United States Patent [19]

Jury

[11] **3,768,288**

[45] **Oct. 30, 1973**

[54] **PROCESS FOR THE PRODUCTION OF TUBE FROM DUCTILE METAL**

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[73] Assignee: **Jury & Spiers Proprietary Limited**, Norwood, Australia

[22] Filed: **Feb. 22, 1972**

[21] Appl. No.: **228,208**

[30] **Foreign Application Priority Data**

Feb. 25, 1971 Australia 4131/71

[52] **U.S. Cl.** **72/61**, 72/367

[51] **Int. Cl.** **B21d 51/14**

[58] **Field of Search** 72/61, 62, 367, 370, 72/368

[56] **References Cited**

UNITED STATES PATENTS

3,173,196	3/1965	Grimm	72/367
3,077,661	2/1963	Fromson	72/368
2,119,960	6/1938	Price	72/62

FOREIGN PATENTS OR APPLICATIONS

190,585	12/1922	Great Britain	72/367

Primary Examiner—Lowell A. Larson

Attorney—Albert H. Oldham et al.

[57] **ABSTRACT**

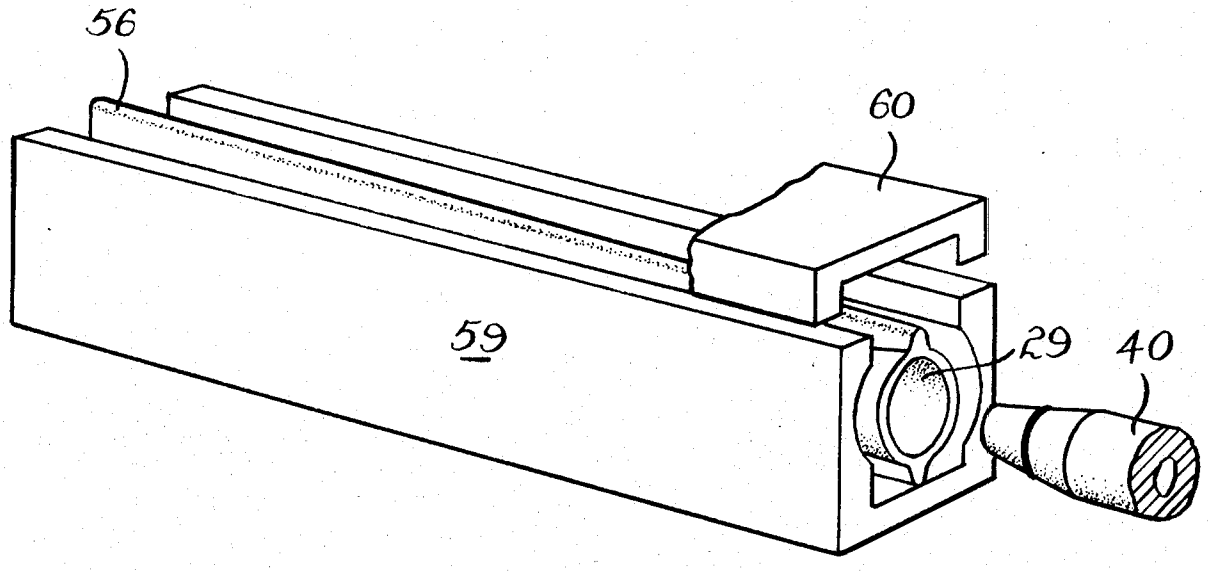
The invention relates to a process for forming a thin walled tubing which may either be linear or formed to a shape as for example for a heat exchanger, and includes the following steps:

a. flattening a tubular work piece,

b. rolling the flattened member so as to increase its length and reduce its wall thickness without substantially increasing its width, and

c. introducing fluid into the member at sufficient pressure to deform its contiguous walls away from one another.

4 Claims, 14 Drawing Figures



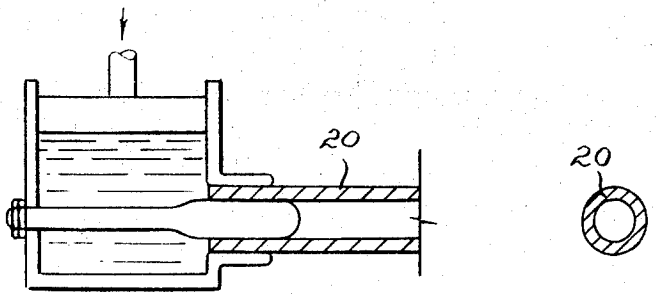


FIG 1

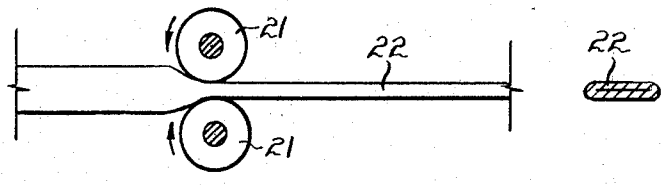


FIG 2

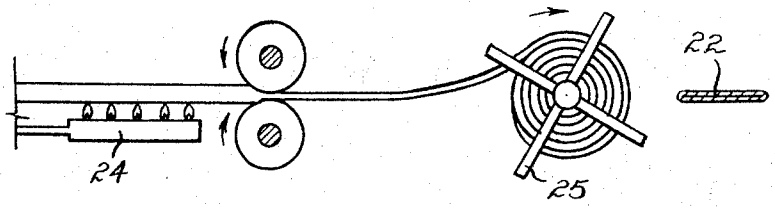


FIG 3

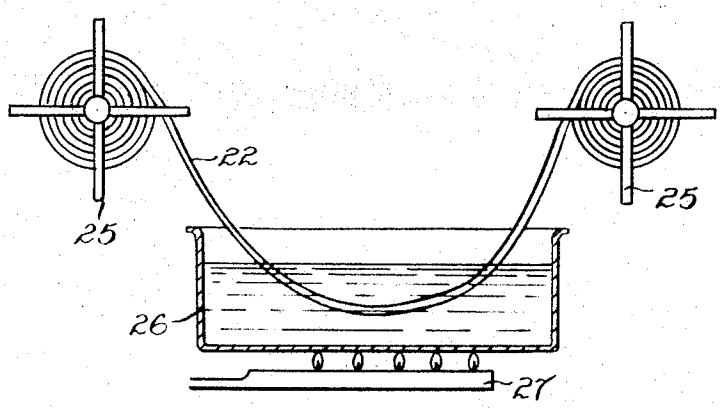


FIG 4

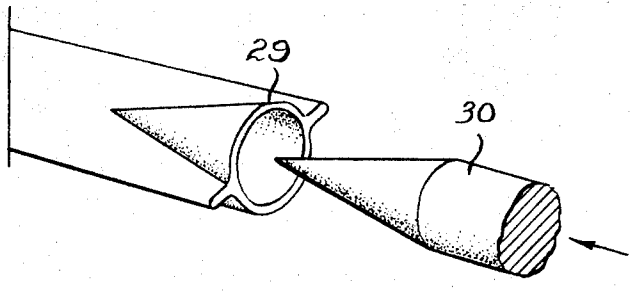


FIG 5

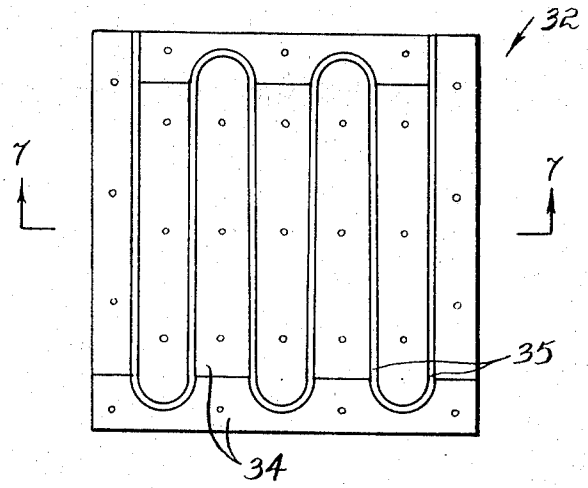


FIG 6

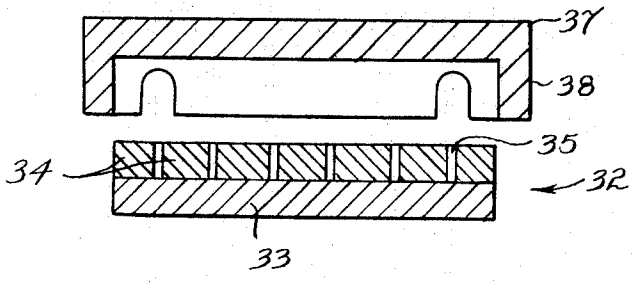


FIG 7

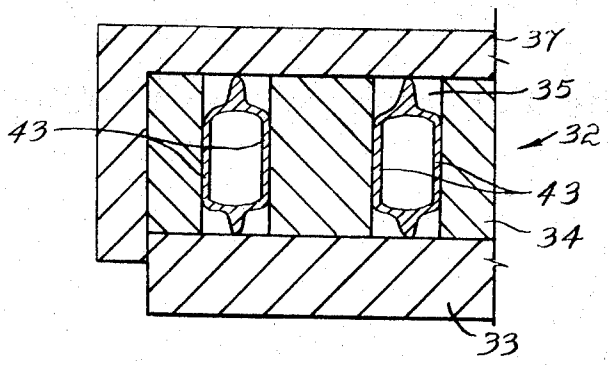


FIG 8

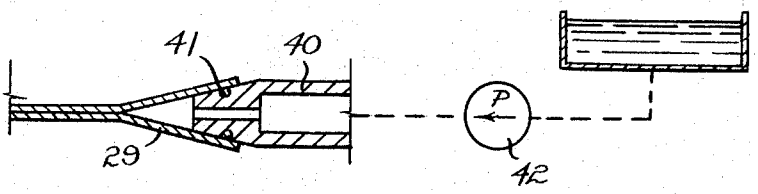


FIG 9

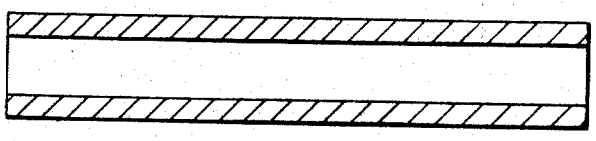


FIG 10

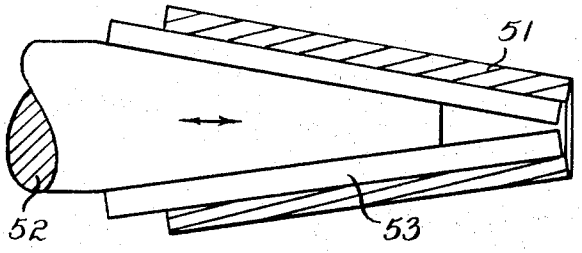


FIG 11

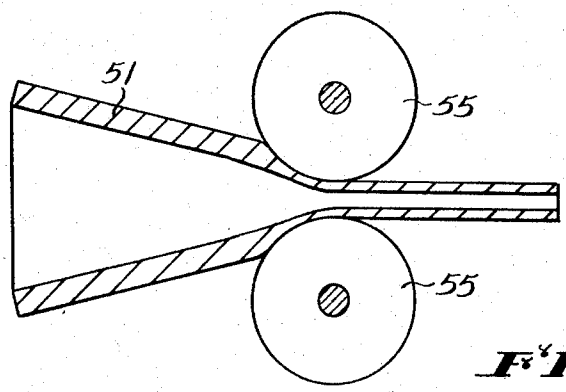


FIG 12

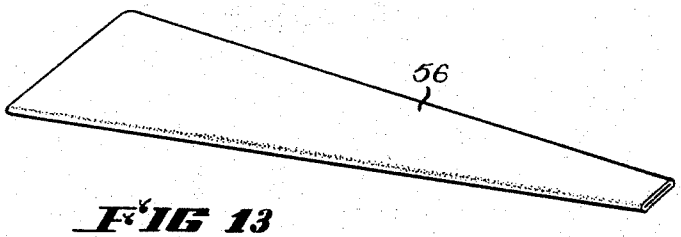


FIG 13

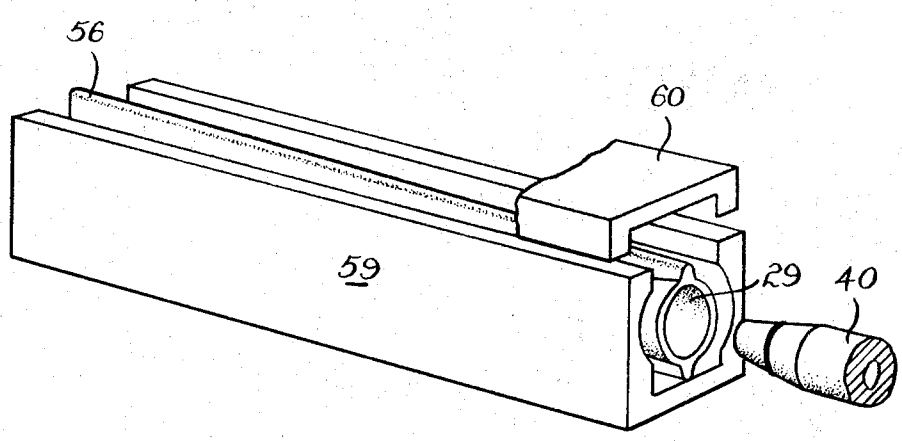


FIG 14

PROCESS FOR THE PRODUCTION OF TUBE FROM DUCTILE METAL

This invention relates to a process for the production of thin walled tube from ductile metal.

BACKGROUND OF THE INVENTION

In the usual process for the production of thin wall tubing, a billet of thick walled tubing is first extruded and then is progressively drawn over a draw-bench to extend the length and reduce the wall thickness. The tension applied to the metal, however, limits the amount of reduction of wall thickness which can be attained in any one pass and, consequently, it is usually necessary to anneal the tube a number of times during the process.

This problem has been recognised and many attempts have been made to produce tube by a less expensive method. Thus, according to one proposal, as shown in U.S. Pat. No. 3,173,196, the thick wall tube is firstly flattened and, subsequently, is rolled to make a flat member with contiguous side walls and the flat member is then expanded by fluid pressure.

As shown in U.S. Pat. Nos. 2,998,639 and 3,034,204, deformation of metal sheets to form conduits by application of fluid at pressure has been proposed, but not the formation of a length of thin wall tube from a unitary member having contiguous side walls.

BRIEF DESCRIPTION OF THE INVENTION

With the object of providing an inexpensive method of producing a thin walled tube from ductile metal, this invention may be briefly described as including the steps of

a. advancing a flattened tubular member in the direction of its longitudinal axis a number of times between rollers so positioned as to both extend the length of the member and reduce its wall thickness, during each pass
b. annealing the member between passes,
c. placing the resulting member into a hollow die having the configuration of the required article,
d. closing the ends of the flattened member and
e. introducing fluid into the space between the contiguous walls at a pressure sufficient to deform the contiguous walls away from one another and thereby form a tube having greater length and smaller wall thickness than the work piece and defined by the said die.

There is frequently a requirement for a tubular article of tapered or conical form. Lamp posts, masts for boats, masts for radio antennae and many other members are of this configuration.

However the techniques formerly employed for the production of such articles have resulted in very high costs, and this invention has as one of its advantages the simplifying of production of such articles.

In another of its forms the invention may include the further step of forming the tubular work piece to a conical shape before flattening. The formation of a relatively short tubular work piece to a conical shape is a relatively simple operation and can be achieved by any one of a number of known and inexpensive techniques. This invention avoids the need for forming an elongate member to a conical shape, which requires expensive techniques.

The invention may take many forms and two examples are described hereunder in some detail with reference to and are illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic representation showing the extrusion of ductile metal to form a tubular work piece,

FIG. **2** is a diagrammatic representation of the stage of flattening the tubular work piece to form a member having contiguous side walls,

FIG. **3** is a diagrammatic representation of the stage of advancing the flattened member in the direction of its longitudinal axis to extend its length and reduce its wall thickness,

FIG. **4** is a diagrammatic representation of a further stage wherein the flattened member is coated with a tin alloy,

FIG. **5** diagrammatically illustrates the forming of a conical opening in one end of the tube,

FIG. **6** is a plan view of a forming tool having a cavity shaped to receive a length of the flattened member,

FIG. **7** is a section on line **7—7** of FIG. **6**,

FIG. **8** is an enlarged fragmentary section illustrating the manner in which the forming tool retains the flattened member as its contiguous walls are deformed away from one another to form a thin wall tube,

FIG. **9** diagrammatically illustrates the insertion of a hollow closure member into the conical opening for the injection of fluid at pressure into the flattened member,

FIG. **10** illustrates the first stage of a second example, showing a short tubular work piece of ductile metal,

FIG. **11** shows the second stage of the second example wherein the ductile metal work piece of FIG. **10** is formed to a conical shape,

FIG. **12** shows a further stage of the second example wherein the conical member of FIG. **11** is flattened between rollers,

FIG. **13** illustrates the flattened member after it has been rolled so as to reduce its wall thickness and extend its length, and

FIG. **14** illustrates a still further stage wherein the flattened work piece is positioned within a retaining tool with one end flared to a conical shape to receive a hollow closure member for the injecting of fluid at pressure.

In the first example which is illustrated in FIGS. **1** through to **9**, the end product is a heat exchanger having a pair of substantially parallel walls and thickened ribs on the other walls which function firstly to streamline the flow of heat exchanging fluid and secondly to stiffen the thin walled tube. The cross-sectional shape of the thin walled tube of the end wall product is shown in FIG. **8**.

A tubular work piece **20** is extruded as diagrammatically illustrated in FIG. **1** from 70–30 brass (70 percent copper, 30 percent zinc) to an outside diameter of three-fourths inch and a wall thickness of 0.048 inch (18 gauge British Standard). The work piece is then annealed at a temperature of 650°C. so that it can be flattened with little or no danger of cracks developing.

As shown in FIG. **2** the work piece is flattened by passing between rollers **21** to form a flattened member which is designated **22**. The flattened member is again passed through the rollers in the direction of its longitudinal axis with the rollers set more closely so as to extend its length and reduce its wall thickness. With

70–30 brass, the wall thickness is reduced from 0.048 to about 0.010 inch in three stages of rolling (after the first flattening stage) and between two of the three stages the flattened member **22** is annealed by passing above a gas jet **24** which again heats it to a temperature of 650°C. The flattened member **22** increases only slightly in width but very considerably in length and this increase in length takes place by deformation of the metal which is not subjected to the same high degree of stress otherwise imparted if the conventional straining method is used. For this reason the amount of annealing required is substantially reduced. The flattened member **22** after rolling is a flexible ribbon like member and is stored on a take-up spool **25.**

Since the end product is to be a heat exchanger it is desirable that the outer surface of the metal be tinned, and FIG. **4** shows the ribbon like flattened member **22** extending between two take-up spools **25** and passing through a bath containing an alloy **26** of 60 percent lead and 40 percent tin for "tinning" of the outer surface. The bath is heated by a gas jet **27** which retains the alloy **26** in liquid form.

A length of the flattened member **22** is then cut from the roll on the spool **25** and one end thereof is flared so as to form a conical opening **29** by means of a tapered punch **30.** The other end is crimped or otherwise sealed against opening so that fluid injected at pressure does not escape.

FIGS. **6, 7** and **8** illustrate a retaining tool generally designated **32,** the retaining tool **32** having a base **33** to the upper surface of which is secured a series of blocks **34** arranged to have spaces **35** there-between. As shown in FIG. **6,** the spaces **35** constitute a single cavity having a series of spaced parallel portions interconnected at their ends by curved portions and representing the shape of the required end product.

The ribbon like flat tube cut from the roll is then positioned within the cavity with its ends projecting therefrom, and an upper tool portion **37** is positioned over the retaining tool **32,** the upper tool portion **37** having depending flanges **38** which engage the side walls of retaining tool **32** so as to reduce outward movement thereof when fluid is applied at pressure to the flattened tube contained within the cavity.

As shown in FIG. **9** a hollow closure member **40** having an elastomer **0** ring **41** is inserted in the conical opening **29** to sealably engage the inner walls thereof, and oil is pumped into the flattened tubular member through the hollow closure member **40** by the pump **42** at a pressure of about 5,000 p.s.i. This then deforms the contiguous walls of the flattened member away from one another to thereby form the flattened member into a tubular member the side walls **43** of which are retained by the vertical faces of the blocks **34** to be substantially parallel.

It is found that a heat exchanger formed in accordance with this invention does not require the addition of fins to achieve a high efficiency (although fins may be used to still further improve efficiency if desired). It is further found that a heat exchanger may be formed by this process much more inexpensively than by the conventionally used process wherein parallel tubes are joined at their ends by U shaped tubular members or are brazed into header tubes. The heat exchanger described herein is particularly suitable for use as a condenser heat exchanger for an air conditioner. The invention however is applicable to other heat exchangers for example motor vehicle radiators.

In the second example which is illustrated in FIGS. **10** through to **14** of the drawings, a method is described for the formation of a mast for a boat.

A length of extruded aluminium alloy tube **50** having relatively thick walls constitutes a work piece and this is first formed to a conical shaped member **51** as shown in FIG. **11** by means of a reciprocating mandrel **52** which reciprocates within a series of circumferentially arranged segmental members **53.**

The conical shaped member **51** is then passed between flattening rollers **55** (after annealing if this is necessary), the flattened member so formed is annealed, and re-rolled between the rollers **55** (set closer together) to form the elongate flattened member **56** wherein again the length is increased substantially and the width only to a small degree by the rolling operation. The flattened member **56** then has one end closed by welding, crimping or the like and the other end flared to form a conical opening **29** as in the first embodiment. The flattened member is placed within a retaining tool **59** of U section, and the retaining tool **59** has an upper tool portion **60** positioned over it. The hollow closure member **40** of similar formation to that described in the first example is inserted in the conical opening **29** of the flattened member and again fluid at pressure is pumped into the flattened member to deform the contiguous walls away from one another.

In both the above described examples the work piece has been considered to be an extruded member. However tubular members are well known to be produced by processes other than extrusion and the invention will be found to be applicable to tubes produced by some of the other processes. In particular it is applicable to tubes produced by the "double wrap" processes.

In both the above described examples the expansion of the flattened member takes place within a retaining tool. However a retaining tool is essential only in some instances and in many other instances it has been found a satisfactory product results if expansion takes place without the use of a retaining tool.

While the flattening operation has been described in both the above examples as a rolling operation, the flattening may be achieved by a simple pressing operation. Other equivalents to the various stages of the above described examples will be evident to those skilled in the art, and in particular, it will be clear to those skilled in the art what annealing (if necessary) will be required between rolling stages, and what metals may be used. For example, very low (deep drawing) carbon steel may be reduced in thickness many times without the need for any annealing whatsoever.

What I claim is:

1. A process for the production of thin walled tube, comprising the steps of:

a. advancing a tubular flattened member in the direction of its longitudinal axis a number of times between rollers so positioned as to both extend the length of the member and reduce its wall thickness during each pass,

b. annealing the flattened member between passes,

c. placing the resulting member into a hollow die having the configuration of the required article,

d. closing the ends of the flattened member,

e. introducing fluid into the space between the contiguous walls at a pressure sufficient to deform the

contiguous walls away from one another and into the hollow of the die and thereby form a tube having greater and smaller wall thickness than the work piece and of a shape defined by the said die.

2. A process according to claim 1 comprising the further step of bending the flattened member on its longitudinal axis prior to placing the member into the die, the die having a cavity corresponding to the bent shape of the member.

3. A process according to claim 1 comprising the further step of forming the tubular work piece to a conical shape before flattening and elongating.

4. A process according to claim 1 comprising the further step of forming a conical opening in one end of the flattened member, closing the conical opening with a hollow closure member, and introducing said fluid at pressure into the space between the contiguous walls through the hollow closure member.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,768,288 Dated October 30, 1973

Inventor(s) Harold Rex Jury

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 47, change "o" to -- O --.

Column 5, line 3, after "greater", insert -- length --.

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents