

[54] **METHOD FOR MAKING EVAPORATOR OR CONDENSER CONSTRUCTION**

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Related U.S. Application Data

[63] Continuation of Ser. No. 737,080, June 14, 1968,
abandoned.

[52] U.S. Cl. **29/157.3 R, 29/157.6, 29/479,**
29/482, 285/287

[51] Int. Cl. **B21d 53/00**

[58] Field of Search **29/475, 478, 479,**
29/482, 503, 471.1, 157.3 R, 157.3 B, 157.6;
285/286, 399, 382.4, 157, 287

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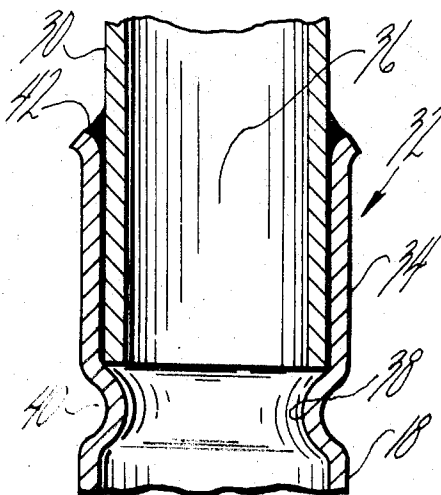
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Attorney—McCormick, Paulding & Huber

[57] ABSTRACT

The method of making a refrigeration evaporator or condenser construction wherein the ends of preferably aluminum tubes which have been extended through heat exchange plates or fins in a refrigeration evaporator or condenser construction are joined with U-bend connectors, said method comprising forming radial internal beads near the ends of the tubes to be connected to provide stops for the ends of the U-bend connectors which are of lesser diameter, flaring the very end portions of the tubes to be connected, laying a thermofluid welding material around the connector end portions within the flared ends of the tubes to be connected, and applying heat to flow the said material prior to chilling.

9 Claims, 6 Drawing Figures



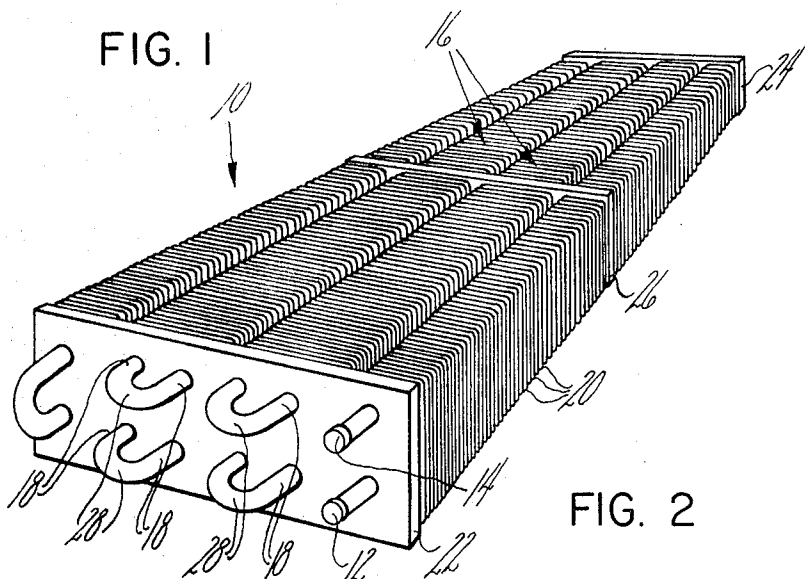


FIG. 2

FIG. 3

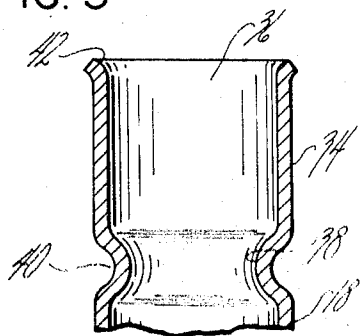
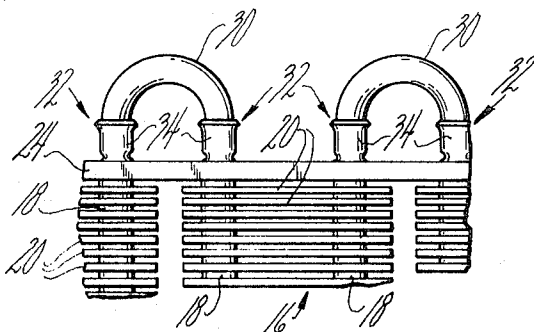


FIG. 6

FIG. 4

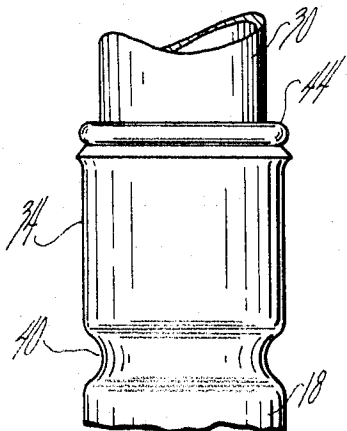
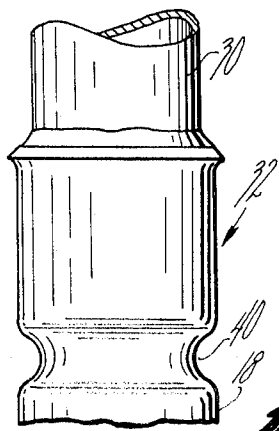
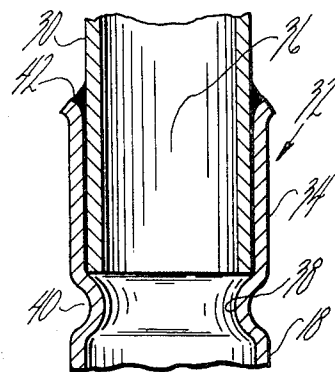


FIG. 5



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METHOD FOR MAKING EVAPORATOR OR CONDENSER CONSTRUCTION

CROSS-REFERENCE

This is a continuation of application Ser. No. 737,080 filed June 14, 1968 for METHOD FOR JOINING TUBE ENDS, now abandoned.

BACKGROUND OF THE INVENTION

Coils or tubes in evaporators and condensers for refrigeration apparatus are conventionally made of copper, with U-bend connectors of the same diameter. Each end to be connected is generally enlarged substantially with a mandrel or other expanding tool to form a socket to receive a connector end and a welding material. The enlarging embeds impurities in the inner surface of the socket which may cause trouble, but do not because of burning away at the high temperatures to which the copper can be subjected during welding, soldering or brazing.

Copper is often in short supply, and aluminum tubing is a desirable substitute except for the soldering, brazing or welding difficulties it presents. That is, the welding temperature for aluminum must be lower, and the impurities embedded by the expanding tool remain to prevent a satisfactory joiner. This invention has been developed to overcome these difficulties.

SUMMARY OF THE INVENTION

According to the present invention there is provided a method of manufacturing evaporators or condensers for refrigeration apparatus comprising the steps of thrusting at least two elongated main tubes, the ends of which have a mill stock finish, through heat exchange plates so that the said plates are mounted in a generally parallel relationship on the main tubes, and connecting at least one pair of ends of the main tubes with a generally U-shaped connector tube having a mill stock finish. The ends of the connector tube are of such size relative to the ends of the main tubes that the U-shaped connector tube may have each of its two tube ends telescopically assembled with a respective one of the pair of main tube ends, thereby forming a connection consisting of two joints each including one tube end inserted in another tube end. A radially inwardly directed bead is formed on the larger diameter tube end of each proposed joint, which bead is spaced from the adjacent open end of the larger diameter tube end to define a socket between the open end and the bead. The socket has an inside diameter equal to the inside diameter of the remainder of the tube in which it is formed, and has an interior surface having a mill stock finish. Each tube end of the connector tube is telescopically assembled with an associated one of the pair of main tube ends to bring the smaller diameter tube end of each joint into abutting relation with an associated bead. A bonding material is applied around each end portion of the smaller diameter tube end of each joint and generally adjacent the open end of the larger diameter tube end of each joint. Each joint is then heated to cause the bonding material to flow and thereby to run into any space between the end portion of each main tube to be connected and the associated end portion of the end of the connector tube. Each joint is thereafter cooled to solidify the bonding material.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of an evaporator or condenser unit constructed in accordance with the method of the present invention.

FIG. 2 is a somewhat enlarged fragmentary plan view of the remote end of the unit of FIG. 1.

FIG. 3 is a somewhat enlarged fragmentary longitudinal sectional view through a tube to be connected and shows the tube after a socket has been formed therein.

FIG. 4 is a somewhat enlarged fragmentary view of a partially completed socket joint.

FIG. 5 is a fragmentary view showing a completed socket joint.

FIG. 6 is a longitudinal sectional view through the socket joint of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED METHOD

The method of the present invention is illustrated with reference to an evaporator or condenser coil particularly adapted for use in refrigeration apparatus.

Referring now to the drawing, and particularly to FIGS. 1 and 2, an evaporator or condenser coil utilizing tubes joined in accordance with the invention and indicated generally at 10 comprises a plurality of generally similar parallel fin and tube sections connected in series between a fluid inlet 12 and a fluid outlet 14 to provide a passageway for suitable fluid medium. The length and number of sections in a coil may vary in accordance with the heat transfer requirements of the apparatus with which it is to be used. However, the illustrated coil 10 includes four sections, typical sections being generally indicated at 16, 16. Each section 16 includes elongated parallel tubes 18, 18 which carry a longitudinal spaced series of transversely disposed heat exchange plates or fins 20, 20. Support plates 22 and 24 receive the end portions of the tubes 18, 18 there-through and maintain the sections 16, 16 in generally parallel relation each to the other and to the other two sections which comprise the coil 10. One or more additional support plates such as indicated at 26 may be provided, if desired, to engage the tubes intermediate the fins to impart further rigidity to the structure.

The tubes 18, 18 in each section 16 are integrally connected in pairs. Specifically, each tube 18 is joined at one end to another tube 18 in the same section by an integral U-bend portion 28 as shown in FIG. 1. At its other end each tube 18 is connected to one end of a generally U-shaped connector tube 30 at a socket joint generally indicated at 32. The other end of the connector tube 30 is joined to another tube in an adjacent section at another joint 32. The tubes 18, 18 and their associated connecting tubes 30, 30 are preferably made from aluminum and in the description of operations which follows the present invention is illustrated with particular reference to a method for joining the ends of aluminum tubes.

The coil 10 is assembled by supporting the various plates and fins in aligned and spaced relation while the various tubes are thrust therethrough. The integrally connected tubes 18, 18 are inserted in pairs through the support plate 22 and have end portions 34, 34 which extend for some distance beyond the support plate 24. Preferably the fins and tubes are retained in permanently assembled relation by expanding the tubes after the fins have been positioned thereon. This expan-

sion operation may, for example, be carried out by applying a pressure fluid to the tubes and, if desired, the support plates 22, 24, and 26 may also be permanently assembled with the tubes by this expansion operation.

Each connector tube 30 has ends of sufficiently less diameter than the ends of the tubes to be connected so that each end of the connector tube can be inserted into an associated end of a tube to be connected. Where an aluminum soldered joint is to be provided, as in the illustrated case, it is preferable that the outside diameter of the connecting tube 30 be from 0.010 to 0.030 inches smaller than the inside diameter of each associated tube 18 to be connected to insure formation of a sound joint.

The progressive steps for making a typical socket joint 32 are illustrated in FIGS. 3-6. A socket 36 is first provided in the end portion 34 by forming a radially inwardly directed bead 38 on the tube 18 spaced from the end thereof. The bead is formed by rolling or otherwise forming an external groove 40 in the tube 18 either before or after the tube has been assembled with the various fins and support plates. The socket 36 has a lip 42 which is provided by applying a suitable tool to the end of the tube 18 to widen or slightly flare the open end thereof so that the end of the connector tube 30 may be easily inserted therein.

At this point it should be noted that the socket 30 is formed without exposing the interior surface thereof beyond the lip 42 to contact with a forming or expanding tool or the like. Thus, the interior surface of the socket 36 retains its mill stock finish. It should be further noted that each end portion of the connector tube 30 also retains a mill stock finish, since no forming operations are performed thereon. A mill stock finish is generally free of embedded impurities and does not require abrasive type cleaning preparatory to soldering, therefore, in the exercise of the present method such cleaning operations are unnecessary. However, for best results it is desirable to preclean the surfaces to be joined to remove any surface oil, grease, or other foreign matter and for this purpose a suitable hydrocarbon solvent is preferably used.

A suitable flux is preferably applied to the surfaces to be joined and this operation may be most conveniently performed before the connector 30 is inserted into the socket 38. A reactive flux of the zinc chloride base type is preferably employed.

The connecting tube 30 is inserted into the socket 36 to bring the end thereof into abutting relation with the bead 38 as shown in FIG. 6. Thereafter, a ring of thermal fluid welding material or aluminum solder 44 is applied to the flared end of the tube 18 and around the connecting tube 30, the position of the solder ring being shown in FIG. 4. Since the capillary action of the aluminum solder is generally poor, it is desirable to support the tube 18 in a generally axially vertical position before sufficient temperature is applied to melt the solder and run it into the space between the associated end portions of the tubes.

The narrow spread between the melting ranges of aluminum solder and aluminum alloys make control of soldering temperature amdnatory. The high thermal conductivity of aluminum requires rapid application of heat in order to insure adequate temperature in the area to be soldered. Preferably a soldering temperature in the range of 720° and 800° F is maintained. The soldering operation may be carried out in various ways as,

for example, by radiant heating, electrical resistance heating or by the controlled application of a torch. However, in accordance with one preferred method of practicing the invention the joints 32, 32 are heated by applying an induction heating means.

The solder will displace the flux as it runs into the joint, thereby causing some flux residue in the tubes. Due to the corrosive nature of the flux this residue must be removed after the joint has cooled sufficiently to achieve fluid tight solidification of the welding material with the associated end portions of the tubes. This flux residue is preferably removed by circulating a suitable washing fluid through the connected tube structure. Water at a temperature of at least 190° F has proven generally effective for this purpose. However, if the amount of flux residue formed is heavy it may be desirable to circulate a 5 percent ammonia solution through the tube structure to effect this cleaning operation.

While the method of the present invention had been illustrated with reference to aluminum tube joint constructions it should be understood that the aforescribed method may be advantageously employed to join tubes made from other materials. More particularly, the present method is applicable to constructions wherein the end portions of tubes are to be connected at bonded joints and wherein it is desired that the associated joint surfaces to be bonded together be substantially free of embedded impurities. Thus, joint constructions made from aluminum or other tubing and secured by a suitable bonding material, as, for example, a thermo setting resin or epoxy compound may be made in accordance with the present method and such constructions are contemplated within the scope of the invention. Where a thermo setting bonding compound is used a temperature will generally be applied to flow the bonding material in the joint and to cure it. However, this temperature will generally be somewhat lowered than the temperature applied when a solder or like welding material is employed.

A preferred method for practicing the invention is illustrated and described, but it will be understood that various changes may be made from the method disclosed and that the drawings and description are not to be construed as defining or limiting the scope of the invention, the claims forming a part of this specification being relied upon for that purpose.

I claim:

1. In a method for making an evaporator or condenser construction for refrigeration apparatus the steps of providing at least two elongated main metal tubes defining a plurality of main tube ends, each of said main tubes having substantially uniform inside and outside diameters throughout the length thereof and having a mill stock finish, providing at least one generally U-shaped connector tube having substantially uniform inside and outside diameters throughout the length thereof and a mill stock finish and defining a pair of connector tube ends, said main tube ends and said connector tube ends having such relative inside and outside diameters that said U-shaped connector tube may have each of its two tube ends telescopically assembled with an associated one of said main tube ends to form a connection consisting of two joints each involving one tube end inserted in another tube end, thrusting said main tubes through heat exchanged plates and in general parallel relation, forming only a radially inwardly directed bead on the larger diameter

tube end of each proposed joint and which bead is spaced from the adjacent open end of said larger diameter tube end to define a socket between said open end and said bead, said socket having an inside diameter equal to the inside diameter of the remainder of the tube in which it is formed and an interior surface having a mill stock finish, assembling each tube end of said connector tube telescopically with an associated one of the pair of the pair of main tube ends to bring the smaller diameter tube end of each joint into abutting relation with an associated bead, applying a solder bonding material around each end portion of said smaller diameter tube end of each joint and generally adjacent the open end of said larger diameter tube end of each joint, heating each joint to cause said bonding material to flow and thereby to run it into any space between the end portion of each tube to be connected and the associated end portion of the end of the connector tube and cooling each joint to achieve fluid type solidification of the bonding material.

2. The method as set forth in claim 1 wherein the step of forming only a radially inwardly directed bead is further characterized as forming said bead on each of said main tubes.

3. The method as set forth in claim 1 wherein the step of forming a radially inwardly directed bead is further characterized as rolling an external groove on the larger diameter tube end of each proposed joint spaced from the adjacent open end thereof.

4. The method as set forth in claim 1 including the additional step of applying a tool to said open end of said larger diameter tube end to flare said open end thereof to receive said smaller diameter tube and easily.

5. The method set forth in claim 4 wherein the step of applying said bonding material is further characterized as applying said bonding material to the flared end of said larger diameter tube end and around said smaller diameter tube end.

6. The method set forth in claim 5 including the additional step of applying flux to the exterior surface portion of said other tube and the interior surface portion of said one tube at the end portions thereof before the step of applying said bonding material, and circulating washing fluid through the connected tubes to remove excess flux therefrom after the step of heating.

7. The method as set forth in claim 4 including the additional step of supporting said main tubes in an axially vertical position before the step of heating each joint.

8. The method as set forth in claim 1 wherein the step of heating is further characterized as heating each joint with induction heating means.

9. The method as set forth in claim 1 wherein said tubes are aluminum and including the additional step of cleaning the associated end portions of said tubes with a hydrocarbon solution.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,750,248

Dated August 7, 1973

Inventor(s) Herbert R. Morris

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

Col. 3, line 63, "amdnatory" should be --mandatory--.

Col. 4, line 19, "had" should be --has--.

Col. 4, line 37, "lowered" should be --lower--.

Col. 5, line 9, delete "of the pair" (second occurrence)

Col. 5, line 21, "stop" should be --step--.

Col. 6, line 4, "and" should be --end--.

Signed and sealed this 30th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents