from one end to a point suitably intermediate its length, thereby to provide a pair of opposed resilient clamping jaws 51 of semi-circular cross section and which tend to spring inward. The collet is engaged with the upper portion of the shank S and the distance D to which the shank projects beyond the collet is required to be exactly of a predetermined extent. This extent will be the same for screw drivers which require exactly similar bits. However, since the range of manufacture will require bits of various dimensions

the extent D to which the shank S projects beyond the collet must be selected to accord with the particular bit which is to be formed and hence will be varied accordingly as the bit may conform to one or another set of dimensions. The selection of the extent D is effected by a suitable gage designated generally as 52 and which includes a vertical tubular casing 53, open at its upper end and formed with internal threads 54 extending for a suitable distance from its lower end. The lower end of the casing 53 is closed by a screw stem 55 which projects into the casing and engages the threads 54. The stem 55 is held in any position to which it may be adjusted by a lock nut 56 which bears against the lower end of the casing 53 and is provided at its lower end with a head 57 by means of which it may be positionably adjusted, that is to say, adjusted to project to a greater or less extent into the casing 53. The stem 55 and the casing 53 delimit a vertical well 58, the extent of which determines the distance D and the internal diameter of which slightly exceeds the maximum shank diameter within the manufacturing range. For a bit of some particular set of dimensions the required depth of the well 58 is determined by any appropriate shop measuring tool, the position of the stem 55 being adjusted to conform to and prescribe this depth. The distance D is the same for all bits which conform to a particular set of dimensions. When bits of another set of dimensions are to be made a corresponding change in the depth of the well 58 is required and the stem 55 is adjusted to effect this change, the extent of the adjustment of the stem 55 being predetermined from its previous position and any appropriate shop measuring tool being used in connection with the adjustment in order to insure the accuracy of the positioning of the stem as adjusted.

For convenience of use the gage 52 is preferably permanently mounted at one end of the table 1 (Figures 1 and 5). Thus the casing 53 projects through an opening in a bracket 59 and is suitably attached to the bracket, e. g., as by welding, the bracket serving for the attachment of the gage to an end of the table.

The use of the gage is illustrated in Figure 6. In such use the collet 50 is inserted over one end of the shank to an extent (sufficiently indicated by dot and dash lines in Figure 6) merely sufficient for the collet to be stable upon the shank. The portion of the shank which projects beyond the collet is thereupon inserted into the well 58, the lower end of the shank coming to rest upon the upper end of the stem 55. The collet 50 is thereupon pushed downward upon the shank until its movement is arrested by the engagement of its split lower end upon the shoulder provided by the upper end of the casing 53, this position of the collet being shown in full lines in Figure 6. At such time the portion of the shank which projects beyond the collet will have an extent equal to the depth of the well 58, this extent being the distance D. When the collet engages the upper end of the casing 53, its jaws 51 will exercise a frictional grip upon the shank of such degree that the shank and the collet are securely associated, that is to say the shank is held without any liability of accidental displacement relatively to the collet whereby when the shank is fitted in the machine the distance D is maintained exactly as determined by the cooperation of the collet and the gage 52. Using the collet as a handle the shank

is thereupon transferred from the gage 52 to the machine.

The mechanism for holding the shank in the machine

The mechanism for holding the shank in the machine (Figures 1, 9, 11 and 12) is designated generally as 60 and is located centrally of the length of the bar 9 to which it is attached. This mechanism includes a cylindrical vertical casing 61 open at its upper and lower ends, the casing 61 being mounted in a central opening in the bar 9 and projecting above and below the bar. The opening in the bar 9 in which the casing is fitted is of enlarged diameter at its upper end in order to provide a shoulder for supporting engagement by a circumscribing flange 62 formed upon the casing, the upper face of the flange being flush with the upper face of the bar 9. The portion of the casing 61 which projects below the bar 9 is formed with an internal terminal taper 63. The casing 61 encloses a clamping collet 64 which is generally similar in construction to the locational collet 50. Thus the collet 64 is preferably in the form of an open-ended sleeve which is split from its lower end to a point suitably intermediate its length, thereby to provide a pair of clamping jaws 65 of a semi-circular cross section. Each jaw 65 is formed with an external taper 66 which extends to its lower end, the opposing tapers 66 presenting an inverted conical surface which bears against the taper 63 of the casing 61. The collet 64 projects beyond the casing 61 and its projecting portion carries a circumscribing flange 67 which is preferably in the form of a ring secured in fixed relation.

The collet 64 is formed with a central vertical opening, the diameter of which conforms to the diameter of the shank. The shank is inserted through this opening and projects to a suitable extent beyond the lower end of the collet. Whereas the jaws of the locational collet 50 maintain their secure engagement with the shank by reason of their inherent resiliency the jaws of the clamping collet 64 are positively urged into the clamping engagement with the shank and are positively held in such engagement. For this purpose downward pressure is positively applied to the flange 67. This downward pressure effects the movement of the collet 64 (the shank moving with it) from what may be called an idle position to a lower position which may be called an active position. The movement of the collet thus effected is so slight as to be scarcely sensually perceptible but it is sufficient to cause the lower portions of the jaws 65 to exert very strong frictional clamping pressure upon the shank, this pressure being the result of the co-operation of the tapers 63 and 66.

The application of downward pressure to the flange 67 is effected by a manually operated lever 68 pivotally connected to a bracket 69. This bracket consists of a straight horizontal plate 70 and a pair of vertical ears 71 which extend upwardly from the plate at opposite sides thereof. The plate 70 has an opening through which projects the portion of the casing 61 above the flange 62. The plate 70 rests upon the upper face of the bar 9 and has overhanging engagement with the flange 62, being thus utilized to secure the casing 61 to the bar 9 in the relation above described. The bracket 69 is secured to the bar 9 by fastenings 72 which project through the plate 70.

The lever 68 is of general L-shaped outline and

includes an arm 73 which provides a handle and preferably extends at a suitable upward inclination from the bracket 69. At its lower end the lever 68 has a forked formation which provides a pair of arms 74 extending in upward relation to the lower end of the arm 73.

The arms 74 are arranged between the ears 71, each arm being adjacent the inner face of a corresponding ear. Pins 75 at the upper ends of the arms 74 pivotally connect the arms to the ears 71. At their lower ends the arms 74 are provided adjacent their inner faces with vertical rollers 76 which, when the arm 73 is depressed, bear upon the flange 67 and apply downward pressure to the clamping collet 64. The rollers 76 are so located that when the arm 73 is fully depressed their axes will be very slightly beyond (to the right, Figures 9 and 11 being considered) a perpendicular plane passing through the pivots 75, that is to say slightly beyond dead center. This location of the rollers 76 insures that when the arm 73 is fully depressed the parts will be in locked relation, the clamping collet 64 being thereby positively maintained in its active position. In order that the rollers may not be moved beyond their locking positions the bar 9 carries a post 77 which is located under the arm 73 near its lower end and which provides a stop for positively limiting the downward movement of the arm. When the arm 73 engages the post 77 the rollers 76 are in the locking relation above described. When the bit has been formed upon the shank S and the shank is to be withdrawn from the machine the pressure on the clamping collet is relieved by raising the arm 73 to a suitable extent.

In the insertion of the shank S into the clamping collet the locational collet 50 is used as a handle and the downward free movement of the shank through the clamping collet is continued until the lower end of the collet 50 engages the shoulder presented by the upper end of the collet 64. The distance D above described then becomes the extent of the shank between its lower end and the upper end of the collet 64. When the shank has been inserted to the permissible extent through the clamping collet the arm 73 is lowered until it engages the post 77. Such downward movement of the arm 73 effects the very slight movement of the clamping collet from its idle position to its active position, the shank S and the locational collet 50 participating in this movement. During the formation of the bit the shank S is rigidly and securely held by the collet 64. When the bit has been completed the cutters 48 are returned to their normal lower positions. Thereupon the bar 9 is returned to its upper position and the shank is removed from the machine. For this purpose the arm 73 is raised in order to relieve the pressure on the collet 64. The frictional bearing of the portions of the arms 74 which surround the pivots 75 upon the adjacent faces of the ears 71 is of sufficient degree to maintain the lever 68 in the position to which it is moved when the arm 73 is raised. When the pressure on the clamping collet has been thus relieved the shank is withdrawn by pulling it upward, the locational collet 50 being used as a handle. When the shank is pulled upward the clamping collet will move with it to the very slight extent which is sufficient for its jaws 65, by virtue of their inherent resiliency, to spring outward from the shank and thus release it at which time the shank may be freely withdrawn from the collet

64. When the jaws 65 release the shank the collet 64 will be in its idle position in which it is conditioned for the insertion of another shank and a repetition of the operations.

The milling cutter units

The milling cutter units 7 (Figures 1, 10 and 11) are similar in construction and correspond in number to the number of flutes to be cut. The machine shown in the drawings is for the formation of bits of cruciform cross section and hence includes four units 7.

Each unit includes a milling cutter 48 which is mounted at the inner end of a horizontal shaft 78. The shafts 78 are arranged in right angular relation to one another as best shown in Figure 10. Two of the shafts in offset relation extend longitudinally of the table 1 and the other two, also in offset relation, extend transversely of the table 1. The milling cutters of the shafts which extend in the same directions confront one another in spaced relation and the four milling cutters, each spaced ninety degrees from adjacent cutters, de-limit the passage 49 above described. Each unit 7 includes a mounting plate 79 for the direct support of its shaft 78. The plate 79 is provided at its upper end with a pair of inwardly projecting parallel ears 80. The shafts 78 are journaled at their ends in suitable bearings (not shown) carried by the ears 80. Each unit 7 includes gearing for the operation of its shaft 78, the gearing of the several units, of course, being driven simultaneously. The gearing includes a vertical bevel gear 81 mounted in fixed relation upon the shaft 78 and a bevel gear 82 meshing with the gear 81. The gear 82 is mounted in fixed relation at the upper end of a shaft 83. The gear 82 is supported in operative relation to the gear 81 by a bracket 84 which is attached by fastenings 85 to the plate 79. The bracket 84 provides a bearing for the shaft 83, the downward displacement of which relatively to the bracket is prevented by a spacing collar 86 fitted on the reduced projecting upper portion of the shaft 83 and arranged between the hub of the gear 82 and the upper face of the bracket 84. The mounting plate 79 has upward and downward movement in the operation of the machine and extends upward and outward at a suitable angle to the vertical, its angular setting being adjustably variable as will be later described. The shaft 83 is therefore driven by a universal shaft (Figure 11) designated generally as 87, the two shafts being in slidable relation. The universal shaft 87 includes an upper section 88 and a lower section 89, these sections being connected by a universal joint 90 of any suitable form. The part of the shaft 83 within bracket 84 is formed with an axial recess 91 which extends to its lower end. The shaft section 87 projects into the recess 91. The driving connection between the shaft section 87 and the shaft 83 may include keys 92 on the shaft section which are slidable in keyways 93 in the wall of the recess 91. Each cutter unit 7 includes a supporting frame designated generally as 94 (Figures 10 and 11), one element of this frame being a base plate 95 (Figures 3 and 11) which rests upon the table 1 and which, for the purpose of positional adjustment, is mounted for movement in directions at right angles to the horizontal axis of the shaft 78 of the unit. The lower section 89 of the universal shaft 87 extends vertically and is journaled in a supporting block 96 secured by fastenings 97 to the inner end face of the base plate

95. A spacing collar 98 is preferably interposed between the block 96 and the adjacent part of the universal joint 90.

The table 1 is formed with a central opening 99 of circular outline to accommodate the lower shaft sections 89, these projecting to a suitable extent below the table. The opening 99 also accommodates the blocks 96, the lower faces of which are preferably flush with the lower face of the table. The opening 99, as best shown in Figure 3, is provided with angular extensions 100 to accommodate attachment flanges of the blocks 96.

The gearing of the several units is driven from an electric motor 101 which may be conveniently mounted upon one of the legs 2 (Figures 1 and 2). The operative connections between the motor 101 and the universal shafts 87 may conveniently be of chain and sprocket form (Figures 2, 3 and 11). Each shaft section 89 carries at its lower end a sprocket 102 and the upper end of the motor shaft carries a sprocket 103, the sprockets 102 and 103 being coplanar. A sprocket chain 104 is engaged with the sprockets 102 and 103 and serves to drive all of the universal shafts 87 in the same direction, the chain 104 being kept under suitable tension by a pivotally mounted spring biased tensioning arm 105 (Figure 2) having a terminal roller for engagement with the chain.

Each cutter unit 7 in connection with the mounting of its shaft 78 includes three serially connected plates (Figures 1, 10 and 11), namely an inner plate, an intermediate plate and an outer plate. The inner plate is constituted by the mounting plate 79 above referred to. The intermediate plate 106 may be called a guide plate in that it has guiding cooperation with the mounting plate 79. The outer plate 107 may be called a supporting plate in that it is the part to which the guide plate 106 is attached. The mounting plate 79 is formed in its outer face with a dovetail groove 108 which extends between its upper and lower ends. The guide plate 106 is formed on its inner face with a dove-tail projection 109 which extends between its upper and lower ends and, conforming in cross sectional outline to the groove 108, fits within it. The projection 109 is, however, of somewhat less width than the groove in order to provide a clearance for a gib 110 which is used in accordance with standard shop practice and is secured in any suitable manner to a wall of the groove 108. The projection 109 and the groove 108 provide connections between the mounting plate 79 and the guide plate 106 which permit the upward and downward movement of the mounting plate upon the inner face of the guide plate, guiding the mounting plate in such movement, and in all other respects positively couple these plates in rigid relation. The guide plate 106 is formed on its outer face with a dovetail groove 111 which extends transversely between its side faces. The supporting plate 107 is formed on its inner face with a transversely extending dove-tail projection 112 which conforms in cross sectional outline to the groove 111 and fits within it. The projection 112 is dimensioned to provide a clearance for a gib 113 which is fitted between the upper face of the projection and the overlying face of the groove 111, the gib 113 being suitably secured to the adjacent wall of the groove 111. The projection 112 and the groove 111 positively couple the plates 106 and 107 in rigid relation but permit a lateral adjustment of the position of the plate 106 relatively to the plate

107. This lateral adjustment is enabled by the universal joint of the shaft 87 and is for the purpose of insuring accuracy in the centering of the cutters 48 relatively to one another, that is to say of insuring accuracy in the symmetrical definition of the passage 49. Since the corresponding plates of the several cutter units 7 (mounting plates 79, guide plates 106 and supporting plates 107) are of the same dimensions each guide plate, as adjusted, will occupy the same position relatively to its companion supporting plate as the guide plates of the other units. The adjustment, once made, is permanent for any set of cutters and needs to be repeated only as there may be a substitution of some one or more of the cutters or if, for any reason, it should become necessary to disassemble or reassemble any one or more of the units 7. The adjustment in any case is minute in lineal extent and may be effected by horizontal screws 114 which bear against the side faces of the supporting plate 107 and have threaded engagement in openings in brackets 115 carried by and projecting outward from the guide plate 106 and suitably attached to its side faces.

The angularity of the paths in which the cutters 48 have their upward and downward movement is varied in accordance with the particular predetermined angularity of the bases of the flutes. For this purpose the plates 79, 106 and 107, serially connected as a group G, are mounted for angular, i. e. pivotal, adjustment. The cutter unit supporting frame 94 includes a pair of parallel vertical side walls 116 suitably spaced and extending in upright relation from the base plate 95. The supporting plate 107 is mounted near its lower end upon a transverse pivot pin 117 (Figures 1 and 11) which extends between the side walls 116. The plate 107 is located between the side walls 116 and its side faces are closely adjacent the inner faces of the walls 116. When the angle of the paths of movement of the cutters is to be adjustably varied the plate group G is moved as a unit in the proper direction and through the proper degree about the pivot 117, any suitable shop measuring tool being used for the determination of the degree of movement. The walls 116 are connected near their upper ends by a draw pin 118, one end of which is tapped as at 119 (Figure 10) into one of the walls and the other end of which carries a knurled head 120 serving as a finger piece and bearing against the outer face of the other wall. The parts of the walls through which the draw pin 118 extends have a certain measure of resiliency and normally are strongly held against the side faces of the plate 107 by the draw pin 118, the connected plates G thus being clamped in the particular position determined upon. When the position of the group G is to be varied the draw pin 118 is backed off to permit the walls 116 to release the plate 107, thereby to permit the free manual adjustment of the position of the plates G. When this adjustment has been made the pin 118 is tightened, thereby to secure the plates G in the newly adjusted position.

The passage 49 may be varied in dimensions in order to accord with particular predetermined cross-sectional dimensions of the bit. In effecting such variation the cutters, with their axes in the common normal plane H, are adjustably moved toward or away from one another, the degree and relative direction of adjustable movement being the same in each instance. For the purpose of such adjustable relative positioning of the cutters the base plates 95 of the frames

94 are mounted for slidable adjustment upon the table in directions normal to the axes of the cutter shafts 78. Each base plate 95 is accordingly confined in a guide channel provided by a pair of parallel guide bars 121 and 122, one located at each side of the base plate. The guide bars are secured to the table 1 by bolt fastenings 123. The guide channels may be conveniently of dove-tail cross section. For cooperation with the guides 121 and 122 each base plate is formed with longitudinally extending rabbeted grooves 124 and 125, the walls of which extend from the side and bottom faces of the base plate and the cross section of which conforms to the cross-sectional outline of the guide channels, the guide bars conformably fitting within the grooves 124 and 125. In order to insure the perfect alinement of the base plates 95 the table 1 is formed in its upper face with straight grooves 126 (Figures 10, 11 and 11a). A groove 126 is provided for each base plate 95 and extends in the direction of adjustable movement of the base plate, that is to say in the same longitudinal direction as the base plate. One of the guide bars, e. g. the guide bar 121, is provided along its outer edge with a longitudinal rib 127 which projects downward from its bottom face and fits in the corresponding groove 126. In assembling the frames 94 of the units 7 upon the table 1 the guide bars 121 are initially secured to the table by their fastenings 123 with their ribs 127 located in the grooves 126. The frames 94 are then positioned upon the table, the rabbeted groove 124 of each frame being engaged with the guide bar 121. Thus the guide bars 121 are utilized to effect the perfect alinement of the frames 94. The guide bar 122 is then engaged with the other rabbeted groove 125 and is moved to a position in which its fastenings 123 may be applied. Each frame 94 is positively adjusted upon the table 1 by an adjusting screw 128 (Figures 10 and 11) which extends in the same longitudinal direction as its companion base plate 95 and is rotatably mounted in a bracket 129 located behind the frame 94 and attached to the table 1 by fastenings 130. Each frame 94 is formed above its plate 95 with a web 131 having a threaded opening which is engaged by the threaded portion of the screw 128. Accordingly as the screw 128 is turned in one direction or the other it will project to a greater or less extent rearward from the web 131 and the degree to which it projects from the web, its head bearing against the rear face of the bracket 129, will determine the position of the plate 95 relatively to the guide channel provided by the bars 121 and 122. In order to hold the frame 94 in any position to which it may be adjusted upon the table 1 a locking screw 132 is provided. The bracket 129 is formed with a threaded opening in which the threaded portion of the screw 132 engages. The screw 132 projects inwardly from the bracket 129 and is positioned relatively to the bracket to cause its head to bear with suitable pressure against the rear face of the web 131. Thereby the screw 132 effectively "locks" the frame 94 in the position to which it is adjusted by the screw 128.

The mechanism for reciprocating the cutters

The mechanism 8 (Figures 2, 3, 4, 9 and 11) for effecting and controlling the upward and downward movement of the cutters 48 includes a series of cams 133, one for each cutter. The cams 133 are of the movable wedge type and are

moved in opposite directions, i. e. reciprocated, to raise and lower the cutters. The cams are mounted upon the upper face of a horizontal operating ring 134 to which they are rigidly secured by fastenings 135, the central opening 136 of the ring registering with the opening 99 in the table 1. The shaft sections 89 project through the opening 136 and the sprockets 102 are located suitably below the ring 134. The movement of the cams 133 is produced by the rocking movement of the ring 134 in its plane and about its radial center. The ring is guided in its rocking movement by a series of conformably curved blocks 137 secured to the table 1 and arranged adjacent the under face of the table, the peripheral edge of the ring adjoining the inner faces of the blocks. The ring is supported upon ledges provided by plates 138 arranged below and secured to the blocks 137. The plates 138 are curved in conformity to the outline of the blocks and project inward from them, their projecting portions providing the ledges upon which the ring 134 rests. The blocks are secured to the table 1 by fastenings 139 which are also utilized to secure the plates 138 to the blocks. The guide plate 106 is formed on its inner face with a recess 140 of suitable depth and which extends to its lower end. The upper wall of the recess 140 provides a shoulder 141. The recess 140 accommodates the upper portion of a post 142; the upper end of which is suitably spaced from the shoulder 141. The portion of the post 142 within the recess 140 is rigidly secured, as by screw fastenings, to the base of the dove-tail groove 108 in the mounting plate 79. An expansive helical spring 143 is arranged in the recess 140 between the post 142 and the shoulder 141 and reacts against these parts. The post 142 projects downward from the group of connected plates G and is provided at its lower end with an anti-friction roller 144 which rides upon the surface of a corresponding cam 133. Clearances for the downwardly projecting portion of the post 142 are provided by registering recesses 145 and 146 in the plate 95 and the table 1 respectively, the recesses 146 being formed as angular extensions of the opening 99 of the table 1 and being severally adjacent and at an angle to the recesses 100. The opposite movements of the cams 133 may be called advancing and retractile movements. In their advancing movements, which are clockwise (Figure 3 of the drawing being considered), the cams raise the posts 142 in opposition to the pressure of their loading springs 143 and thereby to a corresponding extent raise the mounting plates 79. The cutters 48, the shafts 78, the bevel gears 81 and 82 and the shafts 83 participate in the upward and downward movements of the mounting plate. The springs 143 serve two purposes. One purpose is suitably to retard and cushion the upward movements of the mounting plates 79 in order that these movements may not be too abrupt, thereby avoiding liability of injury to the cutters 48 and the shank S. The other purpose is to effect suitably more rapid downward movements of the plates 79 than would result from dependence on gravity alone, the springs thereby maintaining the contact of the rollers 144 with the surfaces of the cams. When the cams have reached the limit of their advancing movement the cutting of the flutes has been completed and thereupon the cams are retracted to permit the downward movements of the mounting plates 79 and the return of the cutters 48 to

their normal lower positions, the cutters in such return acting with planishing effect upon the flutes as above described. During the upward and downward movements of the mounting plates 79 the shafts 83 are continuously rotated by the universal shafts 87 but are slidable with relation to the universal shaft sections 88.

The extent of the upward movements or "throw" of the cutters 48 depends upon the degree of inclination of the cam surfaces and the extent of the advancing movements of the cams. These factors are selected to provide for a cutter throw of maximum degree, that is to say a throw which will enable the cutters to cut flutes of the greatest length within the manufacturing range. It will be understood that cutters of different diameters may be used, ideal practice involving the selection of a diameter which will accord with the extent of the flutes to be formed. The ring 134 is rocked by parts which are operated and controlled by a pneumatic system as hereafter described in detail. The lengthwise adjustment of the frames 94 as effected by the adjusting screws 128 is in any case of such slight extent and at such a comparatively slow rate that the rollers 144 of the posts 142 will readily move in either direction transversely of the cam surfaces as an incident of the adjustment, the width of the cam surfaces being such that the rollers 144 will engage them in any position to which the frames 94 may be adjusted.

The bar 9, as above explained, is mounted for pivotal movement in a horizontal plane about the post 10 as an axis. In the event that access should be required to some one or more of the units 7 for such purposes as cleaning, repair or substitution of parts the bar 9 may be swung about the post 10 as a pivot from the angular position which it normally occupies to an angular position at one side of the machine as shown in broken lines in Figure 9. Thereupon free access for any required purpose may be had to any one or more of the units 7. When the required work has been done and the units are again assembled in proper relation the bar 9 is then swung back into the angular position which it normally occupies (Figures 13, 14 and 15) wherein what may be called its free end abuts the base of the recess 26 of the standard 23.

The pneumatic actuating system

The mechanism 29 and the cam ring 134 are operated and controlled by a pneumatic system which, generally speaking, includes two automatic valves of the type known in the trade as "four-way," a number of bleeder valves and various pipes constituting the air flow lines. One of the four-way valves 147 is provided for the operation and control of the mechanism 29 and the other four-way valve 148 is provided for the operation and control of the cam ring 134.

The purpose of convenience is served by locating the valves 147 and 148 according to the showing of Figure 5 wherein the valve 147 is mounted upon the end face of the table 1 at the right and rear side of the table and the valve 148 is mounted upon the upper face of the table 1 adjacent its front side and its end face at the left.

The valves 147 and 148 are similar in construction and are of a well known type (the "Keller" type) which has been on the market for many years and can be purchased from industrial supply houses. However, an understanding of the system of pneumatic operation and control

involves the description of various details of these valves. These details are sufficiently shown in Figures 8 and 8a, it being understood that the description is applicable to both of the valves. The valve construction is shown in these figures in relation to the various air flow lines which are connected to it. Two reference numerals are applied to each flow line, one indicative of the valve 147 and the other indicative of the valve 148.

The four-way valve shown in Figures 8 and 8a consists of a base plate 149 by means of which the valve is attached to the table and a casing 150 which is secured to the plate 149 by screws 151. The casing 150 provides a valve chest 152. A piston unit generally designated 153 is mounted in the valve chest 152 and consists of a pair of spaced pistons 154 and 155 of the same diametrical dimensions and a rod 156 connecting the pistons. Since the pistons 154 and 155 are of the same diametrical dimensions the valve unit is perfectly balanced and will move in either axial direction accordingly as the pressure may be relieved upon one or the other of the outer faces of the pistons 154 and 155. The casing 150 is formed internally with aligning cylindrical guides 157 for the respective pistons 154 and 155. The outer ends of the casing 150 are provided with end heads 158. The piston 154, its guide 157 and the adjacent casing head 158 provide a pressure chamber 159, the outer face of the piston 154 being a wall of this chamber. The piston 155, its guide 157 and the adjacent head 158 similarly provide a pressure chamber 160 at the opposite end of the valve chest, the outer face of the piston 155 being a wall of the chamber 160. The pistons 154 and 155 are mounted upon the end portions of the rod 156. An axial duct or passage 161 of narrow diameter is formed in the rod 156 and extends from end to end thereof, the ends of the duct 161 communicating with the pressure chambers 159 and 160. The movement of the piston unit is in either direction of the longitudinal axis of the rod 156 and such movement results in one of the pressure chambers being progressively reduced in volume and the other pressure chamber being progressively increased in volume. In connection with the movement of the piston unit air will flow from the pressure chamber which is being reduced in volume through the duct 161 to the pressure chamber which is being increased in volume. The end heads 158 are provided with axially located threaded openings 162. As furnished by the manufacturer these openings are closed by removable plugs (not shown).

The piston unit 153 operates a plate valve 164 which has sliding movement upon the inner face 165 of the base plate 149, the face 165 providing the bottom wall of the valve chest 152. The plate valve 164 is formed in its underface with a recess 166 for controlling the communication between certain ports to be later described. The plate valve 164 is mounted at the lower end of a stem 167 which has a loose or free fit in a socket formed in a collar 168 located centrally of the rod 156 to which it is fixed. The valve 164 is biased against the face 165 by a helical spring 169 fitted upon the stem 167 and reacting against the valve 164 and the collar 168. When the piston unit 153 is shifted in either direction it effects a corresponding shifting movement of the plate valve 164 longitudinally of the bottom wall 165 of the valve chest 152.

The base plate 149 is formed with four laterally extending ports 170, 171, 172 and 173. The

ports 170 and 172 are open to one of the side faces of the base plate and the ports 171 and 173 are open to the opposite side face of the base plate. The ports of each pair open to one side of the base plate are offset with relation to the ports of the other pair open to the opposite side of the base plate. The ports 170, 171, 172 and 173 extend slightly more than half way through the base plate and at their inner ends are in communication with angularly extending ports 174, 175, 176 and 177, respectively, which are in open communication with the valve chest 152 through the inner face 165 of the base plate. The port 172 is an exhaust which functions in both operative positions of the plate valve 164 and vents the compressed air to the atmosphere.

The piston unit 153 has two operative positions in one of which (which may be called its "left" position) the piston 154 is located at the left end of the pressure chamber 159 (Figure 8 of the drawing being considered) and in the other of which (which may be called its "right" position) the piston 155 is located at the right end of the pressure chamber 160. The angular ports 174, 175, 176 and 177, considered as a series, are arranged in succession along a longitudinal central line of the face 165. The plate valve 164 at no time covers the port 174. When the piston unit 153 is in its right position the plate valve 164 covers the angular ports 176 and 177 and establishes two paths of flow, one of which is from the port 173 to the port 172 and through the recess 166 and the other of which is from the port 170 to the port 171 and through the valve chest 152. When the piston unit 153 is in its left position the plate valve covers the angular ports 176 and 175 and establishes two different paths of flow, one of which is from the port 171 to the port 172 and through the recess 166 and the other of which is from the port 170 to the port 173 and through the valve chest 152.

The features above described as 149 to 177 inclusive are common to the valves 147 and 148. The changes in the flow lines of air are effected in the same way by both valves. The normal positions or relations of the parts of the valves are the same in both instances.

The compressed air for the system of pneumatic operation and control is delivered by a line 178 from a storage tank. The line 178 communicates with two branches 179 and 180, the branch 179 delivering to the valve 147 and the branch 180 to the valve 148.

The normal position of the piston unit 153 is its right position as shown in Figure 8. In this position of the piston units (of the two valves 147 and 148) all parts of the machine are in their normal positions and the machine is, therefore, ready for the cycle of operations which are performed in the production of the drill bit. The operation of the machine is initiated by the manual actuation of a bleeder valve 181 (Figure 5) which is conveniently located adjacent the front of the table 1 and is provided at the end of a bleed line 182 connected to the valve 147, the connection being with the head 158 at the left side of the valve (Figure 8 being considered) and the bleed line being in communication with the valve chest 152 through the opening 162. When the bleeder valve 181 is actuated air is vented from the left end of the valve chest with the result that the pressure upon the outer face of the piston 154 is relieved and the piston unit is shifted to its left position.

The bleeder valve 181 is one of a series of

bleeder valves incorporated in the system of pneumatic operation, the remaining bleeder valve being designated as 183, 184 and 185 and being automatically operated in succession. The bleeder valves 181, 183, 184 and 185 are of a well known type and are similar in construction, their details being shown in Figure 8b. Each bleeder valve includes a casing 186 which provides a chamber 187 in communication with a conical valve seat 188 externally formed upon the inner end wall of the casing. The seat 188 accommodates a normally closed valve 189 provided at the lower end of a stem 190 which projects through the casing and through an opening in its outer end wall, the projecting portion of the stem carrying an operating button 191 having a hemi-spherically curved surface. The valve 189 is normally held in its closed position by a spring 192 arranged within the chamber 187 and reacting against a shoulder 193 formed on the casing 186 and a shoulder 194 provided on the valve stem 190 near its upper end. The casing 186 is formed with vent openings 195 leading from the chamber 187. When the button 191 is pushed inward against the pressure of the spring 192 the valve 189 is moved away from its seat and air is vented to the atmosphere through the chamber 187 and the vent openings 195. The buttons 191 of the several bleeder valves are movable elements for the control of the actuation of the different mechanisms with which the bleeder valves are severally associated.

The power for the operation of the mechanism 29 is delivered by a piston 196 which is movable in a cylinder 197, the flow of air for the operation of the piston 196 being controlled by the valve 147. The normal position of the piston 196 is at the right end of the cylinder 197 (Figure 5 being considered). When the piston 196 is moved to the left end of the cylinder 197 the mechanism 29 is operated to effect the downward movement of the bar 9. When the piston 196 is returned to its normal position at the right end of the cylinder 197 the mechanism 29 is operated to provide for the upward movement of the bar 9 to its normal position. The leftward movement of the piston 196 is governed by the bleeder valve 181 and its return movement to the right is governed by the bleeder valve 185 which is provided at the end of a bleed line 198 connected to the head 158 of the valve 147 opposite the head to which the bleed line 182 is connected.

The power for the operation of the cam ring 134 is delivered by a piston 199 which is movable in a cylinder 200, the flow of air for the operation of the piston 199 being controlled by the valve 148. The normal position of the piston 199 is at the right end of the cylinder 198 (Figure 5 being considered). When the piston 199 is moved to the left end of the cylinder 198 the cam ring 134 is operated upon its advancing stroke. When the piston 199 is returned to its normal position at the right end of the cylinder 200 the cam ring is operated on its retractile stroke. The leftward movement of the piston 199 is governed by the bleeder valve 183 and its return movement to the right is governed by the bleeder valve 184. The bleeder valve 183 is at the end of a bleed line 201 connected to an end head 158 of the valve 148. The bleeder valve 184 is at the end of a bleed line 202 connected to the head 158 of the valve 148 opposite the head to which the line 201 is connected.

The air for moving the piston 196 to its nor-

mal position to the right and for holding it in such position is delivered by a line 203 and the air for moving the piston 196 to the left and for holding it in such position is delivered by a line 204, the lines 203 and 204 being preferably flexible hose sections. One end of the line 203 is connected to the left end of the cylinder 197 and the other end is connected to the base plate 145 for direct communication with the port 171. One end of the line 204 is connected to the right end of the cylinder 197 and its other end is connected to the base plate 145 for direct communication with the port 173. The air supply branch 179 for the valve 147 is connected to the base plate 145 for direct communication with the port 170. The exhaust port 172 is preferably connected to an air exhaust pipe 205.

The air for moving the piston 199 to its normal position to the right and for holding it in such position is delivered by a line 206 and the air for moving the piston 199 to the left and for holding it in such position is delivered by a line 207, the lines 206 and 207 being preferably flexible hose sections.

One end of the line 206 is connected to the left end of the cylinder 200 and its other end is connected to the base plate 145 of the valve 148 for direct communication with the port 171. One end of the line 207 is connected to the right end of the cylinder 200 and its other end is connected to the base plate 145 for direct communication with the port 173. The air supply branch 179 for the valve 147 is connected to the base plate 145 for direct communication with the port 170. The exhaust port 172 of the valve 148 is preferably connected to an air exhaust pipe 208.

When the piston unit of the valve 147 is in its normal right position air will flow from the delivery branch 179 through the ports 170 and 174 into the valve chest 152 and thence through the ports 175 and 171 and the line 203 to the left end of the cylinder 197 to effect the movement of the piston 196 to the right. At the same time the air at the right side of the piston 196 will escape through the line 204, ports 173 and 177, recess 166, ports 176 and 172 and exhaust pipe 205 to atmosphere. When the piston unit of the valve 148 is in its normal right position (Figure 8 being considered) the paths of flow will be identical, the air being delivered into the left end of the cylinder 200 through the line 206 and at the same time the air at the right side of the piston 199 escaping from the cylinder through the line 207.

When the piston unit of the valve 147 is in its left position (Figure 8 being considered) air will flow from the delivery branch 179 through the ports 170 and 174 into the valve chest 152 and thence through the ports 177 and 173 and the line 204 to the right end of the cylinder 197 to effect the movement of the piston 196 to the left. At the same time the air at the left side of the piston will escape through the line 203, ports 171 and 175, recess 166, ports 176 and 172 and exhaust pipe 205 to atmosphere. When the piston unit of the valve 148 is in its left position the paths of flow will be identical, the air being delivered into the right end of the cylinder 200 through the line 207 and at the same time the air at the left side of the piston 199 escaping from the cylinder through the line 206.

Support for the cylinder 197 (Figures 9 and 13) is provided by the bar 9 and the arm 32 of the mechanism 29. A split or two-part bracket

209 is mounted in fixed relation upon the outer end of the cylinder 197. The inner part of the bracket 209 is provided with spaced horizontal ears 210 which provide a recess 211 that enables the bracket to be fitted to the outer end portion of the bar 9. The bracket is pivotally connected to the bar 9 by a pin 212 which extends through the ears 210. The rod 213 upon which the piston 196 is mounted is pivotally connected at its outer end as at 214 to the arm 32 of the mechanism 29. The pivotal connection 212 between the bracket 209 and the bar 9 enables the cylinder 197 to swing in a horizontal plane in compensation for the movement of the pivot 214 through the arc of which the pivot 33 of the lever 30 is the radial center.

The piston 196 in its movement to the left swings the lever 30 from the position shown in full lines in Figure 9 to the position shown in broken lines. As above explained this movement of the lever 30 results in the outward movement of the cam members 33 and 39 and the downward movement of the bar 9. The completion of the downward movement of the bar 9 is immediately followed by the actuation of the bleeder valve 183 for the purpose of causing the movement of the piston 199 to the left.

The bleeder valve 183 is mounted on an angle bracket 215 (Figures 9, 13 and 14) which is secured to the standard 23 at its inner side, the valve 183 being located adjacent the rear side of the bar 9 and projecting forwardly from the bracket 215. The cam member 39 of the mechanism 29 is utilized in connection with the actuation of the bleeder valve 183. The direct actuating element is an anti-friction roller 216 which moves with the cam member 38 and, upon the completion of the downward movement of the bar 9, engages and depresses the button 191 of the valve 183 and then releases it. The roller 216 is carried by an arm 217 which conveniently consists of a pair of plates. The arm 217 is pivotally connected as at 218 to a supporting block 219 carried by an angle bracket 220. The block 219 is attached to the bracket 220 by a fastening 221 and the angle bracket is attached to the cam member 38 adjacent its upper face by fastenings 222 which pass through the horizontal flange of the bracket. The arm 217 projects rearwardly from the block 219 and the roller 216 is fitted between the free ends of the plates which constitute the arm, its pintle being mounted in these plates. The block 219 is provided at its outer end with a projecting ear 223 which extends between the plates of the arm 217 and in which the pivot 218 is fitted. The block 219 is formed with shoulders 224 adjacent the ear 223 and the arm 217 is spring biased normally to rest against them. The arm 217 is held rigid by the shoulders 224 during the outward movement of the cam member 38 and at the time when it engages and depresses the button of the valve 183 and moves beyond it, the continued outward movement of the roller 216 releasing the valve which thereupon resumes its normally closed condition. When the cam member 38 is moved inward upon the return stroke of the arm 32 the arm 217 yields on its pivot when it engages the button of the valve 183 and rides over it, of course without an actuation of the valve. When the roller 216 during the inward movement of the cam member 38 passes beyond the valve 183 the arm 217 is restored to its normal position in which it is held against the shoulders 224.

The movement of the piston 199 to the left

(Figures 3, 5 and 9 being considered) which results from the actuation of the bleeder valve 183 effects the movement of the cam ring 134 through its advancing stroke. For this purpose the cam ring carries a rigidly attached arm 225 (Figures 2, 3 and 9) which projects forwardly beyond the table 1 and is of such length that it may serve as a handle for the manual operation of the cam ring 134 if such should be required. The rod 226 upon which the piston 199 is mounted is connected by a link 227 to the forwardly projecting part of the arm 225. The movement of the piston 199 to the left effects a corresponding movement of the arm 225, that is to say a movement of the arm from its full line position shown in Figures 3 and 9 to the position shown in broken lines in these figures during which the arm moves the cam ring 134 through its advancing stroke. The bleeder valve 184 is conveniently located adjacent the front of the table 1. When the arm 225 very nearly reaches the limit of its movement to the left it engages and depresses the button 191 of the bleeder valve 184 with the result that the piston unit 153 of the valve 148 is returned to its normal position, i. e. its right position, as shown in Figure 8. Thereby the flow of air in relation to the cylinder 200 is reversed with the result that the piston 199 is returned to its normal position at the right end of the cylinder 200 and the arm 225 is restored to its normal position as shown in full lines in Figures 3 and 9. The arm 225 during its return movement effects the movement of the cam ring 134 through its retractile stroke, thereby returning the cam ring to its normal position.

The bleeder valve 185 is conveniently mounted adjacent the front face of the table 1. The arm 225 is utilized for its actuation and is operative on its return stroke for this purpose. The actuation of the bleeder valve 185 is directly effected by a roller 228 which engages its button to move it inward, the operation being similar to that of the operation of the bleeder valve 183 by the roller 216. The roller 228 is carried by an arm 229 which is pivotally mounted upon a block 230, the arm 229 and block 230 being similar in construction to the arm 217 and block 219 above described. The block 230 is carried by the arm 225 and is mounted for any positional adjustment that may be required. For the purpose of positional adjustment the block 230 is formed with a slot 231 and is connected to the arm 229 by a fastener 232 which passes through the slot. When the roller 228 has actuated the bleeder valve 185 it passes beyond it, releasing the button with resultant closing of the valve. During the next movement of the arm 225 to the left the engagement of the roller 228 with the button of the valve 189 will result in the displacement of the arm 229 whereby the roller rides over the button without actuating it. The actuation of the bleeder valve 185 results in the shifting of the piston unit 153 of the valve 147 to its normal right position with the consequent movement of the piston 196 to its normal position at the right end of the cylinder 197.

Recapitulation of the cycle of operations

The cycle of operations of the machine may, for convenience, be briefly recapitulated as follows: The cutters 48 are driven at all times from the motor 101. The shank S is fitted in the clamping collet 64 and is secured by lowering the arm 73. The operator then actuates the bleeder valve 181 by manually depressing its button 191.

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The piston 195 is thereupon shifted to the left and actuates the mechanism 29 to effect the downward movement of the bar 9, this movement bringing the shank into the relation shown in Figures 18 and 19 at which time the preliminary cuts are completed. After the bar 9 has reached the limit of its downward movement the roller 216 actuates the bleeder valve 183 with the result of the movement of the cam ring 134 through its advancing stroke whereby the cutters 48 are moved to their upper positions as shown in Figure 20 and the flutes are completely cut. When the arm 225 nears the limit of its movement to the left it actuates the bleeder valve 184 with the result of the return movement of the arm 225, the retractile movement of the cam ring 134 to its normal position and the downward movement of the cutters 48 to their normal lower positions, the flutes being planished by the cutters during their downward movement. As the arm 225 nears the limit of its return movement the roller 228 actuates the bleeder valve 185 with the result of the movement of the piston 186 to its normal position at the right end of the cylinder 197, the mechanism 29 being thereby operated to permit the return of the bar 9 to its normal upper position by the springs 15 and 20. At this time all parts of the machine are in their normal positions and the machine is conditioned for a repetition of the cycle of operations.

I claim:

1. The method of forming fluted bits upon an end of the shank of a screw driver which consists in the provision of a group of rotary milling cutters of the same diameters with their axes in a normal common plane, in the arrangement of the milling cutters in angular and equally spaced relation to one another with their peripheries mutually and coextensively spaced, thereby to delimit a passage among them of symmetrical contour which has a normal minimum sectional dimension, continuously driving the milling cutters, inserting a screw driver shank into the passage while of normal minimum sectional dimension with its axis in alinement with the axial center of the passage, such insertion involving a relative movement of the shank and the cutters, holding the cutters during such insertion to maintain the minimum sectional dimension of the passage unchanged, the shank having a diameter greater than the minimum sectional dimension of the passage and its insertion being in the direction of its axis and in a direction normal to the common plane and being to an extent where its outer end reaches a plane which prescribes the points at which the cutting of the flutes commences, these points lying within lines of predetermined angularity which are tangential to the cutters and extend outwardly from the passage at similar angles to the axis of the shank, the shank by such insertion causing the cutters to make preliminary cuts in its terminal portion of lineal contours conforming to the curvature of the cutters, thereupon holding the shank stationary and at the same time effecting simultaneous coextensive movements of the cutters in predetermined directions of angularity to which the tangential lines conform and which have components opposite to the direction of movement of the shank and also outward components, the movement of the cutters with the shank held stationary the while causing the cutting of the flutes and being continued until the outer ends of the bases of the flutes coincide, in a plane parallel to the normal common plane of

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the axis of the cutters, with the cylindrical surface of the shank, thereupon moving the cutters back to their normal positions and withdrawing the shank from the passage by effecting its movement in a direction opposite to the direction of its first movement.

2. A method as set forth in claim 1 wherein the return movements of the cutters are in the same paths as their first movements from their normal positions, the shank is held stationary during such return movements, thereby to cause the cutters to act with planishing effect upon the surfaces of the flutes, and the withdrawal of the shank from the passage is effected upon the completion of such return movements.

3. The method of forming fluted bits upon an end of the shank of a screw driver which consists in the provision of a group of rotary milling cutters of the same diameters with their axes in a normal common plane, in the arrangement of the milling cutters in angular and equally spaced relation to one another with their peripheries mutually and coextensively spaced, thereby to delimit a passage among them of symmetrical contour which has a normal minimum sectional dimension, continuously driving the milling cutters, inserting a screw driver shank into the passage while of normal minimum sectional dimension with its axis in alinement with the axial center of the passage, such insertion involving a relative movement of the shank and the cutters, holding the cutters during such insertion to maintain the minimum sectional dimension of the passage unchanged, the shank having a diameter greater than the minimum sectional dimension of the passage and its insertion being in the direction of its axis and in a direction normal to the common plane and being to an extent where its outer end reaches a plane which prescribes the points at which the cutting of the flutes commences, these points lying within lines of predetermined angularity which are tangential to the cutters and extend outwardly from the passage at similar angles to the axis of the shank, the shank by such insertion causing the cutters to make preliminary cuts in its terminal portion of lineal contours conforming to the curvature of the cutters, thereupon effecting a further relative movement of the shank and the cutters whereby the shank has a further axially directed penetration into the passage, moving the cutters outward relatively to one another at a predetermined uniform rate during the further relative movement of the cutters and the shank whereby the sectional dimension of the passage is progressively increased and the cutters cut the flutes, the movement of the cutters outward relatively to one another being without effect upon the coplanar relationship of their axes and being continued until the bases of the flutes by reason of the predetermined rate of outward movement of the cutters are substantially coincident within the said lines tangential to the cutters and the outer ends of the bases of the flutes coincide in a plane parallel to the normal common plane of the axes of the cutters with the cylindrical surface of the shank, thereupon returning the cutters to their normal starting positions and withdrawing the shank from the passage.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,433,145	Nord	Dec. 23, 1947