April 15, 1958 G. R. REITER 2,830,363

METHOD FOR MAKING A TUBULAR ELEMENT

Filed April 15, 1954 3 Sheets-Sheet 1

FIG. 1

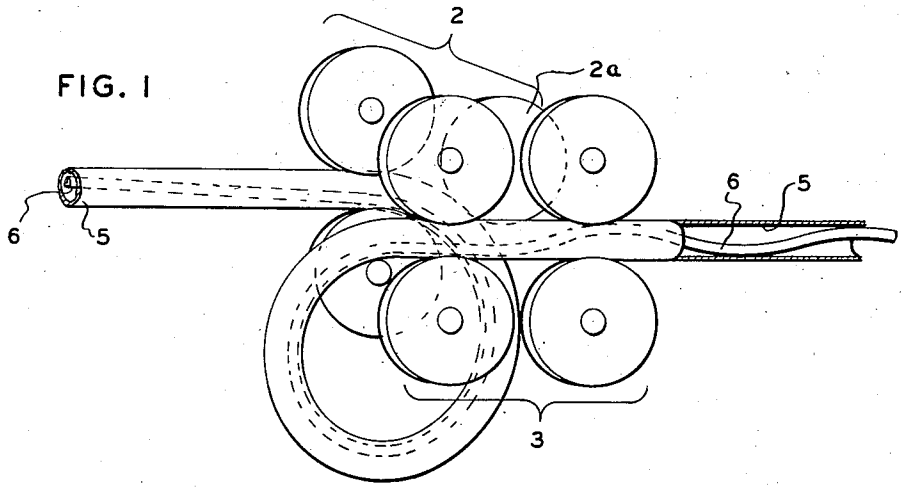


FIG. 2

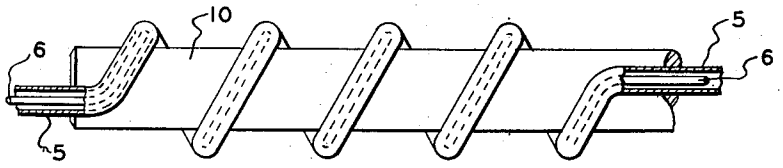


FIG. 3

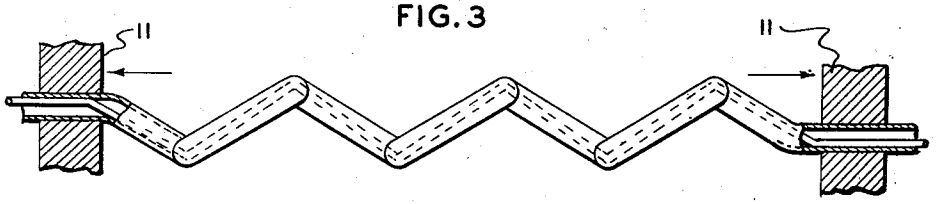
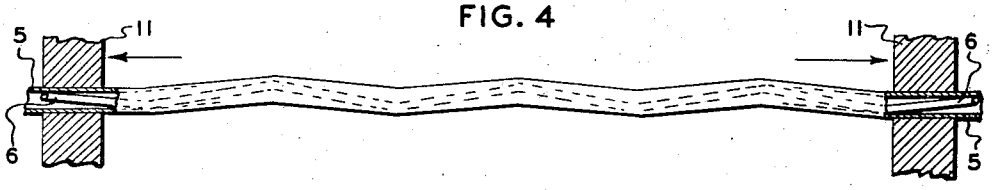


FIG. 4



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April 15, 1958 G. R. REITER 2,830,363

METHOD FOR MAKING A TUBULAR ELEMENT

Filed April 15, 1954 3 Sheets-Sheet 2

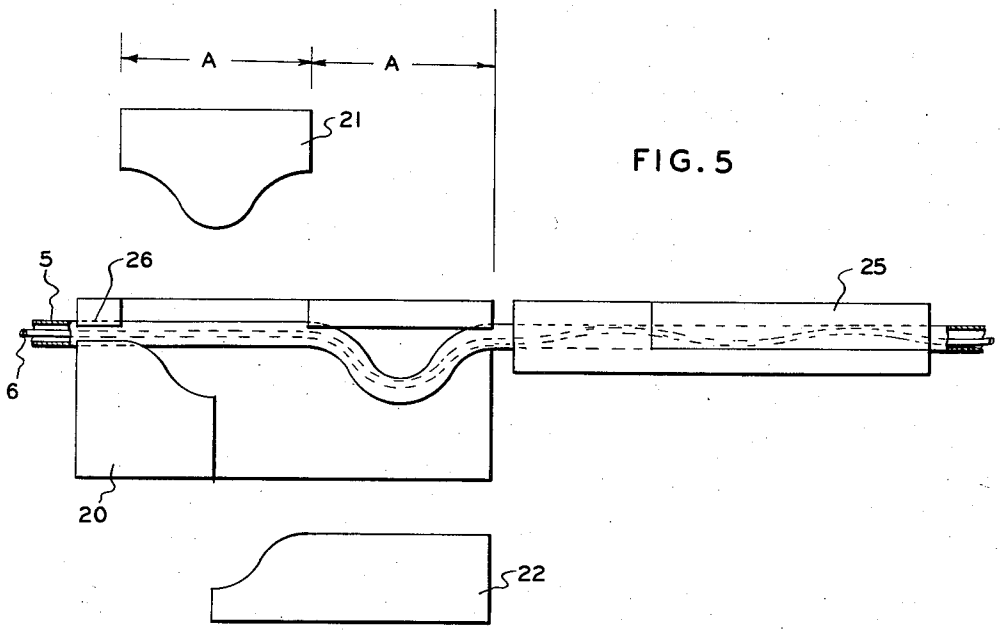
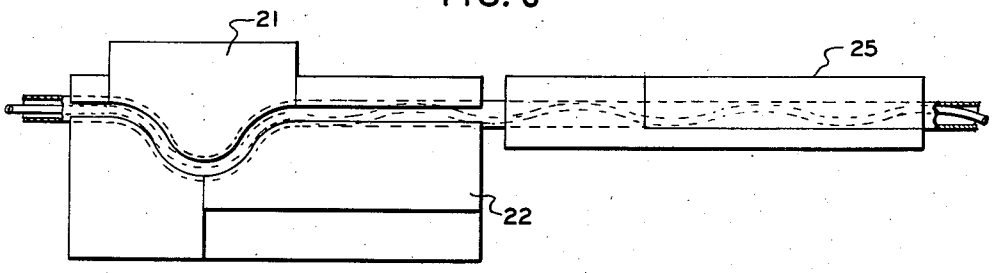


FIG. 5

FIG. 6



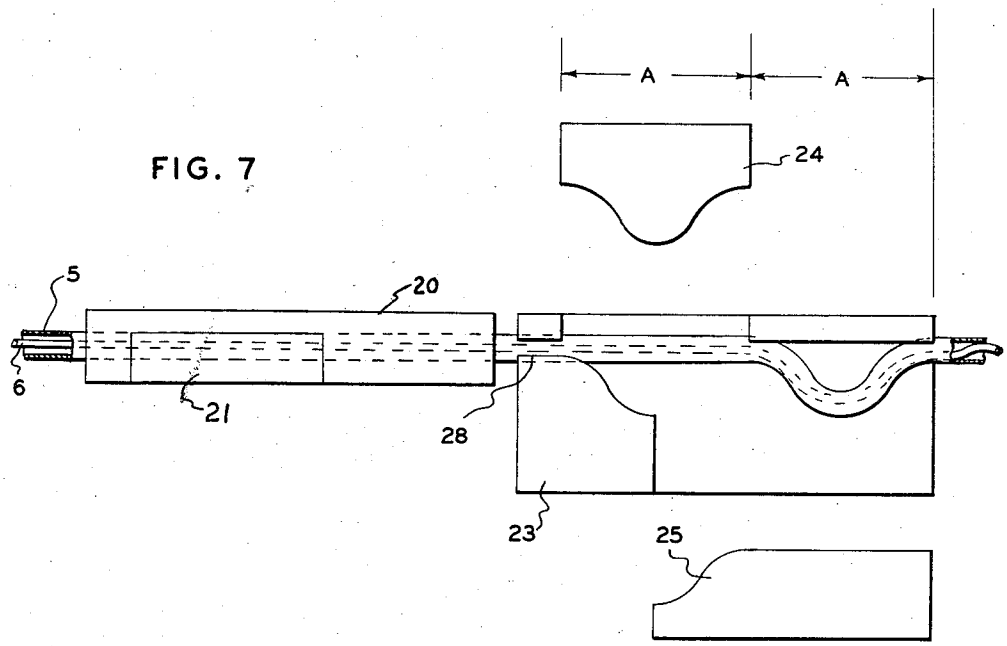
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April 15, 1958 G. R. REITER 2,830,363

METHOD FOR MAKING A TUBULAR ELEMENT

Filed April 15, 1954 3 Sheets-Sheet 3

FIG. 7



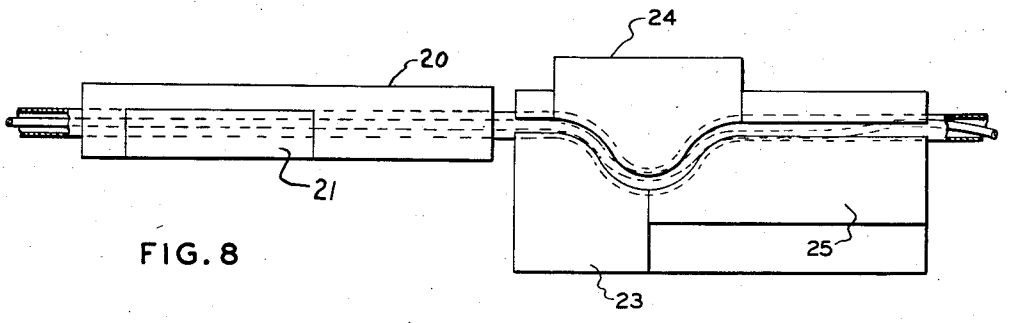


FIG. 8

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2,830,363

METHOD FOR MAKING A TUBULAR ELEMENT

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Application April 15, 1954, Serial No. 423,345

2 Claims. (Cl. 29—517)

This invention relates to a method and apparatus for making a tubular element which consists of a spiral or curved member, such as a wire or tube, disposed in a tubular member.

This invention has many applications, such as to provide a heat exchanger; a vibration damper for tubes; a pump element of the Archimedes screw-type; a coaxial cable, etc. While this invention thus has many applications, it will be described herein as applied to a bi-tubular heat exchanger for use in a refrigeration system.

It is desirable in refrigeration systems to place the capillary restriction in heat exchange relation with the suction line since this increases the efficiency of the refrigeration system. This has been accomplished heretofore by wrapping the capillary tube about the outside of the suction line or placing the capillary tube in metal bond contact with the suction line. However, these arrangements are expensive and unless carefully constructed may not provide the desired heat exchange relation between the elements.

The present invention provides an improved heat exchanger particularly adapted to provide heat exchange relation between the suction line of a refrigeration system and the capillary tube. Not only does the present invention contemplate disposing the capillary tube inside of the suction line, but it also embodies the idea of insuring that the capillary tube is always in contact with some portion of the inner wall of the suction tube. This is accomplished by the method and apparatus of the present invention.

By placing a spiral or curved capillary tube in contact with the inner wall or surface of the suction tube along all points of the capillary tube, the amount of heat exchange is increased since there is not only heat exchange relation between the capillary tube and the fluid flowing through the suction line but there is also heat exchange between the capillary tube and the suction tube, the latter being metal-to-fluid-to-metal heat exchange due to a film of oil building up between the capillary tube and the suction tube from the oil that is in the refrigeration system. This produces a more efficient heat exchanger.

It will be understood, of course, that this particular type of heat exchanger wherein a curved tube is disposed inside of a straight tube could be employed in situations other than a refrigeration system. It results in giving not only fluid-to-metal heat exchange, which normally results from placing a tube inside of a second tube through which fluid flows, but also metal-to-fluid-to-metal heat exchange.

A primary object of the present invention is to provide a more efficient heat exchanger.

Another object of the invention is to provide a spiral or curved member inside of a straight member with the curved member always being in contact with the inner wall or surface of the straight member.

Further objects and advantages of the invention will

become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of this invention, the method thereof for forming a spiral member inside of a straight tubular member comprises the steps of placing a first straight member inside of a second straight tubular member, curving both members while thus assembled in a predetermined way, and the straightening of the assembly which straightens the second member and leaves the first permanently curved within the second.

There is also provided apparatus for forming a curved member inside a straight hollow member including means to dispose a first longitudinal member inside a second longitudinal hollow member, means to curve the members in a predetermined way, and means to straighten the second member leaving the first member permanently curved.

For a better understanding of this invention, reference may be had to the accompanying drawings, in which:

Fig. 1 is an elevation view partly in section of one form of apparatus that may be employed to manufacture a bi-tubular assembly, as a heat exchanger;

Fig. 2 is an elevation view partly in section of a modified form of apparatus;

Fig. 3 is an elevation view partly in section of the partial straightening step of the apparatus shown in Fig. 2;

Fig. 4 is an elevation view partly in section of the complete straightening step of the apparatus shown in Fig. 2;

Fig. 5 is an elevation view of another form of apparatus for making the heat exchanger;

Fig. 6 is an elevation view similar to Fig. 5 showing the parts in operative position;

Fig. 7 is a plan view of the apparatus shown in Fig. 5; and

Fig. 8 is a plan view similar to Fig. 7 showing the parts in operative position.

Referring to the drawings and particularly Fig. 1, one embodiment of apparatus constructed in accordance with this invention comprises a first set of rollers **2** and a second set of rollers **3** spaced from the first set of rollers **2**. These rollers coact to make a bi-tubular element comprising a tubular member **5** having disposed therein a second tubular heat exchange member **6**. The rollers of the first set of rollers **2** are so disposed with respect to each other that they will bend or curve the longitudinal hollow straight member **5** and the straight member **6** inserted in the member **5** as the combination is passed through the rollers. The first set of rollers curves or bends members **5** and **6** to such an extent that they are both deformed. It will be understood that the inner member **6** is disposed inside of the outer member **5** prior to passing the members through the first set of rollers **2**.

The members **5** and **6**, which have been curved by the first set of rollers **2**, then pass through the second set of rollers **3**, which are designed tto straighten the outer member **5**. The roller **2***a* of the first set of rollers **2** is disposed in a different plane than the plane of the other rollers of the set to prevent the members **5** and **6** from circling back into their own feed path to the rollers **2** and to aid in spiraling the members **5** and **6** toward the second set of rollers **3**. The first set of rollers **2** form the members **5** and **6** in a shape corresponding to a cylindrical spiral. The second set of rollers **3** is in a plane at an angle to the plane of the first set of rollers so that the members **5** and **6** will spiral into the second set of rollers **3**. The position and angle of rollers **3** depend on the mechanical tightness and angle of rollers **2** and **2***a*. The exact angular relationships are not important provided the end of the spiraling tube enters rollers **3**,

The inner member **6**, which has been deformed, as previously stated, by the first set of rollers **2**, retains at least part of its curvature while passing through the second set of rollers **3** since the outer diameter of inner member **6** is less than the inner diameter of outer member **5** so that the second set of rollers **3** cannot directly exert a positive displacement on the inner member **6** to straighten it. After passing through the second set of rollers **3**, the outer member **5** is again straight while the inner member **6** is curved. The inner member **6** is so curved by the set of rollers **2** that it is in contact at all points with the inside wall of the outer member or tube **5**.

Another embodiment of the invention involves wrapping the outer member **5** and the inner member **6** about a mandrel **10** after the inner member **6** has been disposed inside the outer member **5**. The members **5** and **6** are then removed from the mandrel or the mandrel may be removed from inside of the members **5** and **6** depending on the desired operation. By curving the members **5** and **6** about the mandrel **10**, the members **5** and **6** are curved or deformed in the form of a cylindrical spiral. It is then necessary to straighten the outer member **5** to provide the desired heat exchanger. Suitable force applied lengthwise of the spiral or in other words parallel to the axis thereof, as indicated by the arrows in Figs. 3 and 4, may be applied to members **11** attached to each end of the outer member **5**. The force required to straighten the outer member may be applied in two straightening operations, as shown in Figs. 3 and 4, or in a single straightening operation, if desired. At the completion of the straightening step, the inner member **6** is curved or spiraled inside of thte outer member **5** with the inner member **6** always being in contact with some portion of the inner wall of outer member **5**.

It will be understood that the same steps are performed by the apparatus of Fig. 1 as the apparatus of Figs. 2–4. Thus, the first set of rollers **2** of Fig. 1 spirals the members **5** and **6** similar to the bending of the members **5** and **6** about the mandrel **10** of Fig. 2. The second set of rollers **3** of Fig. 1 straightens the outer member **5** while this operation is performed in Figs. 3 and 4 by applying force to the members **11**.

Figs. 5 to 8 disclose a third apparatus for forming a curved member inside of a straight tube. This apparatus includes a first stationary die **20** and a pair of cooperable movable dies **21** and **22** and a second stationary die **23** and a pair of cooperable movable dies **24** and **25**. The stationary die **20** has an opening **26** through which the members **5** and **6** are fed into the stationary die. It will be understood that the inner member **6** has been disposed inside the outer member **5** prior to passing into the opening **26**. When the members **5** and **6** pass through the stationary die **20**, the movable die **22** and then die **21** are moved toward each other and toward the stationary die to impart a discontinuous curved or substantially sinusoidal shape to the inner and outer members or tubes. The members **5** and **6** then index the distance A in the first stationary die **20** and when the die next closes the curved portion of the outer member **5** is straightened, the inner member **6** is partially straightened but remains curved since its outer diameter is less than the inner diameter of outer member **5** so that the dies cannot completely straighten member **6**.

To insure that the outer member **5** is straight before being acted upon by the second set of dies the members **5** and **6** pass through an opening **28** in the stationary die **23**. The movable die **25** and then die **24** are moved toward each other and toward the stationary die **23** to bend the inner and outer members to a discontinuous curved or substantially sinusoidal shape. However, it will be observed that the second bending occurs at right angles to the plane of the original bend since the plane of the second stationary die **23** and its movable dies is at right angles to the plane containing the first stationary die **20** and its movable dies. The peaks of the second curve or sinusoid fall halfway between the peaks of the first curve or sinusoid on the member **5**. The members **5** and **6** then index the distance A to pass to the second section of the second stationary die where the outer member **5** is restraightened similar to the operation in the first stationary die **20**. However, the combination of the two sinusoid curves is still imparted to the inner member **6** so that the inner member **6** is in substantial contact with the inner wall of outer member **5** along the entire length of the inner member **6**. It will be understood that the sinusoid bends could be performed manually rather than in a press, if desired.

The present invention may be employed not only to form a heat exchanger having a spiral or curved member inside of a tubular member but also may be employed anywhere that it is desired to form a spiral member inside of a tubular member. For example, an effective vibration damper for a tube may be constructed by spiraling a wire or small tube inside an outside tube by this invention. Similarly, a pump element of the Archimedes screw-type may be produced by spirally locating a tube or wire inside a tube. Another use may be to form a coaxial cable by spiraling a central conductor with spaced insulations inside of an outer tube so that the springback of the conductor holds the insulators in place. It will be obvious that the method and apparatus of this invention may be employed to form other similar suitable devices.

The present invention has the advantage of eliminating one exposed tube in a refrigerator since the capillary tube is disposed inside the suction tube. It also will be understood that the spring of the inner member against the outer member may be sufficient to permit the inner member to remain in contact with the outer member even though the outer member is later curved or bent to be guided around obstructions or to conform to manufacturing practice.

It should be understood that the completed apparatus including the generally spiraled inner member could be shaped into a curved or looped configuration for heat exchange purposes and, in fact, can be left in that combination merely through terminating the straightening step somewhat short of a completely straight outer member or tube.

While the present invention has been described by reference to a particular embodiment thereof, it will be understood that modifications may be made by those skilled in the art without actually departing from the invention. I, therefore, aim in the appended claims to cover all such variations as come within the true spirit and scope of the foregoing disclosure.

I claim:

1. The method of producing an article of manufacture comprising a substantially straight tubular member having therein a spiralled tubular member of smaller diameter than said straight member which comprises the steps of placing a first straight tubular member loosely inside a second straight tubular member, bending the assembly of said members into the form of a cylindrical spiral and thereafter applying a straightening force to said second tubular member sufficient to substantially straighten the second tubular member, said straightening operation applied to said second member causing said second member to contact portions of said first member and cause said first member to become spirally arranged within the substantially straight second tubular member and in contact with portions of said second member.

2. The method of claim 1 in which the straightening force is applied in a direction substantially parallel to the axis of said cylindrical spiral.

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5

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