

July 5, 1966

J. R. GRIFFIN

3,259,003

METHOD AND APPARATUS FOR FORMING OPENINGS IN TUBULAR MEMBERS

Filed June 26, 1964

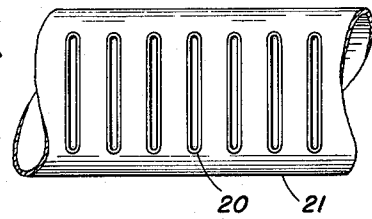
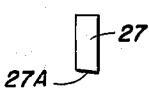
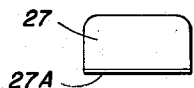
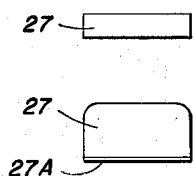
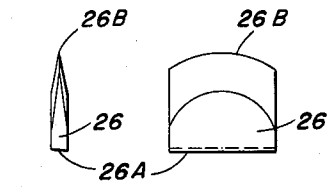
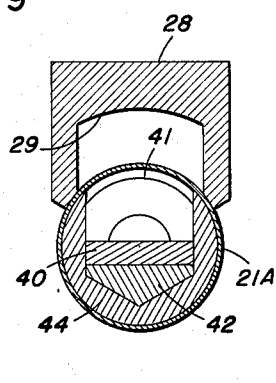
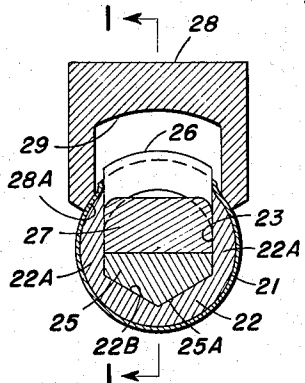
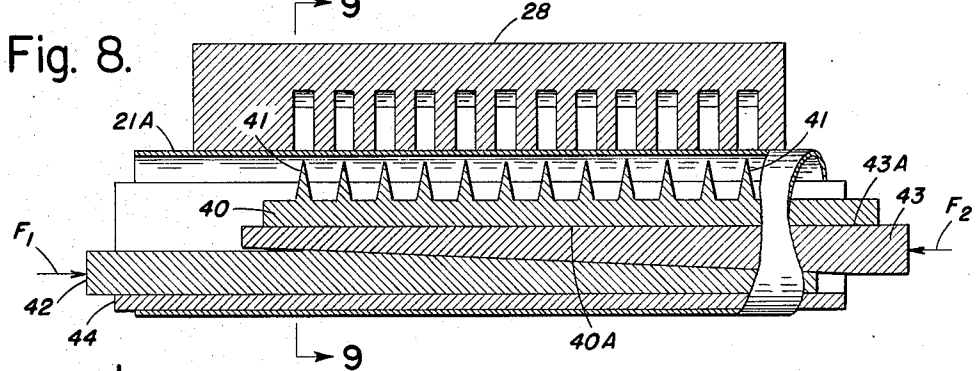
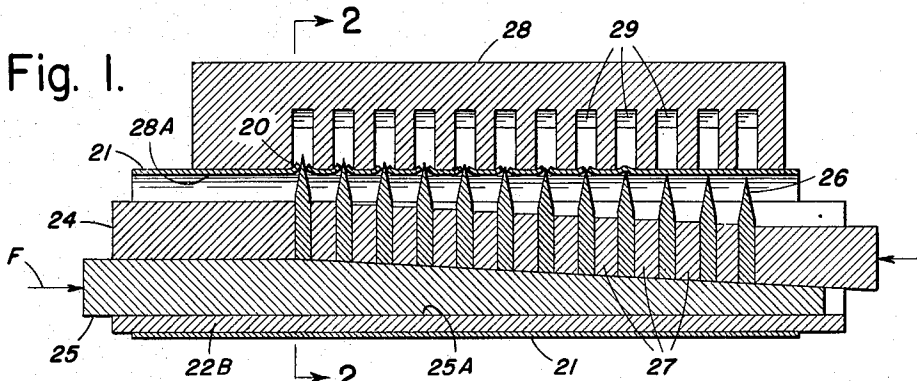


Fig. 2.

Fig. 9.

Fig. 3. Fig. 4.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 10.

INVENTOR
James R. Griffin

BY *Frank J. Gordon*
ATTORNEY

1

3,259,003

METHOD AND APPARATUS FOR FORMING OPENINGS IN TUBULAR MEMBERS

James R. Griffin, Louisville, Ky., assignor to American Radiator & Standard Sanitary Corporation, New York, N.Y., a corporation of Delaware

Filed June 26, 1964, Ser. No. 378,371
12 Claims. (Cl. 83—54)

This invention relates to a method and apparatus for forming openings in tubular members and more particularly to a method and apparatus for making gas burners from performed tubular members with a plurality of port openings formed therein.

Heretofore, it had been customary to form tubular gas burners having a plurality of port openings by first forming the port openings in a sheet of flat stock material and then forming the flat sheet material with the port openings therein into the desired tubular shape of the finished burner. With this type of construction a gas tight seam was required to be formed along the abutting edge portion of the sheet to render the tube defined thereby gas tight. A further disadvantage of this type of tubular burner construction was that the size and shape of the respective port openings, which are critical for optimum burner performances, are likely to be distorted as the flat stock material is rolled into a tubular shape. Consequently, since the rolling of such flat stock into tubular form disturbs the tolerances and the strict dimensions of the port openings formed therein, it has been difficult to produce a gas burner capable of optimum effectiveness and efficiency by this construction.

It is therefore an object of this invention to provide an improved method and apparatus by which the prescribed shape and size of port openings for optimum burner performance can be directly formed in a preformed tubular member.

Still another object is to provide a method and apparatus for forming a plurality of port openings in the surface of a preformed tubular member in a manner in which distortion of the tubular member is prohibited during the port forming operation.

Another object is to provide a method and apparatus in which a preformed tubular member may be optionally formed with a plurality of port openings that are either outwardly extruded or formed flush with the surface of the tubular member.

Still another object is to provide a method and apparatus for forming a plurality of port openings in a preformed tubular member that is relatively simple, inexpensive and positive in operation.

In accordance with this invention, the foregoing objects, features and advantages are attained by a method comprising the steps of internally bracing or supporting the walls of a preformed tubular member and inserting into the tubular member so braced a cutting tool and a member having an inclined plane. The cutting tool and the member having the inclined plane are provide with cooperation surfaces so that upon the application of an axial force to the inclined plane member, the latter is displaced longitudinally of the tubular member. Accordingly, radial displacement or movement of the cutting tool relative to the preformed tubular member is effected to result in the cutting tool piercing port openings in the adjacent wall portion of the tube.

To control the extrusion or shape of the port opening so formed, a cooperating female die member may be disposed adjacent the external portion of the tube opposite the cutter portion of the tool that pierces the port opening in the tubular member. The arrangement is such that the relative size of the opening of the female die with respect to the size of the cutting tool

2

determines the shape of the port opening formed. Thus by coordinating the size of the die opening in the female die with the cutter of the cutting means, the port openings thus defined thereby can be either outwardly extruded or formed flush with the surface of the tubular member.

The apparatus by which the foregoing method can be performed comprises an elongated tube base member which is adapted to be fitted into the preformed tubular member so as to prevent inward distortion of the tubular member. This is attained by providing the tool base member with an external surface contour which complements the internal contour of the tubular member whereby the base member is closely fitted thereinto. Accordingly, the tool base member is provided with a longitudinally extending channelway which opens to the circumferential portion of the preformed tubular member in which the port openings are to be formed. A cutting tool means having a plurality of cutters is adapted to be inserted within the channelway of the tool base member. A wedge forming means having an inclined surface is interposed between the base member and the cutting tool. The arrangement is such that axial displacement of the wedge means longitudinally of the tubular member effects a radial displacement of the cutting tool which results in the cutters piercing the tubular member to define therein the port openings. To retain the metal between adjacent port openings so formed, a female die may be provided. Accordingly, the size of the female die openings with respect to the size of the cutters determine whether or not the port openings are outwardly extruded or formed flush with the surface of the tubular member.

In one form of the invention, the cutting tool may comprise a series of independent cutters which are spaced apart from one another by spacer blocks. In this form of the invention, the axial displacement of the inclined plane results in the port openings, being successively and progressively formed with minimum of instantaneous applied force.

In another form of the invention, a pair of complementary inclined planes are interposed between the tool base member and the cutting tool so that the respective cutters thereof pierce the tube to form all of the port openings therein simultaneously.

A feature of this invention resides in the method and apparatus in which the close tolerance and strict dimensions of the respective burner ports formed in a preformed tubular burner can be positively maintained so as to obtain optimum burner performance in a readily simple, economic and positive manner.

Another feature of this invention resides in the provision of an apparatus utilizing a cutter means having either a plurality of independent cutters spaced one from the other by the interposition therebetween of individual spacer blocks, or a plurality of cutters integrally formed with spacers.

Other features and advantages will become more readily apparent when considered in view of the drawings and specification wherein:

FIGURE 1 is a sectional side view taken along line 1—1 of FIG. 2 showing a tubular member and the means for forming a plurality of port openings in a wall portion thereof.

FIGURE 2 is a sectional view taken along line 2—2 of FIG. 1.

FIGURE 3 is a detailed end view of a cutter used in the embodiment of FIG. 1.

FIGURE 4 is a side view of the cutter of FIG. 3.

FIGURE 5 is a detailed end view of a spacer block used in the embodiment of FIG. 1.

FIGURE 6 is a side view of FIG. 5.

FIGURE 7 is a top plan view of FIG. 6.

FIGURE 8 is a longitudinal side sectional view of a modified form of the invention.

FIGURE 9 is a sectional view taken along the line 9—9 of FIG. 8.

FIGURE 10 is a plan view of a tubular gas burner formed by the apparatus and method herein.

In the gas burner art, it is important that the burner ports of a tubular gas burner be strictly dimensioned so that optimum burner performance can be attained. Herebefore, considerable difficulty has been encountered in maintaining these desired close tolerances and strict dimensions.

Accordingly, there is shown in the drawings an improved means by which port openings 20 can be formed directly in a preformed tubular member 21 so that the close tolerance and strict dimensions of the port openings can be maintained for optimum burner performance. There is shown in FIGS. 1 and 2 a performed tubular burner member 21 and a means for forming a series of port openings directly therein. The means for forming the port openings 20 comprise an elongated tool base member 22. As best seen in FIG. 2, the tool base member 22 is provided with a longitudinally extending cut out portion or channelway 23 formed therein to define the tool base member having opposed extended side portions 22A and an interconnected web portion 22B. The outer surface of the base member 22 conforms closely to the internal contour of the tubular member 21. The construction and arrangement of the tool base member 22 is such that it will brace a substantial internal circumferential wall portion of the tubular member and thus will prohibit inward distortion of the preformed tubular member 21 when a driving force is applied to a port forming means as will be hereinafter described. If desired, the bottom 22B of the channelway of the tool base member 22 may be provided with inclined surfaces so as to define a substantially V-shaped bottom in the cross section thereof.

The means for piercing the port openings 20 in or through a wall portion of the preformed tubular member 21 comprises a cutting tool 24 and a cooperating wedge member 25 having an inclined plane for actuating the cutting tool during a port opening operation. The extended sides 22A of the tool base 22 serve as a means to position the cutting tool 24 adapted to be disposed in the channelway 23 formed therein for piercing the wall portion of the tubular member to define the port openings 20 as will be herein described.

In the form of the invention shown in FIGS. 1 and 2, the wedge member 25 has a V-shaped bottom 25A to complement the V-shaped bottom 22B of the channelway 23 formed in the tool base 22. As best seen in FIG. 2, the wedge member 25 is dimensioned so that it can readily slide along the bottom of the channelway.

In FIGS. 1 and 2, the cutting tool 24 is shown as comprising a plurality of independent cutters or cutter blades 26 which are longitudinally separated by spacer blocks 27 interposed between adjacent pairs of cutters 26. The respective cutters 26 are constructed so as to form transversely extending slotted port openings 20 in a circumferential surface portion of the preformed tube as best seen in FIG. 10.

In accordance with this invention, the bottoms 26A and 27A of the cutters 26 and the cooperating spacer blocks 27 interposed therebetween are each provided with an inclined surface which complements the inclined surface 25A of the wedge member 25. The arrangement is such that when a force F is applied to the wedge member 25 in a direction longitudinally of the tubular member, the respective cutters 26 are successively and progressively radially displaced or cammed outwardly to effect piercing of the circumferential wall portion of the preformed tube 21 to form the port openings therein.

As best seen in FIG. 1, it will be noted that the specific

co-action between the wedge member 25 and the respective cooperating cutters 26 is such that the respective cutters 26 are progressively advanced or raised from left to right as the wedge member 25 is moved to the right as indicated by the force arrow F. Thus the respective port openings 20 defined thereby are successively and progressively formed. With this construction, a minimum of instantaneous force is required to be applied to the block since the respective port openings are successively formed.

Depending upon the wall thickness and type of material from which the preformed tube 21 is formed, a female die 28 may or may not be used to retain the metal between adjacent ports.

As shown in FIGS. 1 and 2, the female die 28 is disposed along the external surface of the preformed tubular member which is to be pierced by the cutters 26. The female die 28 comprises simply a block having a convex surface portion 28A complementing the curvature of the tubular member 21 that it overlies and which is to be pierced by cutters 26. The female die 28 accordingly is provided with a series of transversely extending openings or slots 29 to receive the respective cutters 26 of the cutting tool.

In accordance with this invention, the size of the openings 29 in the female die 28 with respect to the size of the associated cutters 26 determined whether or not the port openings 20 formed thereby will be outwardly extruded or formed flush with the surface of the tubular member. Accordingly, by oversizing the openings 29 in the female die 28, the metal from the preformed tube 21 upon the piercing of the cutter blades 26 therethrough is allowed to follow the cutting tool 26 to result in an outwardly extruded shape port opening 20. By minimizing the tolerance between the size of the openings 29 in the female die 28 and the complementary cutter blade 26 associated therewith, the amount of material following the respective cutters during the piercing operation can be reduced. With the most minimum clearance between the die 28 and the cutters 26, port openings 20 defined thereby will be flush with the surface of the tubular member.

Accordingly, cutters 26 can be designed so that the required port opening 20 in the tubular member can be obtained by the tapered end surface of the cutter. As best seen in FIGS. 3 and 4, the cutting edge or piercing edge 26B of the respective cutters 26 are provided with opposed inclined surfaces which converge to a sharp cutting tip.

From the foregoing description, it will be readily apparent that the apparatus for successively and progressively forming a series of port openings 20 in a preformed tubular element 21 is relatively simple in construction and positive in operation. Also, it is to be noted that the cutting tool 24 is defined by a plurality of independent cutters 26 spaced from one another by a series of independent spacer blocks 27. By employing spacer blocks 27 of various dimension, any desired pattern or configuration of port opening arrangements may be formed in the surface of a preformed tube. Also, by regulating the tolerance between the openings 29 of the female die 28 and the cooperating cutters 26 associated therewith, the size and the shape of the respective port openings 20 can be varied accordingly. Further, the co-action between the respective cutters 26 and the inclined wedge 25 is such that the individual cutters 26 are successively and progressively actuated so as to effect a progressive piercing of the preformed tubular member with a minimum of instantaneous applied force.

In another form of the invention, as illustrated in FIG. 8, the means for forming a plurality of port openings 20 in the preformed tubular member 21A comprises cutting tool 40 including a plurality of integrally connected spaced cutters 41 and a pair of cooperating inclined wedge members 42 and 43. In accordance with this form of the invention, the tool base member 42 is substantially similar

5

to that described with reference to FIGS. 1 and 2, and it is arranged to closely fit within the bore of the tube 21A in a manner similar to that hereinbefore described.

The wedge members 42 and 43 have their respective complementary inclined surfaces in engaging relationship, and they are interposed between the bottom of the cutting tool 40 and the bottom of the channelway defined by the tool base member 44. In this form of the invention, the base 40A of the cutting tool 40 is rendered flat or horizontally disposed. Likewise the upper surface 43A of the upper wedge member 43 is horizontally disposed with respect to the bottom 40A of the cutting tool 40. Consequently, when opposite forces F1 and F2 are applied on the opposed ends of the respective inclined wedges 42, 43 to effect relative movement therebetween, the arrangement is such that the cutter tool 40 is radially displaced. Accordingly, each of the integrally connected cutters 41 thereof will simultaneously pierce the wall portion of the preformed tube 21A. Thus, in this form of the invention, all of the respective port openings 20 are simultaneously formed upon the application of a force F1 or F2 applied to the ends of the respective inclined planes 42, 43.

If desired, a female die 28 may be cooperatively associated with the cutter 41 in the manner hereinbefore described with reference to FIGS. 1 and 2 to determine the size and shape of the respective port openings 20 to be formed.

The method for forming a plurality of port openings 20 in the surface of a preformed tube 21, in accordance with this invention comprises, the steps of internally bracing or supporting the wall of a preformed tubular member in a manner to permit the insertion therein of a cutting tool 21 or 40 constructed so as to pierce a plurality of port openings through the surface of the preformed tubular member when radially displaced. Displacement of the cutter is attained by positioning a wedge member 25 or 42, 43 between the cutting tool 24, 40 and a wall portion of the tubular member. An axial force is then applied to the wedge member so as to effect a longitudinal displacement thereof whereby the cutting tool 24 or 40 cooperatively associated therewith is radially displaced to pierce the port openings in the surface of the tubular member.

In one form of the invention, the plurality of independently operated cutters 26 are successively and progressively displaced as the wedge member 25 is moved relative thereto. With this method, the port openings 20 are formed with a minimum of instantaneous force being applied to the inclined plane.

In another method, the cutting tool 40 is actuated in a manner in which all of the port openings 20 are pierced simultaneously. This is attained by utilizing a cutting tool 40 having a plurality of integrally connected cutters 41 and a pair of cooperating wedge members 42, 43 having complementary surfaces arranged so that the radial displacement cutting tool 40 is proportional to the relative displacement of the respective planes.

With either of the above methods the size and shape of the respective port openings can be varied by utilizing a cooperating die member 28. Also cutters of various sizes and shapes may be employed to obtain any desired shape or size of port openings.

While the instant invention has been described with respect to particular methods and embodiments thereof, it will be readily understood and appreciated that variations and modifications of the invention may be made without departing from the spirit or scope thereof.

What is claimed is:

1. A method of simultaneously forming a plurality of port openings in a wall portion of a preformed tubular member comprising the steps of,

- (a) internally supporting along the length of said tubular member a circumferential wall portion thereof so as to prohibit distortion thereof,

6

(b) positioning a cutting tool having a series of integrally connected spaced cutters within said tube for piercing a series of spaced port openings in a wall portion of said tubular member,

(c) supporting said cutting tool on a pair of complementary superimposed members having inclined planes extending into said tubular member whereby said cutting tool is adapted to be radially displaced upon relative movement between said members having inclined planes,

(d) and applying an axial force to said members having inclined planes whereby relative axial displacement of said members effects the simultaneous piercing of said cutters through the wall portion of said tubular member.

2. A means for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,

(a) an elongated tool base adapted to be fitted into the bore of said tubular member to prohibit the distortion of said tubular member,

(b) said tool base having an external contour closely conforming to a circumferential portion of the internal wall surface of said tubular member to brace the same,

(c) and said tool base having a longitudinally extending channelway formed therein opening to the unbraced circumferential wall portion of said tubular member,

(d) a cutting tool including a plurality of longitudinally spaced cutters adapted to be disposed in the channelway of said tool base within said tubular member,

(e) and means defining an inclined surface disposed between the base of said channelway and said cutting tool whereby longitudinal displacement of the last said means effects radial displacement of the respective cutters to pierce the wall portion of said tubular member to form the port openings therein.

3. The invention as defined in claim 2 and including:

- (a) a female die adapted to be disposed externally of said tubular member, said die having openings for complementing the cutters of said cutting tool to control the size and shape of said port openings formed thereby.

4. A means for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,

(a) an elongated tool base adapted to be fitted into the bore of said tubular member to prohibit the distortion of said tubular member,

(b) said tool base having an external contour closely conforming to a circumferential portion of the internal wall surface of said tubular member to brace the same,

(c) and said tool base having a longitudinally extending channelway formed therein opening to the unbraced circumferential wall portion of said tubular member,

(d) a cutting tool including a plurality of independent longitudinally spaced cutters adapted to be disposed in the channelway of said tool base within said tubular member,

(e) and means defining an inclined surface disposed between the base of said channelway and said cutting tool whereby longitudinal displacement of the last said means effects radial displacement of the respective cutters successively and progressively in piercing the wall portion of said tubular member to form the port openings therein.

5. A means for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,

(a) an elongated tool base adapted to be fitted into the bore of said tubular member to prohibit the distortion of said tubular member,

- (b) said tool base having an external contour closely conforming to a circumferential portion of the internal wall surface of said tubular member to brace the same,
- (c) and said tool base having a longitudinally extending channelway formed therein opening to the unbraced circumferential wall portion of said tubular member,
- (d) a cutting tool including a series of integrally connected, spaced apart, cutters adapted to be disposed in the channelway of said tool base within said tubular member,
- (e) and means defining a pair of cooperating inclined surfaces disposed between the base of said channelway and said cutting tool whereby relative longitudinal displacement of the last said means effects radial displacement of said cutters to effect a simultaneous piercing of said port openings therein.
6. A means for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,
- (a) an elongated tool base having a channelway formed therein, said tool base being adapted to be fitted into the bore of a tubular member,
- (b) said tool base having an external surface contour complementing the internal contour of a circumferential wall portion of said tubular member so as to prohibit the inward distortion thereof, and said channelway being open to a circumferential wall portion in which said port openings are to be formed,
- (c) a cutting tool including a plurality of longitudinally spaced cutters adapted to be disposed in the channelway of said tool base,
- (d) and a member having an inclined plane operatively associated with said cutters for radially displacing the same to pierce the port openings in said tubular member.
7. The invention as defined in claim 6 wherein said cutters and said member having cooperating complementary inclined cam surfaces whereby displacement of said member successively and progressively cause said cutters to form the port openings in said tubular member.
8. A device for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,
- (a) an elongated tool base adapted to be fitted within the bore of said tubular member to prohibit the inward distortion of said tubular member,
- (b) said tool base having an external surface contour complementing a circumferential portion of the internal wall surface of said bore to brace the same, and
- (c) said base having a longitudinally extending channelway formed therein, said channelway opening to a second circumferential wall portion of said tubular member in which said port openings are to be formed,
- (d) a cutting tool adapted to be disposed within the channelway of said base,
- (e) said tool including a plurality of independent cutters, each of said cutters having an inclined base portion,
- (f) a spacer interposed between adjacent pairs of said cutters to space one cutter from another,
- (g) a means defining an inclined plane,
- (h) said inclined plane complementing the inclined base of said cutters,
- (i) and said means and said cutters being relatively movable so that upon the application of an axial force to said means longitudinally of said base, the respective cutters are successively and progressively cammed to pierce said port opening in said second circumferential portion of said tubular member.
9. The invention as defined in claim 8 and including:
- (a) a female die adapted to be disposed externally of

- said tubular member opposite said second circumferential wall portion,
- (b) said die having a series of openings complementing said cutters to control the size and shape of said port openings formed thereby.
10. A device for forming a plurality of port openings through a wall portion of an elongated preformed tubular member comprising,
- (a) an elongated tool base adapted to be fitted within the bore of said tubular member to prohibit the inward distortion of said tubular member,
- (b) said tool base having an external surface contour complementing a circumferential portion of the internal wall surface of said bore to brace the same,
- (c) said base having a longitudinally extending channelway formed therein, said channelway opening to a second circumferential wall portion of said tubular member in which said port openings are to be formed,
- (d) said channel having a substantially V shaped bottom,
- (e) a cutting tool adapted to be disposed within the channelway of said base,
- (f) said tool including a plurality of independent cutters, each of said cutters having an inclined base portion,
- (g) a spacer interposed between adjacent pairs of said cutters to space thereon one from the other,
- (h) a means defining an inclined plane,
- (i) said inclined plane complementing the inclined base of said cutters, and a V shaped bottom complementing the bottom of said channel,
- (j) said inclined plane and cutters being relatively movable so that upon the application of an axial force to said means defining the inclined plane longitudinally of said base, the respective cutters are successively and progressively cammed to effect the piercing of said tubular member to define the portion openings therein.
11. A means for forming a port opening through a wall portion of a tubular member comprising,
- (a) an elongated tool base adapted to be fitted into said tubular member to internally support walls of said members against distortion thereof,
- (b) said tool base having an external surface contour complementing the internal contour of said tubular member,
- (c) a cutting tool means adapted to be inserted into said tubular member,
- (d) wedge means interposed between said base and said cutting tool means whereby displacement of said wedge means longitudinally of said tubular member effects radial displacement of said cutting tool means toward the wall of said tubular member to effect the piercing of said tubular member to define a port opening therein, and wherein said wedge means has an inclined surface and said cutting tool means including a plurality of independent spaced cutters supported on said inclined surface whereby axial displacement of said wedge means causes said cutters to successively and progressively pierce port openings in said tubular member.
12. A means for forming a port opening through a wall portion of a tubular member comprising,
- (a) an elongated tool base adapted to be fitted into said tubular member to internally support walls of said members against distortion thereof,
- (b) said tool base having an external surface contour complementing the internal contour of said tubular member,
- (c) a cutting tool means adapted to be inserted into said tubular member,
- (d) wedge means interposed between said base and said cutting tool means whereby displacement of said

9

wedge means longitudinally of said tubular member effects radial displacement of said cutting tool means toward the wall of said tubular member to effect the piercing of said tubular member to define a port opening therein, and wherein said wedge means comprises a pair of complementary members having inclined surfaces and said cutting tool includes a plurality of integrally connected spaced cutters supported on said wedge means whereby displacement of said pair of complementary members relative to each other effects simultaneous piercing of said cutters through said tubular member.

5

10

10

References Cited by the Examiner

UNITED STATES PATENTS

295,090	3/1884	Whitman	-----	83—191	X
750,746	1/1904	Woodburn	-----	83—191	
1,521,866	1/1925	Carlson	-----	83—191	X
1,790,515	1/1931	Trumble	-----	83—191	X
2,297,415	9/1942	Johnson	-----	166—55.3	X
2,315,437	3/1943	Luccons	-----	166—55.3	

10 WILLIAM W. DYER, JR., *Primary Examiner.*

L. B. TAYLOR, *Assistant Examiner.*