May 6, 1969 R. A. GRAY, JR., ET AL 3,442,106

METHOD AND APPARATUS FOR MAKING WROUGHT METAL BRANCH FITTINGS

Filed Sept. 12, 1966 Sheet 1 of 2

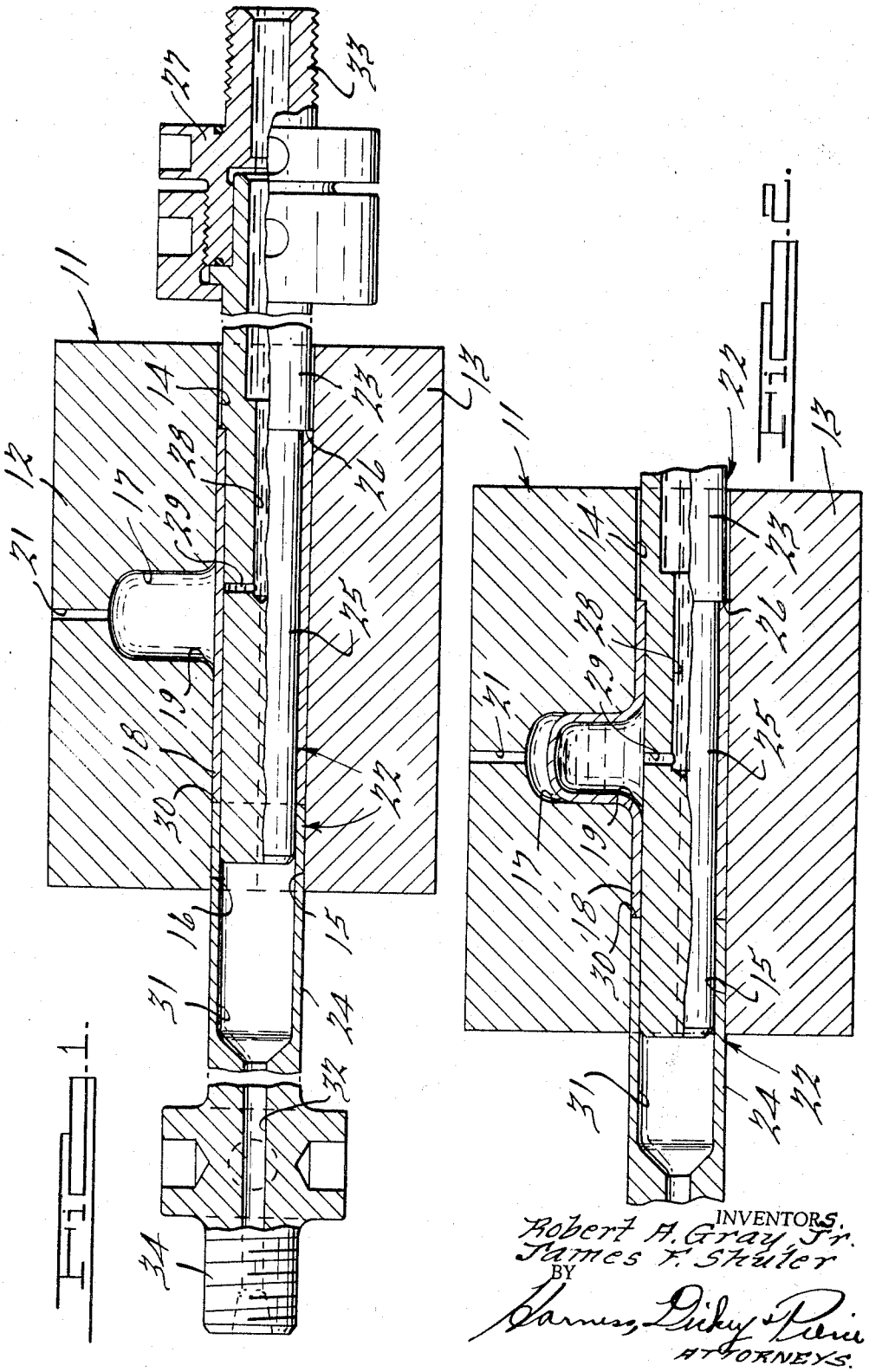


Fig. 1.

Fig. 2.

INVENTORS.
Robert A. Gray, Jr.
James F. Shuler
BY
Barnes, Dicky & Pierce
ATTORNEYS.

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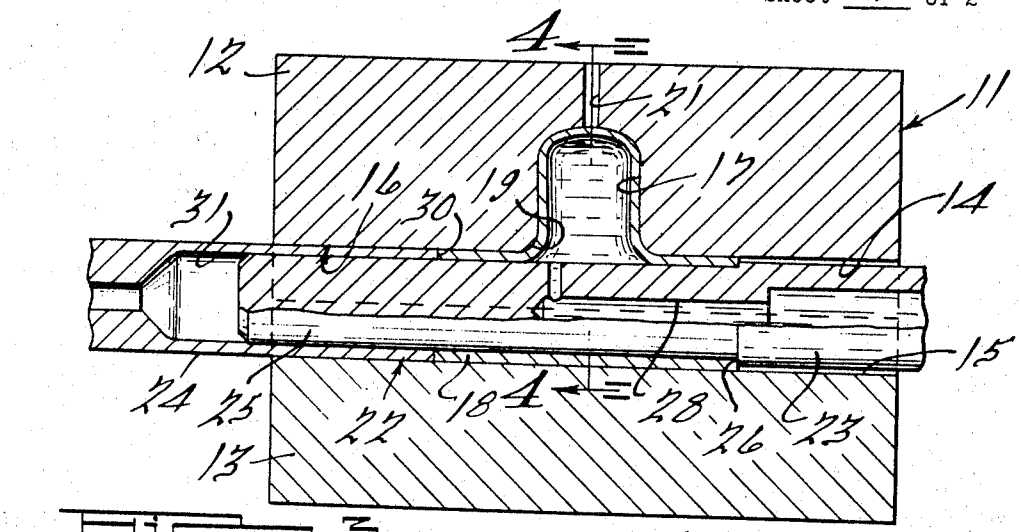


Fig. 3.

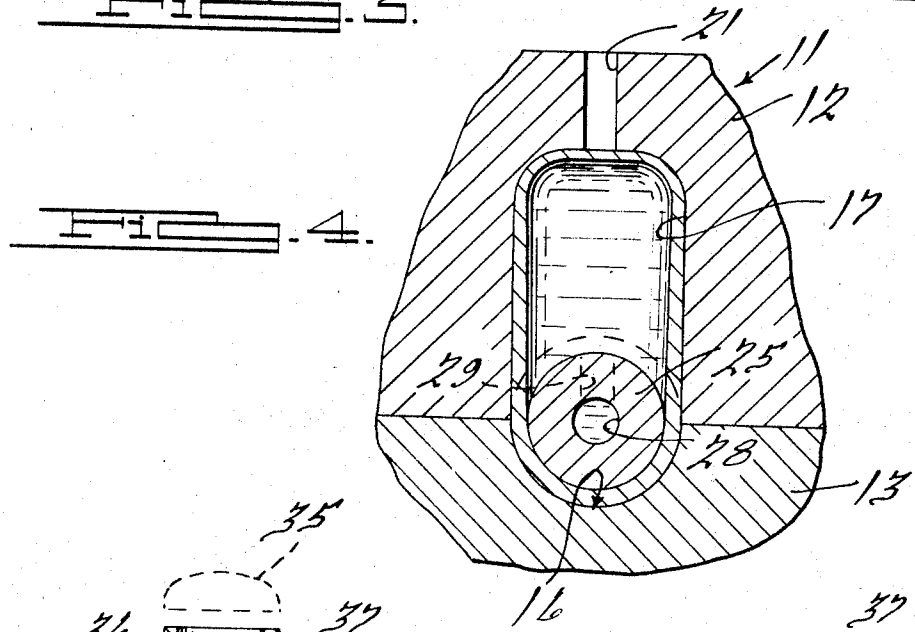


Fig. 4.

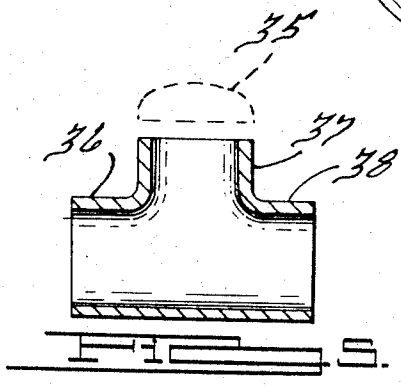


Fig. 5.

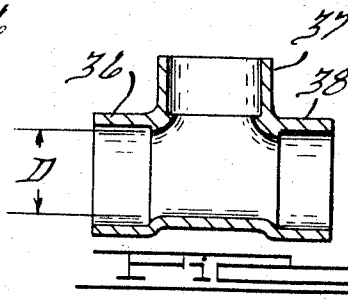


Fig. 6.

INVENTORS
Robert A. Gray, Jr.
James F. Shuler
BY
Barnes, Dickey & Pierce.
ATTORNEYS.

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METHOD AND APPARATUS FOR MAKING WROUGHT METAL BRANCH FITTINGS

Robert A. Gray, Jr., and James F. Shuler, Port Huron, Mich., assignors to Mueller Brass Co., Port Huron, Mich., a corporation of Michigan

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ABSTRACT OF THE DISCLOSURE

A die has main cavity and a branch cavity. A tubular blank is placed in the main cavity and male and female rams engage the blank ends. The male ram has a reduced portion extending through the blank and into the female ram, and a fluid passage in the male ram conducts fluid pressure to the vicinity of the branch cavity.

This invention relates to the manufacture of wrought metal branch fittings. The phrase "branch fittings" in this specification and the appended claims is meant to include pipe fittings of various types such as T's, crosses and other fittings having lateral branches for connection to pipes, whether the several outlets be of the same or different sizes.

The manufacture of wrought metal branch fittings by deforming tubular stock has taken two basic forms, one of which is the combined application of mechanical end pressure and internal hydraulic pressure on the tube, and the other being the use of a fusible and deformable alloy within the tube combined with mechanical end pressure. The combined mechanical pressure and fluid method is exemplified by Gray et al. Patent No. 2,203,868 issued June 11, 1940, while the combined mechanical pressure and fusible metal method is shown in Seeber et al. Patent No. 2,111,695 and Arbogast Patent No. 2,557,403. In either case, a die surrounds the tubular blank and is provided with a radial cavity into which a portion of the material of the tubular blank is forced so as to define a branch.

One major problem which is present in both of these methods is the build up of metal at the central portion of the fitting due to the forcing of the ends toward the center. This has necessitated the internal machining of the fitting after manufacture in order to enlarge the internal diameter to the required size and reduce flow interference. Thus, not only is metal wasted but a costly manufacturing process results.

A modified form of the combined mechanical pressure and fusible metal method is shown in Heuss et al. Patent No. 2,975,510, in which pressure in the final stages is exerted only in the fusible metal and not on the tubular blank. However, this has been found to result in excessive thinning of the metal wall thickness at the central portion of the fitting. In order to manufacture an acceptable branch fitting with the method of Heuss et al., it is necessary to provide an initial wall thickness which is substantially greater than that needed with other known methods. Thus, this method has the drawback of other conventional methods in that excessive metal is needed, and in the case of copper fittings for example, this could mean substantially greater expense.

It is an object of the present invention to provide a novel and improved method and apparatus for the manufacture of wrought metal branch fittings which overcomes the above described disadvantages of previously known methods and permits the manufacture of a seamless branch fitting without excessive metal being used and without the need for subsequent machining operations or fusible metal in order to obtain the required inside diameter for proper flow characteristics in the run of the fitting.

It is another object to provide an improved apparatus of this nature which permits the use of initial tubular stock with the minimum inside diameter required to be in conformance with control standards, thus having a minimum weight in the final branch fitting.

It is a further object to provide an improved method and apparatus having these characteristics, in which lapping or folding of the metal at the central portion of the tubular blank is prevented.

It is another object to provide a novel method and apparatus of this type which permits various kinds of stops and solder cups to be formed in the branch fitting for the pipe ends, and which further permits the inside diameter of the branch fitting to be used as a piloting diameter for a sizing tool in forming the solder cups.

Other objects, features and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a partially schematic cross-section view showing the tubular blank in position between the telescoping rams of the invention, ready to be deformed;

FIGURE 2 is a view similar to FIGURE 1 but showing the blank in partially deformed position;

FIGURE 3 is a view similar to FIGURES 1 and 2 but showing the blank in the fully deformed position;

FIGURE 4 is a cross-sectional view taken along the line 4—4 of FIGURE 3, and showing the cross-sectional configuration of the wall at the central portion of the branch fitting;

FIGURE 5 is a view of the completely deformed blank, similar to that of FIGURE 3 but showing the cap of the branch removed, and

FIGURE 6 is a view similar to FIGURE 5 but showing the manner in which solder cups could be formed in the sockets of the branch fitting by sizing the end diameters.

Briefly, the illustrated embodiment of the invention is centered around the use of two telescoping ram elements which engage opposite ends of the tubular blank and force these ends toward each other as the blank is confined within a die having a lateral cavity to receive the branch being formed. From the very beginning of the deforming operation, one of the rams, the male element, is telescopically received by the female ram element, so that the run of the fitting is always confined within the annular space between the male ram element and the die. The male ram element has a shoulder which engages one end of the tubular blank and the end of the female ram element engages the other end. The male ram element also has a fluid passage extending axially therethrough, with a lateral end passage in the area of the branch cavity of the die. Fluid under pressure is applied through these passages while the ends of the blank are being forced together, to cause the metal to flow into the branch cavity of the die. After the deformation is complete, the blank is taken from the die and the end of the branch is cut off to form the fitting.

Since the male ram element is at all times disposed within the run of the tubular blank as it is formed into a branch fitting, there will be no thickening, lapping or folding of the metal in the central portion of the branch fitting. The metal will substantially retain its original inside diameter throughout the run of the fitting, and there will be no constriction formed therein which would hamper fluid flow.

Referring more particularly to the drawings, the die is generally indicated at **11** and comprises an upper half **12** and a lower half **13**. Each half of the die may be formed of a block of steel, and the facing surfaces of the two die elements have aligned semi-cylindrical grooves **14** and **15** which together form a cylindrical cavity indicated generally at **16**. Upper die **12** has an upwardly extending recess **17** which is circular in shape and is intended to receive the extruded portions of a tubular blank **18** during the branch forming operation. The diameter of recess **17** is so chosen as to create the proper diameter for the branch, and a radius **19** is formed between recess **17** and main cavity **16**. A vent opening **21** is provided at the top of cavity **17** for permitting air removal during operation.

The ram is generally indicated at **22** and has two parts, a male element **23** and a female element **24**. Male element **23** has a main section of cylindrical shape which is slidable within cavity **16**, and a reduced section **25** at the outer end thereof, a shoulder **26** being formed between the main section and section **25**. The radial width of shoulder **26** is roughly equal to the wall thickness of tubular blank **18**, so that section **25** is slidable within the tubular blank. The outer end of ram element **23** is provided with a connection **27** for attachment to a source of pressurized fluid, and a central passage **28** is provided in element **23** leading from this connection to an intermediate portion of section **25** thereof. A radial branch **29** leads from this end of passage **28** to the surface of ram section **25**.

Female ram element **24** has a main portion which is of constant outside diameter, the diameter being such that this ram element is slidable within cavity **16**. A shoulder **30** at the end of element **24** is engageable with tubular blank **18**. The internal diameter **31** of the outer portion of ram element **24** is such that portion **25** of ram element **23** is slidable therein. This portion of ram element **24** is of sufficient length to accommodate section **25** of ram element **23** as it penetrates ram element **24** during the branch forming operation. A passage **32** leads from bore **31** toward the other end of the female ram element for permitting air to escape from bore **31**. The outer ends of ram elements **23** and **24** have means **33** and **34** respectively, for connecting these elements with a force exerting apparatus (not shown) so that the ram elements may be forced toward each other during the operation.

The tubular blank **18** may be made of any extrudable, malleable material such as copper which is to be formed into the branch fitting. Although the principles of this invention are applicable to various sizes and shapes of tubular blanks, a preferable manner of carrying out the invention would be to choose the inside diameter of tubular blank **18** as that prescribed by appropriate standards for the use to which the branch fitting is to be put. For example, standards such as the ASA B16, 22–1963 Standard for Wrought Copper and Bronze Solder-Joint Pressure Fittings require the inside diameter of the fitting to be above a specified minimum to prevent undue constriction of fluid flow. The tubular stock from which blank **18** is cut could have this inside diameter, since the forming method of this invention will not reduce the inside diameter any further. Thus, a minimum weight stock could be used to manufacture any particular branch fitting.

The original length of tubular blank **18** is of course much greater than its final length, and the length of ram section **25** is such that it is greater than the original length of blank **18**.

In carrying out the invention, tubular blank **18** will be placed in an intermediate portion of cavity **16**, being centered on cavity **17** if the branch is to be centered in the final fitting. Male ram section **25** is inserted in blank **18** until shoulder **26** engages the right hand end of the blank in FIGURE 1. Female ram element **24** is inserted in cavity **16** until end **30** thereof engages the left hand end of the blank.

The two ram elements are then moved toward each other with considerable force, and at the same time fluid under pressure is delivered to passages **28** and **29**. This will cause the material in the central portion of the tubular blank to be forced upwardly into branch cavity **17**, as seen successively in FIGURES 2 and 3.

From the very beginning of this operation, a portion of ram section **25** will be disposed within ram element **24**, so that all portions of the tubular blank which remain in cavity **16** will be unable to move radially inward because of the presence of ram section **25**. As blank **18** shortens, therefore, it will retain its inside diameter along the main run of the fitting. The metal which flows into branch cavity **17** will be forced against the sides of this cavity, assuming the diameter of the cavity.

In its final position, as seen in FIGURE 3, the material forced into cavity **17** will engage the top of this cavity, branch **29** of passage **28** still being disposed opposite cavity **17** at that time. Ram section **25** will be well within ram element **24**.

After the forcing operation has been completed, the die sections **12** and **13** will be separated, ram elements **23** and **24** withdrawn and the fitting removed. At this time the cap portion **35** may be removed (FIGURE 5), leaving a completed branch fitting.

Various means may be used to create stops or solder cups for pipe ends to be connected to the fitting. One such method is seen in FIGURE 6 which shows the ends **36**, **37** and **38** of the fitting enlarged by sizing to provide solder cups to the required depth. The controlled minimum diameter indicated at D in FIGURE 6 would still be retained in the central portion of the fitting. A particular value of the controlled inside diameter is that it may be used as a piloting diameter for the sizing tool used to increase the size of the ends.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a method for fabricating a wrought metal branch fitting, the steps of placing a tubular blank in the main cavity of a die having a main cavity and a branch cavity, placing a cylindrical member closed at one end in said tubular blank to prevent radially inward movement of the metal thereof, exerting oppositely directed forces on the ends of said tubular blank to force both ends of said tubular blank toward said branch, and simultaneously exerting fluid pressure on the inside of said blank adjacent said branch cavity through a passage leading from the other end of said cylindrical member, whereby said main cavity and blank ends will be free of fluid.

2. In an apparatus for making wrought metal branch fittings from a tubular blank of predetermined length, a die having a main cavity and a branch cavity, ram means comprising male and female ram elements, said male ram element having a main section slidably fitting within said main die cavity and a reduced section slidably fitting within said tubular blank, said reduced section of the male ram element being longer than the original predetermined length of said tubular blank, a shoulder between said main ram section and reduced ram section said shoulder being engageable with one end of said tu-

bular blank, a female ram element having an outer diameter slidably fitting within said main cavity and an inner diameter at one end thereof for slidably receiving that portion of the reduced male ram element section which extends beyond said tubular blank, the annular end of said female ram element engaging the other end of said tubular blank, and a blind passage in said male ram element connectible to a source of pressurized fluid and having an opening in the vicinity of said branch cavity, whereby said main die cavity and blank ends will be free of fluid.

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RICHARD J. HERBST, *Primary Examiner.*

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