United States Patent

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[54] METHOD OF FORMING A HEAT EXCHANGER

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[52] **U.S. Cl.**.....**29/157.3 R**, 29/DIG. 47, 72/267

[51] **Int. Cl.**.....**B21d 53/02**, B21k 29/00

[58] **Field of Search**.....29/157.3 R, DIG. 47; 72/266, 72/267

[56] **References Cited**

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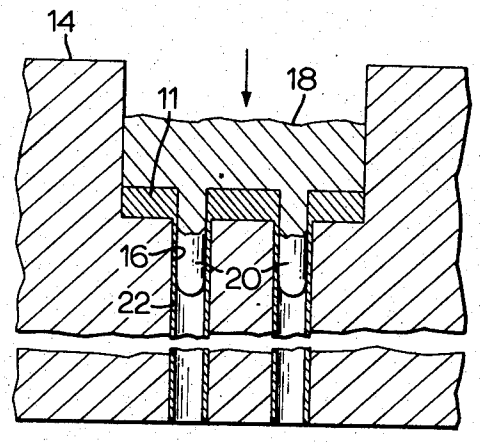
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[57] **ABSTRACT**

An improved method of forming a heat exchanger including the step of forming a plurality of heating tubes integrally with an end plate and by an impact extrusion process and connecting the interior passages of the tubes in a heat exchanger circuit.

4 Claims, 7 Drawing Figures



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SHEET 1 OF 2

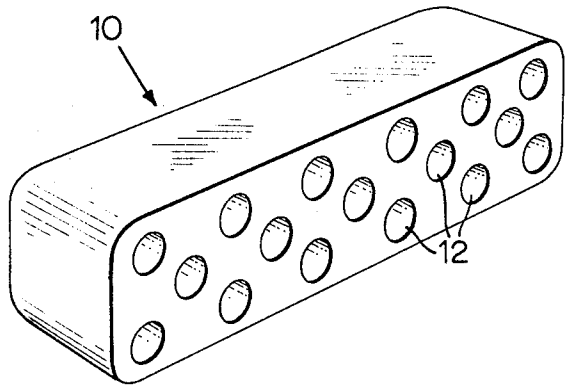


FIG. 1

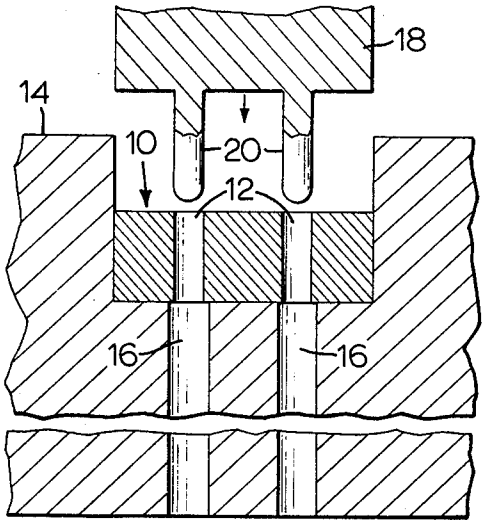
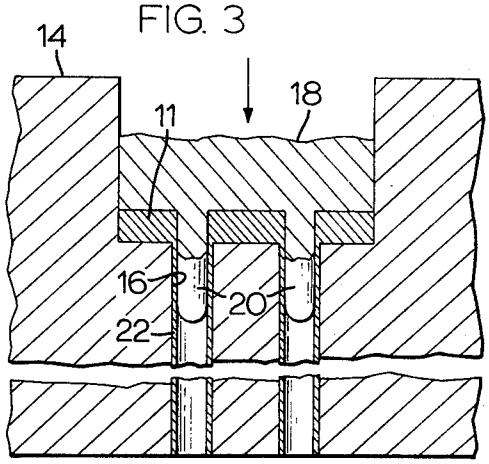


FIG. 2

FIG. 3



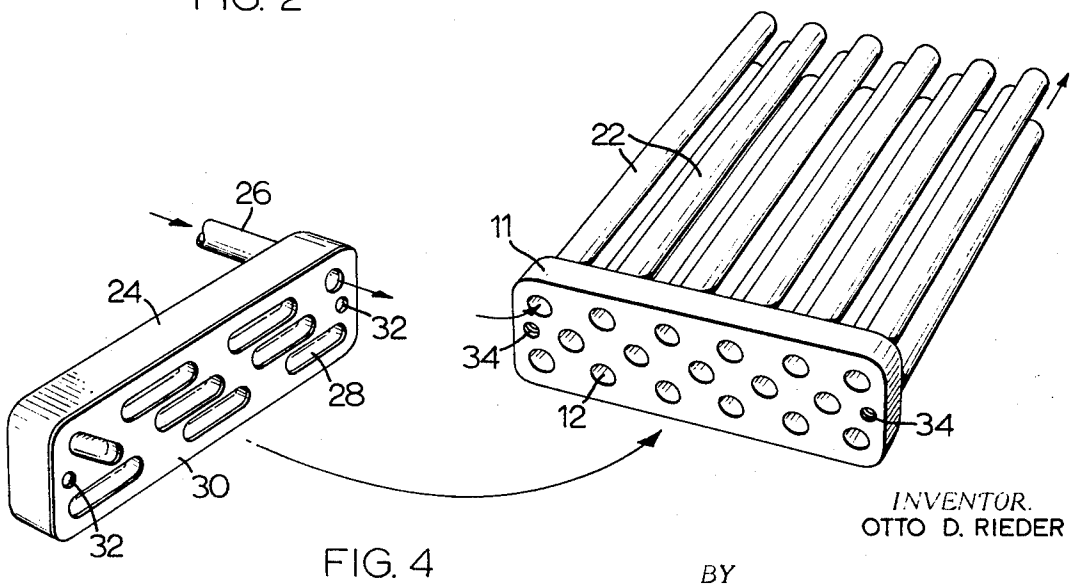


FIG. 4

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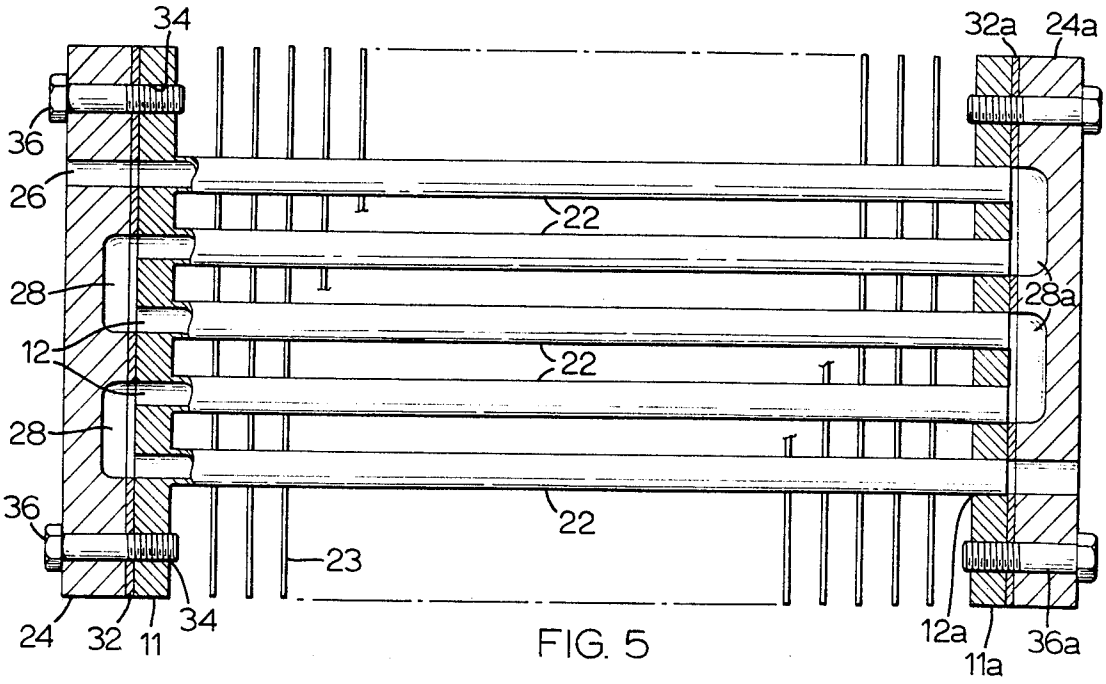


FIG. 5

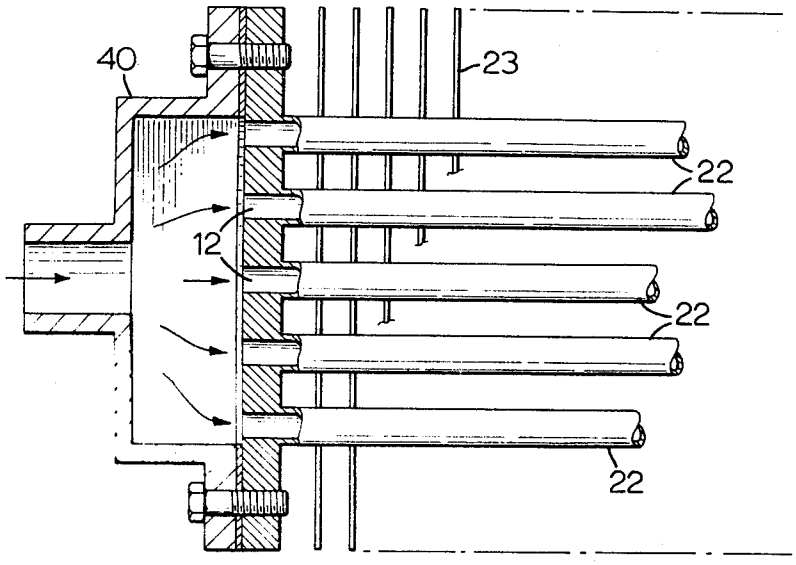


FIG. 6

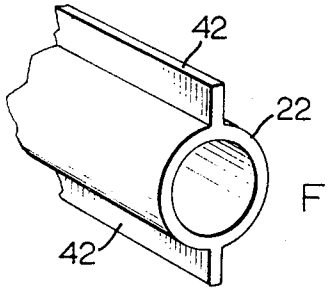


FIG. 7

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METHOD OF FORMING A HEAT EXCHANGER

This invention relates to the manufacture of heat exchangers. In particular this invention relates to an improved method of manufacturing a heat exchanger wherein the tubes of the exchanger are formed from a unitary slug by means of an impact extrusion process.

PRIOR ART

The most common type of heat exchanger presently in use, in applications such as domestic refrigerators and air conditioners, has a liquid flow path formed by a plurality of parallel tubes which are connected in series. A heat exchanger of this type is formed by bending long lengths of tube, generally copper, into a U-shaped configuration; the legs of the U-shaped form are then passed through openings formed in a plurality of fins or plates placed one on top of the other, and the free ends of adjacent tubes are connected by short U-shaped lengths of tube. To make this type of connection it is necessary to swage the ends of the long legs of tubes to receive the ends of the short lengths of tube. The two sections of tube then are soldered together. In many forms of constructions there are a very large number of tubes and consequently the assembly of the exchanger according to known methods is a costly and time-consuming operation.

In a straight through heat exchanger where the heating tubes are arranged to provide in parallel flow paths, it is necessary to secure both ends of the heating tubes within header tanks or manifolds. Again the time cost involved in soldering or otherwise securing both ends of the tubes in header tanks is substantial.

SUMMARY

The present invention provides an improved method of manufacturing a heat exchanger which considerably reduces the time costs involved in the assembly operation.

According to the present invention, the first step in the manufacture of the heat exchanger is to form a slug with a plurality of passages therein corresponding to the number of tubes which are required in the heat exchanger. The slug is then extruded by impact extrusion to form a plurality of tubes which are integrally connected at one end by a base formed from the non-extruded portion of the slug. The interior passages of the tubes are then connected in a heat exchanger circuit to permit fluid to pass through the tubes in heat exchange relationship with the exterior of the tubes.

The invention will be more clearly understood after reference to the following specification read in conjunction with the drawings.

PREFERRED EMBODIMENT

In the drawings,

FIG. 1 is a pictorial view of an impact extrusion slug according to an embodiment of this invention;

FIG. 2 is a diagrammatic illustration of a cross section of an impact extrusion punch and die prior to impact;

FIG. 3 is a cross sectional view similar to FIG. 2 showing the relative positions of the die and punch after impact;

FIG. 4 is a pictorial view of an extruded tube assembly together with manifold or header tank for connecting the tubes in series;

FIG. 5 is a partial cross sectional view of an assembled heat exchanger of the type wherein the tubes are connected in series;

FIG. 6 is a partial cross sectional view of a portion of a straight through type heat exchanger; and

FIG. 7 is a pictorial view of a portion of a heat exchanger tube having integrally formed fins.

With reference to FIG. 1 of the drawings, the reference numeral **10** relates to an extrusion moulding slug according to an embodiment of the present invention. The slug is made from extrudable aluminum and formed with a plurality of passageways **12** arranged in a pattern corresponding to the required pattern of tubes. The thickness of the slug is determined according to conventional extrusion moulding practice in accordance with the total length of the tubes required and the thickness of the end plate required after extrusion. The slug **10** is located within an extrusion die **14** which has die openings **16** arranged to align with the passages **12**. A punch **18** having guide pins **20** is arranged above the die **14** so that the guide pins **20** are aligned with the die openings **16**. As shown in FIG. **3** of the drawings, the slug is extruded by the impact of the punch **18** and tubes **22** are extruded through the gap formed between the die openings **16** and the pins **20** in a conventional manner.

A typical part of the extrusion process is illustrated in FIG. **4** wherein the remaining portion of the slug **10** forms an end plate connecting the tubes **22**. The passageways **12** extend through the tubes **22** and the slug **10**. Whereas no reduction in production cost could be achieved by forming the individual tubes by an extrusion moulding process as opposed to the conventional tube manufacturing process, the method of the present invention wherein a plurality of tubes are formed simultaneously and connected at their ends by an end plate by an impact extrusion process does effect a considerably saving. The formation of this structure also provides an element in a form which simplifies the method assembly of a heat exchanger of the type which has a plurality of fin plates extending between the heating tubes. The end plate retains the heating tubes in their spaced position so that the fins may be very easily and quickly slipped over the free ends of the tubes and positioned at any required location relative to the length of the tubes. With this structure it is no longer necessary to use the fins as jigs for holding the tubes in a fixed position relative to one another while connecting adjacent ends of the tubing. A typical extruded structure may have an end plate measuring 1 inch by 3 inches and a thickness of three-sixteenth inch. From an end plate of this type there may be 17 tubes extending from one face. Each of the tubes may measure one-fourth inch O/D and three-sixteenths inch I. D. and they may measure 10 inches in length. It will be understood that these dimensions are given by way of example and they are not intended to limit the scope of this invention in any way.

FIG. **4** also shows a suitable header or manifold cover **24** which has a input passage **26** and a number of elongated recesses **28** formed in the lower surface thereof. A gasket **30** is also provided having openings therein corresponding to the openings and recesses in the manifold **24**. Passages **32** are also formed in the manifold **24** and gasket **30** and are adapted to be aligned with the threaded passages **34**, which are formed in the end plate. It will be seen that the recesses **28** are arranged to connect every second pair of adjacent passageways **12** formed in the end plate **11**.

A typical assembled heat exchanger according to an embodiment of the present invention is illustrated in FIG. **5** of the drawings. In this figure a structure similar to that shown in FIG. **4** of the drawings is shown at the left end of the assembly. At the left end it will be seen that the manifold **24** and gasket **32** are secured to the end plate **11** by bolts **36** which threadably engage the passages **34** with the end plate **11**. In this construction the input passage **26** of the header is aligned with one of the openings **12** formed in the end plate **11**. The recesses **28** in the manifold connect every second pair of adjacent passages **12**. At the end of the assembly an end plate **11*a*** is secured to the free ends of the tubes by a conventional welding process. The end plate **11*a*** has a plurality of passages **12*a*** extending therethrough to receive the free ends of the tubes **22**. The second manifold **24*a*** and gasket **32*a*** are secured to the end plate **11*a*** by bolts **36*a***. The manifold **24*a*** and gasket **32*a*** are of substantially the same construction as the corresponding manifold and gasket located at the other end, except that the recesses **28a** are adapted to connect the adjacent ends of tubes which are not connected by the passages **28** in the other manifold **24**. This arrangement establishes a flow path wherein the heat exchanger tubes are connected in series.

It will be understood that the manifold and end plate construction shown in FIG. 5 for connecting the free ends of the tubes is not essential to the formation of the heat exchanger. The free ends of the tubes could be connected by the conventional short U-shaped pipe sections.

FIG. 6 of the drawings shows an alternative form of manifold header type 40 suitable for connecting the ends of the tubes 22 to provide an in parallel flow path for the fluid which is passing through the heat exchanger.

The further advantage of the extrusion moulding process is that it permits the formation of heat exchanger tubes with integrally formed fins extending longitudinally thereof. An example of the finned tube construction is shown in cross section in FIG. 7. In this construction the tube 22 is formed with a pair of longitudinally extending fins 42 which project outwardly therefrom to effectively increase the heat transfer surface area. This construction may conveniently be used in a number of heat exchanger devices to eliminate the need for providing finned plates such as those identified by the reference numeral 23 in FIGS. 5 and 6. Alternatively, the fins 42 may be used in combination with fin plates 23 to further increase the heat transfer to the surface area of the exterior of the heat exchanger unit. It has not previously been practical to provide longitudinally extending heat exchanger fins as this would have required welding or otherwise securing the fins along the through length of the conventional heat exchanger tubes.

From the foregoing it will be apparent that the present invention provides an improved method of manufacturing a heat exchanger wherein a slug 12 is subjected to impact extrusion to form the tubular assembly shown in FIG. 4. The assembly of the heat exchanger is then completed by locating the fins 23 over the tubes in a predetermined spaced relationship and securing manifolds 24, 24*a* or 40 at either end so as to place the interior passages of the heating tubes in a heat exchanger circuit to permit the fluid to pass through the tubes in heat exchanging relationship with the exterior of the tubes.

Various modifications of this invention will be apparent to those skilled in the art without departing from the spirit of this invention. For example the total number of tubes and their arrangement relative to one another may vary according to the requirements of the heat exchanger. In addition heat exchanger may be manufactured without the use of the fins illustrated in the FIGS. 5 and 6. The structure of the extruded core of this invention is very useful in a heat exchanger which does not require fins as the end plate holds the tubes in a fixed position removing the need for applying independent clamping devices to hold the tubes in the spaced relationship.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of forming a heat exchanger comprising the steps of:
   a. forming a slug with a plurality of passages therein corresponding to the number of tubes required,
   b. extruding said slug by impact extrusion to form a plurality of tubes integrally connected at one end by a base and spaced apart from one another over the remainder of their length and
   c. connecting the interior passages of said tubes in a heat exchanger circuit to permit fluid to pass through said tubes in heat exchange relationship with the exterior of said tubes.

2. A method of forming a heat exchanger comprising the steps of:
   a. forming a slug with a plurality of passages therein corresponding to the number of tubes required,
   b. extruding said slug by impact extrusion to form a plurality of tubes integrally connected at one end by a base and spaced apart from one another over the remainder of their length, said passages opening through said tubes and through said base to dispose an open end of each passage on opposite sides of said base, and
   c. interconnecting adjacent ends of said tubes to provide a heat exchanger flow path for fluid to permit fluid to pass through said tubes in heat exchanging relationship with the exterior surfaces of said tubes.

3. A method as claimed in claim 1 wherein said tubes are formed with longitudinally extending radially projecting heat exchange fins in the impact extrusion step.

4. A method of forming a heat exchanger comprising the steps of:
   a. forming a slug having an inner face, an outer face and a peripheral edge with a plurality of passages spaced inwardly from the peripheral edge and extending between the inner face and the outer face,
   b. extruding said slug by impact extrusion to form a plurality of tubes which are integrally connected at one end by a base formed from the unextruded portion of the slug and spaced apart over the remainder of their length, the interior passages of said tubes being an extension of the passages formed in said slug, and
   c. connecting the interior passages of said tubes in a heat exchanger circuit to permit fluid to pass through said tubes in heat exchange relationship with the exterior of said tubes.

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