United States Patent [19]

Walker

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[54] **METHODS OF ASSEMBLING TUBE SUPPORTS**

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[73] Assignee: **Hick, Hargreaves and Company Ltd.**, Bolton, England

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[52] **U.S. Cl.** ..... **29/455**, 138/112, 165/162, 248/68 R

[51] **Int. Cl.** **B21d 39/00**, F28d 7/00

[58] **Field of Search** ..... 29/455, 433, 278, 241, 29/157.3, 270; 248/49, 68 R, 54 R; 165/162, 172; 138/112, 106, 107; 81/3 J

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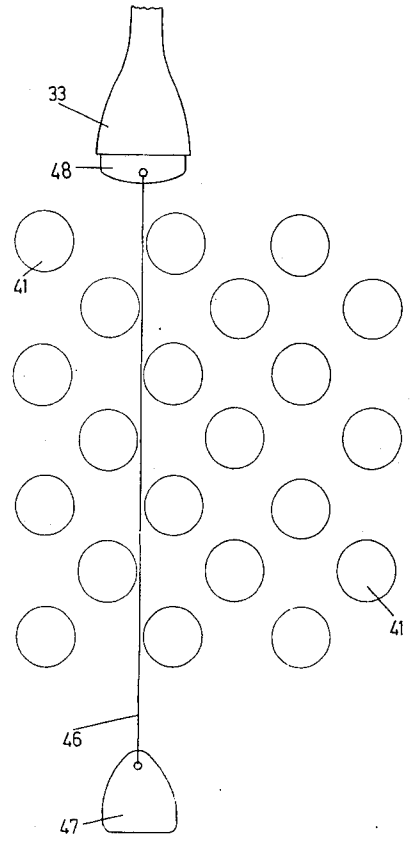
Assistant Examiner—Daniel M. Yasich
Attorney, Agent, or Firm—Eric H. Waters

[57] **ABSTRACT**

Tubes of a condenser or the like are supported by resilient tubing threaded, while in a flattened evacuated state, between the tubes and then allowed to return to its normal shape to press against the tubes. The tubing is sealed at one end by a detachable clip, or by a plate which stretches the tubing end flat, and the clip or plate is pulled through the tube bundle by a line fed between the tubes by gravity. Alternatively the tubing end is clamped by a tool which is remotely manipulated to push the tool and tubing between the tubes and then to release the tubing end. The tool comprises two relatively pivotable clamping plates each provided with a manipulation rod. The tubing ends are secured in a perforated block at the periphery of the tube bundle, by plugs engaging the tubing ends in the perforations of the block.

3 Claims, 12 Drawing Figures



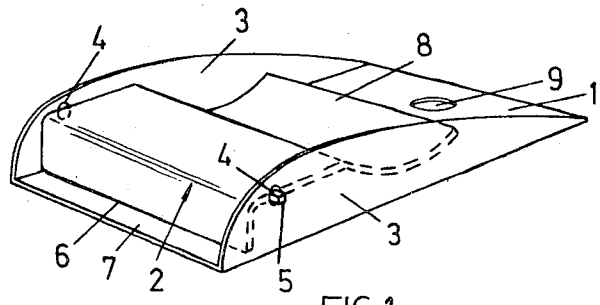


FIG.1

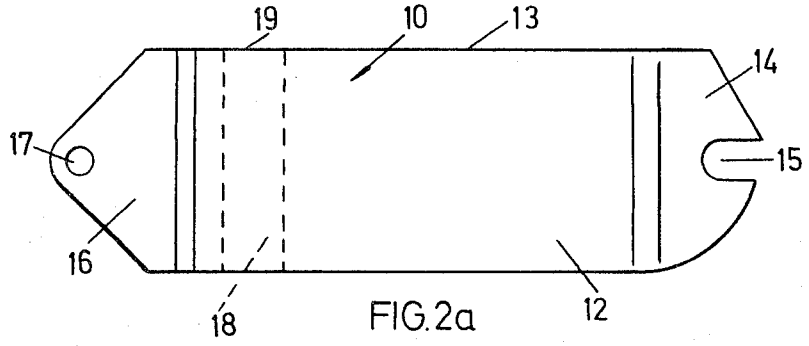


FIG.2a

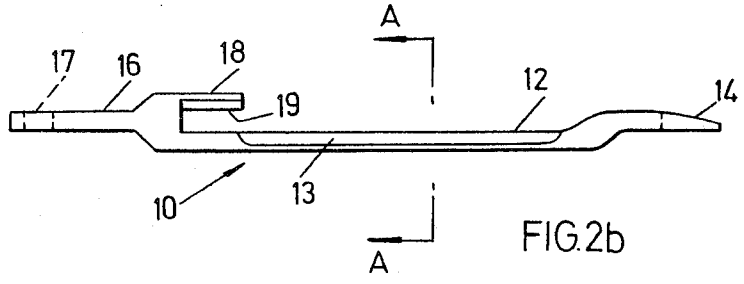


FIG.2b

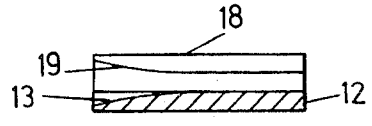


FIG.2c

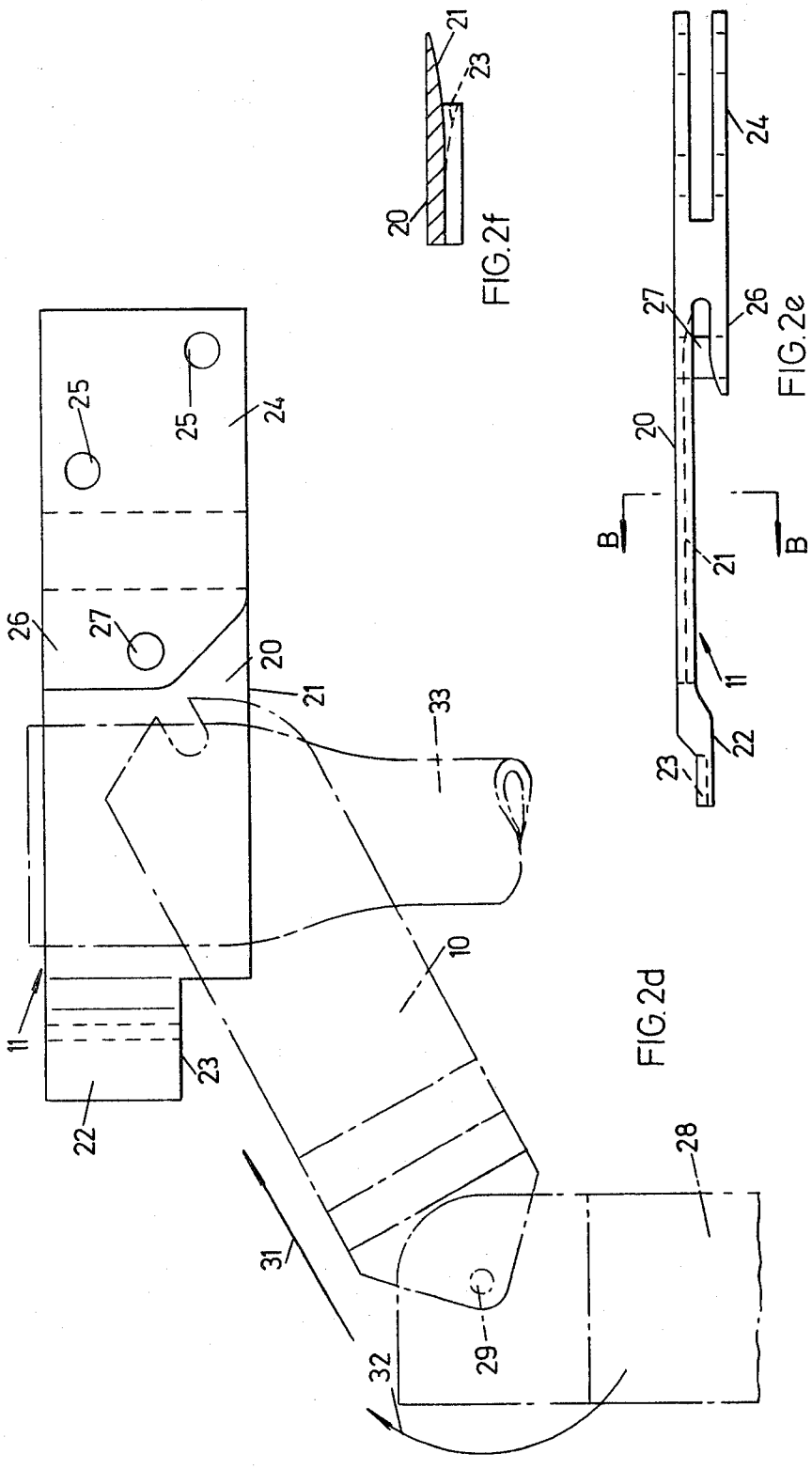


FIG. 2f

FIG. 2e

FIG. 2d

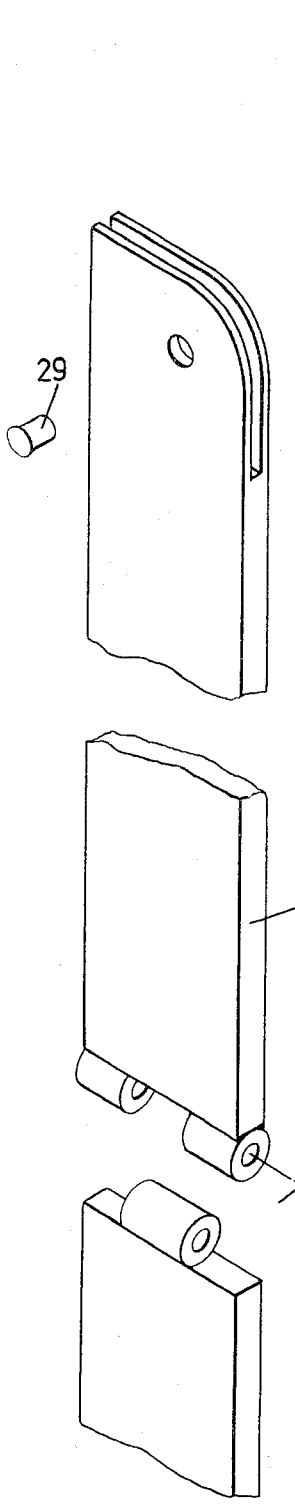


FIG. 2g

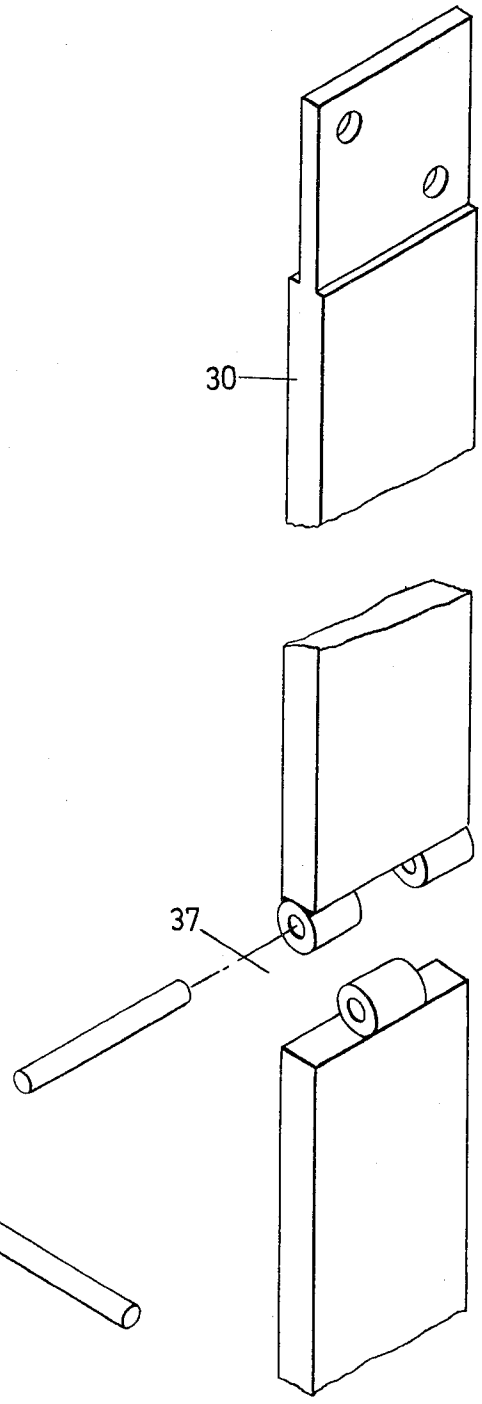


FIG. 2h

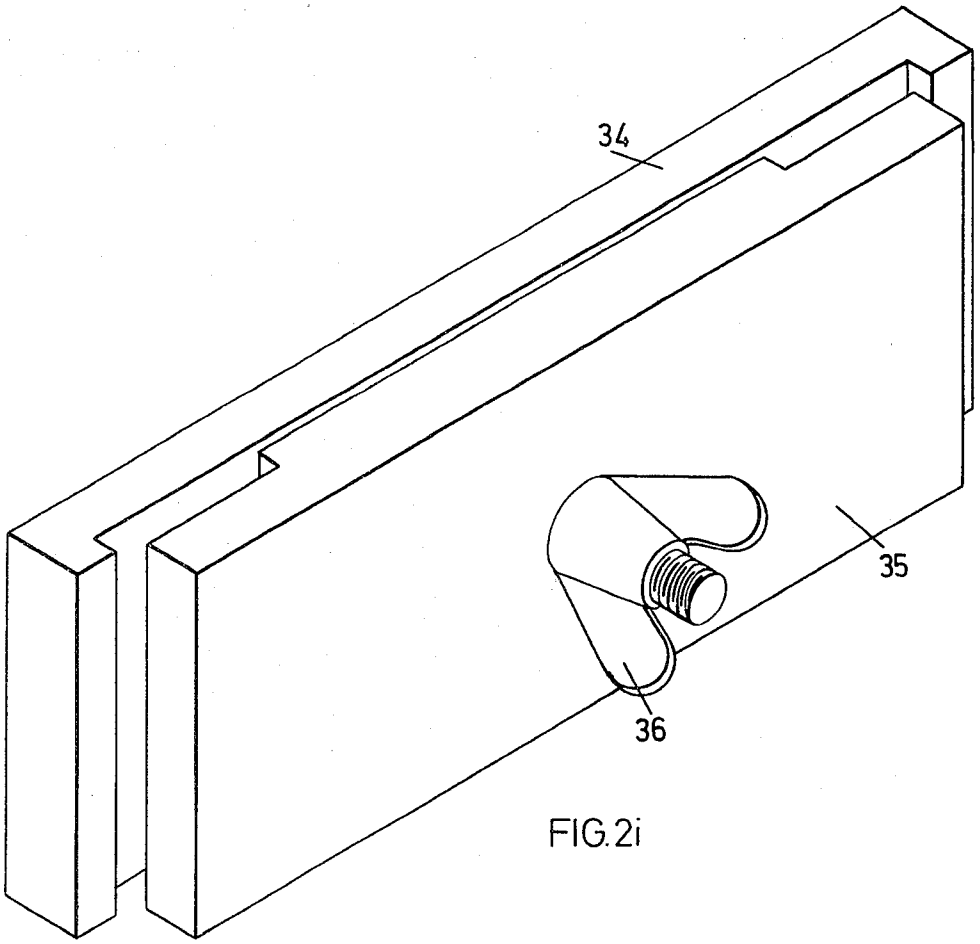


FIG.2i

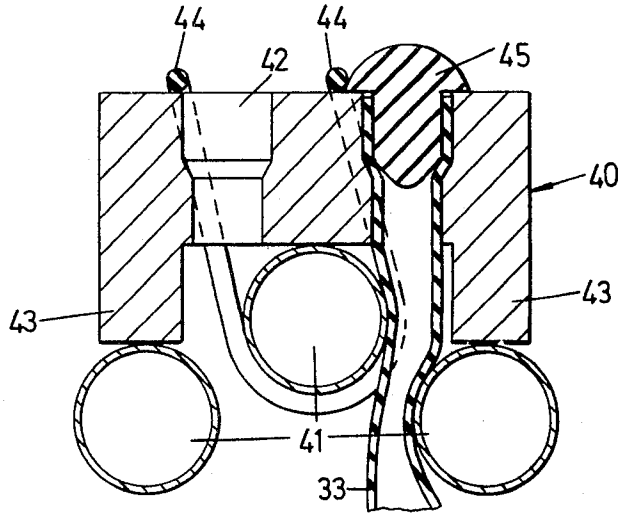


FIG.3

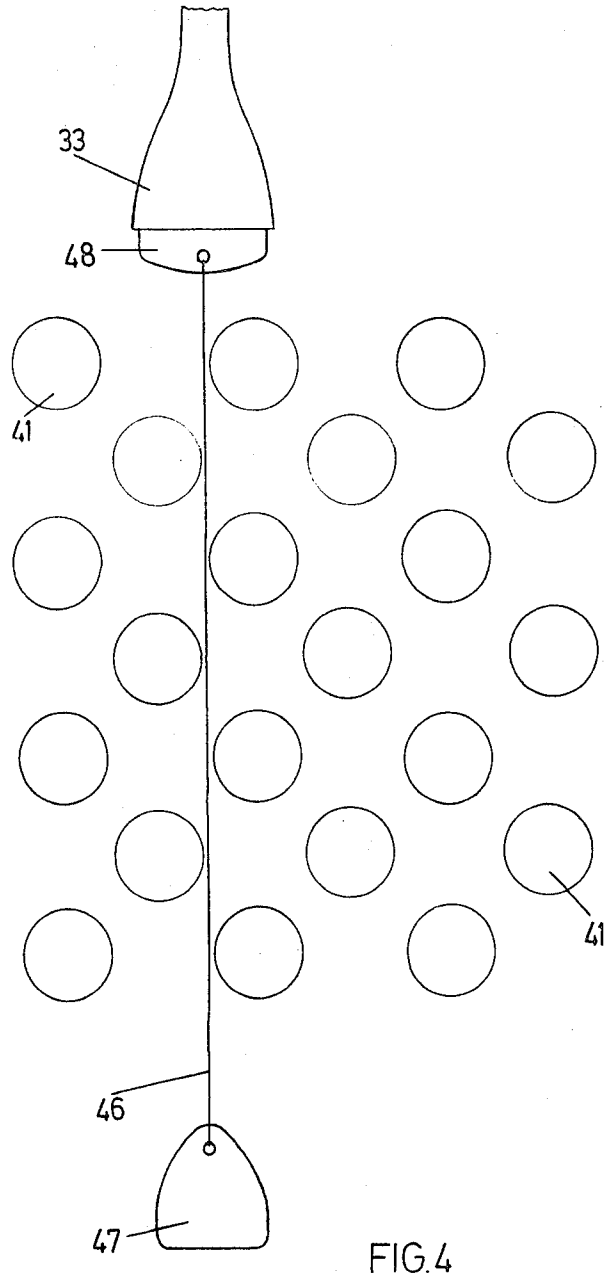


FIG.4

METHODS OF ASSEMBLING TUBE SUPPORTS

Our British Pat. No. 1188564 relates to a heat exchanger, condenser or other heat exchanged apparatus comprising a tube bundle, wherein the tubes are supported at least partly by resilience of interposed flexible resilient tubing extending generally transverse to and in contact with the tubes, the tubing at least partly embracing the external surface of each tube. Specification No. 1188564 also relates to a method of assembling such apparatus, wherein the tubing is sealed and evacuated whereby the evacuated tubing becomes flattened so that it is easily threaded between the tubes, and the vacuum is then broken, the tubing being impervious to gas. It will be understood that when the vacuum is broken, the flattened tubing will return to its original unflattened state and will therefore press against the tubes by virtue of its resilience, its diameter being greater than the spacing between the tubes.

The present specification is concerned with developments of the aforesaid method, enabling the same to be put into practice.

According to one form of the aforesaid method, one end of the tubing is sealed by a connection member, e.g., a detachable clip, by means of which the tubing is pulled between the tubes of the apparatus. The other end of the tubing is sealed in any convenient way. Preferably the clip is a self-locking over-centre device.

Alternatively said connection member may be a flat rigid strip e.g. of metal inserted into the said end and of such dimensions as to stretch the tubing essentially flat at the end; the strip therefore forms an at least partial seal, which can be completed if necessary by an adhesive or sealing medium. The said strip is then used to pull the tubing between the tubes of the apparatus.

More specifically, where access is available, say, at top and bottom, or both sides, of a tube bundle, a line e.g., of nylon or similar material is first passed through the bundle, e..g., by attaching the line to a thin flat plate and allowing the plate to fall by gravity, through the bundle. The other end of the line is then attached to a connection member as described above and the evacuated tubing is pulled through and into position in the tube bundle.

Occasionally a tube bundle has staybars, positioned in such a way as to prevent passing of the said thin flat plate and to overcome this problem the following method is adopted. A flexible chain of ball and socket or ball and connecting pin construction having suitable diametral dimensions and sufficient mass to allow the chain to pass by gravity through the tube bundle is fed around the staybar. The chain is passed through the tube bundle and draws behind it a line by means of which the evacuated tubing is drawn through the tube bundle.

Depending on the design of particular heat exchangers it is sometimes not possible to have access at opposite sides of a tube bundle if for example a baffle plate is adjacent and close to one or more sides of a tube bundle. For installation of the tubing in these circumstances the following method is in accordance with the present invention. An insertion tool made in two or more parts, thin enough to pass through the tube bundle between the tubes, is fitted onto the end of a length of resilient tubing. This causes the end of the resilient tube to be sealed and allows the tubing to be evacuated and therefore collapsed into a flat section. The other

end of the tubing is sealed e.g. by a laboratory type pinch clip. The collapsed tubing is pushed into the required position by manipulation of the tool and the insertion tool is removed and withdrawn from the resilient tube bundle leaving the tubing in the tube bundle, the tubing tending to return by virtue of its resilience to its normal circular cross section and thus providing support by making intimate contact with the two rows of tubes between which it passes.

Frequently it is not possible to use a rigid insertion tool because of the limiting confines of the heat exchanger body and in such cases an insertion tool is used having hinges along its length, the hinges being so spaced as to allow the tool to be fed into the tube bundle from a confined space.

The insertion tool consists of two preferably flat clamping members of which one is pivotable on the other between a first position in which the two members are face to face and form a clip or clamp for sealing the end of the tubing, and a second position in which the tubing is released from between the members or can be inserted for subsequent gripping by the members. Push-rods or bars can be attached to either or both of the members.

According to yet another aspect of the invention, the tubing after insertion between the tubes is secured by one or more perforated blocks, strips or sheets through the perforations in which the tubing passes and which preferably bear against the outer tubes, the tubing being so secured that it cannot move from the perforation back into the tube bundle, e.g. by means of plugs in the tubing ends.

The present invention will be further described with reference to the accompanying drawings, in which:

FIG. **1** shows in perspective a clip used for sealing and manipulation of the end of flexible rubber tubing;

FIGS. **2***a* to **2***i* show a tool for sealing the end of the flexible rubber tubing and inserting the tube between tubes of a condenser or the like;

FIG. **3** shows in cross-section a tubing-retaining block; and

FIG. **4** shows schematically the threading operation.

FIG. **1** shows a clip made of steel, consisting of a channel-section member **1** and a hinged member **2** pivoted between the flanges **3** of the member **1**. These flanges have pivot holes **4** near their edges near one end of the member **1** which receive lugs **5** projecting from the edges of the member **2** so that the latter can pivot between the flanges. The member **2** at its end adjacent to the lugs **5** has an end flange **6** at right angles to the body of the member and, in the clamping position shown in FIG. **1**, substantially at right angles to but slightly spaced from the web portion **7** of the channel-section member **1**. The other end of the member **2** is provided with a concave tongue **8** which forms a grip by means of which the member can be lifted and also acts as a stop to limit the pivoting of the member **2** clockwise (as seen in FIG. **1**) beyond the gripping position shown.

In use, the tongue **8** is lifted to pivot the other end of the member **2** away from the web **7**, and the end of flexible rubber tubing (not shown) which is to be threaded between the tubes of the condenser or the like as disclosed in U.K. Pat. No. 1188564 is inserted between the end of the member **2** and the web **7**. The tongue **8** is then pressed down towards the web **7** with the result that the edge **6** of the member **2** presses the tubing

against the web **7**, flattening and sealing the end of the tubing. Since the edge **6** is on the opposite side of the pivot lugs **5** from the tongue **8** which acts as a stop, an over-centre locking action is obtained which prevents the clip from being released until the tongue **8** is deliberately lifted. That is to say, the resistance of the tubing being gripped holds the clip closed.

A hole **9** is provided in the web **7** at the end remote from the pivot holes **4.** In order to permit the rubber tubing gripped by the clip to be threaded between the tubes of the condenser or the like, in accordance with the U.K. Pat. No. 1188564, a thread or line of nylon or the like is first passed between the tubes as described above, for example being weighted by a flat plate of, for example, brass or steel. The trailing end of this line is attached to the hole **9,** and the rubber tubing is evacuated so that it becomes flat and readily bendable, its end remote from the clip being sealed in any convenient way, and the line is then used to pull the clip and hence the tubing between the tubes of the condenser. Because of the over-centre arrangement of the clip, the tension in the tubing during this pulling operation will tend to hold the clip closed.

After the tubing has thus been completely threaded between the tubes of the condenser, the clip is released by lifting of the tongue **8,** and the other end of the tubing can also be unsealed, so that the tubing will tend to return to its initial round cross-section and thereby press against the tubes of the condenser.

As described above, it may be impossible to use a thread or line to pull the evacuated rubber tubing between the tubes. If this is the case, an insertion tool as shown in FIGS. **2***a* to **2***i* can be used. This tool includes a first clamping member **10** shown in plan, side-view and cross-section respectively in FIGS. **2***a* to **2***c*, and a second clamping member **11** shown in plan, side-view and cross-section respectively in FIGS. **2***d* to **2***f*. These members are made of high carbon steel.

The member **10** is generally strip-shaped having a main clamping portion **12** provided along one edge with a chamfered wedging surface **13.** At one end of the portion **12** is a flange **14** containing a socket **15.** At the other end is a flange **16** containing a pivot hole **17,** and a cam **18** which overlies part of the portion **12** and is spaced therefrom, the cam being provided with a chamfered wedging surface **19.** The wedging surfaces **13** and **19** are on the same longitudinal edge of the member **10** and, when seen in cross-section as in FIG. **2***c*, face one another.

The member **11** consists of a strip-like main clamping portion **20** having a chamfered wedging surface **21** along one edge. At one end of the portion **20** is a cam flange **22** provided with a Chamfered wedge surface **23** on one edge. At the other end is a fork **24** provided with a pair of fixing holes **25,** and adjacent to this a flange **26** parallel to and spaced from part of the clamping portion **20;** a pivot pin **27** extends from the flange **26** to the said part of the portion **20.** The wedging surfaces **21** and **23** provided on the same side of the member **11** and, seen in cross-section as in FIG. **2***f*, face towards one another.

To enable the insertion tool consisting of the members **10** and **11** to be manipulated and thereby passed between the tubes of the heat exchanger or the like, a first manipulating rod **28** (FIG. **2***d* and **2***g*) is pivotally secured to the member **10** by a pin **29,** and a second manipulating rod **30** (FIG. **2***h*) is rigidly secured to the member **11** by means of the fixing holes **25,** the longitudinal direction of the rod **30** being perpendicular to that of the member **11.**

The way in which the members **10** and **11** are fitted together is illustrated in FIG. 2d, in which the member **10** and its rod **28** are shown in broken lines. The member **10** is fitted to the member **11** obliquely, the recess **15** engaging the pivot pin **27,** as shown by the arrow **32.** The respective wedging cam surfaces **19** and **23** are thereby caused to engage each other so as to urge the members **10, 11** towards each other and flanges **22, 18** will therefore prevent the members from moving apart from a direction perpendicular to their planes. The end of the rubber tubing **33** is so placed that it will be gripped between the wedging surfaces **13, 21** as the member **10** is pivoted, and the end of the tubing will therefore be gripped between the main portions **12, 20** and thereby sealed. The resilience of the tubing, by pressing the flanges **18, 22** together, will effectively prevent the member **10** from pivoting on the pin **27** and thereby becoming free from the member **11.**

The rods **28, 30** which are substantially parallel, are now used to pass the tool consisting of the members **10, 11** and thereby the tubing **33** between the tubes of the condenser, being manipulated simultaneously by an operator. To facilitate this manipulation, a clamp for example as shown in FIG. **2***i* can be used to clamp the two rods together, between clamping plates **34, 35** held together by a wing nut **36.** As the rods are fed into the tube bundle of the condenser, the clamp is moved in steps towards the operator. To enable the tool and the rods to pass between the tubes of the condenser, the rods are hinged as shown at **37.** When the tubing **33** has in this manner been fed through the tube bundle of the condenser, the tubing is released by pivoting of the member **10,** this being effected either by hand or remotely by means of the rod **28.** The tubing **33,** which was previously evacuated and therefore flattened for passage between the tubes, as already described, then returns to its original shape and thereby presses against the tubes.

It is not essential to anchor the tubing, but it is most advisable to do so and for this purpose we use perforated blocks of a plastics or rubber material, preferably a fabric-reinforced rigid resin material. The shape of the retaining blocks is chosen to seat on the arrangement of the tubes at the periphery of the condenser or the like. FIG. **3** shows one possible form of retaining block **40** in longitudinal section, disposed against three external tubes **41** of the condenser or the like. To prevent vibration of the block **40** during operation, O-rings **44** (only one is shown) of for example butyl rubber are fitted to secure the block to the tubes of the condenser. The block shown has two holes **42** aligned with the gaps between the tubes **41,** so as to receive the ends of the flexible rubber tubing **33** (only one shown) threaded between the tubes **41.** The block **40** shown has legs **43** to support it on the tubes. In case of a longer block these legs may not be necessary since the block can engage several outer tubes **41** lying in a common plane. In cross-section, the block has bevelled or rounded upper edges (not shown) to prevent damage to the O-rings. The end of the tubing **33** is anchored in its hole **42** by means of a butyl rubber plug **45** which fits into the tubing end within the outer portion of the hole **42;** the plug is of greater diameter than the natural internal diameter of the tubing **33,** so that the tubing grips the

plug and preferably is pressed against the interior surface of hole **42**. The design of the butyl rubber plug and the recess in the retaining block is such that minimum distortion is given to and maximum life obtained from the flexible tube **33**. This design obviates the use of adhesives which are difficult to apply, prevent easy removal and whose reliability is questionable.

The plug is also so designed that the effects of any impingement from fluids in the condenser or the like are absorbed by the large head of the plug thus preventing damage to the end of the flexible tubing **33**.

FIG. **4** shows very schematically how the tubing **33** is emplaced in the bundle of condenser tubes **41**, when a tool as in FIG. **2** is not used. A weighting member **47** is attached to a flexible line **46** of nylon or the like and is lowered through the tube bundle. The dimensions of member **47** are such that it can pass readily between the tubes **41** and round any obstruction, e.g., a tie bar in the tube bundle. In FIG. **4** the member **47** is shown as a flat metal plate e.g. of brass, and during passage between the tubes **41** this plate would have its plane parallel to the tubes i.e. perpendicular to the plane of the drawing, not face-on as shown. Alternatively other forms of weight may be used e.g. a metal chain as described hereinabove.

The trailing end of the line **46** is secured to a connection and sealing member **48** which seals one end of the tubing **33**, the other end being sealed in any convenient way after evacuation. The member **48** may be a clip as shown in FIG. **1**, but in FIG. **4**, is illustrated as being a flat rigid metal plate **48** inserted into the tubing end and of such width as to stretch the latter flat and thereby substantially seal it, sealing being completed if necessary by an adhesive or sealing material. The member **48** and tubing **33** are pulled through the tube bundle by means of the line **46**, whereafter the member **48** can be removed from the tubing **33** to break the vacuum therein. Like the plate **47**, the member **48** will in use have its plane parallel to tubes **41** while passing therebetween.

I claim:

1. In a method of assembling heat-exchange apparatus comprising a metal tube bundle, and flexible resilient tubing threadable between the tubes of said metal tube bundle by means of a detachable clamping and insertion tool adapted to pass between adjacent metal tubes, said tool including two clamping members disposable face to face and of which one is pivotable on the other about an axis substantially perpendicular to the mating faces between a first position in which the two members are face to face so as to form a clip for sealing the end of the resilient tubing, and a second position in which the mating faces are separated and the tubing is released from between the members or can be inserted for subsequent gripping by the members and said tool being provided with remote manipulation means; the improvement comprising: inserting one end of the resilient tubing between said clamping members in the second position of the latter; effecting relative pivoting of said members into the first position thereof to sealingly clamp said one end of the resilient tubing; evacuating said resilient tubing so as to deform the tubing into a flattened condition; sealing the remote end of said resilient tubing; pushing the tool between adjacent tubes of said metal tube bundle by operation of said manipulation means to draw the flattened resilient tubing between said tubes; effecting relative pivoting of said members about said axis into the second operative position of the latter for releasing the resilient tubing from said members and to expand the tubing into its initial configuration; and withdrawing said tool from said metal tube bundle.

2. A method as claimed in claim **1**, comprising operating said manipulation means in a remote-controlled sequence for releasing said tool from the end of said resilient tubing.

3. A method as claimed in claim **1**, said manipulation means being hingedly connected to said clamping members.

* * * * *