July 18, 1950 C. J. STUART 2,515,841

TUBE CLOSING APPARATUS

Filed Dec. 16, 1943 3 Sheets-Sheet 1

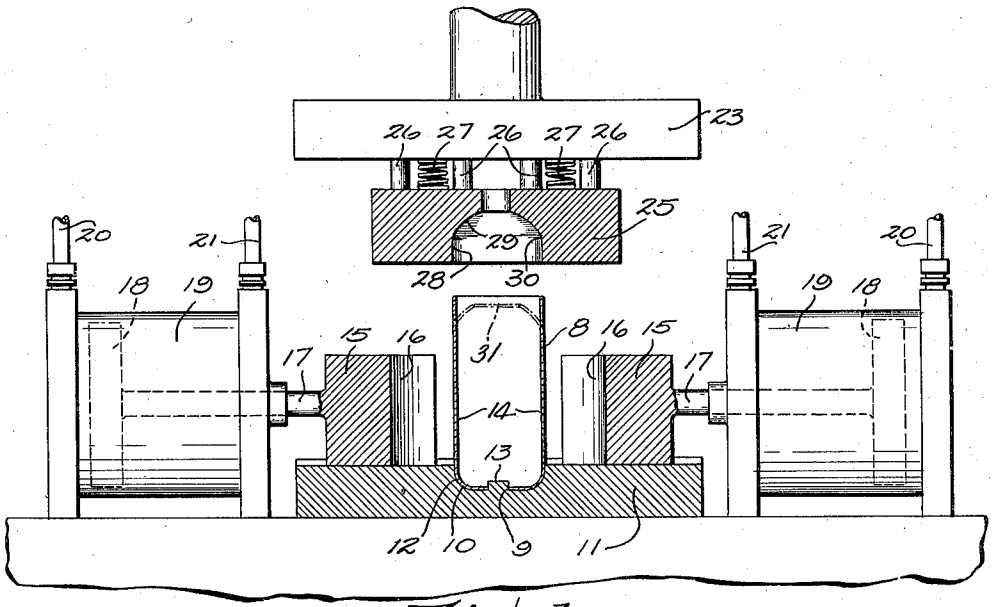


Fig. 1.

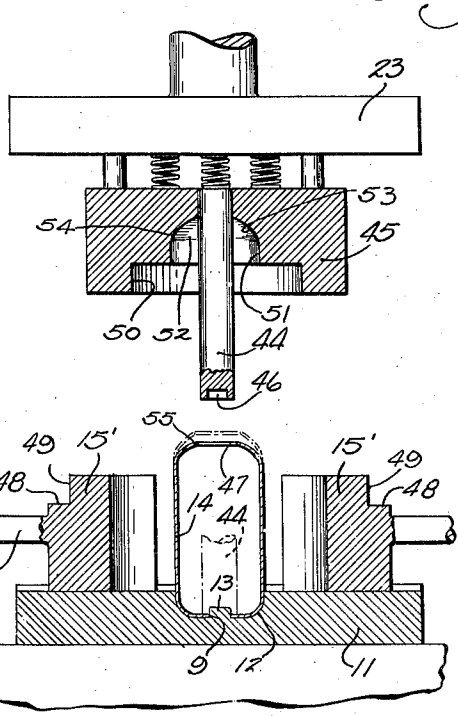


Fig. 2.

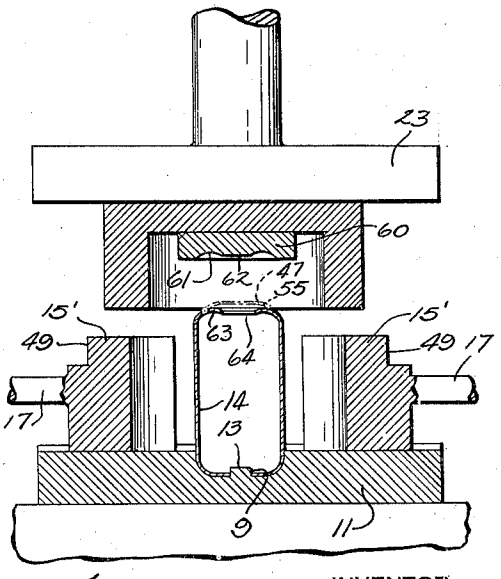


Fig. 3.

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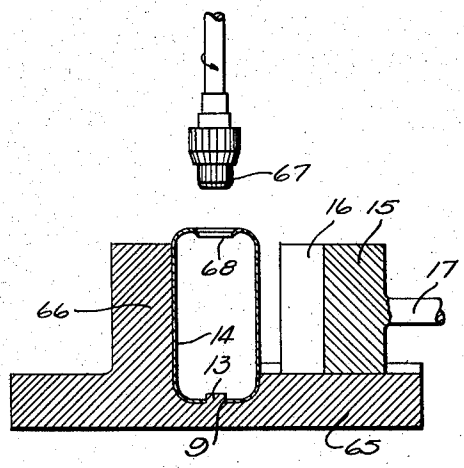
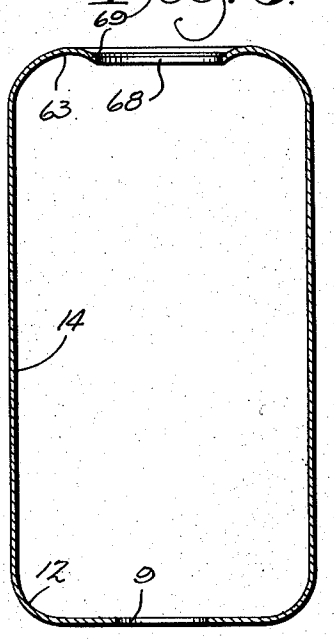


Fig. 4.

Fig. 5.



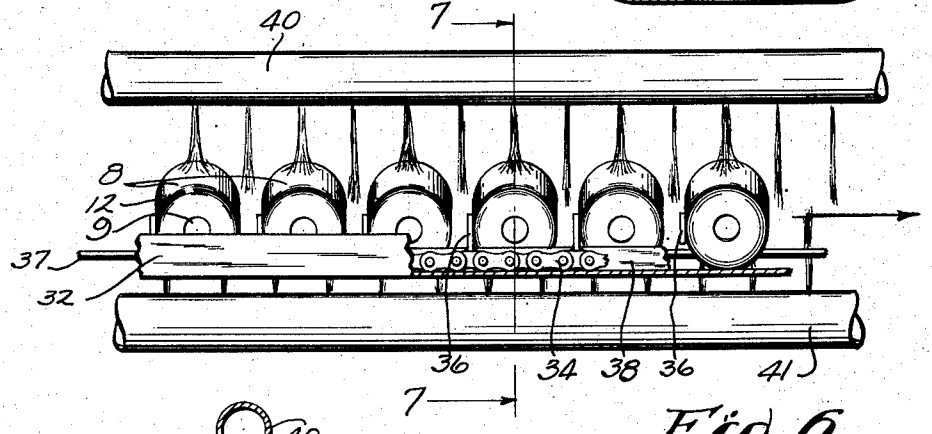


Fig. 6.

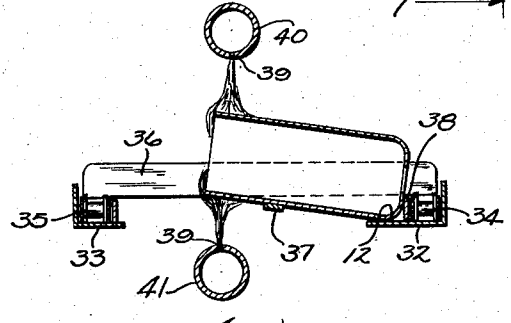


Fig. 7.

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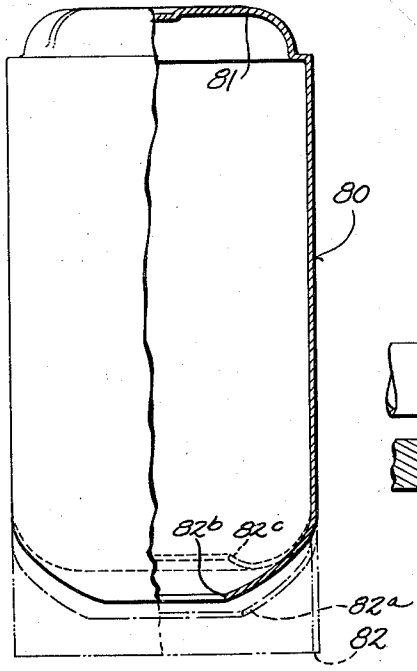


Fig. 8.

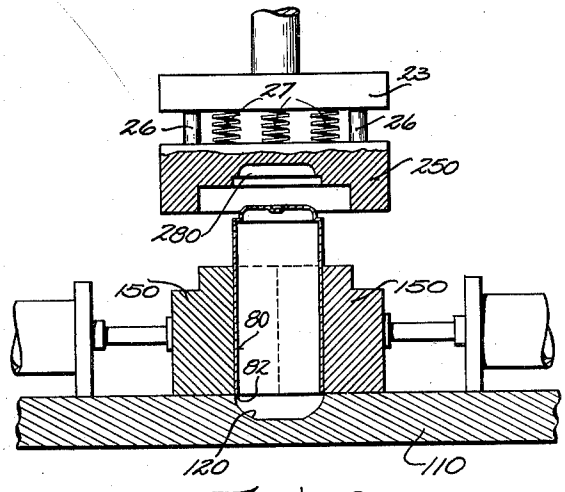


Fig. 9.

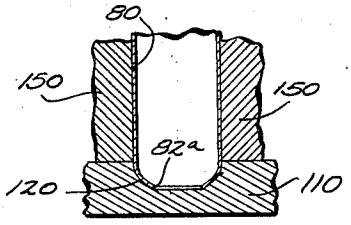


Fig. 10.

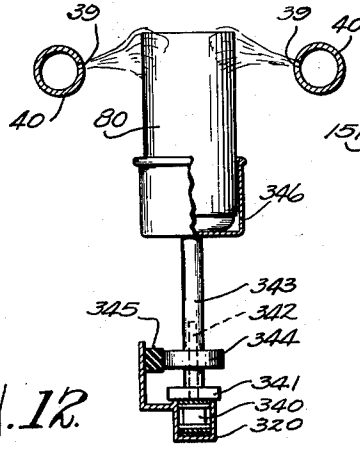


Fig. 12.

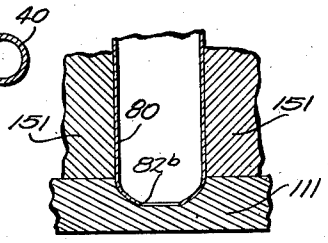


Fig. 11.

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TUBE CLOSING APPARATUS

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Application December 16, 1943, Serial No. 514,561

5 Claims. (Cl. 113—49)

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This invention relates to improvements in tube closing apparatus.

It is the primary object of the invention to provide means for achieving at least partial closing of the end of a casing which is already partially or completely closed at its opposite end, so that it is not feasible to have any supporting mandrel within the casing to assist in the formation of the end closure. It is important to the objectives of the present invention that the finished work present a smooth surface and uniform wall thickness without irregularities or wrinkles despite the fact that it is desirable that the pressing operations thereon be performed at atmospheric temperatures.

More specifically, the invention proposes the partial closing of the end of a tubular casing in a series of steps involving solely cold axial pressure, portions of the work acted upon in the successive operations being annealed between operations. By means of the invention I am able to achieve at low cost an excellence of quality heretofore deemed impossible to obtain in a press method.

Other objects will be apparent to those skilled in the art upon analysis of the following disclosure of my invention.

In the drawings:

Figure 1 is a diagrammatic view, showing partially in side elevation and partially in section an organization for performing the first operation of my tube closing method.

Figure 2 is a fragmentary view similar to Figure 1, showing the apparatus used to perform a second press operation.

Figure 3 is a view similar to Figure 1 and Figure 2, showing apparatus used to perform a third press operation.

Figure 4 is a view similar to Figure 1, showing fragmentarily apparatus used to perform a finishing operation.

Figure 5 is an enlarged detail view, in section, of the completed casing or container.

Figure 6 is a fragmentary view, partially in side elevation and partially in vertical section, showing apparatus used for annealing intermediate the press operations.

Figure 7 is a view of annealing apparatus as it appears in section, taken on line 7—7 of Figure 6.

Figure 8 is a view partially in side elevation and partially in section, showing a modified and preferred embodiment of the product, with dotted lines illustrating successive positions of the formed end portion.

Figure 9 is a view similar to Figure 1, showing

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a modified apparatus which may be used for closing the end of the casing shown in Figure 8.

Figure 10 is a fragmentary detail showing the work and the first forming die at the conclusion of the first forming operation.

Figure 11 is a view similar to Figure 10, fragmentarily illustrating the work and the second forming die upon the conclusion of the second forming operation.

Figure 12 is a view partially in side elevation and partially in transverse section, showing a modified form of annealing apparatus.

Like parts are identified by the same reference characters throughout the several views.

At the commencement of the operations hereinafter to be described, the work piece comprises a deep drawn can of the form shown in full lines in Figure 1 at 8. The can or casing 8 may have a completely closed end, as at 80 in Figure 8, but the particular work piece here involved happens to have an opening at 9 in the bottom which is convexly rounded at 10 where it joins the side wall.

The base plate 11 on the press bed has a recess at 12 into which the bottom end portion of the container 8 fits accurately. A stud 13 projecting upwardly from the base plate at the center of the recess 12 enters the aperture 9 in the work piece to provide additional positioning and support.

The side wall 14 of the work piece is fully enclosed during the press operation to be described. Blocks 15, slidable to and from each other laterally, are concavely recessed at 16 to fit about the tubular wall 14 of the work piece so that, when so engaged, it cannot yield in any direction. The blocks 15 are illustrated in Figure 1 in a retracted position. They are advanced and retracted by fluid pressure, being supplied with arms 17 carrying the pistons 18 which are illustrated in dotted lines within cylinders 19 with which pipes 20 and 21 communicate for actuating the pistons and the respective blocks selectively toward their advanced or their retracted positions subject to the control of conventional valves (not shown). Either hydraulic or pneumatic pressure may be used. In either case, engagement and release of the successive work pieces are virtually instantaneous.

Mounted on the press head 23 is a swaging die 25. The mount actually used is resilient, the die being guided by pins 26 for limited movement against the compression of springs 27. This, however, is not essential to the result. The die has a cavity just sufficiently large to receive the

tubular end of the work piece. The wall portion 28 of the cavity is substantially cylindrical. The wall portion 29 of the cavity is substantially spherical. The change in form is relatively abrupt at the line designated by reference character 30.

The work piece, which may have been hardened by its preliminary fabrication, is preferably annealed as hereinafter described, before being pressed.

The work piece being tightly engaged between the blocks 15, the press head 23 descends and the die 25 first receives and then engages the tubular end of the work piece. As the end margin of the work piece, supported within the cylindrical wall surface 28, is contracted by the spherically rounded wall surface 29 with an inward camming action, the work piece is swaged inwardly to the form indicated by dotted lines at 31.

The steel wall of the work piece has been caused by this first operation to greatly reduce its diameter at its upper end. Yet the work piece is so completely supported that there is no possibility of its buckling. Instead, the metal at the upper end of the wall is caused to flow to its new form despite the fact that the operation is or may be performed at atmospheric temperatures. The result is the production of a dome-like partial end closure with a central opening toward which the wall thickness has increased by the flow of the excess metal accruing from the reduction in diameter.

The forming operation hardens the wall portion of the work piece upon which the die acts. In practice the work piece has been made of steel, but the same hardening effect would be observed if the wall were of any other metals. Accordingly, before performing any further operation upon the swaged wall, I prefer that the wall be annealed. This may conveniently be done by the apparatus shown in Figures 6 and 7.

In the annealing apparatus, the work is preferably rolled by means of a conveyor through a heating zone in which it receives heat from both sides. Angle irons 32 and 33 provide a bed for conveyor chains 34 and 35, such chains being connected by spacer bars 36.

The bottom flange of the angle iron 32 provides a track upon which the convexly rounded portions 12 of the work pieces 8 may roll. Another track is provided at 37 beneath intermediate portions of the work piece walls, leaving the end portions of such walls exposed for the annealing operation. A guide 38 extending longitudinally of the conveyor track 32 is abutted by the partially closed end of the work piece, whereby the work pieces are kept in line. The inclination of the work pieces provides a convenient means of holding them by gravity against the guide 38 to accurately present their hardened wall surfaces to the annealing flames directed toward them by means of the orifices 39 in upper and lower pipes 40 and 41 through which jets of fuel, such as gas, duly ignited, are directed toward the work pieces as the latter are propelled between the pipes by the conveyor bars 36.

As the work pieces move between the upper and lower sets of flames they are rotated so that all portions of the hardened wall surfaces become heated. In practice I have found that the temperature to which they are heated is not particularly critical. With the metal I have used a temperature of 1100 or 1200 degrees F. is suitable.

The upper and lower flames may be offset slightly as indicated in Figure 7 to accommodate the slight offset between the upper and lower portions of the inclined work piece.

When the work piece has been suitably annealed it is placed upon the same or a similar bed plate 11, engaged between clamping blocks 15', and acted upon by another die as shown in Figure 2. This die is mounted on the same or a similar press plate 23 and preferably has a pilot bar 44 mounted centrally in the die 45. A socket 46 in the end of the pilot bar is arranged to engage a boss 13 on the bed plate 11. The end of the pilot bar, in the lowest position of the die, contacts the bottom of the work piece to hold the bottom flat. An upper portion of the bar serves as a limiting stop to define the minimum diameter to which the opening 47 in the work piece may be reduced during the continued closing of the upper end of the receptacle.

It will be noted that the confining and supporting blocks 15' are shouldered at 48, thereby being provided with a generally cylindrical surface at 49. The die 45 is counterbored to provide a complementary female cylindrical surface at 50. When the blocks 15' are closed upon the work piece and the die 45 descends, the female surface 50 will engage about the semi-circular portions 49 of the respective blocks 15' to hold such blocks securely against separation during the action of the die. This interlock between the die and the supporting blocks 15' is not essential but is desirable in any stage of the operation in which, as in that here illustrated, the axial pressure developed on the work piece is relatively high.

As in the case of the die 25 shown in Figure 1, die 45 is provided at 51 with a surface which confines the upper end of the work piece without exerting any reducing pressure thereon. Beyond the shoulder 52 the upper end of the socket of the die is convex, as shown at 53, but in this particular operation the principal work done by the die is effected by the annular portion 54 thereof, which, acting on the inwardly formed and partially completed end wall 31, close to the maximum diameter of the convex portion, forces the entire end wall inwardly from the dotted line position shown in Figure 2 to the full line position assumed by such end wall at 55. The remaining opening 47 will normally be substantially the diameter of the bar 44 carried by the die. Any excess of material in the work piece will engage the bar and be turned inwardly to preclude the reduction of opening 47 below the desired predetermined cross section.

The work piece is now subjected to a third forming operation, represented in Figure 3. The work may again be annealed, but annealing has been found to be unnecessary for this operation. Supported on the same or a similar base 11 the work piece is confined by supporting blocks 15' which are the same as, or similar to, those shown in Figure 2, preferably having means whereby the descending die will be interlocked therewith in the same manner above described.

The die 60 which now acts on the work piece has a quite radically different form from any die used thus far. It does not include any means engaged about the upper end of the work piece to provide support therefor. It merely comprises a block in which there is an annular concave recess at 61 about an intermediate boss 62 which is the approximate size of the opening 47. When the die 60 engages the work piece the upper

end portion 55 thereof extends convexly upwardly from all sides of the work piece. After the die 60 has acted thereon the end wall 63 extends convexly upwardly from all sides but is then turned convexly downwardly and inwardly so that the opening 64 lies at a materially lower level than the opening 47 left by the preceding operation, and is below the highest portions of the convex end wall 63 of the receptacle.

In the apparatus shown in Figure 4 the receptacle is completed for the particular purposes now in mind (a hand grenade casing) by mounting it in a fixture which includes a base plate 65 having a semi-tubular supporting wall 66 against which the work piece 14 is seated. The boss 13 engaged in the central opening 9 in the bottom of the work piece is like that previously used. A single sliding block 15 with a concave work engaging surface at 16 is movable to and from engagement with the work piece for the clamping and release thereof. With the work piece clamped in this fixture a reamer or the like 67 is used to machine the margin of the upper wall of the receptacle 14 at 68 about the opening therein and to provide an annular shoulder at 69. The completed work piece is illustrated in Figure 5.

The work piece 80 shown in Figure 7 is entirely closed at its end 81. The particular form of the end 81 as illustrated in Figure 8 constitutes no part of the present invention.

The general organization of the dies whereby the initially open end of the work piece 80 is at least partly closed is similar to that already described, but the work piece is inverted, the base plate 110 constituting a die having a cavity at 120, the wall of which performs the closing operation.

The sliding blocks 150 correspond generally to the blocks 15 of the apparatus previously disclosed, but instead of holding the work stationary, these blocks constitute, in effect, retractible portions of the die in which the work is formed, the work piece being movable downwardly between the blocks in the course of the forming operation. The plate 250 carried by guide pins 26 and spring 27 from the punch plate 23 is similar in its mounting and operation to the die 25 of the apparatus previously disclosed, but, its cavity 280 is merely fitted to the closed end of the work piece and consequently does not act as a die in this apparatus.

When the work piece is held between the advanced guide blocks 150, its cylindrical free marginal portion 82 will be approximately at the top of the die plate 110, as shown in Figure 9. When the punch descends it will force the work piece downwardly between the guide blocks 150 into the recess 120, with the result that the free margin 82 of the work piece will be forced to the position indicated in dotted lines at 82*a* in Figure 8 and Figure 10.

In the second swaging operation a further closing of the end of the work piece will be effected in the die 111, as indicated in Figure 11, leaving the free margin as shown at 82*b* in Figures 8 and 11.

The final operation by which the margin of the work piece will be forced to the position 82*c* may be identical with that shown in Figure 3, and consequently is not illustrated.

It will, of course, be understood that before the first operation and the second operation the work will preferably be annealed. An alternative form of annealing apparatus which is preferred

in practice is shown in Figure 12. The conveyor chain 340 moves in a guide channel 320 and propels along the upper surface of the channel blocks 341, which are placed at suitable intervals and support pins 342, on which spindles 343 are rotatably mounted. Each such spindle has a friction roller at 344, conveniently made of rubber or the like, and arranged to bear frictionally on a stationary friction bar 345 disposed along the path of travel of the conveyor.

Each of the spindles 343 carries a cup at 346 in which the work piece 80 is disposed in the path of flame jets issuing from the burner openings 39 in the fuel supply pipes 40.

It will, of course, be understood that the various types of dies are interchangeable, as are the annealing devices.

The operation involved in the production of the finished work piece are not in any sense spinning operations, since the pressure is, in every instance, axially developed. Preferably, all of the pressing or forming operations are performed at atmospheric temperature, or, at least at such temperature that the work piece can conveniently be handled. The concave surfaces of the respective dies, upon which the pressing or forming actually depends, act abruptly in each instance and uniformly form all sides of the work piece simultaneously without spinning or preliminary heating except for such residual heat as may be left in the work piece following one of the annealing operations which intervenes between successive pressing operations. In referring to the press operations as being performed "cold," I do not mean to imply that residual heat is necessarily or even preferably absent. I simply mean that since perfect results may be achieved with the work entirely cold, heat is not only unnecessary but plays no important part in the process. It is usually not used because it makes handling more difficult.

The resulting product, even when made of steel, is exceptionally smoothly finished, with no flaws or wrinkles, and has surprising uniformity throughout. As applied to a hand grenade casing, this last fact is of importance because it has been found that hand grenades employing casings made in accordance with the present invention fragmentate into pieces of surprisingly uniform size, this being a very desirable characteristic.

I claim:

1. Apparatus for closing the open end of a tube and comprising in combination a support for the tube having socket means in which the tube is laterally confined, a press member and a platen member for engagement with the ends of the tube, one of said members comprising a die having a concave portion axially engaging the open tube end as said members approach each other, whereby the open end is reduced in cross section while the side of the tube is supported by said confining means, in further combination with work confining and supporting block means comprising separable parts mounted on said support and having cooperating recesses adapted to receive and substantially completely envelop the work below said die, at least one of said blocks being movable transversely respecting the support for work admission and release, the die and at least the laterally movable block having means interlocking in the advance of the die to restrain the block against lateral movement from the work.

2. Apparatus for closing the open end of a tube and comprising in combination a support for the

tube having socket means in which the tube is laterally confined, a press member and a platen member for engagement with the ends of the tube, one of said members comprising a die having a concave portion axially engaging the open tube end as said members approach each other, whereby the open end is reduced in cross section while the side of the tube is supported by said confining means, in further combination with work confining and supporting block means comprising separable parts mounted on said support and having cooperating recesses adapted to receive and substantially completely envelop the work below said die, at least one of said blocks being movable transversely respecting the support for work admission and release, the said blocks each being shouldered to provide male interlock surfaces, and the die having female interlock surfaces engageable with the said surfaces of both of said blocks in the advance of the die, whereby said die locks said blocks and secures the movable block against lateral movement when the die is advanced.

3. In a device of the character described adapted to act upon a generally cylindrical tube having an open margin for the reduction of such margin and at least a partial closing of the tube, the combination with a press member, of a pair of blocks having companion recesses, together adapted to constitute complete lateral enclosure for portions of said tube, at least one of said blocks being laterally movable respecting the press member for admission and discharge of tubes from confining engagement between said blocks, and a second press member movable toward the first press member and comprising a cylindrically walled recess portion adapted telescopically to receive wall portions of the tube adjacent said open margin, said recess portion of the die being adapted to cooperate with said blocks to substantially complete the external support of the tube wall, and means at the end of the aforesaid recess portion of the die comprising an inwardly and axially inclined cam surface for engagement substantially uniformly with all marginal portions of the tube in a direction to reduce such portions inwardly while providing external support therefor to force such portions to assume convex form.

4. In a device of the character described, adapted to act upon a generally cylindrical tube having an open margin for the reduction of such margin for at least a partial closing of the tube, the combination with first and second press members mounted for relative movement to and from each other, of a pair of blocks having companion recesses, together adapted to constitute complete lateral enclosure for portions of said tube, at least one of said blocks being laterally movable respecting the other for admission and discharge of tubes from confining engagement between said blocks, said second press member comprising a cylindrically walled recess portion adapted telescopically to receive wall portions of the tube adjacent said open margin, said recess portion being adapted to cooperate with said blocks to provide external

support for the tube wall, and means at the end of the aforesaid recess portion of the second member comprising an inwardly inclined cam surface for engagement substantially uniformly with said open marginal portions of the tube in a direction to reduce such portions inwardly while providing external support therefor to force such portions to assume convex form, together with a pilot bar projecting axially from said die into the interior of said tube, and constituting means for limiting the reduction of such margin.

5. In a device of the character described, adapted to act upon a generally cylindrical tube having an open upper margin for the reduction of such margin and at least a partial closing of the tube, the combination with a tube supporting base, of a pair of blocks having companion recesses, together adapted to constitute complete lateral enclosure for portions of said tube, at least one of said blocks being laterally movable respecting the base for admission and discharge of tubes from confining engagement between said blocks, and a die movable toward the base and comprising a cylindrically walled recess portion adapted telescopically to receive wall portions of the tube adjacent said open margin, said recess portion of the die being adapted to cooperate with said blocks to substantially complete the external support of the tube wall, and means at the upper end of the aforesaid recess portion of the die comprising an inwardly and upwardly inclined cam surface for engagement substantially uniformly with all marginal portions of the tube in a direction to reduce such portions inwardly while providing external support therefor to force such portions to assume convex form, together with a pilot bar projecting axially from said die into the margin of said tube and constituting means for limiting the reduction of such margin, the support having a boss and the pilot die and registering socket engageable therewith in the most advanced position of the die.

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