United States Patent

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Continuation-in-part of application Ser. No. 681,291, Nov. 7, 1967, now abandoned.

[54] **PRODUCTION OF POINTED WORKPIECES**
6 Claims, 16 Drawing Figs.

[52] **U.S. Cl.** **72/354,** 72/367
[51] **Int. Cl.** **B21c 5/00**
[50] **Field of Search** .... 72/370, 347—49, 280—85, 367, 354

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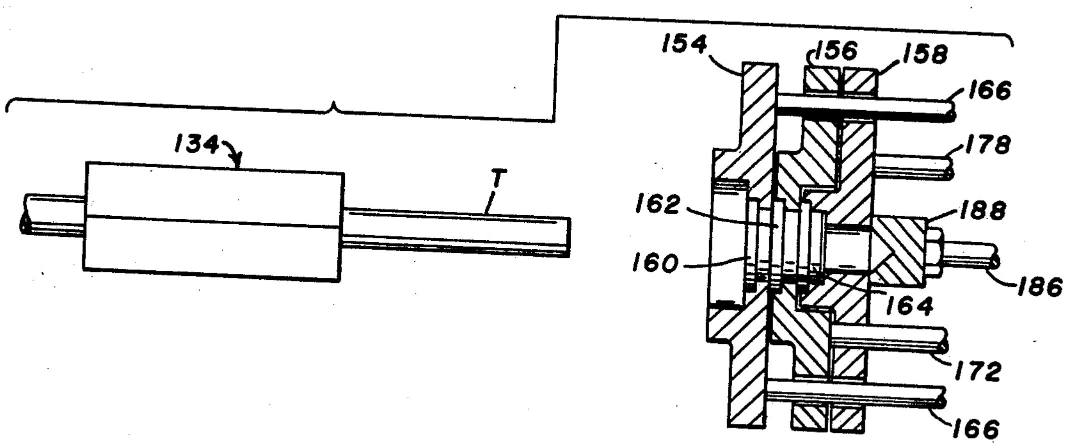
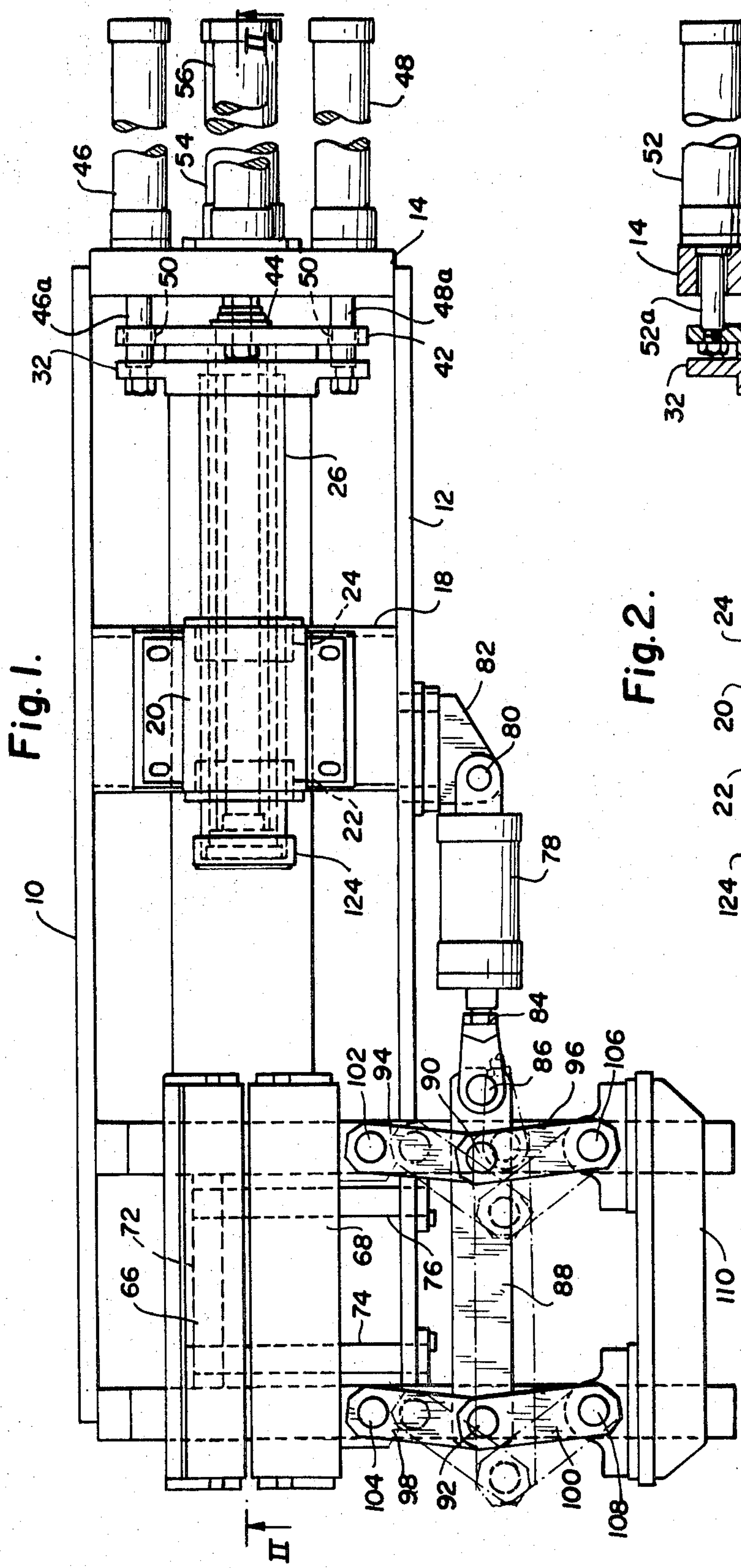
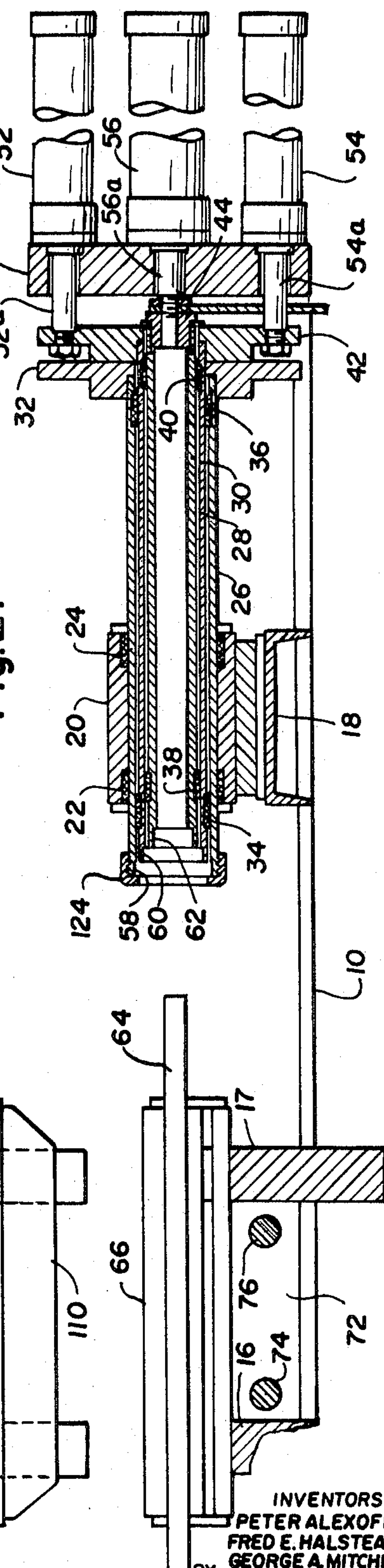
ABSTRACT: Described are a method an apparatus for pointing long slender workpieces, characterized in that concentric, telescoping dies of successively smaller cross-sectional areas are forced over the end of the workpiece to thereby progressively reduce its cross-sectional area in steps. Also described are a method and apparatus for preventing bowing or curving in a point formed by forcing a die over a workpiece to extrude the point.







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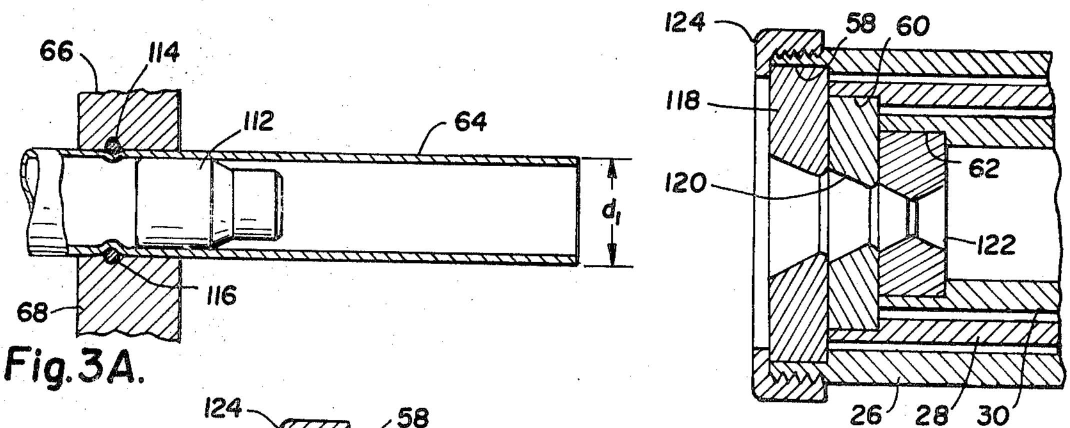

Fig.3A.

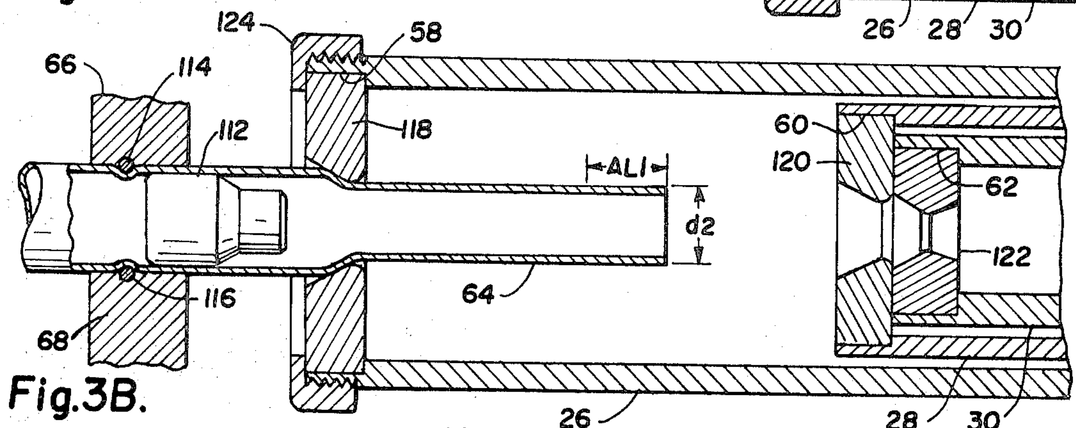

Fig.3B.

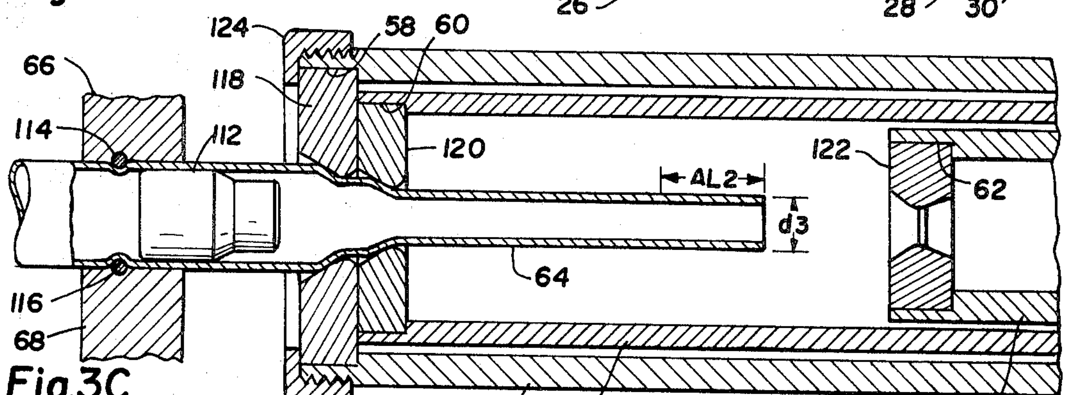

Fig.3C.

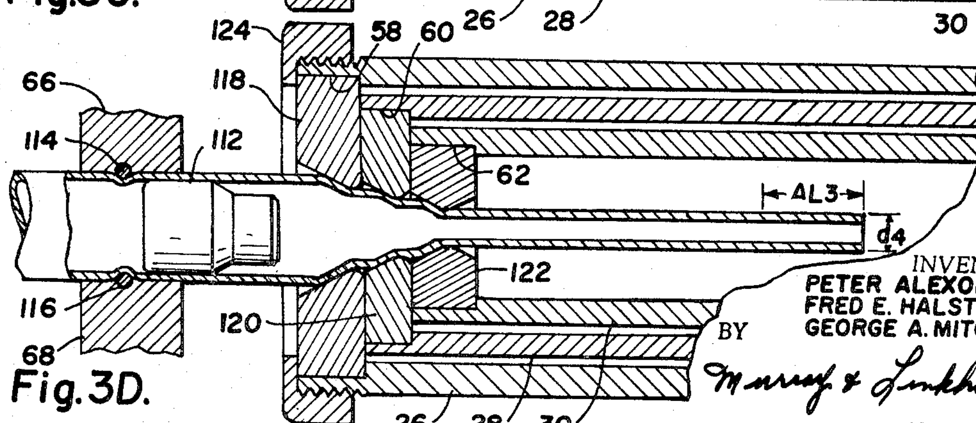

Fig.3D.

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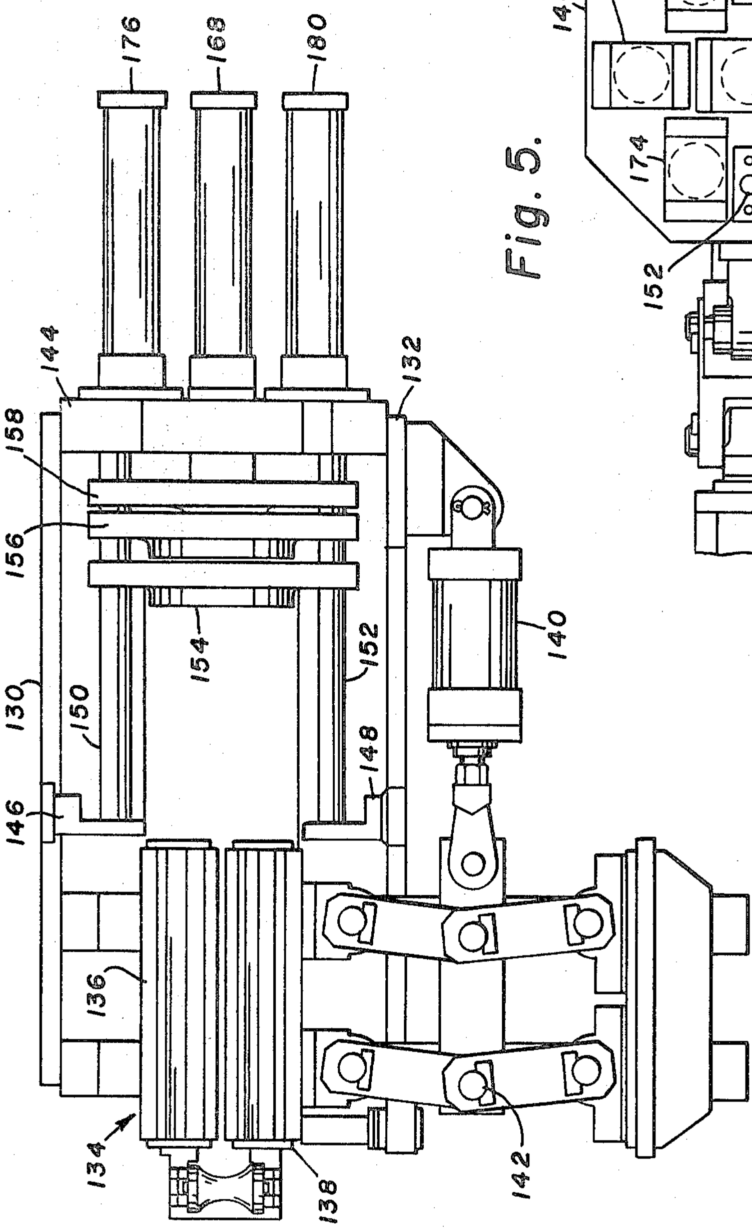

Fig. 4.

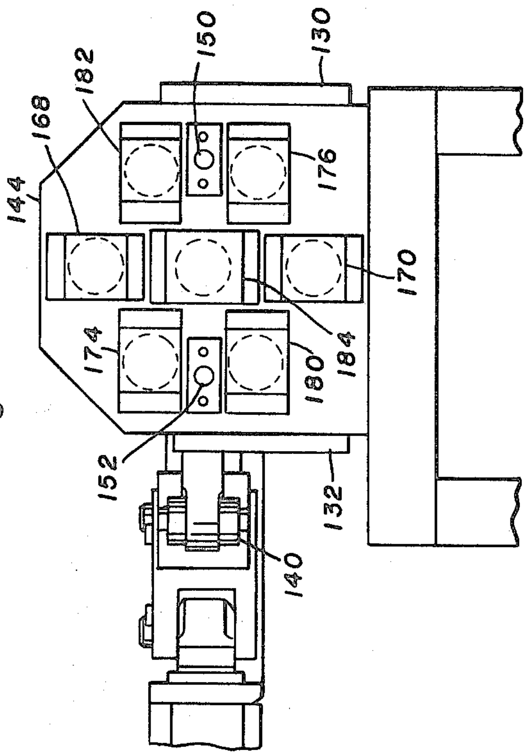

Fig. 5.

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Fig. 6A.

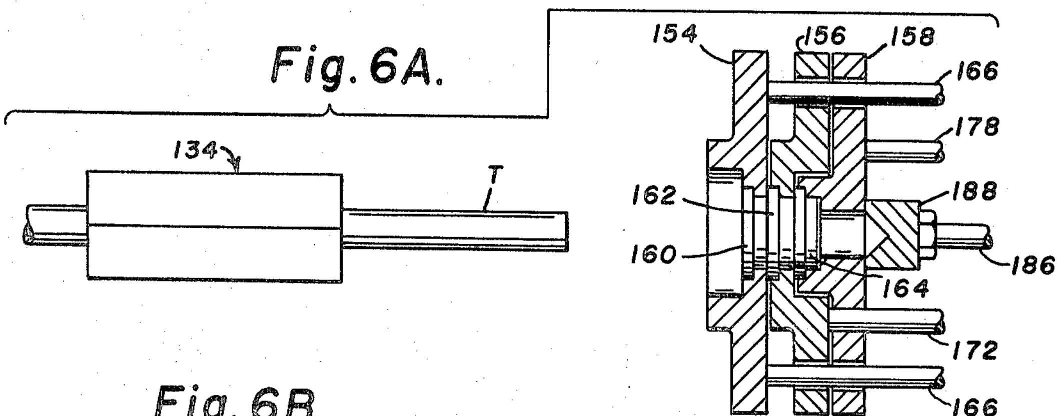

Fig. 6B.

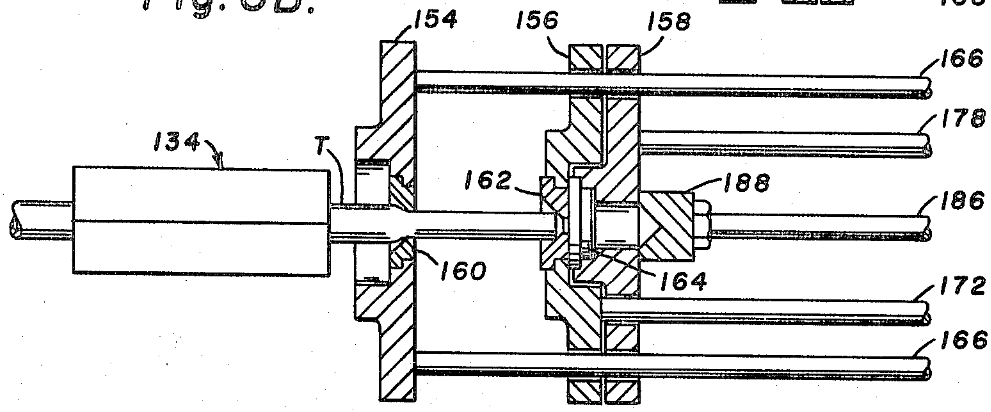

Fig. 6C.

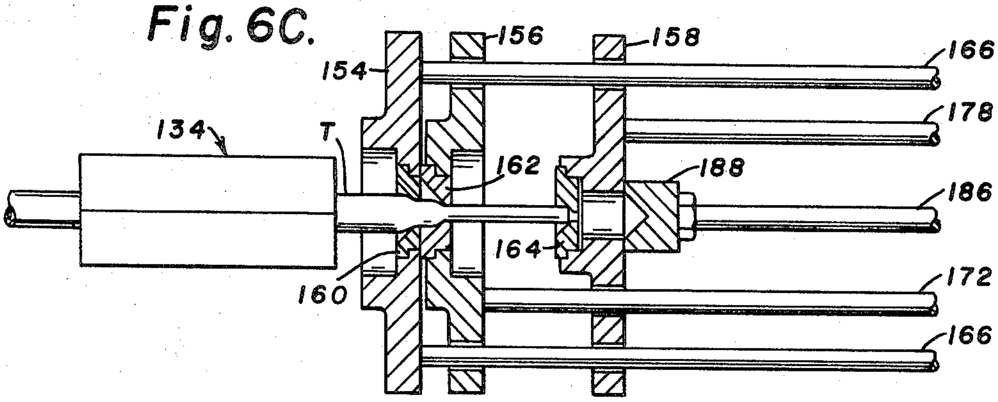

Fig. 6D.

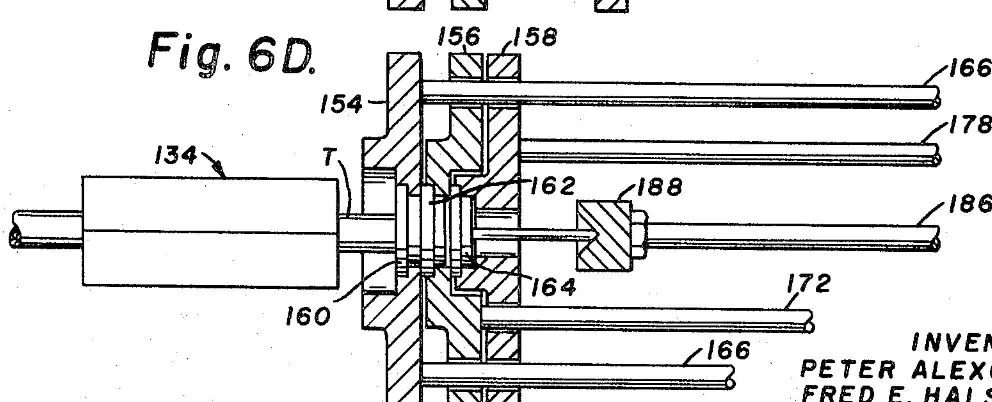

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Fig. 6E.

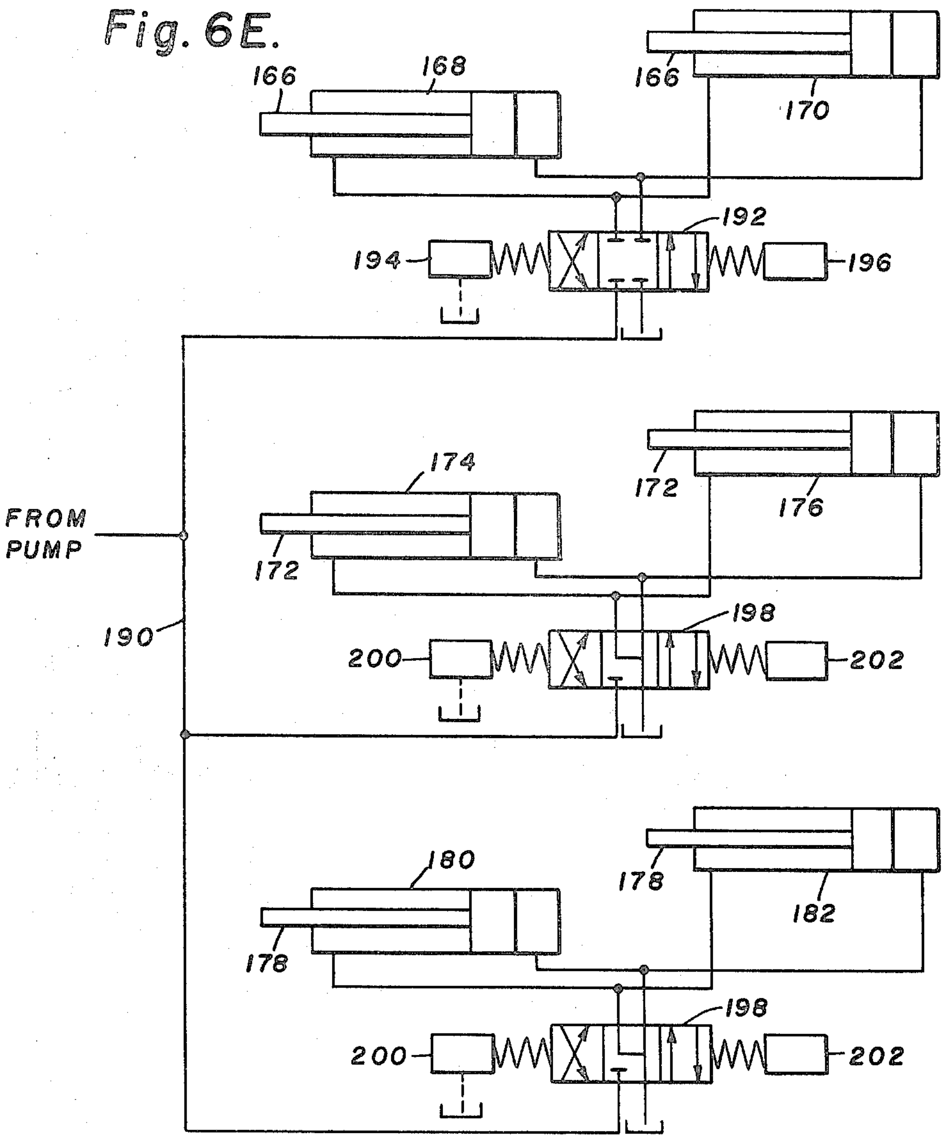

Fig. 9.

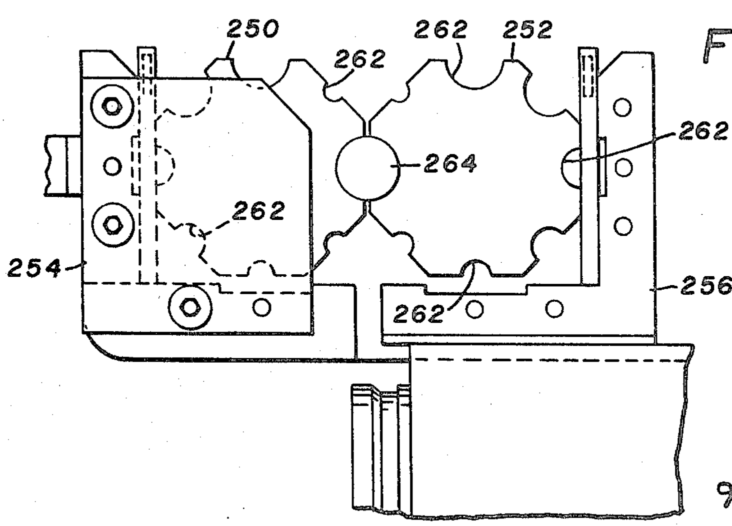

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Fig. 7.

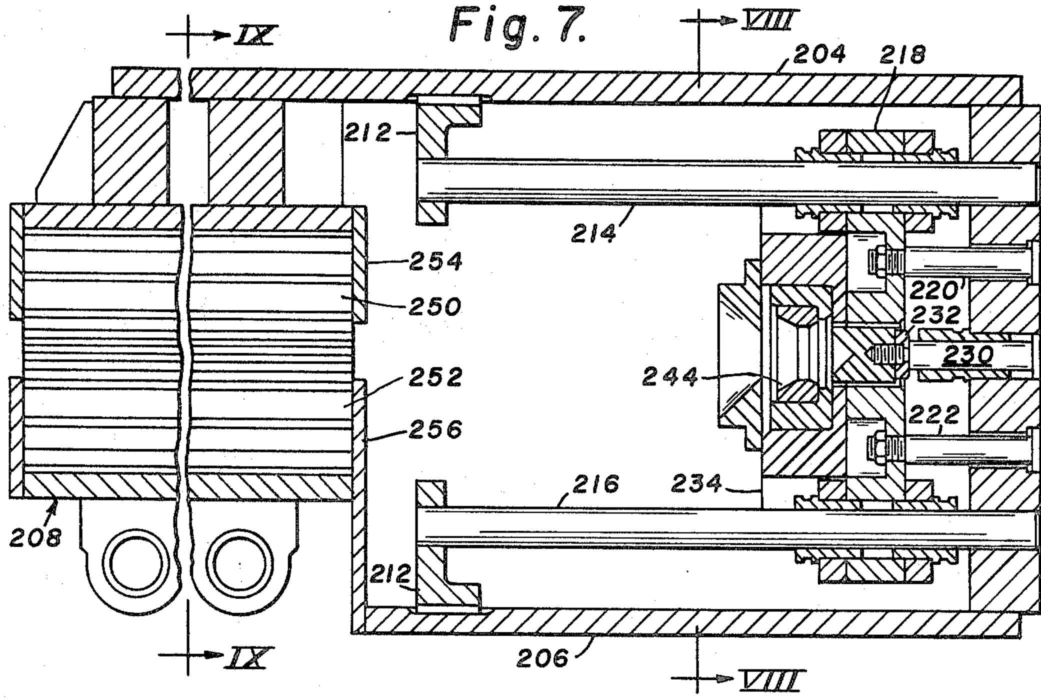
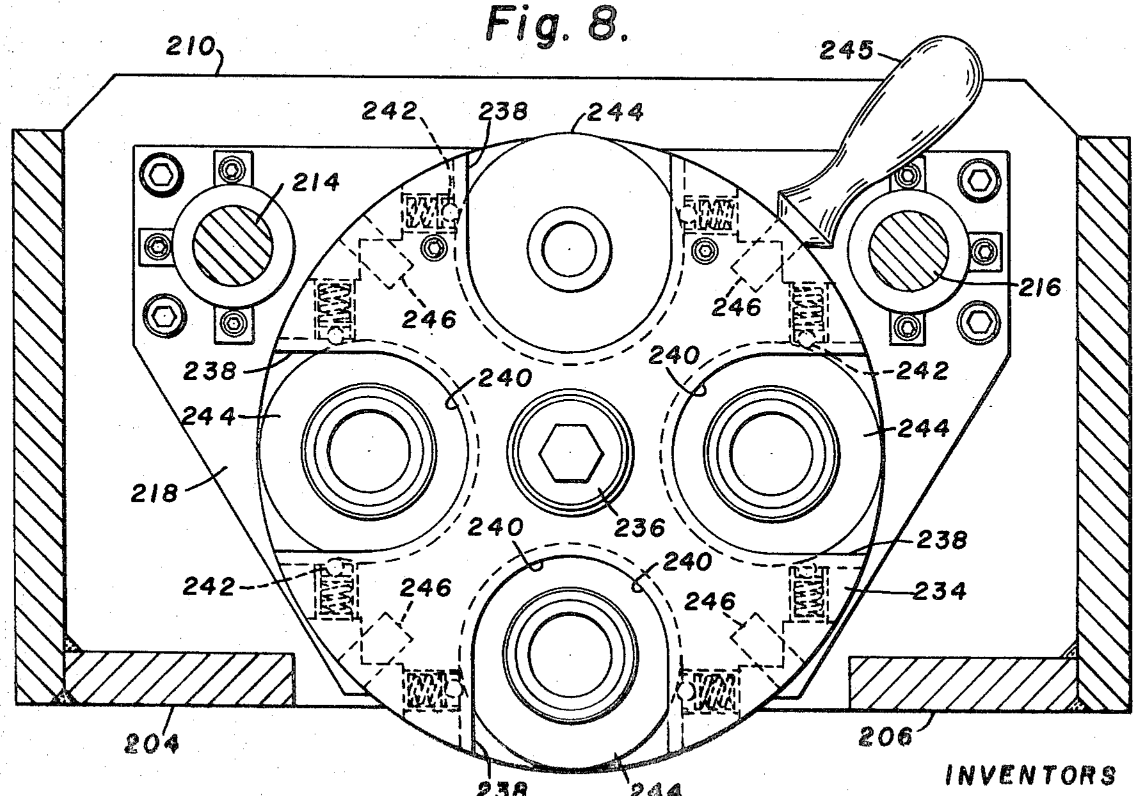


Fig. 8.



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PRODUCTION OF POINTED WORKPIECES

CROSS-REFERENCE TO RELATED PATENTS

This application is a continuation-in-part of copending application Ser. No. 681,291, filed Nov. 7, 1967, now abandoned.

BACKGROUND OF THE INVENTION

As is known, in a conventional tube drawing operation, the reduced diameter end of a tube, mounted on a mandrel, is passed through a die and engaged by gripper jaws on a draw carriage or dolly which travel on a track or guideway on one side of the die. After the reduced diameter end of the tube is passed through the die and engaged by the aforesaid gripper jaws, the draw carriage is forced to move away from the die, thereby pulling the tube through the die. In this process, the diameter and wall thickness of the tube are decreased while its length increases. In a similar manner, bars are drawn on drawbenches by initially pointing an end thereof, the pointed end being engaged by jaws on a draw carriage which moves away from the die to thereby pull the bar through the die.

In the past, the problem of pointing tubes or bars to be cold drawn has been accomplished in many different ways, both at the drawing equipment as an integrated function thereof, and as an auxiliary process which occurs prior to the material being delivered to the drawbench for drawing. The most commonly used method for pointing bars and tubes has been with the use of hammer swaging equipment. This type of operation, however, is noisy and time consuming, and also requires high maintenance on the swaging machine. Furthermore, in the case of certain types of metals, the point produced by hammer swaging is worked by repeated blows of the hammers to the extent that it is brittle and subject to breakage when drawn. Another problem exists with hammer swaging machines where a tube of relatively large diameter and thin wall thickness is to be pointed. This requires a relatively large and high priced machine for the reason that the size of the machine is dictated by the initial outer diameter of the tube, notwithstanding the fact that little actual work must be done to swage or reduce the thin wall of the tube.

Another pointing device used on heavy size tubes is the multiple hydraulic cylinder squeeze pointer that works on the point in steps, resulting in a very rough, long point. The operation, even though universally accepted for larger sizes, is slow and requires high maintenance.

On tubing, one of the most practical types of pointing equipment has been that which produces a folded-type point. Such apparatus is shown, for example, in copending application Ser. No. 451,296, filed Apr. 27, 1965. By reference to that application, it will be seen that the apparatus deforms or squeezes the end of a tube between a pair of opposing dies to produce a cross-sectional configuration of reduced diameter wherein the wall of the tube forms a more or less S-shape. This pointer has no equal from the point of view of lack of noise, ease of feeding material to the dies, and speed of operation. It does, however, have some drawbacks. When the wall thickness of the tube is nonuniform, the fold is more pronounced on one side of the tube than the other, resulting in an offcenter, misformed point. Another problem which exists with this type of pointer is that the conical transition between the reduced diameter point and the remainder of the undeformed tube sometimes has irregularities which raise the possibility of tube points pulling off under the most severe drawing conditions.

Another disadvantage of fold pointing is that in certain tube drawing operations where the tubes are immersed in a lubricant or cleaning acid, the closed end prevents or impedes drainage of lubricant from the interior of the tube. Also, where the tubing is to be drawn on a bull block, it is necessary to insert a floating mandrel into the tube prior to the pointing operation. If the floating mandrel happens to slide into the area of the tube to be pointed, a subsequent attempt to deform the end of the tube in a press or hammer swaging machine will cause extensive damage to the pointing equipment.

In an effort to overcome the disadvantages of the pointing devices which squeeze or fold the end of the tube into a compact mass, attempts have been made to apply push-pointing techniques to the production of pointed tubing. In the push-pointer, the material to be pointed is aligned with a die opening of smaller cross-sectional area than the workpiece. A set of jaws on one side of the die usually grip the workpiece and thrust it through the die, thereby reducing the diameter of the forward end of the tube as it passes through the die.

Push-pointing has been used rather extensively on bars where the cross-sectional reduction per draw is quite low; however, until recently it has not been used on tubing primarily because of the fact that the required outside diameter reduction on tubes is usually quite large and requires a rather heavy thrust to push the tube through the die. This would normally cause the tube to fail in compression before it could be pushed through the die.

Deformation of the tube during push-pointing can be eliminated by forming the tube gradually and in successive push-pointing operations. That is, the end of the tube is passed through a first die having a cross-sectional area less than the original cross-sectional area of the workpiece, and thereafter passed through at least one other die having a cross-sectional area less than that of the first die whereby the cross-sectional area of the end of the tube is reduced in successive steps. Since the tubes are push-pointed in successive operations, the reduction taken in any successive step is not much as to cause failure in compression.

In the past, push-pointing apparatus for tubing employing successive dies required that the tube be aligned with a first die and pushed through that die, thereafter withdrawn from the first die, and then aligned with the second and succeeding dies where the foregoing cycle was repeated. As will be understood, this process is rather slow and cumbersome.

Furthermore, it has been found that when a die is formed over a tube to form a point, there is a tendency for the point to become bowed or curved as it is extruded through the die, the reason being that ordinarily there is nothing to support the forward end of the tube during the push-pointing operation. This condition cannot be tolerated, particularly where successive dies are utilized to form the point since the point must remain in alignment with the longitudinal centerline of the tube to permit successive dies to pass thereover.

SUMMARY OF THE INVENTION

In accordance with the present invention, reduced diameter points are formed on the ends of long slender workpieces of predetermined cross-sectional area and particularly tubing, by the steps of initially clamping the workpiece in place, forcing a first die of cross-sectional area less than said predetermined cross-sectional area over the end of the workpiece to produce a reduced cross-sectional area end, and forcing at least one other die over said reduced cross-sectional area end while the first die remains stationary on the workpiece, the second and any succeeding dies having cross-sectional areas smaller than that of the preceding die whereby the cross-sectional area of the end of the workpiece is reduced in successive steps.

As the successive dies are forced over the end of the workpiece, it is extruded, thereby causing its length to increase. Thus, whereas most pointing operations for tubes simply attempt to squeeze or fold the tube into a compact point, the present invention provides means whereby the end of the tube is extruded by successive dies into a point of increased wall thickness and greatly reduced cross-sectional area. At the same time, the tube is not completely closed such that lubricant, for example, can escape from the pointed end; and since the dies are pushed over the tube, no danger exists of damage to the pointing apparatus because of a floating-type mandrel being lodged in the section of the tube being pointed. That is, if the mandrel should be lodged in the area being pointed, it simply will be pushed backwardly as the dies are forced over the end of the tube.

Further, in accordance with the invention, high pressure hydraulic cylinders are utilized to force at least one die over the forward end of a workpiece, while a relatively low pressure air cylinder is utilized to urge a cup-shaped member over the forward end of the point as it is being formed by the die. In this manner, the pressure of the cup-shaped member against the end of the point prevents it from becoming bowed or curved. In the case of multiple dies, the cup-shaped member and air cylinder force those dies following the die being pushed over the tube against the tube end to maintain it straight until the last die passes over the point, whereupon the cup-shaped member itself engages the end of the point.

The above and other objects and features of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIG. 1 is a top or plan view of one embodiment of the tube pointing apparatus of the invention;

FIG. 2 is a cross-sectional view taken substantially along line II–II of FIG. 1;

FIGS. 3A—3D graphically illustrate the operation of the embodiment of FIGS. 1 and 2 in producing a pointed tube by successive push-pointing steps;

FIG. 4 is a top view of another embodiment of the invention;

FIG. 5 is an end view of the embodiment of the invention shown in FIG. 4;

FIGS. 6A—6E illustrate the operation of the embodiment of FIGS. 4 and 5;

FIG. 7 is a cross-sectional view of still another embodiment of the invention employing a single crosshead having a plurality of rotary dies thereon;

FIG. 8 is a cross-sectional view taken substantially along line VIII–VIII of FIG. 7; and

FIG. 9 is an end view taken substantially along line IX–IX of FIG. 7.

With reference now to the drawings, and particularly to FIGS. 1 and 2, the tube pointing apparatus shown includes a pair of side members 10 and 12 interconnected at one end by means of a mounting block 14 and at the other end by means of blocks 16 and 17 (FIG. 2). Extending between the side members 10 and 12 is a channel member 18 which supports a circular bearing housing 20. The bearing housing 20, at the ends of its inner peripheral surface, is provided with bushings 22 and 24 (FIG. 2) which receive the first cylinder of a set of three telescoping cylinders 26, 28 and 30.

As shown, the first or outer telescoping cylinder 36 slides within the bushings 22 and 24 and is connected, at its trailing end, to a crosshead 32. The intermediate cylinder 28 is separated from cylinder 26 by means of bushings 34 and 36. Likewise, it is separated from the cylinder 30 by means of bushings 38 and 40. The right end of cylinder 28, as viewed in FIG. 2, is connected to a second crosshead 42; while the central cylinder 30 is provided at its right end with a plug 44.

The cylinder 26 and its crosshead 32 are caused to reciprocate by means of a pair of hydraulic cylinders 46 and 48 (FIG. 1) mounted on either side of the block 14 and having piston rods 46*a* and 48*a* passing through openings 50 in crosshead 42 and connected to the crosshead 32. In a somewhat similar manner, the cylinder 28 and its crosshead 42 can be caused to reciprocate by means of hydraulic cylinders 52 and 54 (FIG. 2) mounted at the top and bottom of the block 14 intermediate cylinders 46 and 48. Cylinders 52 and 54 are provided with piston rods 52*a* and 54*a* which are connected to the crosshead 42. Finally, the innermost cylinder 30 is reciprocated by means of a hydraulic cylinder 56 centrally mounted on the block 14 and having a piston rod 56*a* threaded to the plug 44 on the end of cylinder 30. Machined into the left ends of the cylinders 26, 28 and 30 are enlarged diameter portions 58, 60 and 62, respectively, which receive push-pointing dies in a manner hereinafter described in connection with FIGS. 3A—3D.

In the operation of the push-pointing apparatus, the cylinders 46 and 48 are initially pressurized to force the crosshead 32 and the outer telescoping cylinder 26 to the left as viewed in FIG. 2. During this time, the piston rods 46*a* and 48*a* simply slide through the openings 50 in crosshead 42. Thereafter, cylinders 52 and 54 are pressurized to move crosshead 42 and the intermediate cylinder 28 to the left. Finally, the single cylinder 56 is pressurized to move the innermost cylinder 30 to the left. After a push-pointing operation, all of the cylinders 26, 28 and 30 are preferably moved to the right simultaneously.

A tube to be pointed is illustrated schematically in FIG. 2 and identified by the reference numeral 64. This tube is clamped in position during a pointing operation by means of a pair of opposing jaws, generally indicated by the reference numerals 66 and 68. The jaw 66 is stationarily mounted on the plates 16 and 17. Beneath the stationary jaw 66 is a block 72 which extends between plates 16 and 17; and extending between the block 72 and the upright portion of side member 12 are two traverse rods 74 and 76. The rods 74 and 76 carry, for reciprocating movement, the jaw 68. In order to secure a tube to be pointed between the jaws 66 and 68, the jaw 68 is initially moved away from jaw 66 on rods 74 and 76; the tube inserted between the jaws; and jaw 68 then moved toward the jaw 66 in order to secure the tube in place.

Apparatus for reciprocating the jaw 68 on rods 74 and 76 includes a hydraulic cylinder 78 (FIG. 1) having its one end pivotally connected at 80 to a bracket 82 secured to the upright portion of side member 12. The piston rod 84 of cylinder 78 is pivotally connected at 86 to a bar 88. The bar 88, in turn, is provided with two pins 90 and 92 which pivotally support sets of links 94, 96 and 98, 100. The links 94 and 98 are pivotally connected to pins 102 and 104 carried on the jaw 68; while the links 96 and 100 are pivotally connected to pins 106 and 108 carried on a crossplate 110 which is, in turn, connected to plates 16 and 17.

With the arrangement shown, movement of the piston rod 84 to the left as viewed in FIG. 1 will cause the bar 88 to move to the dotted line position shown, thereby pulling jaw 68 away from jaw 66. However, upon reversal of the piston rod 84 and bar 88, the jaw 68 is forced toward the jaw 66, thereby securing the tube 64 therebetween.

With reference now to FIGS. 3A—3D, the manner in which push-pointing occurs is shown. The tube 64 to be pointed is clamped or secured between the jaws 66 and 68. In the illustration given, the tube 64 is to be drawn on a bull block. Accordingly, before the pointing operation begins, a floating mandrel 112 is inserted into the tube. In the case of a floating mandrel, pins 114 and 116 embedded in the jaws 66 and 68 indent or dimple the tube 64 behind the floating mandrel 112. This insures that the mandrel becomes lodged between the interior of the tube and the die at the initiation of a bull block drawing operation. As soon as the drawing operation begins, the dimpled portions formed by the pins 114 and 116 are pulled over the mandrel 112; however by this time the mandrel is securely lodged within the tube at the location of the drawing die. Of course, if the tube is to be drawn on a conventional drawbench where the mandrel is anchored at the end of a mandrel table opposite the drawing die, the dimples are unnecessary and the pins 114 and 116 may be removed from the jaws.

Carried within the enlarged diameter portion 58 of the outer cylinder 26 is a first die 118. Similarly, a second die 120 is fitted into the enlarged diameter portion 60 of cylinder 28. Finally, the die 122 having a smaller diameter than that of the die 20 is fitted into the enlarged diameter portion 62 of the cylinder 30. An end cap 124 is threaded onto the end of the outer cylinder 26 to assist in preventing removal of the dies 118—122 from their seats upon removal of the dies from the pointed tube in a manner hereinafter described.

The pointing operation begins by pressurizing hydraulic cylinders 46 and 48 shown in FIG. 1 to thereby force the cylinder 26 and die 118 to the left as viewed in FIGS. 3A and

3B. As the die 118 is forced over the tube 64, the cross-sectional area of its forward end is reduced such that it now has a diameter $d2$ which is smaller than the original diameter $d1$ of tube 64. In this process, the forward end of the tube is extruded such that its length is increased by an amount equal to ΔL1. Following the first reduction process, therefore, the tube appears as in FIG. 3B. The cylinders 52 and 54 are now pressurized to move the cylinder 28 and die 60 to the left as viewed in FIG. 3C. Note that the die 120 has a diameter $d3$ which is smaller than the diameter $d2$ produced by the die 118. Again, the length of the tube is increased by extrusion in the amount ΔL2. Finally, the single cylinder 56 is pressurized to force the die 122 over the end of the previously extruded tube as shown in FIG. 3D whereby the end of the point now assumes the diameter $d4$ and has increased in length in an amount equal to ΔL3. At the completion of the pointing operation, hydraulic cylinders 46 and 48 are pressurized to withdraw all of the cylinders 26—30 and their associated dies 118—122 to the right, whereupon the jaws 66 and 68 are opened to remove the now-pointed tube 64.

As the dies 118—122 are pushed over the end of the tube to form an extruded point as shown in FIGS. 3A—3D, there is a tendency for the point to become bowed or curved in the extrusion process. This is particularly true as the diameter of the point becomes increasingly smaller; and even through the point must be pulled back through the dies at the completion of a pointing operation, this bowed or curved condition may still persist.

Apparatus for eliminating the curved condition of the point is shown, in one embodiment, in FIGS. 4 and 5. It again includes side members or channels 130 and 132 which support, at one end, a clamping mechanism 134 similar to the clamping mechanism already described in connection with FIGS. 1 and 2. The clamping mechanism 134 again includes a stationary clamping member 136, a movable clamping member 138, an actuating cylinder 140 and a linkage mechanism 142 interconnecting the cylinder and the movable clamping member 138 whereby the member 138 may be moved toward or away from a tube positioned between the two die members 136 and 138. In this respect, the clamping mechanism is the same as that shown in FIGS. 1 and 2.

At the other end of the channels 130 and 132 is a mounting block 144. Between the block 144 and upright channels 146 and 148 supported on the side channels 130 and 132, respectively, are cylindrical slides or columns 150 and 152. Slideable on the columns 150 and 152 are three crossheads 154, 156 and 158. The crossheads 154—158 are perhaps best shown in FIG. 6A and carry dies 160, 162 and 164, respectively. As will be explained hereinafter, the dies 160—164, have successively decreasing diameters as was the case with the embodiment of the invention shown in FIGS. 3A—3D.

Referring still to FIG. 6A, the crosshead 154 is connected through piston rods 166 to a first pair of hydraulic cylinders 168 and 170 (FIGS. 4 and 5) mounted at the top and bottom of the mounting block 144. Similarly, the crosshead 156 is connected through piston rods 172 (only one of which is shown in FIGS. 6A—6D) to a second pair of hydraulic cylinders 174 and 176 also mounted on the mounting block 144. Finally, crosshead 158 is connected through piston rods 178 to another pair of cylinders 180 and 182 also mounted on the mounting block 144. Also mounted on the mounting block 144 is a centrally located air cylinder 184 having a piston rod 186 (FIG. 6A) connected to a cup-shaped member 188 adapted to press against the back face of the third crosshead 158.

The operation of the embodiment of FIGS. 4 and 5 can best be understood by reference to FIGS. 6A—6D. In FIG. 6A, a tube T is shown clamped by the clamping mechanism, schematically illustrated at 134; while all of the crossheads 154, 156 and 158 are shown in their retracted positions with the cup-shaped member 188 in abutment with crosshead 158. The air cylinder 184 is usually pressurized at all times, thereby applying a force against all of the crossheads 154—158. However, with all of the crossheads retracted as shown in FIG. 6A, for example, the air cylinder cannot push them to the left, notwithstanding the fact that it is exerting a mild force thereon. The reason for this can best be explained by the hydraulic schematic shown in FIG. 6E. The cylinders 168 and 170 are connected to a pressure supply line 190 through a closed-center valve 192 operated by means of solenoids 194 and 196. With a closed-center valve of this type, and assuming that the valve is in the neutral position shown in FIG. 6E, oil is trapped on either side of the pistons within the cylinders 168 and 170. Hence, the pistons are locked in place as is the crosshead 154. The cylinders 174 and 176, as well as cylinders 180 and 182, are controlled by means of open-center valves 198 controlled by means of solenoids 200 and 202. In this case, the open-center valves 198 interconnect the chambers on opposite sides of the pistons in cylinders 174 and 176 or cylinders 180 and 182. Hence, as long as the valves 198 are in the neutral positions shown, the pistons and piston rods within cylinders 174, 176, 180 and 182 can move more or less freely.

With this in mind, the operation of the system can now be described with reference to FIGS. 6A—6D. As was mentioned above, all of the crossheads 154, 156 and 158 are retracted at the beginning of a pointing operation with a tube T gripped by the clamping mechanism 134 and the air cylinder 184 pressurized to exert a force on all of the crossheads. By virtue of the fact that the cylinders 168 and 170 are controlled by the closed-center valve 192, the crosshead 154 is locked in position and restrains the crossheads 156 and 158.

A pointing operating begins by actuating valve 192 to pressurized cylinders 168 and 170 and move the crosshead 154 to the left as viewed in FIG. 6B, thereby forcing the die 160 over the end of the tube. This elongates the tube slightly and decreases its diameter, as was the case in FIGS. 3A—3D. By virtue of the fact that the cylinder 184 is pressurized, the cup-shaped member 188 urges the crossheads 156 and 158 to the left also and into engagement with the end of the point being formed. That is, the die 162 on crosshead 156 engages the end of the tube and restrains it from moving offcenter by virtue of the more or less gentle pressure exerted by the air cylinder 184.

After the crosshead 154 is moved to the left as viewed in FIG. 6B, the cylinders 174 and 176 are pressurized, thereby forcing crosshead 156 and its die 162 over the end of the tube T. At the same time, the cup-shaped member 188 and air cylinder 184 exert sufficient pressure on the crosshead 158 to cause its die 164 to again engage the end of the point and restrain it from moving offcenter. Finally, and as shown in FIG. 6D, the cylinders 180 and 182 are pressurized to force the crosshead 158 to the left whereby its die 164 is forced over the end of the point. The cup-shaped member 188 now receives the end of the point and, again, by virtue of the pressure exerted by the air cylinder 184, restrains the end of the point from moving offcenter. Following this, cylinders 168 and 170 are pressurized in the opposite direction to withdraw the dies from the end of the formed tube. This forces crossheads 156 and 158 backwardly also with the oil returning to a reservoir through open-center valves 198; while at the same time the cup-shaped member 188 and piston within air cylinder 184 are forced backwardly by virtue of the higher pressure exerted by the hydraulic cylinders. When the crossheads are all back in their retracted positions shown in FIG. 6A, the crosshead 154 locks them in position, even though pressure is exerted by the air cylinder 184, by virtue of the closed-center valve 192 as explained above. In the embodiment of FIGS. 4, 5 and 6A—6E, therefore, the end of the point is at all times restrained in order that it cannot curve or bow during the extrusion process.

In FIGS. 7, 8 and 9, another embodiment of the invention is shown which does not employ multiple, concentric dies, but does employ an air cylinder for the purpose of preventing bowing in the extruded point. It again includes side members or channels 204 and 206 which support, at one end, a clamping mechanism 208 and at the other end a mounting block

210. Secured to the side members **204** and **206** are upright angles **212**; and extending between the angles **212** and the mounting block **210** are columns or cylindrical guide rods **214** and **216** which carry, for reciprocating movement, a crosshead **218**. The crosshead **218**, in turn, is connected through piston rods **220** and **222** to a pair of hydraulic cylinders **224** and **226**, respectively. Intermediate the cylinders **224** and **226** is an air cylinder **228** connected through piston rod **230** to a cup-shaped member **232**, similar to the cup-shaped member **188** in the embodiment of FIGS. **4**, **5** and **6A—6E**.

Mounted on the crosshead **218** is a rotary head or die holder **234**. The die holder **234** rotates about a central pin **236** which is threaded into the crosshead **218**. Circumferentially spaced around the die holder **234** are slots **238**, each slot **238** having a semicircular seat **240** to receive a die **244**. The dies **244**, in turn, are held within the slots **238** by means of springloaded balls **242** which permit the circular dies to pass into their slots but keep them from falling out under the force of gravity. The rotary die holder **234** may be provided with a handle **245** adapted to slidably fit into bores **246** spaced around the periphery of the die holder **234**.

With the arrangement of FIGS. **7** and **8**, the centerline of a tube being pointed is concentric with the uppermost die shown in FIG. **8**. That is, it lies in the same horizontal plane with the axes of the columns **216**. The operation of the pointer is similar to that described in connection with FIGS. **6A—6E** in that the cup-shaped member **232**, under the force of air cylinder **228**, prevents the end of the point from curving off-center. However, the embodiment of the invention shown in FIGS. **7** and **8** does not employ concentric dies. Rather, a die is rotated into the uppermost position on the rotary head **234**; that die is forced over the end of the tube; the die is retracted; and then the rotary head is rotated to the next, smaller die where the pointing operation can be repeated. This type of pointer is particularly adapted for use in applications where only small reductions in the point need be taken as, for example, points used for a bull block operation.

To accommodate tubes of different diameters, the clamping mechanism **208** is provided with a pair of octagonal inserts **250** and **252** which fit into stationary and reciprocable clamp holding members **254** and **256**, respectively, provided with seats which receive the inserts **250** and **252** (FIG. **9**). Each of the faces of the octagonal inserts **250** and **252** is provided with a semicylindrical channel **262** which, when mated with the corresponding channel in the other insert, forms a cavity **264** for reception of a tube to be clamped. By removing the inserts **250** and **252** and rotating them, it will be readily appreciated that tubes of various diameters can be accommodated by the clamp.

Although the invention has been shown in connection with certain specific embodiments, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

We claim:

1. In apparatus for forming a point on the end of a long slender workpiece, the combination of means for clamping the workpiece in place at a fixed location, a crosshead reciprocable toward and away from an end of said workpiece, a die carried on said crosshead and adapted to be forced over the end of the workpiece to produce a point of reduced cross-sectional

area when said crosshead is forced toward the workpiece, a member having a generally conical surface which engages an edge of the end surface of said workpiece as said die is forced thereover to prevent said end from bowing from the longitudinal axis of the workpiece, said member being reciprocable along said axis, and means for yieldingly urging said member toward said crosshead whereby the member will move forwardly with said crosshead as the die is forced over said workpiece until the end of the workpiece engages said generally conical surface, whereupon further forward movement of said member with the crosshead is terminated and the pointed end of the workpiece is prevented from bowing by engagement with said generally conical surface.

2. The apparatus of claim **1** wherein said means for yieldingly urging said member toward said crosshead comprises fluid cylinder means having a piston rod coaxial with said axis of the workpiece, said member being carried on the end of said piston rod and said conical surface being on the side of said member opposite the piston rod, and means for pressurizing said fluid cylinder to yieldingly urge said member toward said crosshead, the pressure exerted by said fluid cylinder being such that forward movement of the member with the crosshead will stop when the generally conical surface on the member engages said end surface of the workpiece.

3. The apparatus of claim **1** wherein said means for clamping the workpiece in place comprises a first cradle, a second cradle movable toward and away from the first cradle, clamping members carried in the cradles, each of the clamping members having a plurality of sides, and semicircular channels of different diameters formed in said dies and extending parallel to the axis of an article to be clamped, each channel in one member being of the same diameter as a corresponding channel in the other member whereby the members can be rotated to place the same sized channels in juxtaposition for reception of a workpiece to be clamped.

4. The apparatus of claim **1** including a plurality of crossheads each of which carries an associated die, the dies on successive crossheads being of successively smaller diameters and coaxial with the axis of said workpiece, means for forcing the crosshead carrying the die of largest diameter along the axis of said workpiece whereby the die of largest diameter will pass over the end of said workpiece, means for forcing at least a second crosshead carrying a die of smaller diameter along the axis of said workpiece whereby said die of smaller diameter will pass over the reduced cross-sectional area formed by said largest diameter die while the first-mentioned die remains on the workpiece, said generally conical surface on said member engaging said end surface of the workpiece after said die of smaller diameter has passed thereover.

5. The apparatus of claim **1** including hydraulic cylinder means for forcing said crosshead and the die carried thereby toward said workpiece, and wherein said means for yieldingly urging said member toward said crosshead comprises a pneumatic cylinder which exerts a force less than the force exerted by said hydraulic cylinder means.

6. The apparatus of claim **1** wherein said crosshead carries a plurality of dies of successively smaller diameters, and means on said crosshead for moving successive ones of said dies into alignment with the axis of said workpiece.