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3,266,822

METAL FORMING PROCESS FOR SHAPING ENDS OF TUBES
AND THE PRODUCT THEREOF

Original Filed Aug. 21, 1961

2 Sheets-Sheet 1

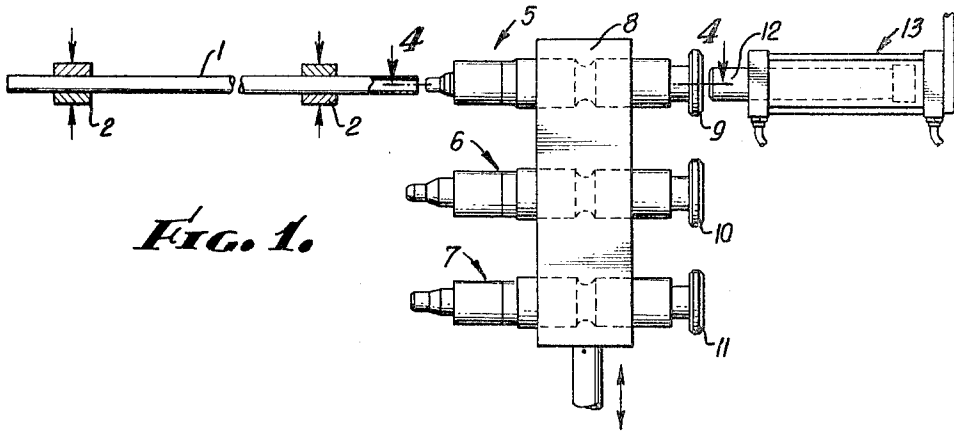


FIG. 1.

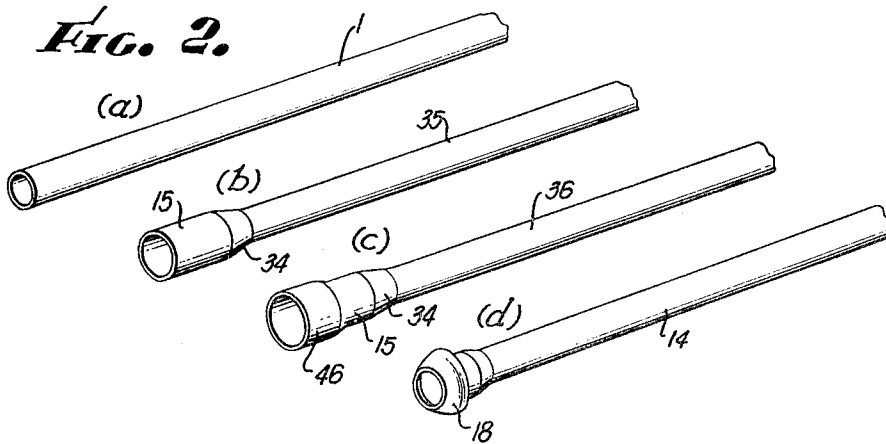
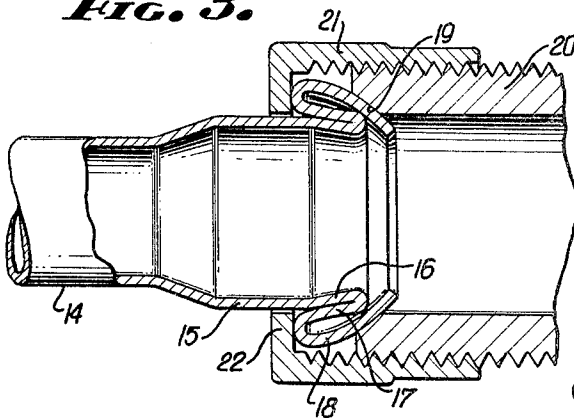


FIG. 3.



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FIG. 4.

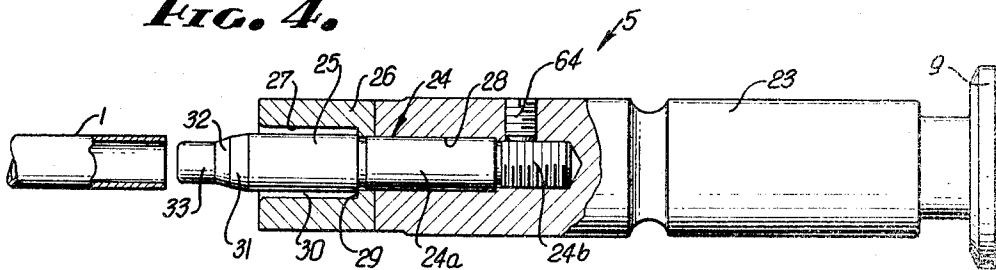


FIG. 5.

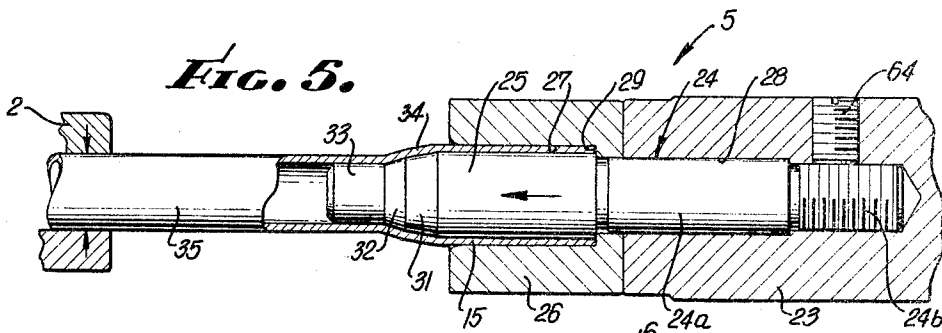


FIG. 6.

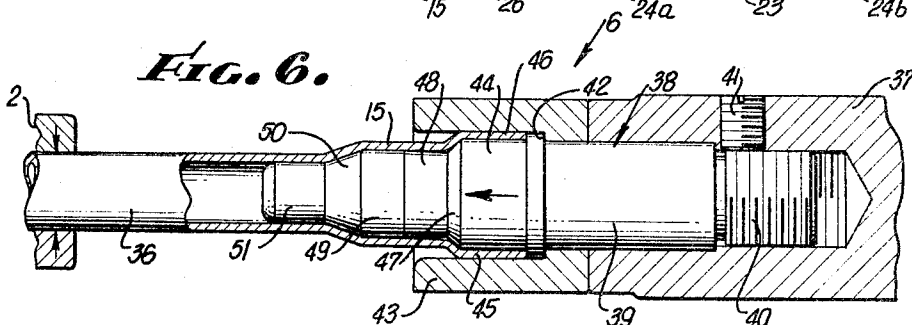


FIG. 7.

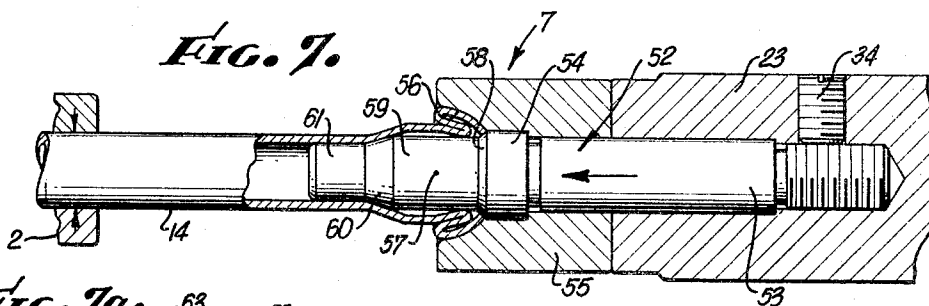


FIG. 7a.

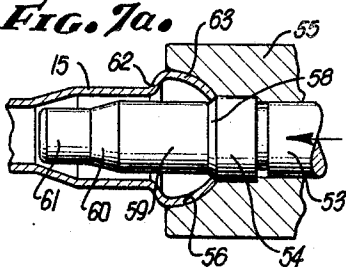
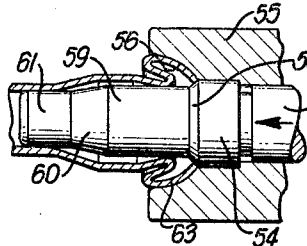


FIG. 7b.



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METAL FORMING PROCESS FOR SHAPING ENDS OF TUBES AND THE PRODUCT THEREOF

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Original application Aug. 21, 1961, Ser. No. 132,868. Divided and this application Mar. 15, 1965, Ser. No. 447,935

1 Claim. (Cl. 285—110)

This is a division of application Serial No. 132,868, filed August 21, 1961, now Patent No. 3,225,581.

This invention relates to metal forming, and particularly to the forming of the ends of tubes to provide an inherently reinforced enlarged head or flange for the tube.

Such metal forming may be applied, as in one example, to copper tubing or brass tubing or the like, to provide a curved flange at one end; the flange is used for attaching the tube to a fitting, such as the inlet side of a faucet. The tube may be coupled to the inlet, as for a wash basin faucet, to connect the faucet to a shut-off valve located below the basin.

It has been common practice to provide a separate reinforcing ring about the enlarged end of the tube, so as to make it possible to strongly urge the tube end into firm contact with the coupling. Such fabrication of the tube is expensive, involved operations being necessary.

It is one of the objects of this invention to make it possible to join the tube end so as to provide reinforcement at the end, and this is accomplished without the addition of reinforcing rings.

It is another object of the invention to make it possible to supply, at little cost, a tubular plumber's fitting made of an integral tube and providing a reinforced head.

In order to accomplish these results, a series of forming tools or punches is used, operating in succession to provide an enlargement at the end of the tube, and then reversely to bend the edge of the enlargement to form three layers of metal around the end of the tube.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming a part of the present specification, and which drawings, unless described as diagrammatic, or unless as otherwise indicated, are true scale. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claim.

Referring to the drawings:

FIGURE 1 is a diagrammatic elevation of a press incorporating the invention;

FIG. 2 is a pictorial view, showing the stages of folding the end of the tube;

FIG. 3 is an enlarged sectional view, showing three manner in which the tube may be attached to a fitting;

FIG. 4 is a view, mainly in section, illustrating the means for accomplishing the first step in the process of forming the tube, the blank and the punch structure being shown ready for the punching operation;

FIG. 5 is a view similar to FIG. 4, but illustrating the completion of the first step, and enlarged;

FIG. 6 is a view similar to FIG. 5, but illustrating the completion of the second step in which there is a further enlargement formed at the end of the tube;

FIG. 7 is a view similar to FIG. 4, illustrating the completion of the third or last step; and

FIGS. 7a and 7b are views similar to FIG. 7 illustrating intermediate positions of the punches.

A tube blank 1 (FIGS. 1, 2(a), and 4) is adapted to

be releasably clamped by the clamping structures 2. This blank is normally made of quite malleable metal such as copper, to ensure that the vending operations will not injure the tube walls.

The blank 1 is a straight tube of uniform diameter, adapted to be supplied to the clamps 2 in any conventional manner. The blank is operated upon in succession by three punch structures 5, 6, and 7. These punch structures are supported in the present instance in vertical arrangement, upon a common support 8. This support is vertically moveable so as to align the punch structures 5, 6, and 7, in succession with the axis of blank 1.

Each of the punch structures at its right-hand end is provided with a disc-like abutment 9, 10, or 11; and is, furthermore, longitudinally movable in the support 8.

In the position shown in FIG. 1, the blank 1 is in alignment with the first punch structure 5. This structure 5 may be urged toward the left by a piston 12. This piston 12 can be hydraulically operated by the aid of the cylinder structure 13.

The first operation effected by the aid of punch structure 5 results in an intermediate stage *b* illustrated by reference character 35 in FIG. 2. This stage now includes an enlarged end 15, joined to the main body of tube 35 by the tapered shoulder 34. The second stage *c* is illustrated by reference character 36 in FIG. 2. In this stage, a further enlargement 46 is formed at the end of the tube. Finally, the last stage *d* corresponding to the completion of the operation by punch structure 7 is illustrated by tube 14 in FIG. 2. Here the end is reversely bent to define a spherical zone surface on the exterior.

The punch structures 5, 6, and 7 produce the finished product, shown enlarged in FIG. 3. Here, the completed tube 14 is shown with its enlarged portion 15. Folded around this enlarged portion are two layers of material formed integrally with the tube 14 and around the outer periphery, forming with the tube three layers in all. These layers 16, 17, and 18 are quite closely folded, the outer two forming a reinforced collar around the exterior of the enlarged part 15.

Furthermore, external layer 18 is curved, preferably as a spherical zone, which fits a spherical seat 19 of fitting 20. This fitting 20 may correspond to the inlet for a valve or the like.

The spherical surface formed on the external layer 18 is urged into place by the aid of a conventional nut 21 having an inwardly directed flange 22. This flange engages the loop form between the layers 17 and 18, and urges the tube 14 tightly against the seat 19.

The first punch structure 5 is adapted to form the enlargement 15 (FIGS. 2, 3, and 5) by expanding the end of the blank 1.

The punch structure 5 as shown in FIGS. 4, and 5, includes the punch holder 23 of generally cylindrical form and integrally formed with the disc 9. The punch structure carries the punch proper 24, as by the aid of a threaded extremity 24b formed on the shank 24a of the punch 24. The punch 24 furthermore has an operating cylindrical portion 25 which is adapted to enter into the blank 1 so as to expand the end of the blank 1. This operating portion 25 is of slightly larger diameter than the shank 24a, and it is surrounded at a slight distance therefrom by the cylindrical walls 27 of a circular recess in the external end of the sleeve member 26. This recess communicates with an adjacent concentric recess of smaller diameter in the opposite end of the sleeve member, this smaller diameter being substantially the same as that of the aperture 28 which fits the shank 24a. This construction permits the sleeve member 26 to be attached to the shank between the punch holder 23 and the end of the tube. The punch proper 25 thus can seat against the

shoulder 29 formed between the aperture 28 and the cylindrical surface 27.

The outer diameter of the punch proper 25 and the diameter of the cylindrical surface 27 together define an annular space 30 for the reception of the expanded end 15 of the tube.

Extending from the punch proper 25 is a conical or tapered portion 31. When this tapered portion enters the end of blank 1, the expansion begins. A somewhat narrower tapered portion 32 extends to the left of the portion 31 and terminates in a cylindrical piloting end 33. Furthermore, a set screw 61 serves to hold the punch 24 securely in place in the holder 23.

When the punch structure 5 is in alignment with the blank 1, as illustrated in FIG. 1, the punch structure 5 can be urged toward the left by the aid of the piston 12. When this force is exerted, the piloting end 33 snugly enters the end of the blank 1 and continued pressure applied to the punch structure finally results in the forming of the end of the tube, as illustrated in FIG. 5, to provide the enlarged portion 15, and a tapered portion 34.

The completion of the first operation therefore is illustrated by the tube structure 35 shown in FIG. 2(b).

In order to effect the second operation resulting in the tube structure 36 shown in FIG. 2(c), first the support 8 is moved upwardly so as to align the punch structure 6 with the axis of the tube 35 (FIG. 6). The punch holder 37 serves in the same manner to support a punch 38 having a cylindrical shank 39. This cylindrical shank terminates in an extension 40 threaded into the holder 37 and held securely against removal by set screw 41.

A flange 42 integral with the punch 38 serves to hold the sleeve 43 in place against the left-hand end of the holder 37, the sleeve 43 and the cylindrical portion 44 of the punch 38 defining annular space 45 corresponding to the still further enlarged extremity 46 of the tube 36. A tapered shoulder 47 extends from the left-hand end of the cylindrical portion 44 and joins reversely tapered portion 48. The tapered portion 48 has a taper of one or two degrees, and serves to permit ready removal of the punch after it has completed its operation.

In succession, there are a cylindrical portion 49 corresponding to the diameter of the enlarged portion 15 of the tube 36, a tapered section 50 and a piloting end 51 corresponding to the internal diameter of the tube 36.

When the structure 6 is brought into alignment with the tube 35 and the piston 12, as before, force may be exerted to urge the structure toward the left to produce the configuration of tube 36, shown in FIGS. 2(c) and 6. The annular space between the sleeve 43 and the cylindrical portion 44 corresponds quite closely with the thickness of the tube wall.

After the punch structure 6 is withdrawn, the support 8 is moved one step upwardly to align the punch structure 7 with the tube 36. This punch structure 7, shown in FIG. 7, includes the holder 23 and is held as by the set screw 34 in a firmly fixed position.

The punch proper 52 includes a shank 53 and an enlarged cylindrical portion 54. This cylindrical portion 54 serves to hold the sleeve 55 tightly against the left-hand end of the holder 23. This is accomplished in the same manner as before.

The sleeve 55 defines at its left-hand end a concave spherical surface 56 (see also FIGS. 7a and 7b). This surface is that of a spherical zone having a center 57 on the axis of the finished tube 14. The larger end of the zone corresponds to the left-hand end of the sleeve. It has a diameter corresponding to the outer diameter of the enlarged end 46.

The punch 52 has a narrow tapered shoulder 58. The taper of this shoulder is such that the cone elements defining this taper are centered on the center 57.

The punch 52 has in succession a cylindrical portion 59 which is about the same diameter as the internal diameter of the enlarged portion 15. The punch struc-

ture also includes the tapered shoulder 60 and a piloting end 61.

As the sleeve 55 is urged toward the left, as viewed in FIGS. 7, 7a, and 7b, the enlarged end 46 of tube 36 is bent inwardly to define a spherical member 63, which ultimately forms the outermost layer 18 of FIG. 3. This inward zone is effected by continued contact of the concave zone 56 with the outer periphery of the portion 46.

The conclusion of this part of the folding is illustrated in FIG. 7a. The continued application of the compressive force toward the left exerted by the punch structure 7 causes a fold to develop shown in incipient form by reference character 62 in FIG. 7a. The bending ring 62 is formed at the inner end of the outer enlarged portion 46. Thus the bending ring is formed by the frusto-conical part 47 (FIG. 6). The fold thus begun as indicated in FIG. 7a is compressed as shown in FIG. 7b and ends with a complete fold as shown in FIG. 7. To ensure that the portion 63 will not converge beyond the spherical surface 56, the small end of the zone has a stop defined by the tapered shoulder 58. This tapered shoulder thus prevents further inward movement of the metal and ensures folding to the ultimate form shown in FIGS. 3 and 7.

The inventor claims:

In combination: a plumbing conduit part having at one end an internal tapered seat shaped substantially as a spherical zone; a tubular metal member of unitary construction having a first intermediate annular fold line, said member having a first annularly and substantially cylindrically extending band on one side of said first annular fold line that projects rearwardly in exteriorly encompassing relationship to the tubular member on the other side of said first annular fold line; said tubular member having a second annular fold line at the rearward terminus of said first annularly extending band, said tubular member having a second annularly extending band projecting forwardly in exteriorly encompassing relationship to said first annularly extending band and converging in a forward direction, said second annularly extending band terminating forwardly of said first annular fold line, said first annular fold line lying immediately behind an intermediate portion of said second annularly extending band to reinforce the same, said portion of said second annularly extending band having an outer surface shaped substantially as a spherical zone sealingly fitting said tapered seat of said first exteriorly threaded part; and a clamping part mounted on the said end of said conduit part for axial adjustment thereon and extending in encompassing relationship to said bands, said clamping part having a flange engaging said member at said second annular fold line to exert seating and sealing pressure upon said second annular band with said tapered seat of said conduit part; said metal member having characteristics of rigidity sufficient normally to maintain the said second annularly extending band in exteriorly encompassing relationship with said first annularly extending band as well as said first annularly extending band in exteriorly encompassing relationship to the tubular member on said other side of said first annular fold line.

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