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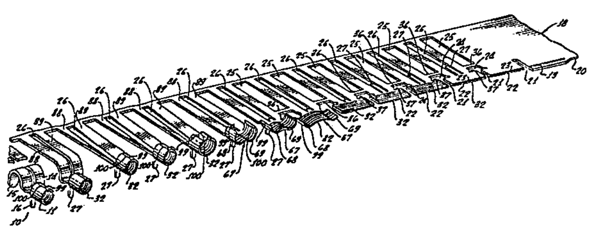
(54) Method of forming threaded metal parts.

(57) In the manufacture of threaded metal parts (10) the machining of the threads has been a major factor in the cost of such parts. The present invention provides an arrangement by which threaded parts may be obtained from sheet metal (18) entirely through a stamping operation. The result is a drastic reduction in the cost of producing the parts, much faster production, savings of material while obtaining parts of superior performance and better appearance.



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ARRANGEMENT FOR FORMING THREADED METAL PARTS

In the manufacture of threaded metal parts the machining of the threads has been a major factor in the cost of such parts, because of the tooling, time, equipment, and material involved. The cost of threading is of particular significance where a part is adapted for economical production without machining, except for a threaded section. For example, there may be a part which in most aspects is adapted for production by stamping, but requires a threaded portion for connecting it to an associated item. Conventionally, it is necessary either to machine the entire part or to stamp a portion of it and weld on a separately machined threaded element. In either event, the cost of the part is greatly increased. Additionally, when parts must be secured together, such as by welding, there is always a question as to the reliability of the connection and some of the parts may fail because of an improper weld.

There have been some efforts to produce threaded parts in another way, such as by engaging them with a die having a thread contour and then bending the part to assume a cylindrical shape. However, for anything approaching a part having a well-formed thread, accurately shaped and of adequate strength, these efforts have been unsuccessful.

The present invention provides an arrangement by which threaded parts may be obtained from sheet metal entirely through a stamping operation.

The result is a drastic reduction in the cost of producing the parts, much faster production, savings of material while obtaining parts of superior performance and better appearance.

Figure 1 is a perspective view illustrating the various stages of forming a part;

Figure 2 is a longitudinal sectional view of the various forming stages, with the punch at the upper end of its stroke;

Figure 3 is a sectional view similar to Figure 2, with the punch at the bottom end of its stroke;

Figure 4 is an exploded perspective view of the fourth, fifth, and sixth stages;

Figure 5 is an exploded perspective view of the seventh, eighth, and ninth stages;

Figures 6, 7, and 8 are enlarged fragmentary sectional views, illustrating the formation of the grooves for the threads at the fourth, fifth, and sixth stages, respectively;

Figures 9, 10, and 11 are enlarged fragmentary sectional views showing the contours of the grooves in the workpiece at the fourth, fifth, and sixth stages, respectively;

Figure 12 is an enlarged fragmentary sectional view showing the punch and die engaging the workpiece at the twelfth forming stage, with the punch just short of the bottom end of its stroke;

Figure 13 is an enlarged fragmentary sectional view showing the punch and die engaging the workpiece at the eleventh and twelfth stages, with the punch at the bottom of its stroke; and

Figures 14, 15, and 16 are enlarged fragmentary sectional views showing the punches in the grooves of a second embodiment.

The part 10 is a bracket or hanger produced in accordance with the present invention, adapted to support a cable, tube, pipe, or the like. It includes an internally threaded cylindrical sleeve portion 11 from one end of which project two support members 14 and 15, which are side-by-side and generally U-shaped in side elevation and slightly divergent toward their outer ends. A tab 16 extends from the same end of the sleeve 11. The sleeve 11, support members 14 and 15, and tab 16 are integral, being made from a single piece of sheet metal. The connection to a cable received in the members 14 and 15 is completed by bending the outer ends of the members 14 and 15 around the cable and deflecting the tab 16 downwardly over the top of the cable.

The hangers 10 are produced from sheet metal strip stock fed from a coil through a progressive die arrangement actuated by a reciprocating press. There are multiple stages in producing the completed parts 10, there being fourteen stages in the example described below. The number of stages necessary will depend upon the size and shape of the part, as well as the material from which it is made, and may be more or less than the fourteen stages described. At each stage part of the forming takes places so that as the strip of material is advanced the parts 10 are produced in increments. The punch includes a number of individual punch elements which move simultaneously in parallel paths as the press makes its downward stroke, cooperating with dies below to accomplish the various forming stages. All of the contouring of the workpiece, including the creation of a cylindrical threaded section, is accomplished by moving the punch rectilinearly toward and away from the die. No mandrel or other internal tool is used even though an accurately formed threaded section is produced.

Figure 1 illustrates the strip of material 18 as it is formed in the various stages in producing the parts 10. The progressive die technique means that with each stroke of the press a completed part is obtained. The result is extremely rapid production at a fraction of the cost of conventional manufacturing operations. At the same time, the parts are of superior quality and offer advantages not realized with ordinary manufacturing procedures.

In the first forming stage a longitudinal groove 19 is formed in the upper surface of the strip material 18 adjacent its longitudinal edge 20. The punch has a flattened bottom edge, which causes the groove 19 to have a flat bottom wall with two side walls diverging from it.

In the second stage, the outer portion of the strip 18, beyond the groove 19, is cut off and a transverse slot 21 is formed. The outer part of the workpiece 18 is sheared off at the center of the groove 19, leaving an outer edge 22 on the workpiece with a bevel 23 at its upper portion. The bevel 23 provides an entrance to the threads in the sleeve portion 11 of the completed part 10, as well as causing the threads to be recessed a short distance inwardly of the sleeve end for their protection. Providing the groove 19 with a flat bottom wall avoids the creation of a sharp edge when the outer part is cut off.

In a third forming stage, additional cuts are made in the workpiece, producing and shaping various openings. This includes an opening 24, communicating with and inwardly of the slot 21 and an elongated rectangular opening 25. Adjacent to the opening 25 and parallel to it is an additional and thinner opening 26, which is rectangular except that at the end adjacent the opening 24 there is a narrow prong 27 which projects into the opening 26 along its longitudinal axis.

Grooves are formed in the upper surface of the workpiece 18 along its edge portion inwardly of the bevel 23, in the next three forming stages, which result in screw threads when the sleeve portion 11 of the hanger 10 is formed subsequently. Accordingly, the grooves are at a shallow angle to the edge 22 of the workpiece so as to interconnect and produce a helix when this portion of the workpiece is given a cylindrical shape. Also, they are spaced apart the distance of the pitch of the threads.

Punches 29, 30, and 31 progressively form the threads in the fourth, fifth, and sixth stages, respectively, as seen in Figure 4. The rectangular outer part 32 of the workpiece 18, beyond the openings 24, is supported on a flat die surface 33 during these stages. There are, in addition, pilots which accurately position the workpiece and restrain it during the fourth, fifth, and sixth forming stages. In the fourth stage, pilots 34 and 35, which have beveled lower corners, enter the openings 24 and 25 in the workpiece, straddling the strip 36 of the workpiece between these two openings. This positions the flat vertical surface 35 of the pilot 34 next to the edge 37 of the workpiece opening 24 on one side of the workpiece section 32 at the fourth stage. A rectangular die opening 38 receives the lower portions of the pilots 34 and 35 upon the downward stroke of the press.

On the other side of the workpiece section 32 at the fourth stage, a pilot 39 enters the opening 24 of the workpiece to position its flat vertical surface 40 alongside the edge 37 of the workpiece. The pilot 39 is the same as the pilot 34. Its surface 40 also is next to the edge 37 on one side of the workpiece section 32 of the fifth stage when the press is in its downward stroke. Additional pilots 41 and 42 are the same as the pilots 34 and 39, fitting next to the edges 37 during the fifth and sixth stages.

Inwardly of the pilots 39, 41, and 42 are pilots 43, 44, and 45, respectively, which are the same as the pilot 35 and adapted to enter the workpiece openings 25 during the fourth, fifth, and sixth stages. Die opening 46 receives the pilots 39 and 43, die opening 47 receives the pilots 41 and 44, and die opening 48 is for pilots 42 and 45.

The first thread formation step at stage four is shown in enlarged sectional views, Figures 6 and 9. As the punch 29 strikes the outer part 32 of the workpiece at stage four, portions of the workpiece become compressed. The punch surfaces 35 and 40, being adjacent the workpiece edges 34, restrain the outer part 32 of the workpiece from movement inwardly from the compression. Outward expansion of the workpiece can take place, however, as the outer workpiece edge 22 is unconstrained.

Parallel ridges 50 on the undersurface of the punch 29 form complementary grooves 51 in the outer part 32 of workpiece 18. On the inner sides of the grooves 51, that is the sides of the grooves adjacent the openings 24, where the workpiece is restrained against lateral movement, straight sloping walls 52 are formed at an angle of 30° relative to a line perpendicular to the upper surface of the workpiece, i.e., to the direction of movement of the punch. The opposite walls 53, on the side where the workpiece is unconstrained, are more steeply sloped at an angle of 17° to the vertical. Bottom walls 54 interconnect the outwardly diverging sidewalls 52 and 53.

The projections of the sidewalls 52 and 53 intersect at lines 55 below the bottom walls 54 of the grooves, as shown in Figure 9. These intersections of the groove walls are spaced apart a distance equal to the pitch of the thread to be produced.

At the fifth forming stage, where the workpiece is struck by the punch 30, inward movement is prevented by the pilots 39 and 41, in the manner illustrated in Figure 7. The ridges 56 on the bottom of the punch 30 form the grooves 51 deeper than in the fourth stage, making the botom walls 54 narrower and depressed further beneath the upper surface 57 of the workpiece. At the same time the grooves 51 are widened by increasing the angle on the outer wall 53 to 23°. The inner walls 52, however, remain at an angle of 30°.

Even though the workpiece section 32 expands outwardly at the edge

22, the position of the grooves 51 remains unchanged. In other words, the ridges 56 on the punch 30 have locations corresponding to the ridges 50 of the punch 29.

At the final thread forming step of stage six, the ridges 59 on the punch 31 deepen the grooves 51 and widen them by imparting a 30^{0} angle to the outer walls 53 of the grooves. Again, the inner groove walls 52 continue to have a 30^{0} slope. The bottom walls 54 of the grooves are sunk substantially to the full depth of the thread, although a minor amount of thread deepening occurs during some of the bending stages, as explained below. At the sixth stage, the bottom walls 54 are made more narrow than at the fifth stage, notwithstanding the fact that the total groove width is increased. The intersecting lines 55 of the sidewall projections remain spaced apart the distance of the pitch of the threads to be produced. The result is that the sidewalls and bottom walls of the grooves 51 define a desired thread configuration, such as that of a conventional screw thread. The roots of the threads are provided by the bottom walls 54 of the grooves and the upper surface portions 57 beetween the grooves 51 act as the crests of the threads.

In the sixth forming stage, as in the fourth and fifth, the inner edge 37 of the outer part 32 of the workpiece is restrained by the pilots 41 and 42 so that increased lateral dimension can occur only in the outward direction. The ridges 59 on the punch 31 correspond in locations to the ridges 50 and 56 of the punches 29 and 30, so that the grooves 51 do not shift positions at the sixth stage.

The progressive thread formation at the fourth, fifth, and sixth stages, deepening the grooves and changing the flank angles, is important in achieving accurate thread contouring. Also, when the completed part has an operative element beyond the threaded section, such as the U-shaped supports 14 and 15, there should be restraint against lateral expansion of the threaded section on the side of such an element, with expansion being allowed in the other direction, so that the material of the workpiece will flow properly during the formation of the grooves to enable the grooves to be given the desired shape while avoiding die breakage.

Additionally, at the sixth stage, the outer portion of the prong 27 is bent downwardly at an angle of 90°.

The seventh stage (Figure 5) is the first in contouring the outer part 32 of the workpiece, ultimately to give it the cylindrical configuration necessary to form the sleeve portion 11 of the completed part 10. The die 60, at the seventh stage, has an upper surface with a convex portion 61 at the center and concave parts 62 and 63 at the outer edges. These curved die surfaces are segments of cylinders with their axes perpendicular to the longitudinal workpiece edge 22. The punch in this instance is defined by two horizontal threaded studs 64 and 65, which are threaded into openings in a vertical flange 66. This positions the studs 64 and 65 above the concave die surfaces 62 and 63, respectively. The threads of the studs 64 and 65 are of a pitch and configuration to match the grooves 51 in the workpiece, with which they are aligned. Consequently, when the outer part 32 of the workpiece is struck by the studs 64 and 65, it is deflected over the convex die surface 61 and into the concave edge portions 62 and 63, but the shape of the grooves 51 remains unchanged. This forming step gives the workpiece a convex central portion 67 and concave upwardly curled edge portions 68 and 69.

At the eighth forming stage, the central portion of the workpiece remains convex upwardly and the outer portions are given a greater upward concave curl. The die 71, at the eighth stage, has an upper surface which has a narrower convex central portion 72, and outer concave portions 73 and 74, which are closer to the center of the die than are the concave edge portions of the die

60. Studs 75 and 76, held on a support flange 77, act as the punch and are similar to the studs 64 and 65. However, the studs 75 and 76 are closer together to correspond to the positions of the surfaces 73 and 74 of the die 71.

As the workpiece is struck by the punch, again the threads are not affected because the studs are complementary to them. The side edge portions 68 and 69 are bent upwardly a greater amount as the studs 75 and 76 engage the outer part 32 of the workpiece closer to its center than at the seventh stage. This workpiece configuration, as shown in Figure 5, has a narrower convex central portion 67 and more curvature to its outer side edge portions 68 and 69.

At the ninth forming stage, additional forming of the outer part 32 takes place, as the cylindrical sleeve end of the workpiece begins to close. The die 79 has a relatively narrow central convex portion 80 and deeper side edge concave portions 81 and 82. The portions 81 and 82 are closer to the center of the die 79 than are the portions 73 and 74 with respect to the center of the die 71. Studs 83 and 84, positioned above the die surfaces 81 and 82, act as the punch elements, suported on a vertical flange 85.

Because the curvature of the workpiece begins to close at the ninth forming stage, the outer side portions of the studs 83 and 84 are cut away to provide flat surfaces 86 and 86 to give the studs 83 and 84 clearance for removal on the upward stroke. The thread grooves are continued for a distance into the flat surfaces 86 and 87, so that damage to the threads of the workpiece will not occur as it is caused to bend upwardly around the studs 83 and 84. The outer part 32 of the workpiece, therefore, at the conclusion of the ninth forming stage, has edge portions 68 and 69 which curl inwardly and overlap part of the bottom portion of the outer part 32 of the workpiece.

At the ninth stage, the strip 36 is cut off, leaving the outer part 32 of the workpiece connected to elongated strips 88 and 89, located one on either side of the prong 27.

The tenth die stage further wraps the end portion of the workpiece around toward its cylindrical configuration. The die 91 at the tenth stage has a concave surface 92 which approaches a semicylindrical shape. However, it is flattened at its intermediate side portions 93 and 94. Above the die surface 92 is a punch 95 in the form of a stud carried by a vertical flange 96, again having threads which match those of the end portion of the workpiece. The sides 97 and 98 of the stud 95 are flattened to permit the stud to leave the workpiece on the upward stroke.

When the punch 95 hits the workpiece it drives the end part 32 into the die opening 92, causing it to assume the shape of the die opening. The flattened intermediate side portions 93 and 94 give the die opening a taper that helps center the end part 32 of the workpiece in the die opening. At this stage, the single stud 95 engages the central part 67 of the workpiece and cooperates with the die opening to reverse the curvature in this area from convex to concave. Upon completion of the tenth stage, the opposite edges 99 and 100 of the end part 32 of the workpiece remain spaced apart, but have been moved closer together because of the increased curvature given the workpiece, so that there is a narrow gap between them.

At the eleventh die stage, outer part 32 of the workpiece is formed into a sleeve, which approximates but does not achieve the cylindrical configuration of the sleeve portion 11 of the completed part. The die 102 at the eleventh stage has a concave surface 103 with rounded convex corners. The punch 104 is similar, having a recess 105 of the same shape. At the eleventh stage, therefore, the opposite edges 99 and 100 of the outer part 32 of the workpiece, which are at the central portion of the punch cavity 105, are brought together to produce a sleeve. The end part 32 has approached a cylindrical configuration sufficiently prior to the eleventh stage to enable the die surfaces 103 and 105 to push inwardly on the workpiece toward its axis as the workpiece is forced into the die openings. The engagement with the outer part 32 of the workpiece is only on its exterior, i.e., the side opposite the thread grooves 51, with no mandrel entering the sleeve. The surfaces 103 and 105 together define a closed curved shaped so as to give the workpiece a somewhat elliptical contour, with the major axis extending vertically. The width of the elliptical section (i.e., the horizontal dimension normal to the direction of movement of the punch) is equal to or slightly less than the outside diameter of the sleeve 11 of the completed part 10.

The die 106 at the twelfth forming stage includes a semicylindrical concave surface 107, having the same curvature as the sleeve portion 11 of the completed part 10, which intersects a flat upper die surface 108. The punch 109 of the twelfth stage has a semicylindrical surface 110 corresponding to the die surface 107, also being complementary to the sleeve portion 11 of the completed part 10. The edges of the surface 110 extend to a flat horizontal bottom surface 111 of the punch. When the workpiece section 32 is engaged by the die surfaces 107 and 110, as seen in Figure 13, it is not only given a regular cylindrical contour, but also the opposite edges 99 and 100 of this section are forced tightly together, with no gap remaining. The fact that the workpiece is no wider than the surfaces 107 and 110 when it enters the twelfth stage assures that it does not become pinched between the horizontal surfaces 108 and 111 of the die and punch. This can be seen in Figure 12 where the punch and die are about to close over the oval-shaped workpiece. A clearance exists at the sides of the workpiece even though the upper extremity of the workpiece at the edges 99 and 100 is engaged by the center of the punch cavity 110 and the lower extremity, opposite from the edges 99 and 100, is engaged by the center of the die cavity 107.

In order to assure complete compliance with the die openings 107 and 110, without a mandrel inside the sleeve, the workpiece end portion 32 is compressed as it is formed in the twelfth stage. This compression causes the material to be forced outwardly to engage the surfaces 107 and 110 throughout its periphery, irrespective of the deviations from a cylindrical form present as it enters the twelfth stage. This compression is accomplished by making the end portion 32 longer between the edges 99 and 100 than the circumference required for the completed sleeve portion 11. As a result, the portion 32 is forced to comply with die surfaces of lesser circumference than it possesses. With the portion 32 of the workpiece being rounded as a sleeve, the compressive forces deflect the outer surface of the workpiece outwardly into intimate contact with the die surfaces. This also causes the edges 99 and 100 to be brought tightly together so that an accurate gap-free seam is produced. This accurate forming to a cylindrical shape by compressing the workpiece and without the use of a mandrel is useful in producing tubular parts even where they are unthreaded.

The grooves 51 in the outer portion 59 of the workpiece are at an angle relative to the axis of the completed sleeve such that a continuous helical thread is produced when the edges 99 and 100 are brought together. This means that the end of one groove 51 precisely aligns with the end of the next adjacent groove 51 at the opposite edge.

At the thirteenth stage the projecting strips 88 and 89 are bent to provide half of the curvature of the U-shaped retainer portions 14 and 15 of the completed part 10. During this forming of the workpiece, the outer portion 32 of the workpiece is held between the surface 112 of the die 113 and the surface 114 of the punch 115. This maintains the end portion 32 in a horizontal attitude, irrespective of the bending of the projecting strips 88 and 89.

At the fourteenth stage, the workpiece receives its final forming and the completed part 10 is separated. At this forming takes place, the outer portion 32 of the workpiece is held between the surfaces of a punch 116 and a die 117.

The threads of the part 10 may be made self-locking so that they will provide tight engaement at any rotational position and will not be loosened by vibration or other service conditions. This is accomplished by making the thread grooves 51 more shallow at the inner end of the threaded section than at the outer end where the mating threaded part enters. The ridges on the punches 29, 30, and 31 are made less deep at the portions of these punches that strike the workpiece inwardly of the edge 32 than are the ridges adjacent the edge 22 to produce this relationship of the thread grooves. The entrance threads of full depth allow the mating of the threads to start without difficulty. The inner threads of less depth cause the sleeve portion 11 to grip the stud, exerting a compressive force on its exterior so that friction resists relative rotation. The stud, entering the tapered threads, can tend to spring the sleeve edges 99 and 100 very slightly apart to produce a resilient, but yielding, gripping force.

For certain parts, such as in producing a threaded sleeve with no other components attached to it, the workpiece is allowed to expand in two directions as the grooves for the thread are formed. With the two opposite edges unrestrained, the workpiece will expand bidirectionally outwardly under the impacts of the punches. When workpiece growth occurs in both directions lateral to the grooves, the flank or wall angles of the grooves are substantially the same in each stage, so each groove is substantially symmetrical in all stages.

Referring to Figure 14, the punch 120 of the first stage has a series of parallel ridges 121 which are spaced laterally apart a distance corresponding to the pitch of the thread to be produced. The flanks 122 and 123 of the ridges 121 converge downwardly as shown, and are steeper than that of the flanks in the desired finished thread. The flanks 122 and 123 may be at an angle of 23°. When punch 120 strikes the metal workpiece 124, which is supported as in the previous embodiment, it forms a set of equally spaced parallel grooves 125 corresponding to the lower portions of punch ridges 121.

At the next die stage, Figure 15, the punch 126 has parallel ridges 127 which are spaced correspondingly to ridges 121 and are adapted to register with and be inserted into the grooves 225. The flanks or sidewalls 128 and 129 of ridges 127 are less steeply inclined than are the flanks 122 and 123, but are still more steeply inclined than are the flanks of the desired completed thread. A 26° flank angle is suitable. After punch 126 strikes workpiece 124, the grooves 125 are deepened and widened and their cross-sectional shapes are changed. The sidewalls of the grooves are mirror images of each other, and have the inclinations and shapes of the lower portions of punch ridges 127.

At the third forming stage of the grooves, as shown in Figure 16, there is some further penetration and , additionally, the groove walls are given their final inclinations, for example 30°. Thus, the flanks 131 and 132 of the ridges 133 of the punch 134 are at a 30° angle.

As illustrated in Figures 14-16, there are no sharp corners where the flanks of the ridges on the punches at the various forming stages connect to the bottom surfaces of the ridges. Instead, each ridge has a rounded contour. The rounded shape helps the ridges penetrate the workpiece so as to cause the metal of the workpiece to flow better during the different forming stages, whereas sharp corners have more tendency to dig into the workpiece metal.

Intermediate the ridges of punches 120, 126, and 134 are upwardly concave rounded surfaces 135, 136, and 137, respectively. These surfaces, which are tangent to the flanks of the ridges, avoid stress concentrations in the punches, and lessen any danger of breakage of the punches as they strike the workpiece.

At the bottom of the press stroke, surfaces 135, 136, and 137 remain spaced above the upper surface 138 of the workpiece 124. This provides air gaps between the punch ridges, which avoid the creation of locks from excessive material between the ridges of the punches, which might occur from variation in thickness of the workpiece or from foreign matter on the upper surface 138 thereof. If a lock is created, a punch may be broken. Therefore, to insure a trouble-free production run, the punches should be dimensioned so as to provide these gaps not only relative to the embodiment of Figures 14-16, but also relative to the thread-forming aspects of the previous embodiment.

THE CLAIMS:

1. The method of forming a part having a screw thread having a predetermined contour comprising the steps of

engaging one side of a workpiece with at least one member having ridges thereon so as to provide a plurality of substantially parallel grooves in said one side of said workpiece extending from adjacent a first edge of said workpiece to adjacent a second edge of said workpiece opposite from said first edge, with said grooves being made more shallow and narrower than said screw thread,

then engaging said one side with an additional member having ridges thereon so as to deepen and widen said grooves to achieve substantially said predetermined contour of said thread, said ridges on each of said members being spaced apart a distance equal to the pitch of the thread to be produced,

and then bending said workpiece to impart a substantially cylindrical configuration thereto,

with the ends of adjacent ones of said grooves being positioned substantially in alignment with each other at said first and second edges to define a helix and produce a screw thread for said workpiece.

2. The method as recited in claim 1 in which said workpiece is so engaged by impact by moving said first and second members rectilinearly relatively toward said one side of said workpiece.

3. The method according to claim 1 or 2 in which said one side of said workpiece is engaged with two members having ridges thereon before being so engaged by said additional member, the second of said two members making said grooves deeper and wider than does the first of said two members.

4. The method according to claim 1, 2, or 3 in which after said workpiece is so engaged by at least one member said grooves have bottom walls which are wider than on the roots of the screw thread to be produced.

5. The method according to any of the preceding claims in which said workpiece has third and fourth edges interconnecting said first and second edges, and in which when said workpiece is engaged by said members having ridges thereon said third edge is confined and said fourth edge is unconfined so as to permit substantial expansion of said workpiece at said fourth edge while preventing substantial expansion at said third edge.

6. The method according to claim 5 in which after said workpiece is so engaged by at least one member, said grooves are provided with opposed sidewalls of which the sidewalls adjacent said fourth edge are more steeply inclined than the sidewalls adjacent said third edge and the flanks of the screw thread to be produced.

7. The method according to claim 1, 2, 3, or 4 in which said workpiece has third and fourth edges interconnecting said first and second edges, said workpiece is unconfined at said third and fourth edges so as to permit expansion of said workpiece at both said third and fourth edges when said workpiece is engaged by said members, and when said workpiece is so engaged with at least one member said grooves are given opposed sidewalls which are at equal angles and are more steeply inclined than the flanks of the screw thread to be produced.

8. The method according to any of the preceding claims in which during said bending of said workpiece into a substantially cylindrical shape said workpiece is engaged on the opposite side thereof by a die having a cavity of predetermined contour therein, and is engaged on said one side by a punch for forcing said workpiece into said cavity for assuming the contour thereof, said punch being provided with ridges thereon complementary to said grooves on said one side of said workpiece, whereby said punch when so engaging said workpiece does not distort said grooves on said one side of said workpiece, and then said workpiece is engaged on said opposite side for bringing said opposite edges thereof into adjacency.

9. The method as recited in claim 8 in which said punch includes two spaced parallel elements, each of which is so provided with said ridges complementary to said grooves on said one side of said workpiece.

10. The method in accordance with any of claims 1 through 9 in which in bending said workpiece to impart a substantially cylindrical configuration thereto, said workpiece is engaged by opposed members each of which has a semicylindrical cavity therein, and said workpiece prior to said bending is given a dimension between said first and second edges which is greater than the combined circumference of said semicylindrical cavities, so that said workpiece is forced into intimate contact with the surfaces of said cavities and said first and second edges are pressed tightly together.

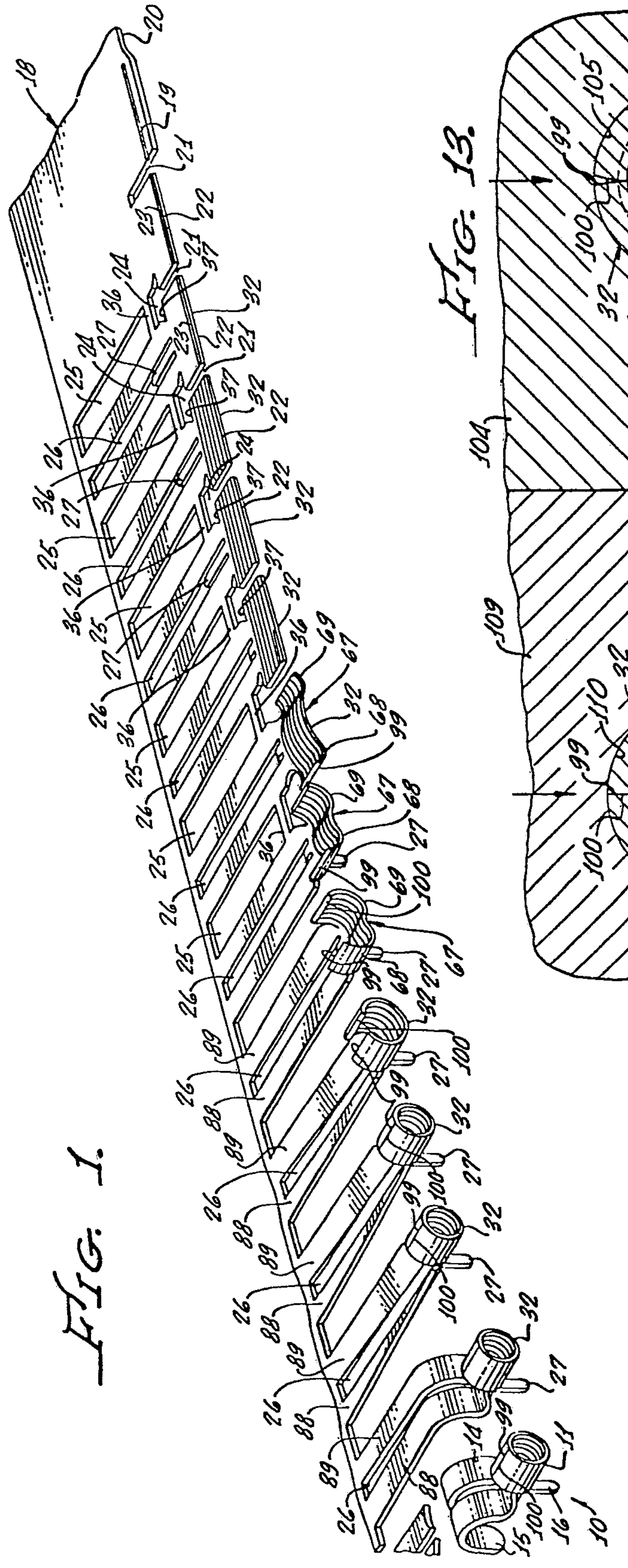

FIG. 1.

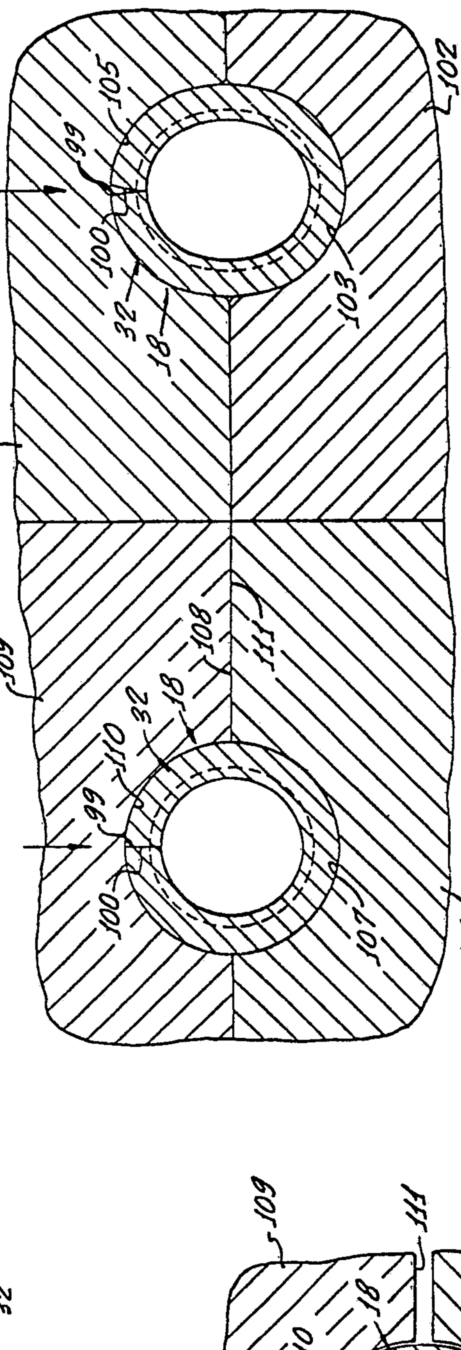

FIG. 13.

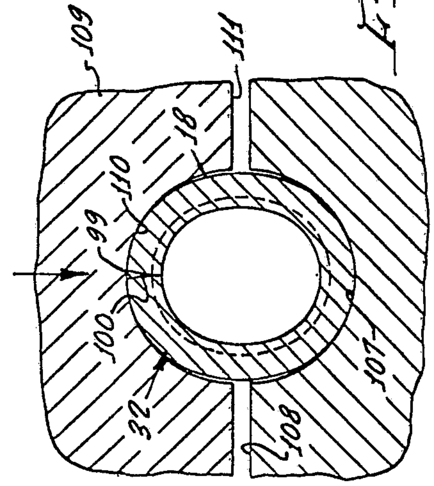

FIG. 12.

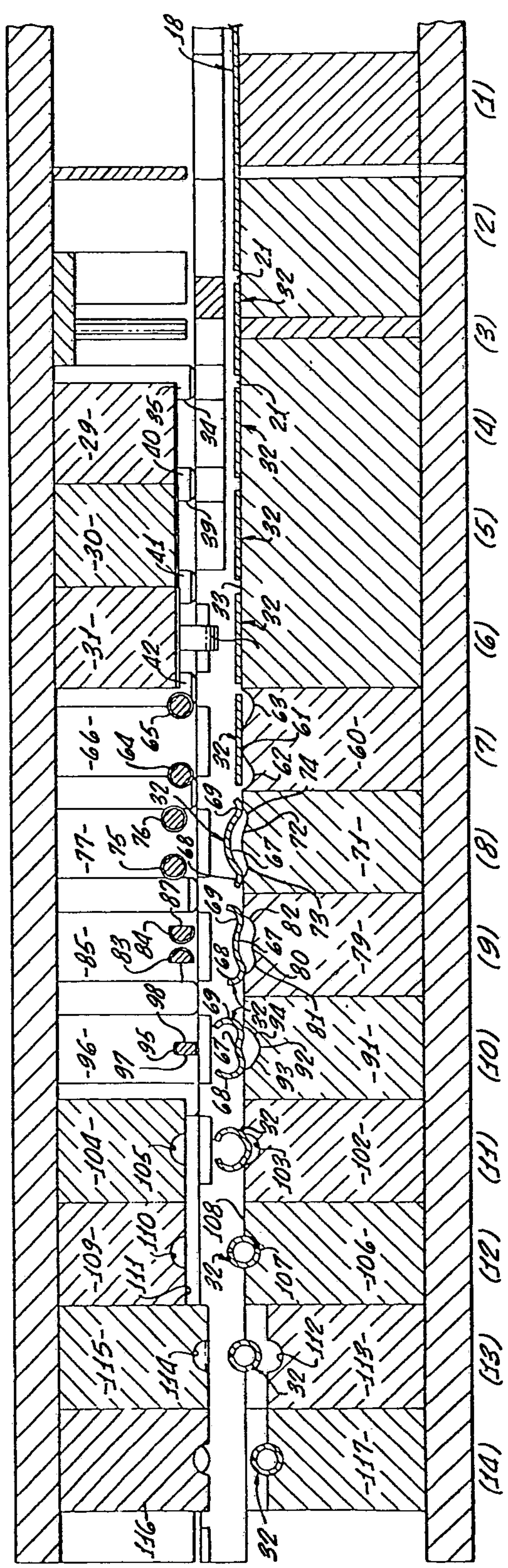

FIG. 2

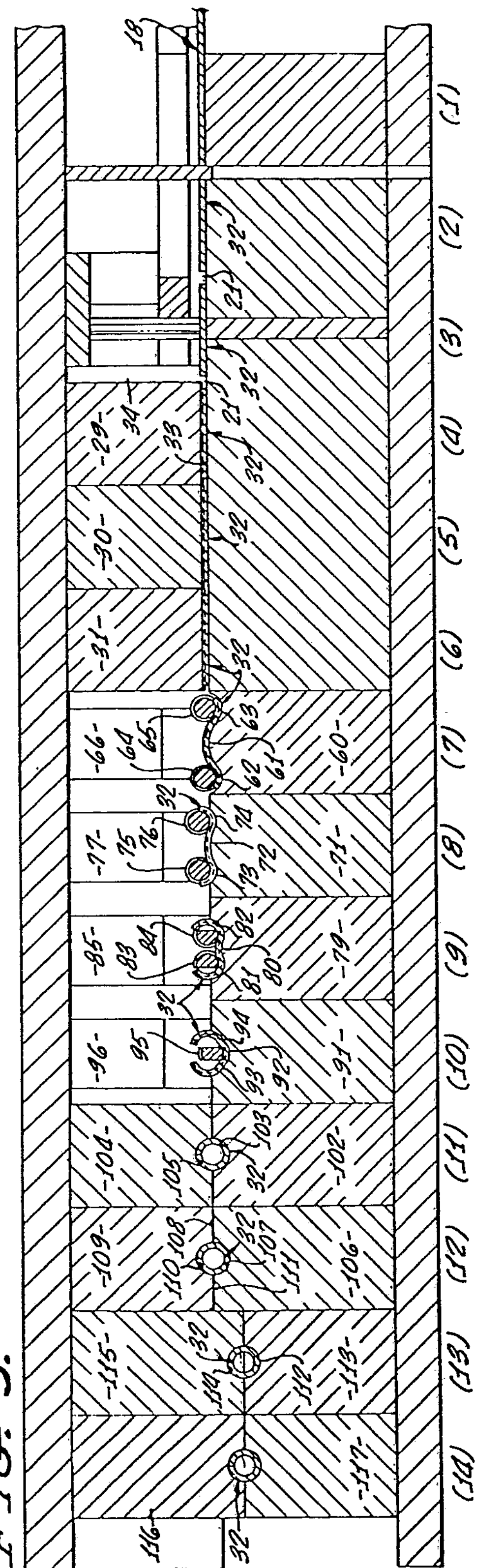

FIG. 3

FIG. 4.

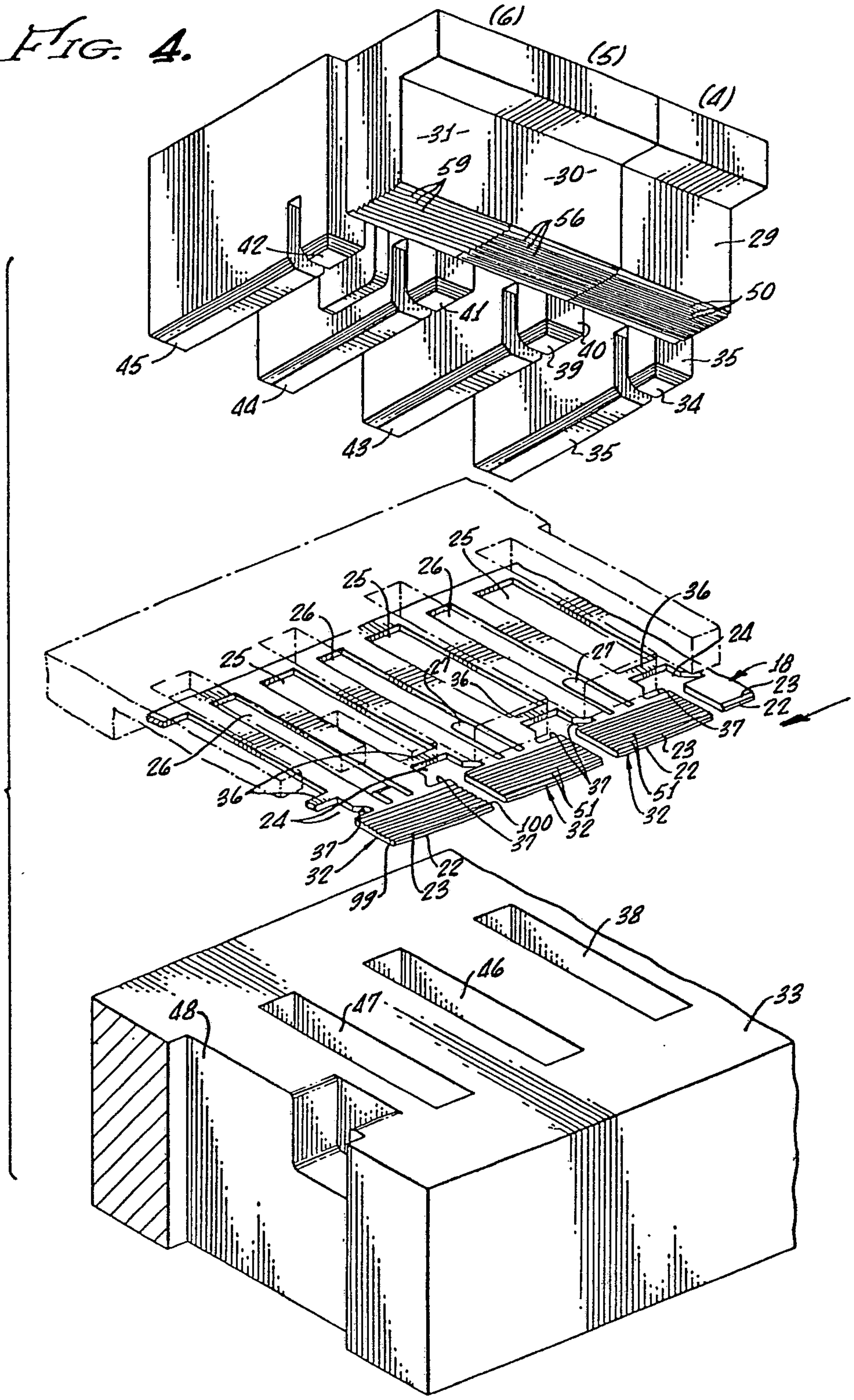
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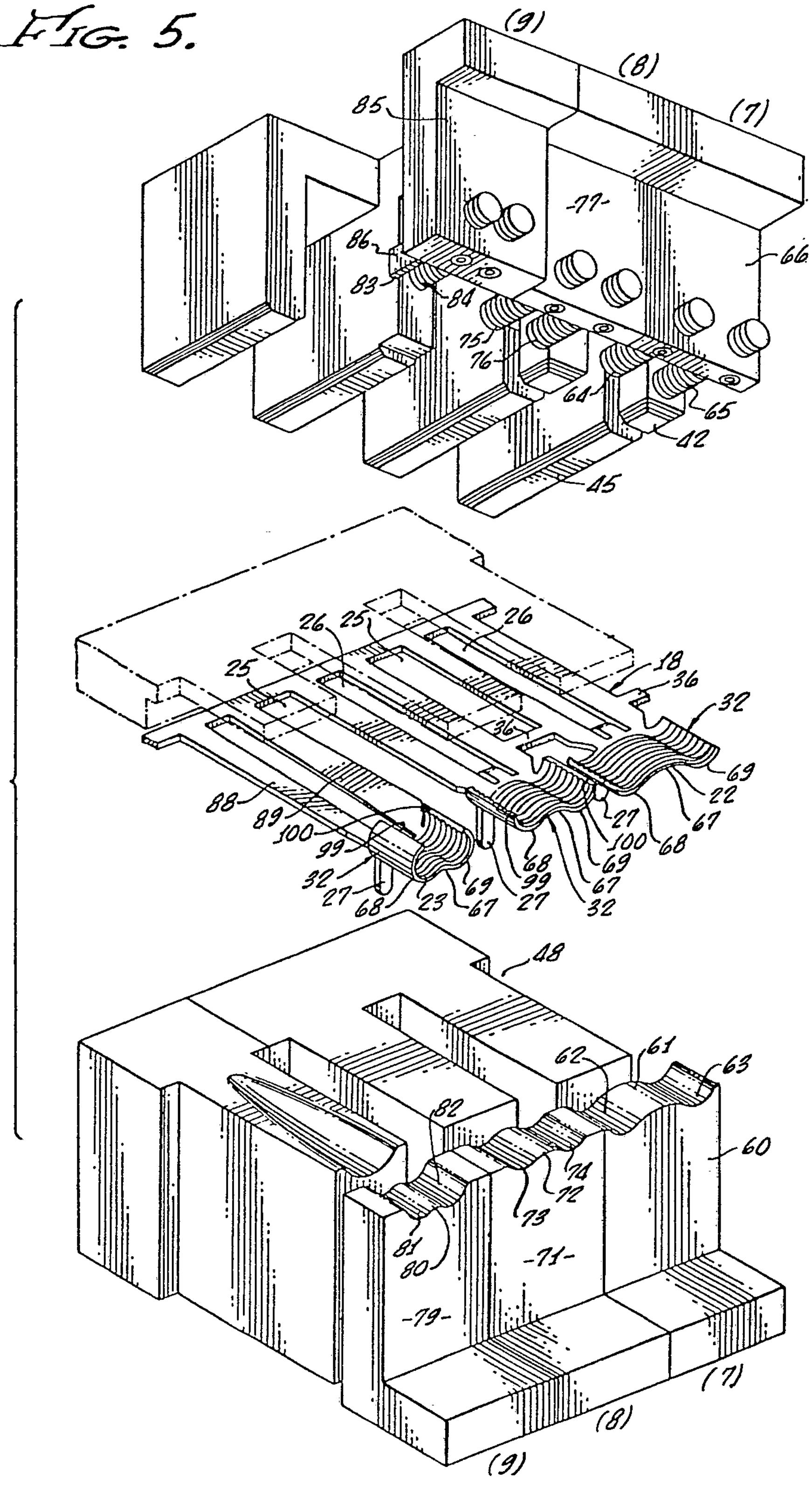
FIG. 5.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23
67
32
48
61
63
62
82
60
74
72
73
81
80
-71-
-79-
(7)
(8)
(9)

FIG. 6.

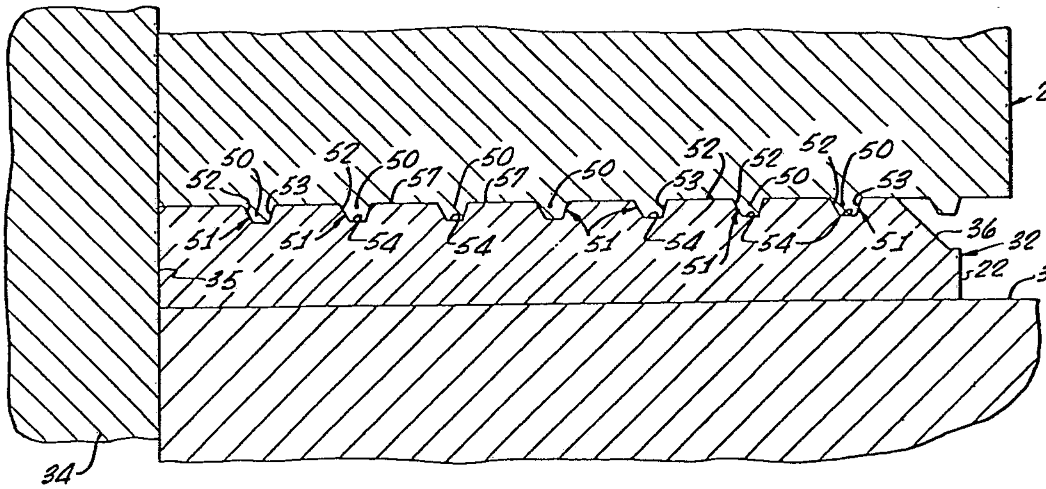


FIG. 7.

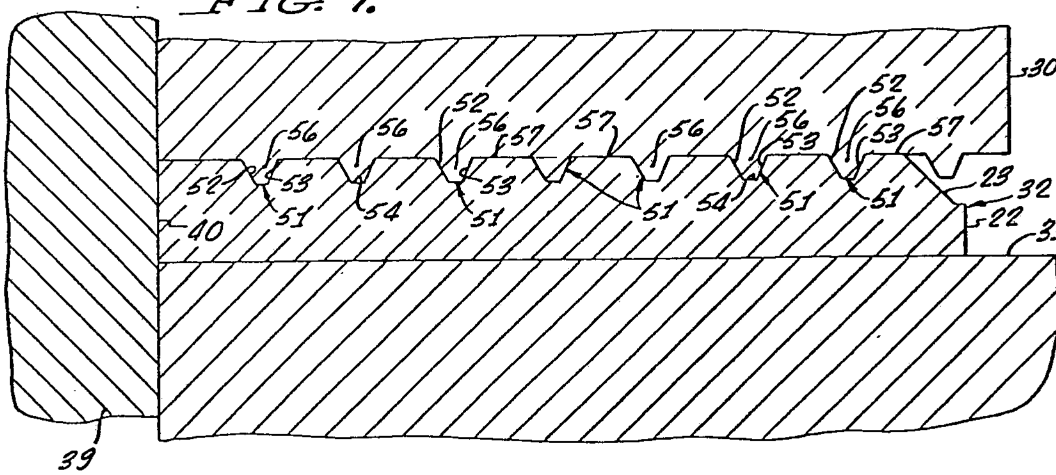
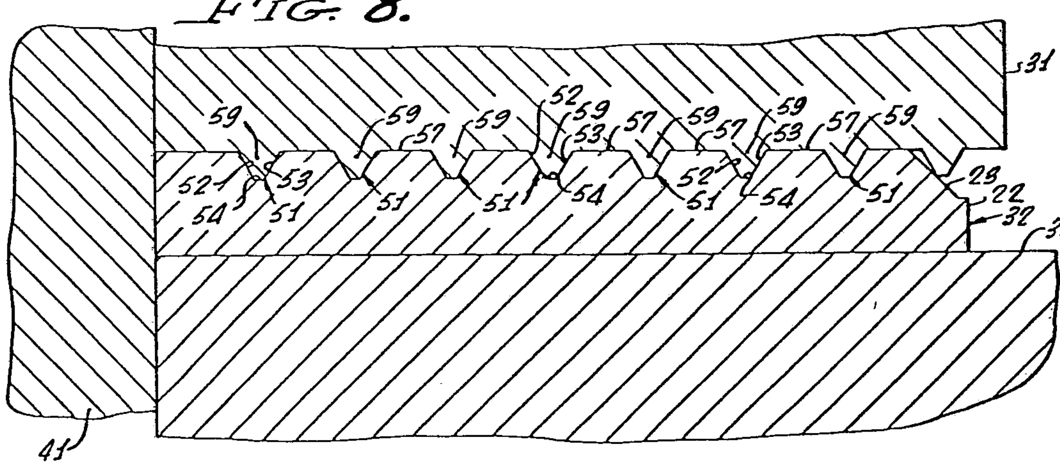


FIG. 8.



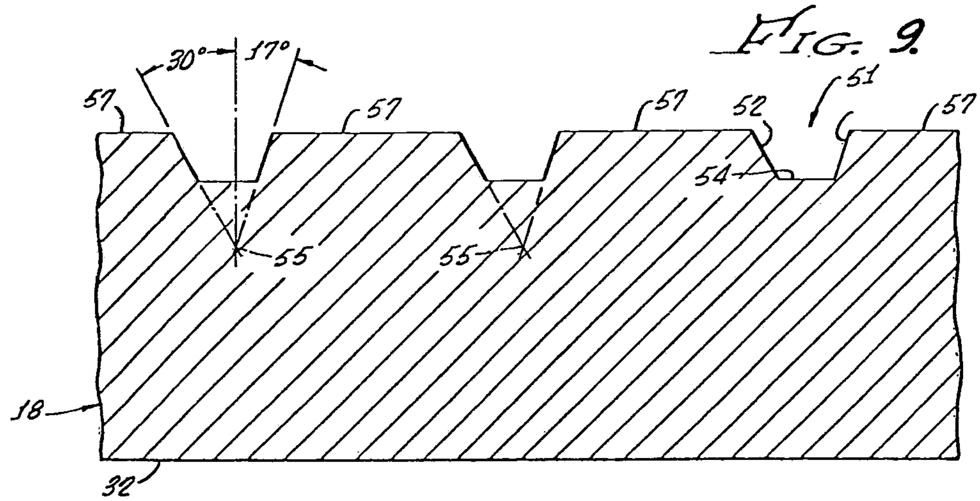


FIG. 9.

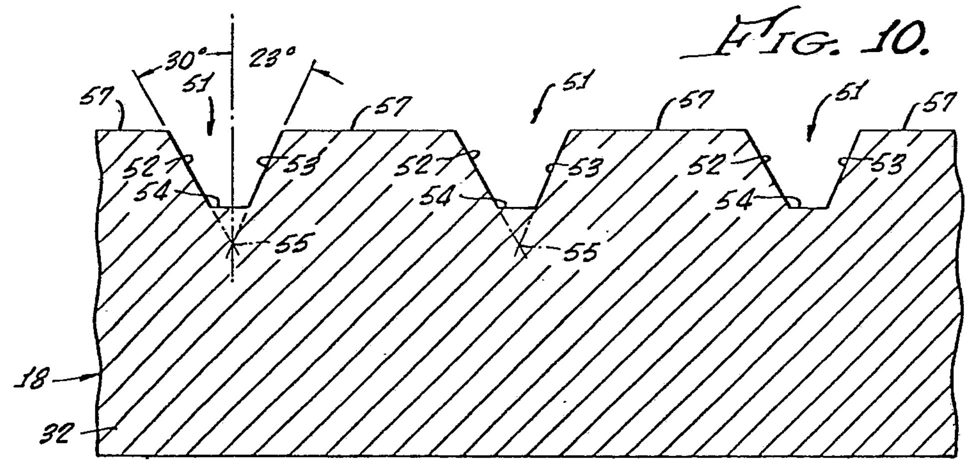


FIG. 10.

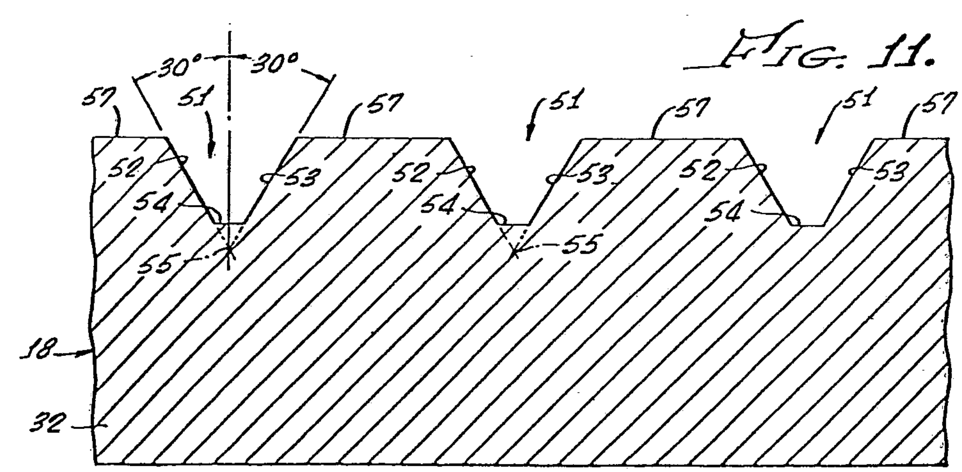


FIG. 11.

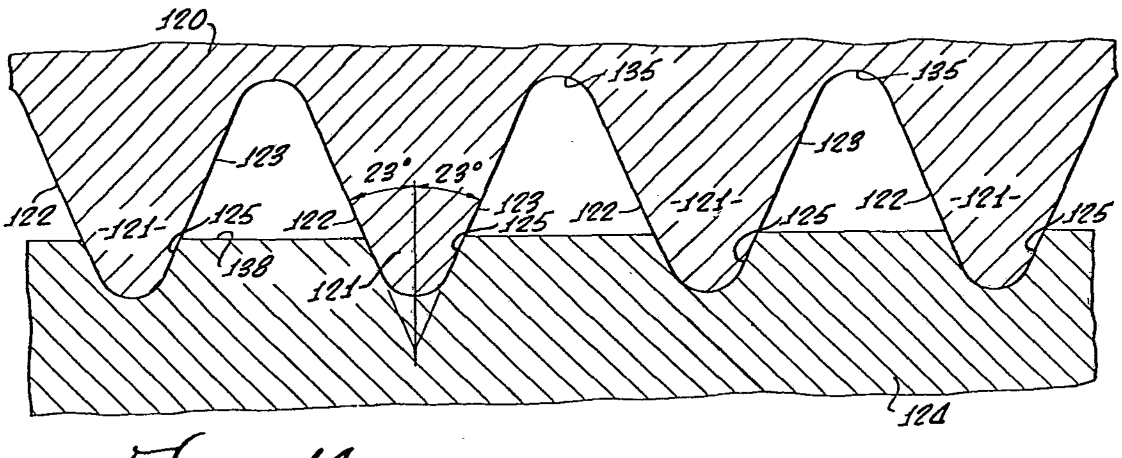


FIG. 14.

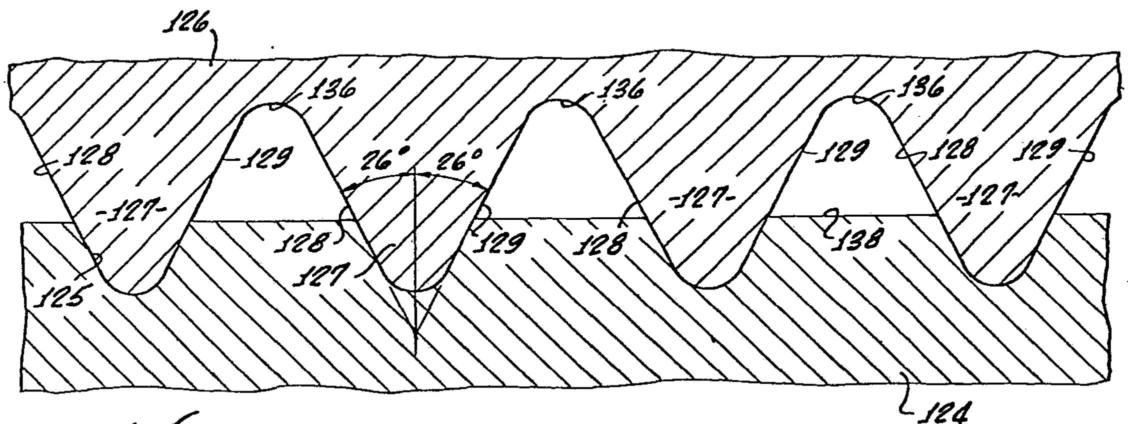


FIG. 15.

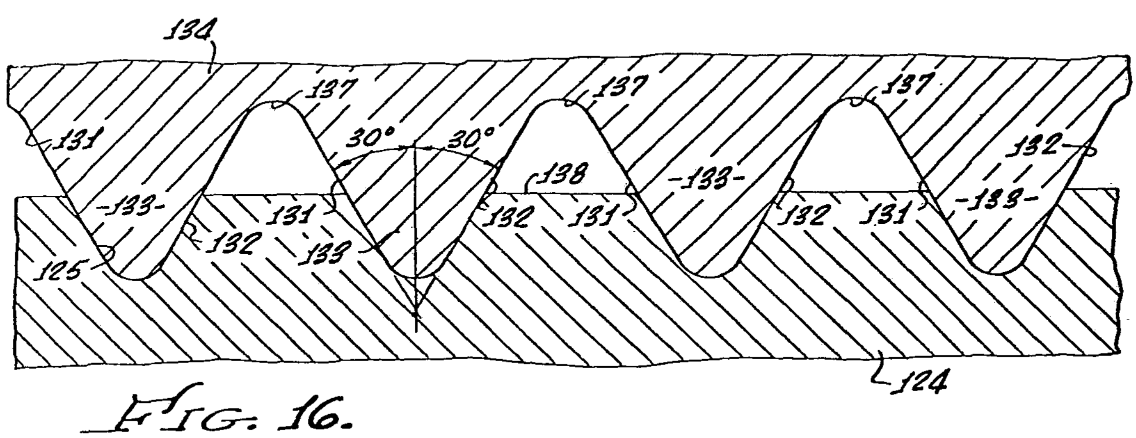


FIG. 16.

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80 10 6343.9

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
	US - A - 1 433 878 (FANCHER et al.) * claims 1, 6, 9; fig. 3 *	1,10	B 21 D 22/02 B 21 D 37/08 B 21 D 53/00
	US - A - 1 369 975 (JOHNSON) * claims 1 to 4; fig. 12 *	1,10	
	US - A - 1 502 133 (ANDERSON) * claim 1 *	1,10	
	AT - B - 164 592 (STE SECURIT'S) * claim 1; fig. 1 to 9 *	1,3,10	TECHNICAL FIELDS SEARCHED (Int. Cl.3)
	GB- A - 1 470 791 (SUPER ELECTRICAL PRODUCTS) * claim 1; fig. 5 *	1,10	B 21 D 17/00 B 21 D 22/00 B 21 D 28/00 B 21 D 35/00 B 21 D 37/00 B 21 D 53/00 B 21 K 1/00
A	DE - B - 1 117 855 (VERMONT AMERICAN CORP.)		
A	US - A - 2 881 510 (LARSON)		
A	US - A - 3 443 542 (KLUMPP JR. et al.)		

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
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T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	20-05-1981	SCHLAITZ