Aug. 2, 1966 G. HINDERER 3,263,476

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

Original Filed Aug. 21, 1961 2 Sheets-Sheet 1

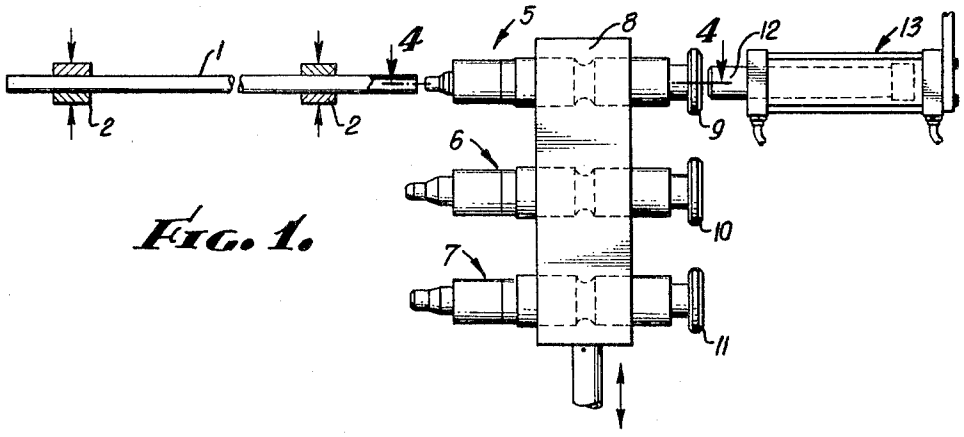


FIG. 1.

FIG. 2.

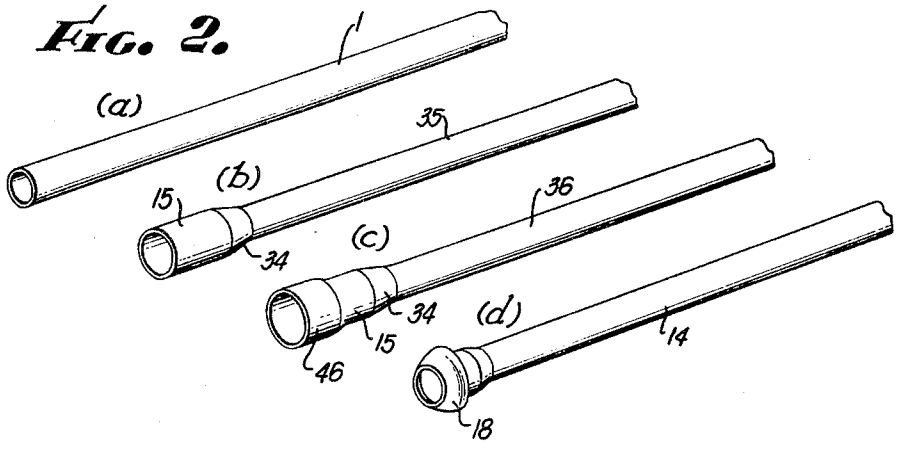
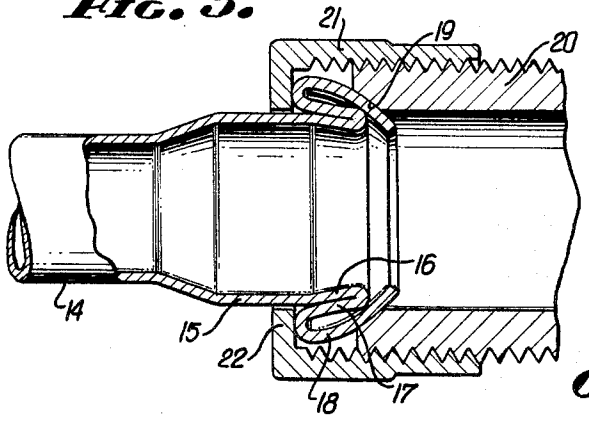


FIG. 3.



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Original Filed Aug. 21, 1961 2 Sheets-Sheet 2

FIG. 4.

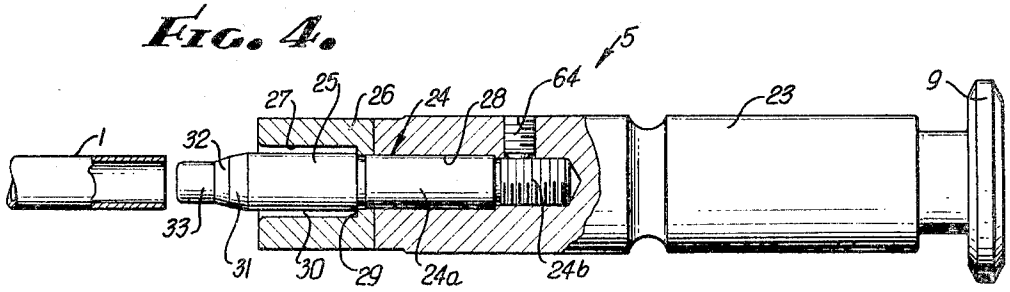


FIG. 5.

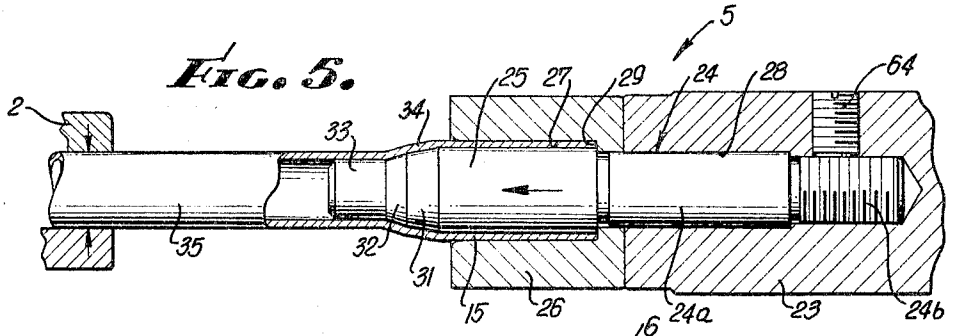


FIG. 6.

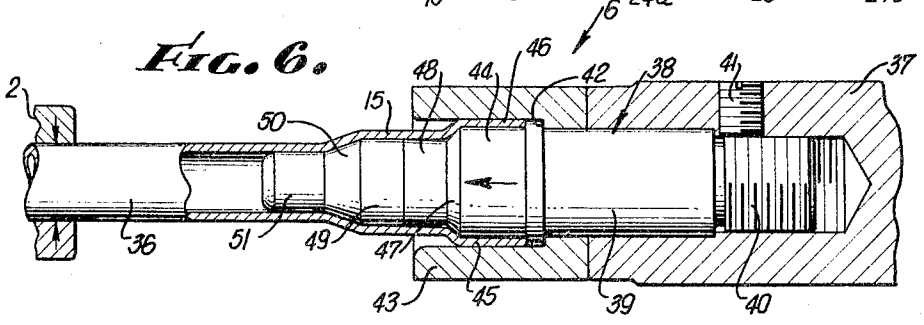


FIG. 7.

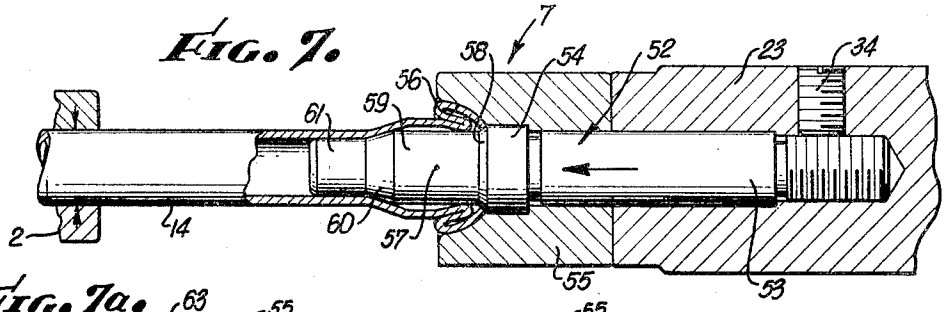


FIG. 7a.

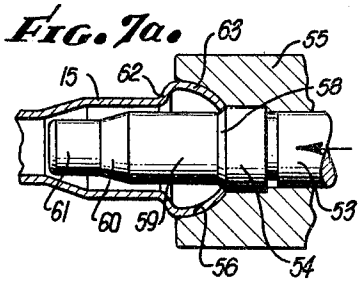
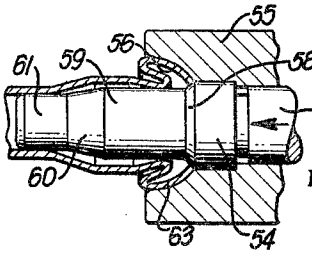


FIG. 7b.



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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, now Patent No. 3,225,581, dated Dec. 28, 1965. Divided and this application Mar. 15, 1965, Ser. No. 447,936

2 Claims. (Cl. 72—386)

This is a division of application Serial No. 132,868, filed August 21, 1961, and now Patent No. 3,225,581, issued on December 28, 1965.

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 claims.

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 the 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. 7*a* and 7*b* 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 movable 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 **24***b* formed on the shank **24***a* 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 **24***a*, 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, tis smaller diameter being substantially the same as that of the aperture **28** which fits the shank **24***a*. 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 **64** 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. 7*a* and 7*b*). This surface is that of a spherical zone having a center **57** on the axis of the finished tube **14**. The outer circular end of the zone has a diameter that closely approaches

the spherical diameter of the zone. 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** that is substantially contiguous with the inner circular end of the surface **56**. 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 structure 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, 7*a*, and 7*b*, 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 bend 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. 7*a*. 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. 7*a*. 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. 7*a* is compressed as shown in FIG. 7*b* 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 or abutment 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:

1. In a punch for folding and constricting the end of a metallic tube: an outer sleeve having at its active end a concave surface forming a spherical zone; and a cylindrical punch member located concentrically at the axis of the zone, and projecting outwardly beyond the surface; said surface having an outer larger circular end and an inner smaller circular end, the outer circular end having a diameter substantially equal to the spherical diameter of the zone.

2. In a punch for folding and constricting the end of a metallic tube: an outer sleeve having at its active end a concave surface forming a spherical zone; and a cylindrical punch member located concentrically at the axis of the zone; said surface having an outer larger circular end and an inner smaller circular end, the outer circular end having a diameter substantially equal to the spherical diameter of the zone; said punch member having an annular tapered shoulder at the smaller end of the zone substantially contiguous with said inner circular end, and converging in a direction outwardly of the recess, and positioned to form an abutment engageable with the end of the tube constricted by said surface.

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R. D. GREFE, *Assistant Examiner.*