

Oct. 29, 1963

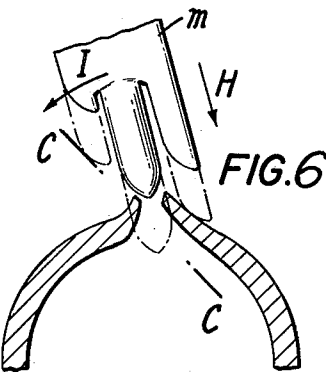
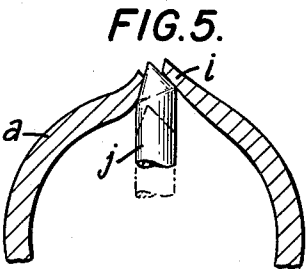
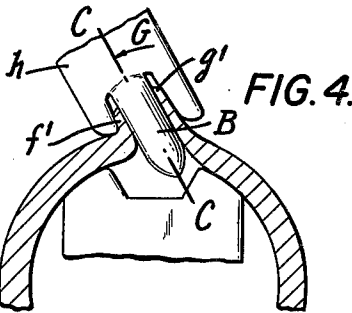
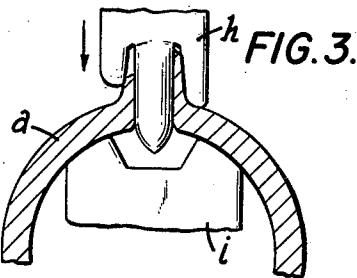
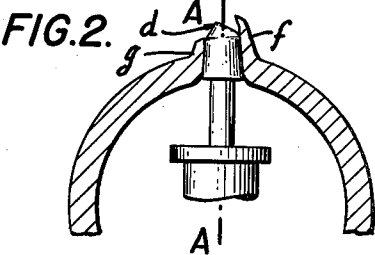
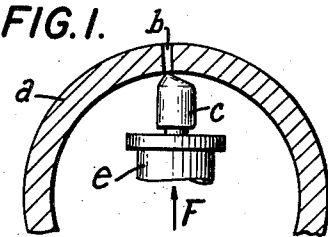
A. HUET

3,108,362

METHOD OF MAKING TUBULAR HEAT EXCHANGER

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3 Sheets-Sheet 1



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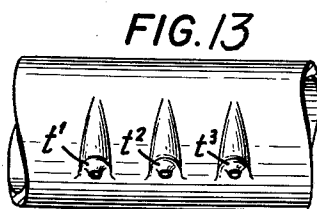
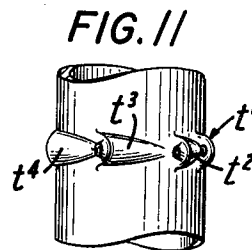
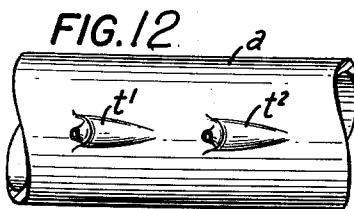
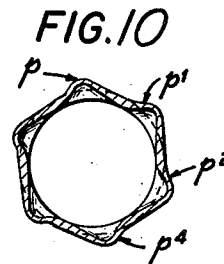
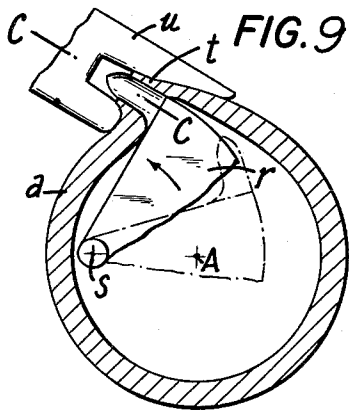
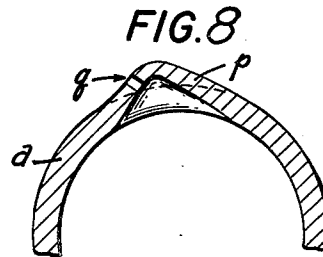
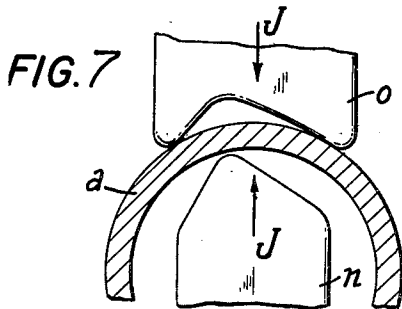
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METHOD OF MAKING TUBULAR HEAT EXCHANGER

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3 Sheets-Sheet 2



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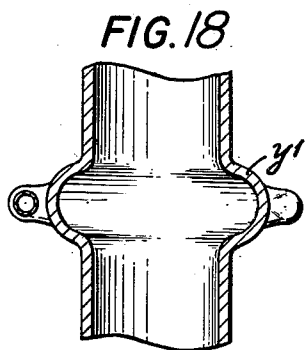
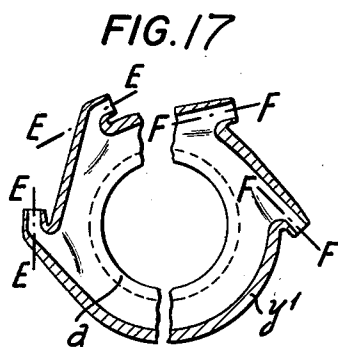
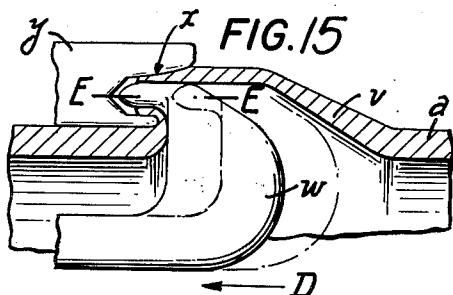
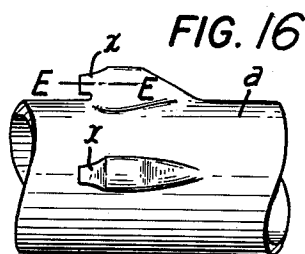
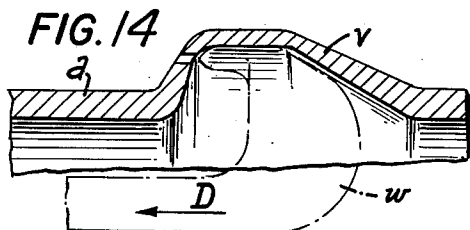
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3,108,362

METHOD OF MAKING TUBULAR HEAT EXCHANGER

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3 Sheets-Sheet 3



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METHOD OF MAKING TUBULAR HEAT EXCHANGER

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5 Claims. (Cl. 29—157.4)

This invention relates to headers having oblique or tangential unions more especially for heat exchangers.

It is known to form unions or tube connections on the wall of a metal header, the metal of the unions forming part of the metal mass of the header. The axis of these unions is perpendicular to the axis of the header, and the two axes are in the same plane. They are generally manufactured by means of a punch, disposed inside the header and passing through the wall of the header under the action of the pressure of a jack, while a die is positioned externally around the place where it is desired to form the union.

The present invention provides, as novel industrial products, headers having unions having an axis directed obliquely with respect to the wall of the header, or parallel to the axis of the header, or parallel to a section at right-angles or oblique to the axis of the header, it being possible in these last two cases to say that the union is, as it were, tangential to the surface of the header.

The unions forming the subject of the invention are manufactured with punches and dies according to processes which will hereinafter be described and which have in common the feature that during a first operation, there is formed a blank of the union or a modification of the shape of the header wall by pressure or punching in a direction perpendicular to the axis of the header, after which, during a second operation with a punch and die, operating in the desired direction other than perpendicular to the axis, the resulting union blank or deformation of the wall is transformed into a union, the axis of which is in the required direction, i.e. oblique or parallel to the axis of the header or to its cross section or oblique section.

The invention will be further described with reference to the accompanying drawings given by way of example, in which:

FIGS. 1 to 4 relate to a first embodiment of a union having an oblique axis, and show the succession of operations in the manufacture as a cross-section through the header.

FIGS. 5 and 6 relate to a modified form of union having an oblique axis.

FIGS. 7 to 9 show another modified form of a union with an oblique axis.

FIG. 10 is a sectional view showing a header of which the cross-section has been treated during a first operation to produce a ring of unions with an oblique axis.

FIG. 11 shows the header of FIG. 10 in perspective.

FIG. 12 is an exterior view showing a header having unions with an oblique axis aligned along one generatrix.

FIG. 13 is an exterior view of a header having unions with an oblique axis disposed side by side along cross-sections of the header.

FIGS. 14 and 15 are sectional views axially of the header and showing one embodiment of a tangential union with its axis parallel to the axis of the header.

FIG. 16 is a perspective view showing two tangential unions distributed along one cross-section.

FIGS. 17 and 18 relate to a modification and are respectively a section perpendicular to the header axis and a section passing through this axis, to show an embodiment comprising a ring of unions having an oblique or tangential axis along one section of the header, the unions

having been manufactured in the trough of a semi-toroidal gallery previously formed in the header wall.

In the constructional form shown in FIG. 1, with a view to forming a union with an oblique axis on a header *a* at one point of this header, at which there has been pierced a slightly oblique hole *b*, an unsymmetrical punch *c* is arranged inside the header, i.e. the operative surface of the punch has an apex *d* offset with respect to its direction of movement A—A perpendicularly of the axis of the header. The upward movement of this punch *c* in the direction of the arrow F, FIG. 1, by means of a jack *e*, causes the formation of an unsymmetrical union with its axis perpendicular to the axis of the header, i.e. the union has a relatively high lip *f* on one side and a lower lip *g* at 180°. Thus, the hole *b* of FIG. 1 is first formed in the header with an axis which is slightly offset with respect to the direction F in which the punch *c* will be displaced. The left face of the punch *c* has a steep slope whereas the right face has a reduced slope. As a result, the left face of the punch rapidly passes through the wall of the header *a*, whereas the right face of the punch *c* gradually raises the wall of the tube so that there is more metal available on the right of the punch *c* than on the left, as seen in FIG. 2. Under these conditions, the lip *f* formed by the outline of the union is higher than the lip *g* located at the left. This construction is thus referred to as an "unsymmetrical" union. The unsymmetrical union *f, g* thus obtained during a first operation then accommodates an external driver punch *h*, as shown in FIG. 3, which works in co-operation with a supporting die *i* positioned inside the header *a*. A rotation of the punch *h* in the direction of the arrow G, FIG. 4, substantially about the axis projected at B, causes a displacement of the axis of the union *f, g* so as to bring it in line with the axis C—C, which is oblique to the axis of the header, the lips *f*¹, *g*¹ then being equal all along the periphery of the union opening. There has thus been formed a union having an oblique axis C—C with respect to the wall of the header.

In the modifications shown in FIGS. 5 and 6, a first unsymmetrical union *i* is obtained, as shown in FIG. 5, in the wall of the header *a*, by means of an unsymmetrical punch *j* which is displaced substantially perpendicularly to the header axis in the manner described in connection with FIGS. 1 to 4.

In a modification as shown in FIG. 6, the blank of the union obtained in FIG. 5 is transformed into the final union with an oblique axis by introducing an external punch *m* in the direction of the arrow H, and then swivelling this punch in the direction of the arrow I to give the union the final axis C—C.

Instead of passing through a first formation stage of an unsymmetrical union perpendicular to the axis, provision is made according to the present invention for the fact that during a first operation, the wall of the header is deformed by pressure between an internal punch *n* and an external die *o* which are brought towards one another in the direction of the arrows J, FIG. 7, by compressing between them the header wall *a* so that there is obtained a kind of ridge *p* in the said wall as will be seen in FIG. 8. This ridge has in section two inclined walls and the more steeply inclined wall thereof, in which will be formed the opening of the final union, is perforated at *q*. A punch *r* capable of pivoting about an axis *s* is then disposed inside the header, as will be seen in FIG. 9, the punch being offset inside the header relatively to the axis A of the latter. The rotation of the punch *r* about the axis *s* brings it from the position in chain-dotted lines to the position in full lines, and causes in the ridge *p* the formation of the final union *t* with an oblique axis C—C, this operation being carried out by co-operation

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with a die *u* disposed externally on the header *a*, as shown in FIG. 9.

It is then possible with this arrangement to form a series of tube unions disposed in ring formation along a cross-section of the header, which has been deformed beforehand at *p*, *p*¹, *p*², *p*³, etc. . . . as shown in FIG. 10, and in which there are finally obtained the unions *t*¹, *t*², *t*³, etc. (FIG. 11).

These unions, instead of being formed in ring formation, could be disposed along one generatrix of the header, as shown in FIG. 12, or could be disposed side by side along the generatrix, as shown in FIG. 13.

Instead of providing unions having oblique axes, it is possible to manufacture unions with an axis parallel to the axis of the header, these being known as tangential unions. To this end, instead of employing a pivoting punch such as that shown in FIG. 9, a punch is used which slides inside the header parallel to the axis of the latter. The wall of the header *a*, having been deformed beforehand as shown in FIG. 14, so as to be given the form of a ridge *v*, is formed with a hole at the point where it is desired to make the union. A punch *w*, which is displaced in the direction of the arrow *D* inside the header parallel to the axis of the latter, ensures the formation of the final union *x* in the steeply inclined face of the ridge *v*, by combination with a die *y* disposed externally of the union. The axis *E—E* of this union is parallel to the axis of the header *a*, and therefore it is considered tangential.

Such unions can be provided in ring formation along a cross-section of the header, as shown in FIG. 16.

In order to permit more easy welding of the tubes to the ends of the unions *x* thus manufactured, it is advisable to space the axis *E—E* of these unions from the wall of the header, and provision is also made according to the present invention to commence by forming a semi-toroidal groove or recess *y*¹ in the wall of the header and at the place where it is desired to produce the unions, as shown in section in FIG. 18. Such an operation is carried out in known manner by compression of the ends of the header, advantageously held in dies, while the place where it is desired to obtain the groove on recess *y*¹ is suitably heated.

Unions having an oblique axis or an axis parallel to the axis of the header are then formed in the bottom of this channel *y*¹, so as to obtain, as shown in section in FIG. 17, a ring of unions which either have their axis *E—E* tangential to the cross-section (left-hand part of FIG. 17) or have their axis *F—F* slightly oblique with respect to the tangent to the cross-section (right-hand part of FIG. 17). In this way, the ends of the lips of all these unions are spaced from the wall of the header, as set out above, and it is then easier to weld thereon the ends of the tubes which are to be connected thereto.

The semi-toroidal groove *y*¹ shown in relief in FIG. 18 could be provided as a depression in the wall of the header *a* and the unions formed in the base of this depression.

The advantage which is obtained by the unions having an oblique or tangential axis as constructed in accordance with the present invention is to make it possible for the welding of the tubes to the header to be carried out in restricted spaces without multiplying the lengths of tubes, and to ensure a perfectly rational flow of the fluids circulating inside the tubes and the header from a dynamic point of view by reducing the changes in direction and pressure losses. The tangential inlet or outlet of the fluid into or from the header may also facilitate the separation of the water and steam in this fluid or of the mixture of fluids which flow in the pipelines.

It is obvious that modifications as regards details can be incorporated into the constructional form as defined by the claims of the invention without thereby departing from the scope thereof.

In particular, it is well understood that all the metal zones on which work is carried out are brought to the

required temperatures for obtaining the desired shaping of the metal.

What I claim is:

1. A process for providing integral unions in the wall of a header which are other than perpendicular to the axis of said header, comprising the steps of shaping the material of the wall of the header by the application of force in a direction perpendicular to the axis of the header to form an unsymmetrical blank for the union having an unsymmetrical outwardly-extending portion to define the wall of said union, and surrounding a central aperture, and shaping said blank by acting upon said outwardly-extending portion with punches and dies moving in a direction other than a direction perpendicular to the axis of the header to form said portion into a union having an axis which is other than perpendicular to the wall of the header.

2. A process for providing integral unions in the wall of a header which are other than perpendicular to the axis of said header, comprising the steps of shaping the material of the wall of the header by the application of force in a direction perpendicular to the axis of the header to form an unsymmetrical blank for the union having an unsymmetrical outwardly-extending portion to define the wall of said union, and surrounding a central aperture, and shaping said blank by acting upon said outwardly-extending portion with a punch disposed interiorly of the header and moving in a direction other than a direction perpendicular to the axis of the header to form said portion into a union having an axis which is other than perpendicular to the wall of the header.

3. A process for providing integral unions in the wall of a header which are other than perpendicular to the axis of said header, which comprises the steps of shaping the material of the wall of the header by the application of force in a direction perpendicular to the axis of the header to define an opening in said wall having opposite non-symmetrical lips of different radial height and shaping said blank with punches and dies moving in a direction other than a direction perpendicular to the axis of the header to displace said lips laterally to form a union having an axis which is other than perpendicular to the wall of the header.

4. A process for providing integral unions in the wall of a header which are other than perpendicular to the axis of said header, which comprises the steps of shaping the material of the wall of the header by the application of force in a direction perpendicular to the axis of the header to define an opening in said wall having opposite non-symmetrical lips of different radial height and shaping said blank with a punch engaging in said opening and then moving in a direction other than a direction perpendicular to the axis of the header to displace said lips laterally to form a union having an axis which is other than perpendicular to the wall of the header.

5. A process for providing integral unions in the wall of a header which are other than perpendicular to the axis of said header, which comprises the steps of shaping the material of the wall of the header by the application of force in a direction perpendicular to the axis of the header to define an opening in said wall having opposite non-symmetrical lips of different radial height, and shaping said blank with a punch engaging in said opening and then pivoting in a direction other than a direction perpendicular to the axis of the header to displace said lips laterally to form a union having an axis which is other than perpendicular to the wall of the header.

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