

April 7, 1970

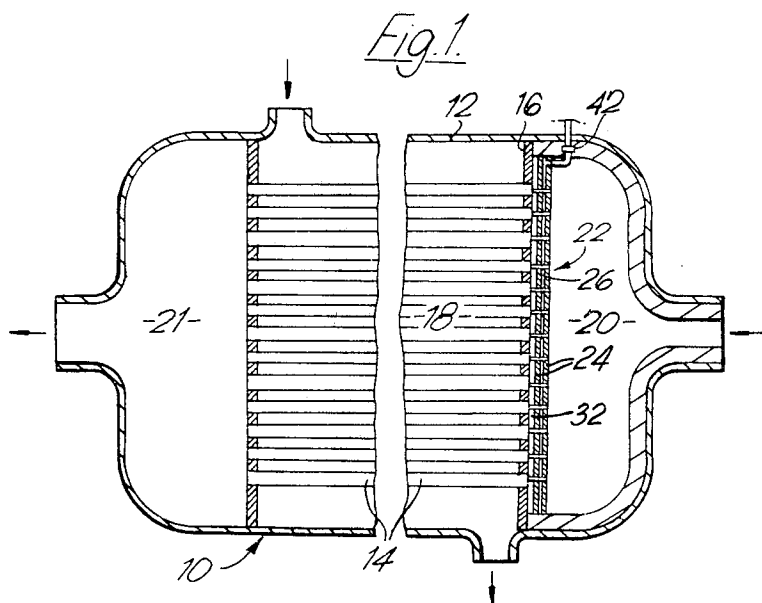
R. G. PEARCE

3,504,739

SHELL AND TUBE HEAT EXCHANGERS

Filed June 6, 1968

2 Sheets-Sheet 1



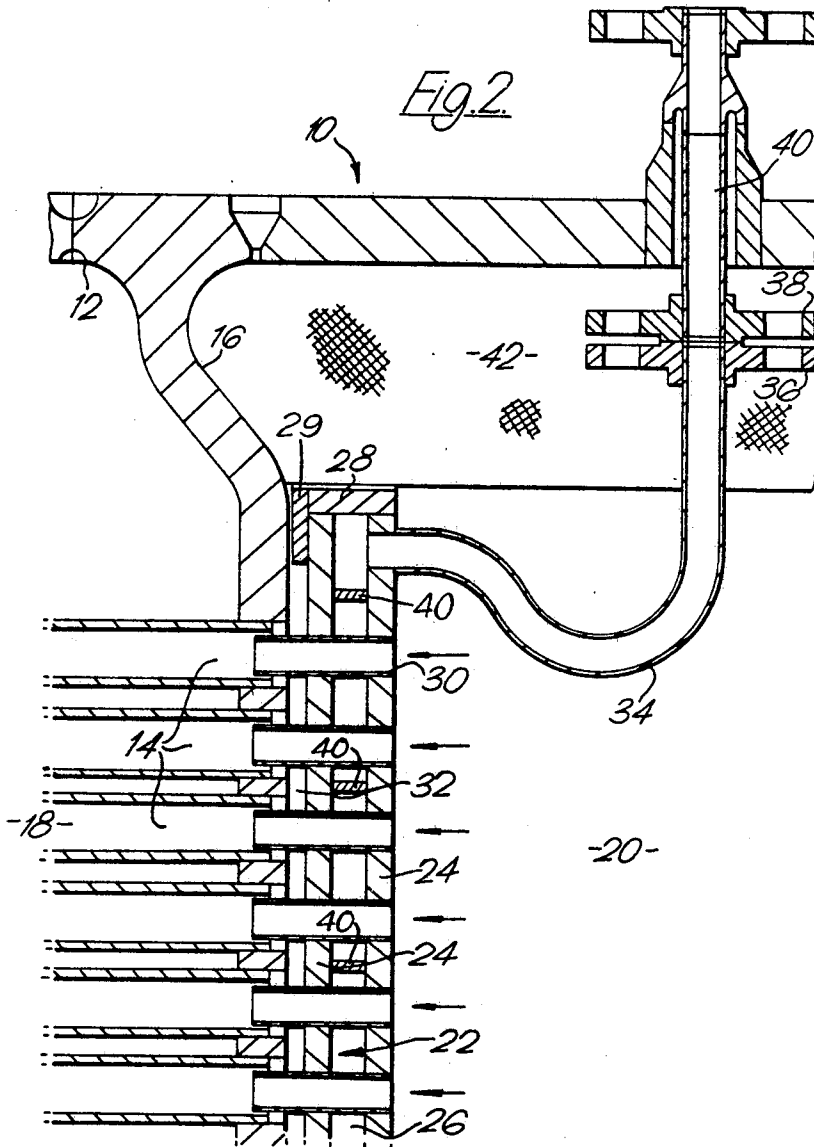
Inventor
ROY G. PEARCE

By *Marvin J. Noyes*
Attorney

Filed June 6, 1968

SHELL AND TUBE HEAT EXCHANGERS

2 Sheets-Sheet 2



Inventor
ROY G PEARCE
By *Morris J. Hayes*
Attorney

1

3,504,739

SHELL AND TUBE HEAT EXCHANGERS

Roy George Pearce, Foster Wheeler House, Chapel St.,
London, NW. 1, England

Filed June 6, 1968, Ser. No. 735,017

Claims priority, application Great Britain, June 15, 1967, 27,761

Int. Cl. F28f 9/02, 9/20

U.S. Cl. 165—134

12 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to improvements in shell and tube heat exchangers in which heat exchange takes place between one fluid passing through the tubes and another fluid surrounding the tubes and within the shell. This heat exchanger has a tube plate which extends across the shell and to which the tubes are connected, and this tube plate is shielded by a fluid-cooled shield plate, preferably liquid cooled, which is positioned in front of the tube plate and has stub tubes extending through it to feed the hot fluid directly to the tubes of the heat exchanger, the arrangement being such that the opposite faces of the shield plate are subjected to substantially identical pressures.

BACKGROUND OF THE INVENTION

A typical shell and tube heat exchanger comprises a shell through which extend a large number of tubes in a direction parallel to the longitudinal axis of the shell. The ends of the tubes terminate in tube plates which divide the shell into end boxes to one of which fluid is fed before passage through the tubes and from the other of which the fluid is removed after passage through the tubes and a main heat exchange region containing the other fluid and through which the tubes extend.

When the differential pressures and temperatures of the two fluids are not excessive such a heat exchanger is perfectly satisfactory. When this is not the case, however, serious problems can arise. If, for example, there is a large difference in pressure between the two fluids a thick tube plate is required and if the fluid fed through the tubes is very much hotter than the other fluid, this thick tube plate is subjected to a large temperature differential, and also it is in contact with very hot fluid.

This situation frequently occurs in chemical plants where heat recovery is required from high temperature gases, e.g. 2,300° F., by using a fluid at, say, 500° F. In such a case it is essential that the tube plates be protected from the fierce hot gases. This has been done in the past by covering the surface of the plate exposed to the hot gases with a layer of refractory material and having ferrules or short tubes inserted through the layer of refractory material to provide access for the hot gases to the tubes. This solution still presents problems, however, because the ferrules or short tubes are liable to burn away at the high temperatures to which they are exposed.

The invention has been made with these problems in mind.

According to one aspect of the invention there is provided a shell and tube heat exchanger in which the heat exchange tubes extend from a tube plate which is subjected to hot inlet fluid, this tube plate being shielded by a fluid cooled shield plate having flow means there-through for the passage of the hot inlet fluid to the tubes, the opposite faces of the shield plate being in communication so that they are subjected to substantially identical pressures.

According to another aspect of the invention there is provided a shell and tube heat exchanger comprising a shell within which a number of heat exchange tubes

2

extending between tube plates which define with the shell inlet and outlet end boxes for the fluid to pass through the tubes and a heat exchange region through which the tubes extend, a fluid-cooled shield plate spaced in front of the tube plate defining the inlet end box in the direction of flow of the fluid so as to shield that tube plate from very hot inlet fluids, and flow means extending through the shield plate for the passage of the inlet fluid from the inlet end box to the heat exchange tubes, the opposite faces of the shield plate being subjected to substantially identical pressures, whereby the tube plate defining the inlet end box is subjected to differential pressure but shielded by the shield plate from a large differential temperature, which the shield plate is subjected to the inlet fluid, is cooled by the cooling fluid and is not subjected to any substantial differential pressure.

The shield plate protects the surface of the tube plate from the very hot fluid and so the tube plate can be thick so as to withstand the differential pressure without being subjected to a large temperature differential. On the other hand the shield plate can be thin because it has no differential pressure to withstand and since it is cooled, preferably by a liquid, no part of it reaches an excessively high temperature or is subjected to a large temperature differential.

In general, the shield plate will be cooled by means of water and when this is the case an auxiliary supply of steam can be obtained.

DESCRIPTION OF THE DRAWINGS

An embodiment of a heat exchanger according to the invention will now be described by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIGURE 1 is a longitudinal section through the heat exchanger; and

FIGURE 2 is a cross-section of part of the heat exchanger.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The heat exchanger 10 shown in the drawings comprises a cylindrical shell 12 through which a large number of tubes 14 extend between a pair of tube plates 16. The tubes are fixed to the plates 16 in any convenient way, for example, by welding or rolling.

The tube plates 16 define with the shell 12 a heat exchange region 18 and an inlet end box 20 and an outlet end box 21. A very hot stream of gases is fed to the inlet end box 20 shown and this passes through the tubes 14 and gives up heat to fluid, for example water, flowing through the region 18.

Positioned in front of the tube plate 16 and exposed to the very hot gases is a shield plate 22. This shield plate is spaced a short distance from the plate 16 and it comprises a pair of thin spaced circular plates 24 which define between themselves a cooling chamber 26 which is completed by a band 28 to which both plates 24 are fixed. An annular ring 29 engages the side of the band 28. Short stub tubes 30 extend right through both plates 24 and just into the ends of the tubes 14 so as to provide passages for the passage of the hot gases from the box 20 to the tubes 14. The stub tubes 30 are a loose fit in the ends of the tubes 14 so that the pressure in the gap 32 between the tubes 14 and the shield plate 22 is substantially the same as that in the end box 20. In this way the shield plate 22 is not subjected to a differential pressure and it can therefore be made from thin material.

The cooling fluid for the shield plate 22, which is preferably water, is supplied to and removed from the shield plate through conduits 34, only one of which is shown.

The conduit 34 terminates at a flange 36 which is in turn connected with another flange 38 on the end of a short tube 40 which passes to the outside of the shell 12. This tube 40 passes through a layer of refractory material 42 whose purpose is to protect the inner wall of the shell 12. The band 28 and ring 29 are loosely fitted in the end box 20. This provides another means of preventing a large pressure differential across the shield plate 22.

The plate 22 is positioned by being pushed into place so that it is a loose fit within the refractory material 42. The flanges 36 and 38 are then connected so as to hold the plate in place and complete the cooling fluid circuit. This simple fitting arrangement enables the shield plate 22 to be removed and replaced or repaired if it ever becomes damaged by the hot gases.

The flanges 36 and 38 are shown buried in the refractory material, this ensures that they are not burnt away. When the shield plate 22 is to be fitted or removed the refractory material can be broken away and locally repaired after fitting the plate 22.

Because the plates 24 and stub tubes 30 are thin they can be kept reasonably cool by means of the cooling fluid although the plate 22 is exposed to very hot gases. At the same time the tube plate 16 is shielded from the hot gases and even if some of the hot gases pass into the gap 32 either around the edges of the plate 22 or via the tubes 30 they are quickly cooled by contact with the rear plate 24. Therefore no large temperature differentials are set up across the tube plate 14 which must of necessity be quite thick to withstand differential pressure between the fluids in the end boxes 20 and 21 and the region 18.

The gap 32 between the plates 16 and 22 can be left empty as shown or if desired it can contain a layer of insulating or refractory material.

The arrangement shown for fixing the shield plate 22 in the shell is not essential. For example, the plate 22 can be attached to the inner periphery of the shell by means of a flexible sealing device.

The cooling fluid, can be passed through the cooling chamber 26 by forced or natural circulation and in order to ensure an even distribution of this fluid throughout the chamber 26 and thus for even cooling over the whole area of the plates 24 passages or baffles 40 may be positioned in the chamber 26. Preferably the cooling fluid is water and then a useful auxiliary supply of steam can be obtained and if the fluid being heated in the region 18 is water, the cooling water for the plate 22 can be derived from that supplied to the region 18 and the heated water or steam mixed with that heated in the region 18.

A latitude of modification, change and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

I claim:

1. A shell and tube heat exchanger comprising a shell, heat exchange tubes, a tube plate from which said tubes extend, means for feeding a hot fluid to said tubes through said tube plate, a shell plate shielding said tube plate, means for fluid cooling said shield plate, flow means for the passage of said hot fluid to said tubes through said shield plate, and means for placing opposite faces of said shield plate in flow communication so that said opposite faces are subjected to substantially identical pressures.

2. A heat exchanger according to claim 1 in which said shield plate is spaced a short distance in front of said tube plate in the direction of flow of said hot fluid, and said flow means direct said hot fluid into the ends of said tubes.

3. A heat exchanger according to claim 1 in which said shield plate comprises a pair of spaced plates de-

fining between themselves a chamber, and an inlet to and an outlet from said chamber for the passage of cooling fluid through said chamber to cool said plate.

4. A heat exchanger according to claim 3 in which baffles are provided in said chamber.

5. A heat exchanger according to claim 2 in which said flow means through said shield plate comprise stub tubes extending through said shield plate into the ends of said tubes.

6. A shell and tube heat exchanger comprising a shell, means for feeding a first fluid through said shell, a number of heat exchange tubes extending within said shell, tube plates between which said heat exchange tubes extend and which extend across said shell so as to define with said shell inlet and outlet and boxes for fluid passing through said tubes and an intermediate heat exchange region through which said tubes extend, means for feeding a second fluid to said inlet end box and from said outlet end box so that it passes through said tubes in heat exchange with said first fluid, a fluid-cooled shield plate spaced in front of the tube plate defining said inlet end box in the direction of flow of said second fluid to shield that tube plate from hot inlet second fluid, means for fluid cooling said shield plate, flow means extending through said shield plate for the passage of said second fluid from said inlet end box to said tubes, and means for flow communication between the opposite faces of said shield plate to prevent substantially differential pressure across said plate.

7. A heat exchanger according to claim 6 further comprising a layer of refractory material in said inlet end box to protect said shell from said second fluid.

8. A heat exchanger according to claim 6 in which said shield plate comprises a pair of spaced plates defining between themselves a chamber, and an inlet and an outlet from said chamber for the passage of cooling fluid through said chamber to cool said plate.

9. A heat exchanger according to claim 8 in which baffles are provided in said chamber.

10. A heat exchanger according to claim 6 in which said flow means through said shield plate comprises stub tubes extending through said shield plate into the ends of said tubes.

11. A heat exchanger according to claim 10 in which said stub tubes and said tubes are in non-sealing engagement, whereby substantial differential pressure is prevented across said shield plate.

12. In a shell and tube heat exchanger comprising a shell, a bank of tubes within said shell, and tube plates between which said tubes extend, the provision of a fluid-cooled shield plate spaced from, and adjacent to, one of said tube plates for shielding that tube plate from very hot inlet fluid to be passed through said tubes, means for passing a cooling fluid through said shield plate, and flow communication means for ensuring that opposite faces of said shield plate are kept at substantially identical pressures, whereby said tube plate can be subjected to a differential pressure but is shielded by said shield plate from large differential temperatures, and said cooled shield plate can be subjected to said very hot inlet fluid and is not subjected to any substantial differential pressure.

References Cited

UNITED STATES PATENTS

2,615,688	10/1952	Brumbaugh	165—134 X
2,986,454	5/1961	Jewett	23—288
3,132,691	5/1964	Esleek	165—158 X
3,185,210	5/1965	Kuhne et al.	165—134

MEYER PERLIN, Primary Examiner

A. W. DAVIS, JR., Assistant Examiner

U.S. Cl. X.R.

165—158, 173