United States Patent

Bosquain et al.

[15] **3,703,028**

[45] **Nov. 21, 1972**

[54] **METHOD FOR MANUFACTURING VERY LARGE HEAT EXCHANGERS**

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[22] Filed: **July 28, 1970**

[21] Appl. No.: **58,779**

[30] **Foreign Application Priority Data**

Nov. 13, 1969 France......................6938976

[52] **U.S. Cl.**..............**29/157.3 R,** 29/202 D, 29/429, 52/127

[51] **Int. Cl.**..........................**B21d 53/02,** B23p 15/26

[58] **Field of Search**.............29/157.3 R, 202 D, 429; 72/145; 52/127, 653

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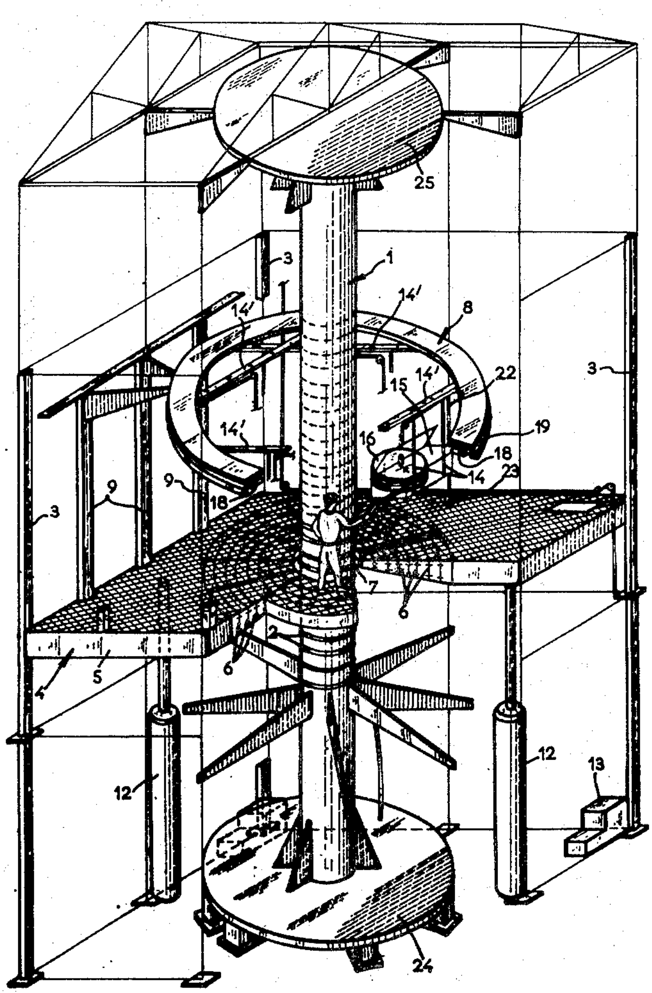
[57] **ABSTRACT**

Process for manufacturing a heat exchanger of the type with a nest of tubes formed of concentric layers of wound pipes between a central core and an outside covering, means of distributing and/or collecting fluid at both ends of the nest of tubes, as well as means for transferring fluid longitudinally in the interstitial space between the wound pipes, in which the core is placed in the space with its axis vertical, and the pipes, previously out to the required length, attached at one end in a distribution or collection system, wound round the said core by means of a rotary movement and a translation movement in relation to the core, and attached at the other end to the other collection and/or distribution device respectively.

3 Claims, 2 Drawing Figures



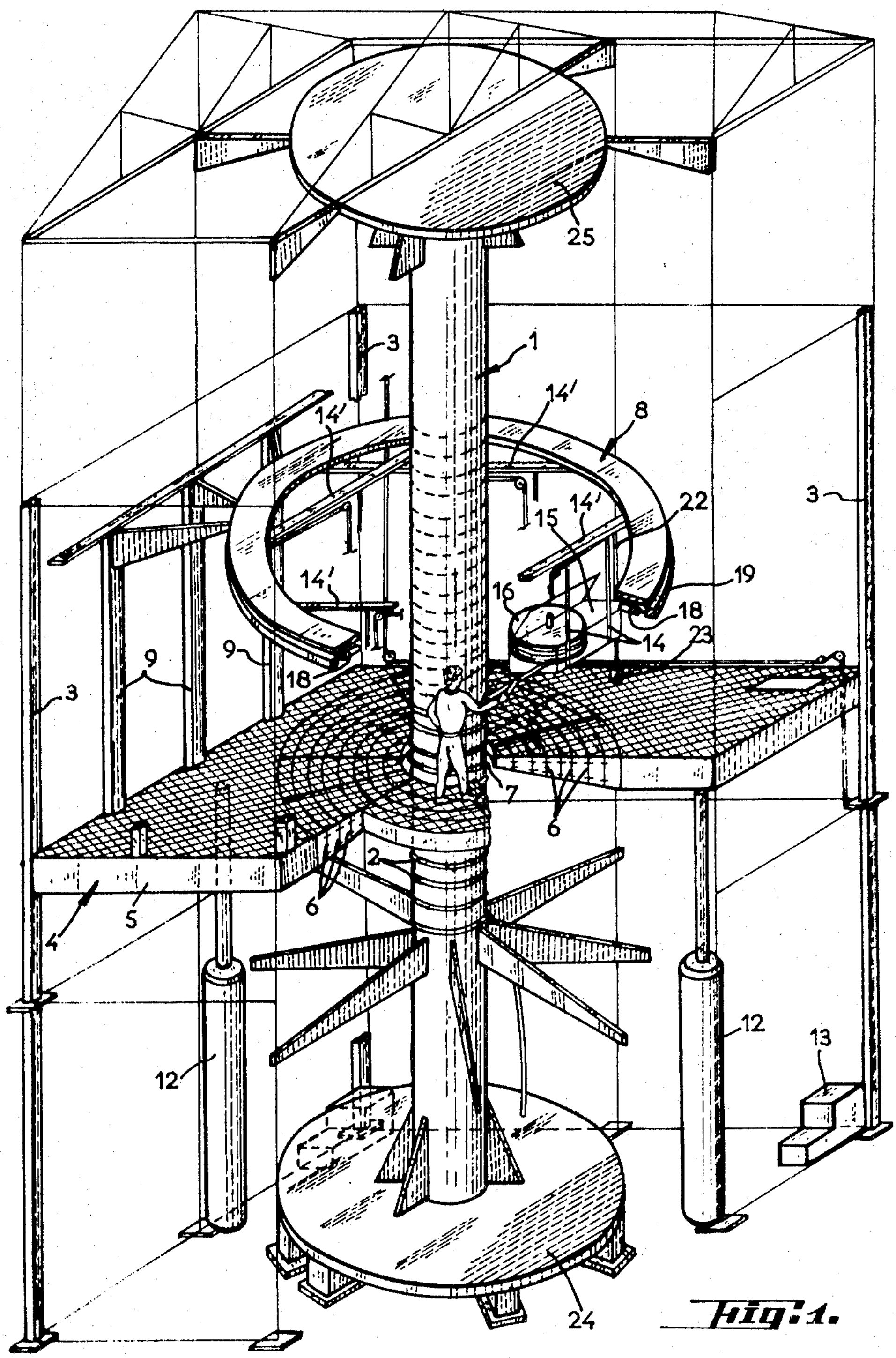


Fig. 1.

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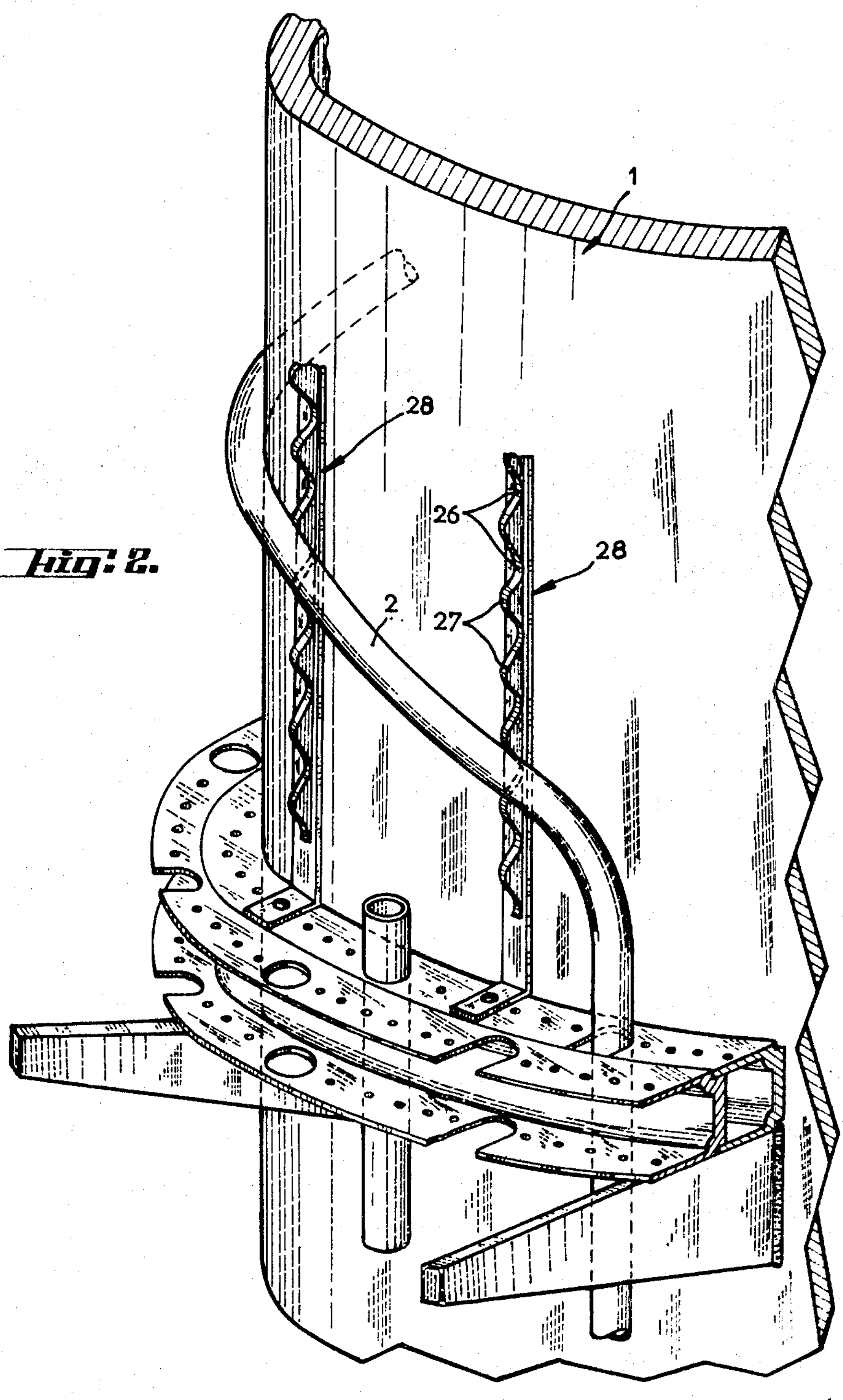
Fig. 2.



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METHOD FOR MANUFACTURING VERY LARGE HEAT EXCHANGERS

The object of the present invention is a manufacturing process for wound heat exchangers, and the installation to carry out this process.

Heat exchangers of this type contain a large number of pipes, usually wound in a spiral round a core, and forming a number of concentric layers of pipes. The usual method of manufacturing such exchangers is to lay the core horizontally and cause it to rotate on its axis, while a winder, from which comes the pipe to be wound, is moved along parallel to the axis of the core. The pipe is curved to the radius it will have once wound on the core by the operation of winding, possibly completing the curve it possesses on leaving the winder, or by means of an appliance with rollers, placed between the winder and the core, or between the winder and the layers of pipes already in position.

The application of this process to the winding of large and therefore heavy exchangers presents drawbacks, resulting mainly from:

- the bending of the core and the points of attachment of the pipes on the manifolds, under the weight of the wound pipes; this bending is constantly changing direction as rotation takes place;
- the force of inertia which occur at each stoppage and restarting of rotation of the core, and which increase, not just with weight, but also with the outside diameter of the wound core.

This bending and these inertia forces cause metal fatigue, particularly at attachment points; this fatigue can cause breakages during manufacture, transport, or as the result of temperature cycles during service. They can also damage the points of attachment or support on the core. Bending stresses can be reduced by increasing the diameter of the core, but this increases the forces of inertia and increases the diameter of the exchanger, and consequently its cost and the exchanges of heat with the surrounding air.

In addition, the tools used for winding in a horizontal position restrict the distance between the ends of winding, and it is harder to fit a large horizontal exchanger into its shell than a vertical one.

The process according to the invention allows these drawbacks to be avoided, notably because it makes turning of the core unnecessary.

The present invention concerns a process for manufacturing a heat exchanger of the type with a nest of tubes formed of concentric layers of wound pipes between a central core and an outside covering, means of distributing and/or collecting fluid at both ends of the nest of tubes, as well as means for transferring fluid longitudinally in the interstitial space between the wound pipes, in which the core is placed in the space with its axis vertical, and the pipes, previously cut to he required length, attached at one end in a distribution or collection system, wound round the said core by means of a rotary movement and a translation movement in relation to the core, and attached at the other end to the other collection and/or distribution device respectively.

According to one form of embodiment of the invention, the core is kept fixed during winding, and a pipe is wound on it by making at least one winder, acting as a container for the said pipe, revolve round the core.

According to another form of embodiment of the invention, several pipes are wound on simultaneously, by making a number of winders, each acting as a container for one of the said pipes, revolve round the core.

According to yet another form of embodiment of the invention, the winders are mounted and able to rotate round the core on a crown fixed rigidly to a mobile support with an up and down translation movement.

According to yet another form of embodiment of the invention, the actual winding operation is performed manually by an operator for each winder, standing on the said support.

According to yet another form of embodiment of the invention, before winding on a layer of pipes, a template is prepared in accordance with the theoretical winding curve, usually a spiral, and consisting of rope, cord or rubber, which then acts as a guide for the winding of the pipes of the layer.

According to yet another form of embodiment of the invention, the installation includes a horizontal support which can move vertically, and means of making the said support move up or down as winding progresses, the said support surrounding the exchanger during winding.

According to yet another embodiment of the invention, the support includes a platform and removable floor sections, corresponding in number and shape to the diameters of the layers of pipes during winding.

According to yet another form of embodiment of the invention, the installation includes one or more winders mounted on a support which is fixed rigidly to the platform.

According to yet another form of embodiment of the invention, the winder or winders are mounted on a rail which surrounds the exchanger during manufacture.

Other purposes and advantages of the present invention will be made clear by reading the following description and examining the accompanying FIGS, which are not restrictive.

FIG. 1 provides a view in perspective, with parts out away, of the whole installation according to the present invention.

FIG. 2 shows part of the installation, also in perspective.

A core or mount **1** is placed vertically in the installation for the winding of a sectional material, and more especially pipes **2**, round the said core.

The whole installation is supported on an infrastructure which includes a number of vertical posts **3**.

This installation includes a support of a particular type. This support consists of unmovable section or platform **5**, and segment-shaped removable gratings **6**, with a central opening for the core **1**. As the diameter of the core **1** increases, the diameter of the central opening **7** is correspondingly increased by removing the segments of grating **6** beside the opening **7**, as necessary.

The removable gratings **6** rests on cross-bars or radial arms (not shown), fixed to the platform **5** of the support **4**, themselves consisting of easily removable components side by side, or any other appropriate means, such as articulated arms, sliding diaphragms, telescopic systems, etc.

This installation also includes a circular crown **8**, concentric with the core. The inside diameter of this crown is greater than the maximum winding diameter required. This circular crown is carried on the support by uprights **9**.

The translation of the support **4** may be brought about by any hydraulic, electrical, mechanical or electronic means. For instance, the support **4** can be translated by hydraulic jacks **12** connected to a speed-varying motor-reducing gear **13**. A set of stabilizing chains (not shown), may contribute to stabilization of this support **4**. It is well understood that support **4** may be moved through other means, for instance by cable and winch, etc.

A number of cross-bars **14'**, fixed rigidly to uprights **14**, on which the spool-holders **15** carrying the winders **16**, is fixed to the circular crown **8**. To simplify things, only one winder has been shown in FIG. **1**. There are usually **4** of them, but any other number can obviously be used.

The weight of the winders **15** is balanced by counter weights **24** suspended to a line **22**.

The spool-holders **15** can slide on the uprights **14**.

A ring **19** moves on rollers **18** fixed to the crown; this ring is strengthened by a network of bars from which the spool-holder **15** is suspended. The suspension system is only partially shown.

The winder contains the length of piping corresponding to the length of the theoretical winding curve for each layer of pipes, between the means of distribution and/or collection, such as, for example, manifolds or tubular plates **25** and **26**. The winder, controlled by the ring **19**, revolves round the core at an speed proportional to the speed of translation of the support. This combination of movements applies the piping more or less along the curve required. The exact position is given by the concave spaces **26** between the projecting sections **27** of the ridged uprights **28** (FIG. **2**), the pipe being placed manually in the concave spaces selected, by the operator. If necessary, the winding curve may be prepared in the form of a template, rope, rubber spring, etc, to guide the operator.

When the movements of the platform and winders are properly synchronized (vertical and rotary speeds made interdependent by a programme), guiding of the pipe may be left out. Copying devices may also be included, if necessary.

Ridged uprights **28** (FIG. **2**) are placed between the core and the first layer of pipes, and between each succeeding pair of layers.

These uprights **28** ensure that there is a uniform distance between the pipes of one layer, and between the layers, and between the core or shell of the exchanger and the layer of pipes next to it; in addition, the concave spaces **26** formed on them between the projections **27** help to hold up the pipes.

Several winders may be attached to the crown **8**, allowing the same number of pipes in a single layer to be placed in position simultaneously.

Halting of the winding movement, for some reason, does not cause the appearance of any significant forces of inertia: such forces are slight, and are not applied at any parts of the exchanger.

The process and the installation described above may be altered without departing from the spirit of the present invention. Several winders may be used simultaneously; one winder may contain several pipes; winding may be done in an upward or downward direction; non-ridged uprights may be used, tubular in form, so that several gases may be made to pass through these tubes.

The core may be placed on a rotating platform fitted with devices to reduce the stresses caused by forces of inertia, since the winder no longer has to revolve round the core.

The process according to the invention may be used to manufacture wound exchangers of widely varying types and sizes. It is especially useful in the case of very large exchangers, such as those used in natural gas liquefaction plants. With this process, contrary to other winding processes, the bending radii remain uniform for one layer of pipes; because of the uniform pitch and the easily checked and adjusted diameters of the layers of pipes, great evenness and precision can be obtained for the winding.

In particular, it is possible to place a bending device (not shown) between the winders and the core).

The functions performed by such a device are, notably:

cleaning of the pipe from the winder, by passing it between two felts, for instance;

straightening the pipe, which has the radius of the spool;

pre-bending of the pipe before winding, approximately to the radius of the core;

possibly flattening of the pipe;

guiding the movement of the pipe;

stretching of the pipe, so as to facilitate winding, and ensure tight spirals.

We claim:

1. A process for manufacturing a very large size spiral tube heat exchanger of the type including concentric layers of wound pipes between a central core and an outer covering and means for distributing and collecting fluid at each end of the pipes and means for conveying a fluid lengthwise in the interstitial space between the wound pipes, the process comprising the steps of mounting the core substantially vertically, surrounding the core with a horizontal support comprising removable floor sections disposed in a plurality of coplanar rings concentric to the core, with said removable floor sections extending up to close adjacency to the core, attaching one end of a said pipe to one of the means for distributing or collecting fluid, winding the pipe in a spiral about the core with the pipe guided and manually positioned during the winding process by a workman standing on the removable floor sections, moving the support with the workman on it vertically along the core during the winding of the spiral pipe thereon, attaching the other end of the pipe to the other means for collecting or distributing fluid at the other end of the core, removing some but not all of said removable floor sections to accommodate the increased diameter of the assembly by virtue of the winding thereon of said pipe, winding thereon a further pipe with the horizontal support moving vertically along the core, and repeating the attachment and winding of further pipes with the removal of further removable floor sections as the assembly increases in diameter.

2. A process as claimed in claim **1**, and guiding the first-mentioned pipe in part by means of a template forming the theoretical winding curve.

3. A process as claimed in claim **1**, and supplying the pipe from a spool while rotating the spool about its axis and also about the axis of the core.

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