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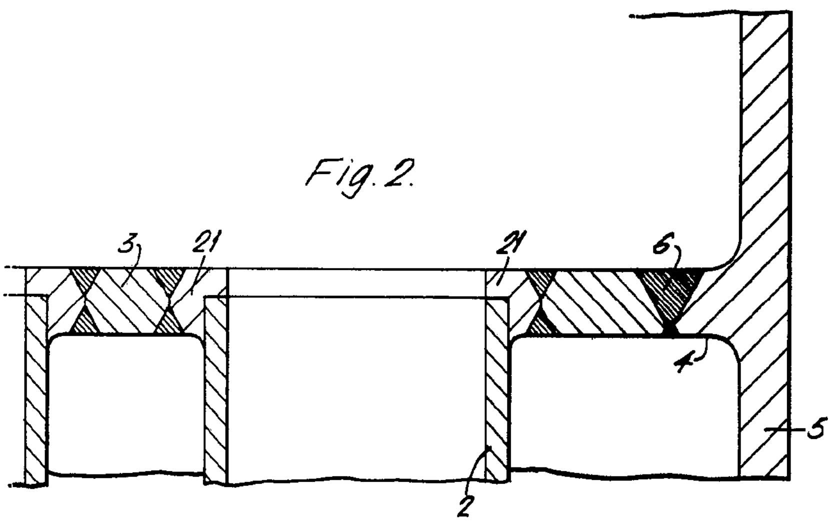
(71) Applicant
British Nuclear Fuels Limited
Risley
Warrington
Cheshire
WA3 6AS
(72) Inventors
John Edward Burton
Ronald Walter Thomas Tombs
(74) Agents
D S Bosshardt

(54) Manufacture of heat exchangers

(57) A tube bundle for use in a heat exchanger has a series of spaced parallel tubes 2 supported by tube plates 3 and is manufactured by depositing welding material around the end of each tube, machining the deposited material to form an annular flange 21 around the end of the tube and welding the flange 21 into apertures in the tube plate 3. Preferably the tubes 2 have a length which is slightly less than the distance between the outer surfaces of the tube plates and the deposited material is deposited so that it overlaps and protects the end surfaces of the tubes. A plug may be inserted in the bore of the tubes during the welding material deposition which, as described, is effected by manual metal arc welding.

One use of heat exchangers incorporating a tube bundle manufactured as above is in apparatus for reducing the volume of, and recovering nitric acid from, radioactive effluents from a nuclear reprocessing plant.

Fig. 2.



GB 2 035 871 A

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Fig. 1.

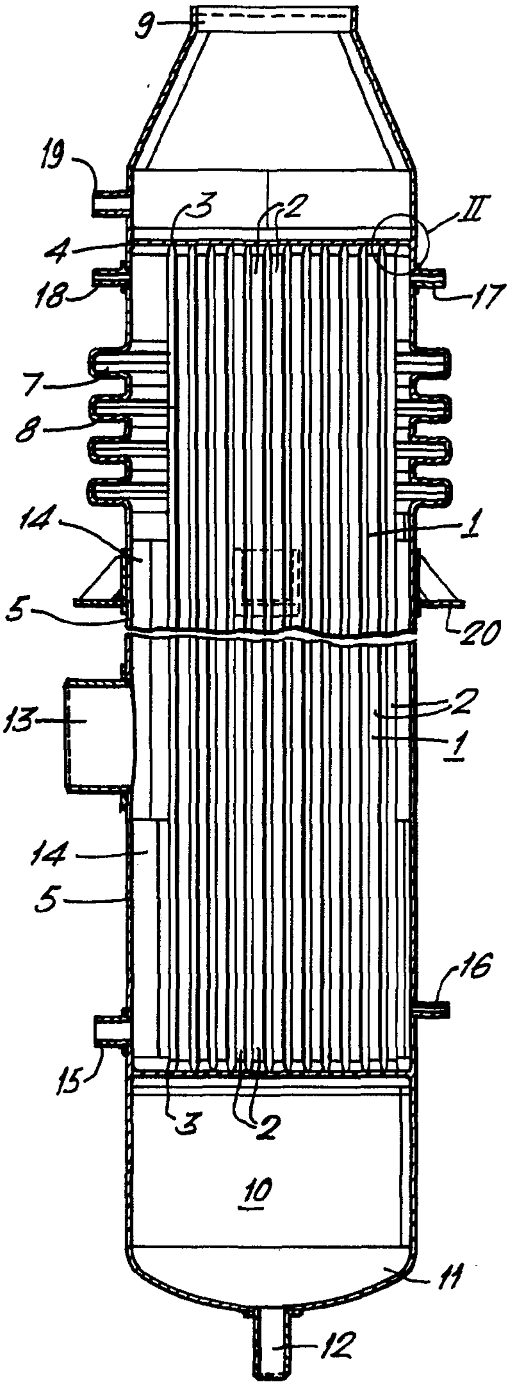

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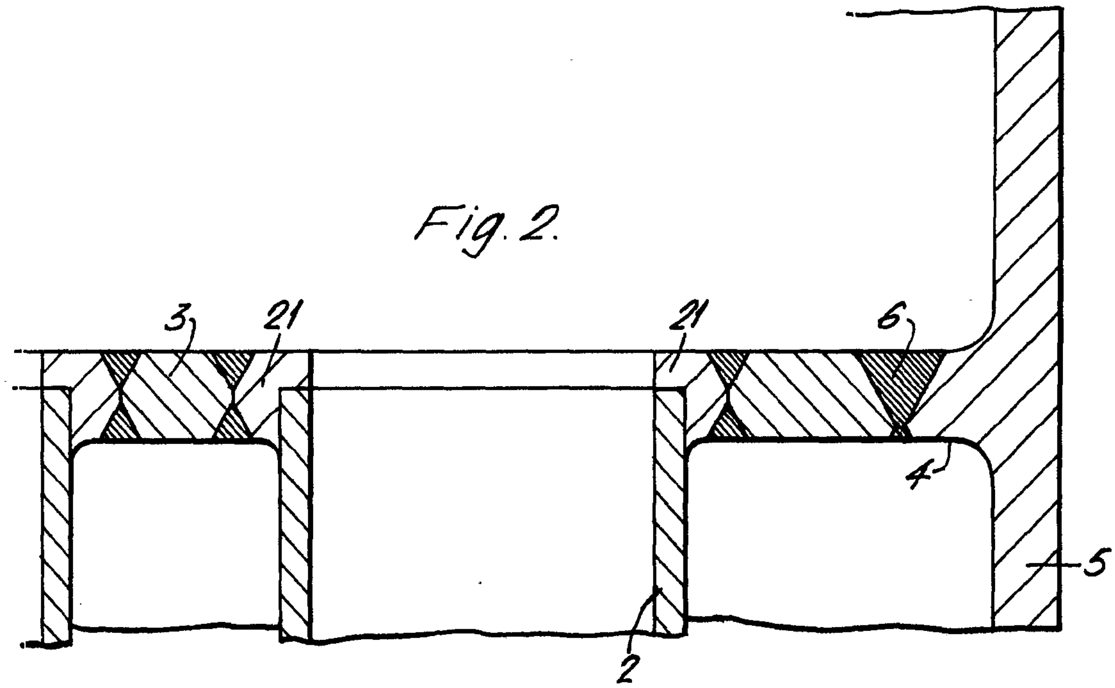
Fig. 2.



SPECIFICATION

Manufacture of heat exchangers

This invention relates to heat exchangers and is primarily concerned with that kind of heat exchanger which employs a cluster of spaced parallel tubes supported by tube plates and enclosed in a tubular shell, the assembly of tubes and tube plates hereinafter being termed a "tube bundle".

In heat exchangers of the hereinbefore specified kind it has been proposed to employ a tube bundle having relatively thick tube plates apertured to receive the ends of the tubes, the latter being swaged radially outwards to engage the walls of the apertures. Where it is required to ensure a fluid tight seal between the outer surface of the tubes and the walls of the apertures it is common practice to run sealing welds at the ends of the tubes round the joints between the tubes and the apertures. Heat exchangers having such tube bundles suffer certain disadvantages such as, for example, the difficulty they offer to the performance of satisfactory examination of the welds. Under certain conditions where the welds come into contact with corrosive fluids, undetected cavitational defects in the welds can secrete fluid and subsequently develop major faults necessitating maintenance of the equipment which may not be practicable.

It has also been proposed that in a tube bundle for a heat exchanger the tube plates are assembled in spaced relationship by the tubes which are secured to non-flanged ends of flanged ferrules, the ferrules being joined to the ends of the tubes and by their flanges to the tube plates. Preferably the ferrules are forgings and the joints between the flanges of the ferrules and the tube plates and between the ferrules and the ends of the tubes comprise butt welds. Tube bundles manufactured in accordance with this latter proposal when used with corrosive fluids have been found to be subject to corrosion at the end grain exposed on the surface of the forging and to erosion caused by turbulence created inside the tubes by the presence of an internal bead at the site of the butt weld between the ferrules and the end of the tubes.

According to the present invention a method of manufacturing a tube bundle for a heat exchanger in which a cluster of spaced parallel tubes is supported by tube plates at the ends of said tubes, comprises the steps of depositing welding material around the ends of each tube, machining the deposited material to provide an annular flange around the end of each tube and welding said flanges to apertures in the tube plates.

The invention will be illustrated by the following description of the structure and manufacture of one embodiment of heat exchanger. The description is given by way of example only and has reference to the accompanying drawing in which:

Figure 1 is a sectional view of a heat exchanger, and

Figure 2 is a sectional view on an enlarged scale of the part of Fig. 1 contained in the circle II.

The heat exchanger shown vertically disposed in Fig. 1 is of composite construction and is fabricated from stainless steel tube and plate. A tube bundle 1 comprises a cluster of spaced parallel tubes 2 end supported by tube plates 3. The tube bundle 1 is joined to collars 4 of a fabricated shell 5 by butt welds 6 at the peripheries of the tube plates 3. A bellows 7 consisting of four convolutions 8 define an expansible section of the shell 5 to accommodate differential thermal expansion of the tube bundle 1 and the shell. The shell 5 extends beyond the tube plates 3 to define an upper chamber 9 and at the bottom a tube chamber 10 closed by a dished end 11 having a downwardly extending branch pipe 12. A large branch pipe 13 on the shell 5 disposed intermediate the tube plates 3 gives access to a shell chamber 14 bounded by the shell 5 and the tube plates, and two smaller branch pipes 15, 16 are located adjacent the lower tube plate 3. In the upper regions of the shell 5 adjacent the upper tube plate 3 there are branch pipes 17, 18, 19. Branch pipes 15, 16, 17, 18 communicate with the shell chamber 14 whilst the branch pipe 19 communicates with the regions of the shell immediately above the upper tube plate. The heat exchanger is adapted to be supported in the vertical position shown in Fig. 1 by support brackets 20 attached to the shell.

The heat exchanger may be used as an evaporator in apparatus for reducing the volume of, and recovering nitric acid from, radioactive effluent resulting from the processing of irradiated nuclear reactor fuel elements. Active liquor the volume of which is to be reduced is fed to the tube side of the evaporator via the branch 12 and hot vapour or steam is fed to the shell chamber 14 via the branch 13. Vapor generated by heat exchange between the hot vapour or steam in the shell chamber 14 and liquor in the tubes 2 passes via the upper chamber 9 to a separator and liquor subsequently separated from the vapour in the separator is returned to the evaporator via the branch 12. The branch pipe 19 provides a drain (connected to branch pipe 12) for any liquor which becomes disentrained from the vapour passing to the separator and unable to drain down the tubes 2 because of vapour velocity within them. Condensate from the shell chamber 14 is drained by way of branch pipe 15. The branch pipe 17 is a vent from the shell chamber and branch pipes 16, 18 are outlets to vacuum pumps for removing non-condensible vapour.

To manufacture the tube bundle each tube

2 is cut to a length slightly less than the distance between the outer surfaces of the tube plates 3. A plug is inserted into the end of the bore of the tube 2 and a body of weld material is built up around each end of the tube 2 using a manual metallic arc process. The weld material deposited around each end of the tubes 2 is then machined to provide an annular flange around the tube. To ensure the integrity of the weld between the tube and the annular flange, the weld may be radiographed. To assemble the heat exchanger the annular flange on the tube is located in a circular aperture in the tube plate 3 and butt-welded thereto.

The butt weld between the annular flange and the tube plate may be radiographed to ensure the integrity of the weld. The weld material of the flange overlaps and protects the end grain exposed at the end of the tube 2. Because the tube 2 is manufactured by drawing, the grain runs along the tube and therefore no end grain is exposed to any corrosive liquid which may be passed through the tube. The inside of the bore of the tube is free from any protuberances which may cause turbulence and hence erosion. Therefore heat exchangers constructed in accordance with the present invention show better resistance to corrosive attack than the prior art devices described above.

CLAIMS

1. A method of manufacturing a tube bundle for a heat exchanger in which a cluster of spaced parallel tubes is supported by tube plates at the ends of said tubes comprising the steps of depositing welding material around the ends of each tube, machining the deposited material to provide an annular flange round the end of each tube and welding said flanges into apertures in the tube plates.

2. A method of manufacturing a tube bundle as claimed in claim 1 wherein each tube is cut to a length slightly less than the distance between the outer surfaces of the tube plates and the welding material is deposited so that the weld material overlaps and protects the end surfaces of the tubes.

3. A method as claimed in either of the preceding claims wherein a plug is inserted into the bore of the tube during the deposition of the welding material.

4. A tube bundle when manufactured by the method of any one of claims 1 to 3.

5. A heat exchanger comprising a tubular shell containing a tube bundle as claimed in claim 4.

6. A method of manufacturing a tube bundle substantially as hereinbefore described with reference to the accompanying drawings.

7. A tube bundle substantially as hereinbefore described with reference to the accompanying drawings.

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