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METHOD AND APPARATUS FOR MAKING HEAT EXCHANGERS

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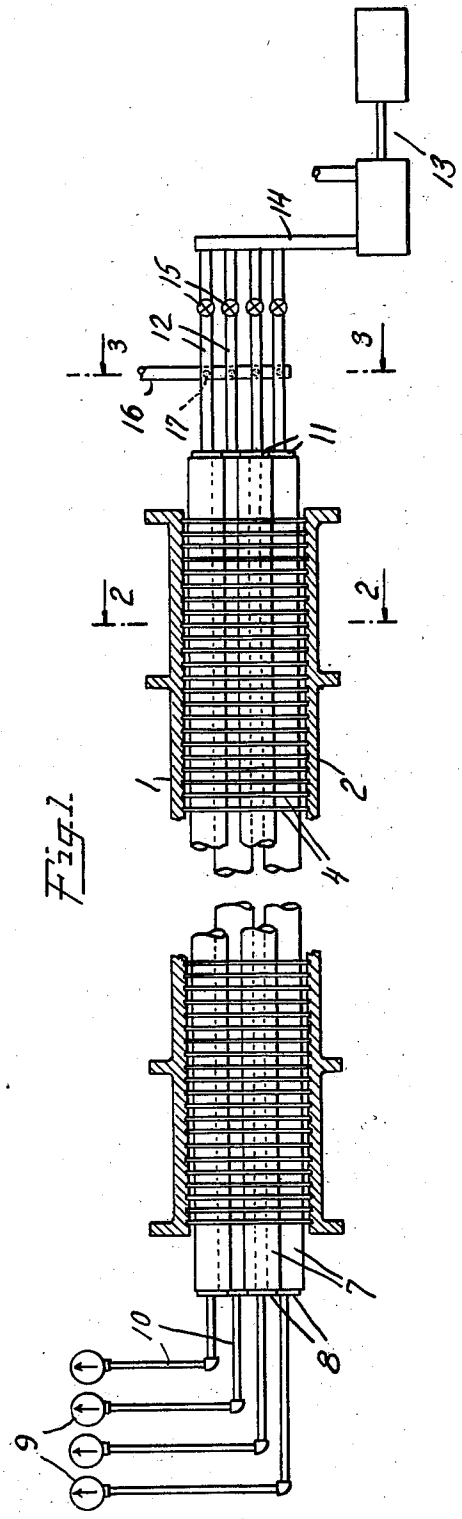


Fig. 1.

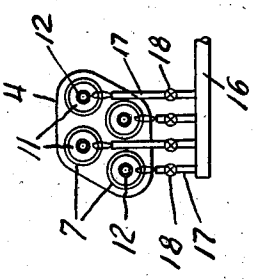


Fig. 3.

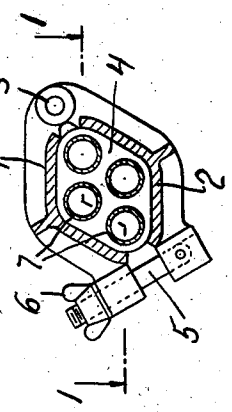


Fig. 2.

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METHOD AND APPARATUS FOR MAKING HEAT EXCHANGERS

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8 Claims. (Cl. 113—118)

This invention relates to methods and apparatus for making heat exchangers or heat exchanger units of the form comprising a number of tubes passing through a series of plates or fins firmly secured to the tubes in efficient heat exchanging relation therewith.

In making heat exchangers comprising one or more units consisting of a number of metal tubes having mounted thereon heat conducting fins or plates the plates have been secured to the tubes by forcing a tube expander through each of the several tubes. Where this process is carried out by drawing or forcing the expander through first one tube and then another the results obtained are not satisfactory because each tube while being expanded has a tendency to elongate or creep and this longitudinal distortion is seldom of the same magnitude for any pair of the tubes. Accordingly the heat exchanger element may be badly warped by the expanding operation and it is exceedingly difficult to straighten the element after the fins have been secured to the tubes. This objectionable warping or distortion of the units may occur to some extent even where all of the tubes passing through the plates or fins are simultaneously expanded by means of mechanical expanders drawn or forced through all of the tubes at the same time, and while improved results can ordinarily be obtained by this method yet it requires elaborate, expensive equipment and in some instances it is necessary to straighten the units after the expanding operation is completed.

An object of the present invention is to eliminate the difficulties inherent in the mechanical expansion method which has been employed in making heat exchangers or heat exchanger units of the type referred to above. In general, my invention contemplates the expansion of the tubes by hydraulic pressure. The use of hydraulic pressure is particularly advantageous in making apparatus of the type referred to above for the tubes do not become distorted or elongated longitudinally to any appreciable extent even though the expanding operation is performed in a series of steps, as by expanding first one tube and then another. Accordingly when my improved method is employed the heat exchanger unit does not become warped or twisted during the expanding operation.

I am aware of the fact that a thin-walled copper tubing or the like has been expanded into a series of fins threaded onto a single section of the tubing, by employing hydraulic pressure for expanding the tubing into firm engagement with the fins. According to my invention however I utilize the force of hydraulic pressure for expanding tubing, preferably thick-walled steel tubing, or the like, into permanent binding engagement with a series of fins or plates threaded onto a number of such tubes. It is thus possible to produce heat exchanger units of this form having fins or plates very accurately spaced from each other along the tube and there is no danger of having any one or more of the tubes become elongated during the expansion operation which is a very serious objection in heat exchanger apparatus of this type in which a number of tubes are interconnected or embraced by each of a number of fins or plates secured thereto. Furthermore, my improved method insures uniformity of the expanding force at all points throughout the tube or tubes being expanded by the hydraulic pressure.

One method of carrying out my improved process is to thread the fins or plates onto the tubes and then force water, or some other liquid, into the tubes under sufficient pressure to extend the tubes beyond their elastic limit into firm binding engagement with the fins or plates. Where a thick-walled tubing is employed, or where for other reasons it is desirable to employ a very high expansion pressure to the interior of each tube, I prefer to heat water, or other liquid, confined in the tubes so that the expansion of the liquid which occurs as the temperature is raised will cause a very high pressure to be developed within each tube. In some instances the liquid may be confined in each tube under considerable pressure before the liquid is heated above room temperature, and thus insure the production of an even higher pressure within the tubes when the liquid is heated to the maximum desired temperature.

The fluid confined in the tubes may be heated in various ways. One way of accomplishing this result is to heat the fluid supply pipe or pipes communicating with one or more of the heat exchanger tubes. By this means the temperature of the liquid may be raised to the desired value without unduly heating the fins or plates threaded onto the heat exchanger tubes. In some instances it may be desirable to immerse the heat exchanger tubes with the fins threaded thereon into a bath of water, or other liquid, heated to a temperature sufficient to cause the desired temperature rise in the liquid confined in the heat exchanger tubes. It is also feasible to heat the entire unit by utilizing low pressure steam, or other heating means. Where water is

used as the hydraulic expanding medium it is desirable to avoid heating the water in the tubes above its boiling point at atmospheric pressure. It is desirable to employ pressure gauges, or the like, for indicating the pressure in the heat exchanger tubes during the expanding operation and the supply of heat to the liquid in the tubes can be carefully regulated so as to build up the desired pressure required for expanding the heat exchanger tubes into binding engagement with the fins or plates. The tubes may be readily expanded by the hydraulic pressure beyond their elastic limit. Under such conditions the fins or plates will remain firmly united to the tubes after the expansion operation is completed and the hydraulic pressure in the tubes is reduced.

My improved process can be carried out by utilizing simple and inexpensive apparatus of various forms. In some instances it is appropriate to fill the heat exchanger tubes with water or other liquid and then heat this liquid after sealing the ends of the tubes to confine the liquid therein. Where the force required to expand the tube is not excessive the expansion operation may be performed by utilizing a hydraulic pump, or the like, for forcing the fluid into the tubes under sufficient pressure to cause the desired expansion of the tubes. As stated above, the pressure thus created may be increased if desired by heating the liquid confined in the tubes after it has been forced into the tubes under considerable pressure. This additional step is particularly desirable where heavy walled tubing is used, for example No. 12 BWG steel tubing, or even heavier tubing which may require an expansion pressure in the neighborhood of 30,000 lbs. per square inch or more. It is exceedingly difficult to expand such tubing or special alloy tubing by any mechanical expansion apparatus, but the necessary operation can be readily performed by utilizing my improved hydraulic expansion method.

One form of apparatus embodied in my invention is illustrated in the accompanying drawing in which

Fig. 1 is a longitudinal view of the apparatus, taken on line 1—1 of Fig. 2, some of the parts being shown in section;

Fig. 2 is a transverse section view, taken on line 2—2 of Fig. 1 and

Fig. 3 is a transverse section view, taken on line 3—3 of Fig. 1.

The apparatus illustrated in the accompanying drawing includes a fin magazine comprising two sections 1 and 2, hinged together as shown at 3. These magazine sections are grooved to accommodate a series of fins or plates 4 and the two magazine sections may be clamped firmly against the plates by any suitable means such as the pivoted bolt 5 and the nut 6. After the fins have been inserted in the magazine and the two magazine sections clamped together a plurality of heat exchanger tubes 7 may be inserted through aligned apertures in the several fins. The fins are thus in a sense threaded onto the series of tubes so that the tubes may be expanded into firm binding engagement with the fins in the manner herein described. The several tubes 7 are provided at one end with plugs 8 and pressure gauges 9 are connected to the several heat exchanger tubes through pipe connections 10 mounted in the several plugs 8. Another series of plugs 11 is provided for the opposite ends of the heat exchanger tubes 7 and a series of pipes 12 are mounted in these plugs and serve as a means for supplying water or other liquid to the several heat exchanger tubes. A hydraulic pump 13 serves to supply liquid to the several pipes 12 through a pipe manifold 14 and each of the pipes 12 is provided with a valve 15 so that after the liquid has been supplied to the several heat exchanger tubes 7 it may be confined therein by closing these valves.

As explained above heat may be supplied to the liquid in the heat exchanger tubes in various ways. One means for accomplishing this result is illustrated in the accompanying drawing which shows a supply pipe 16 for gas or other fuel. This pipe 16 communicates with several burner pipes 17 each controlled by a separate valve 18 and each burner pipe is arranged so that when it is in operation heat is supplied to one of the pipes 12 communicating with one of the heat exchanger tubes 7.

After the fins or plates 4 have been threaded onto the heat exchanger tube 7 and the various connections made as above described, the tube expanding operation may be performed in any one of several ways. For example, where excessive pressure is not necessary in order to expand the tubes to the desired extent, it will suffice to merely inject the liquid into the heat exchanger tubes by means of the hydraulic pump 13 until the pressure as indicated by the pressure gauges 9 is increased to the neighborhood of 2,000 lbs. per square inch. In this manner all of the heat exchanger tubes may be expanded simultaneously, or, by manipulating the valves 15 the operation may be performed in a series of steps by first expanding one tube or one pair of tubes and then expanding the remaining tubes. Where it is necessary to employ a higher pressure in the tubes 7 they may be first filled with water or other liquid supplied by the hydraulic pump 13, and then after closing the valves 15 the several burners 17 may be lighted to supply heat to the liquid in the heat exchanger tubes. If desired, the hydraulic pressure in the heat exchanger tubes may be increased to a considerable extent by means of the hydraulic pump 13 before the valves 15 are closed and the burners lighted, for in this manner an extremely high pressure may be developed within the heat exchanger tubes. In some instances it is desirable to utilize a pressure at least as high as 30,000 lbs. per square inch. By watching the several pressure gauges 19 and regulating the burner valves 18 the pressure in the heat exchanger tubes may be gradually increased to the desired predetermined value required for the expanding operation. Where the expansion of the liquid confined in the tubes which occurs upon heating this liquid, is utilized as above described, it will be understood that for a given liquid temperature the pressure developed in the tubes will be higher when thick-walled steel tubing is employed than where relatively thin-walled heat exchanger tubing is used, for the thick-walled tubing will not expand as readily to relieve the pressure developed by heating the liquid in the heat exchanger tubes. It is thus possible to develop an exceedingly high pressure in the heat exchanger tubes whenever this is needed for expanding heavy walled tubing.

It is to be understood that my invention is not limited to the particular embodiments illustrated and described but includes such modifications thereof as fall within the scope of the appended claims.

I claim:—

1. The process which comprises threading apertured plates onto a plurality of tubes with

each plate embracing all of said tubes supplying a liquid to at least one of said tubes, confining said liquid therein, and applying heat to cause the temperature of the liquid to increase with resultant expansion of the liquid until the said tube has been expanded into permanent binding engagement with the plates.

2. The process which comprises threading apertured plates onto a heavy walled metal tube, confining a body of liquid in the tube and then heating the liquid to raise its temperature and expand the same until this tube is expanded beyond its elastic limit into permanent binding engagement with the plates.

3. The process which comprises threading apertured plates onto a tube, forcing a liquid into said tube under superatmospheric pressure, confining said liquid therein, and then heating the liquid to expand the same, whereby the tube is expanded beyond its elastic limit into permanent binding engagement with the plates.

4. The process which comprises threading apertured plates onto a plurality of tubes with each plate embracing all of said tubes, supplying a liquid to at least one of said tubes under superatmospheric pressure, confining the liquid in said tube under pressure and then supplying heat to said liquid to expand the same whereby said tube is expanded into permanent binding engagement with the plates.

5. The process which comprises threading apertured plates onto a plurality of tubes with each plate embracing all of said tubes, supplying a liquid to the inside of at least one of said tubes, confining said liquid therein and then applying heat to said tube to raise the temperature of said liquid and expand the same until the said tube has been expanded into permanent binding engagement with the plates.

6. The process which comprises threading apertured plates onto a plurality of tubes with each plate embracing all of said tubes, supplying a liquid to at least one of said tubes to substantially fill the same, confining said liquid therein and applying heat to said liquid at a point remote from said plates to cause the liquid to expand until the said tube has been expanded into permanent binding engagement with said plates.

7. Apparatus for expanding heat exchanger tubes into a plurality of plates each embracing a plurality of said tubes, comprising means for supplying liquid to a plurality of said tubes, means for confining the liquid in the tubes and means for supplying heat to the liquid confined in a plurality of said tubes to increase the volume of said liquid until the tubes have been expanded into permanent binding engagement with the plates.

8. Apparatus for expanding a plurality of tubes into plates each embracing a plurality of said tubes, comprising means for supplying a liquid to said tubes under superatmospheric pressure, means for confining the liquid in said tubes, and means for supplying heat to the liquid in said tubes to further increase the hydraulic pressure obtaining within the tubes.

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