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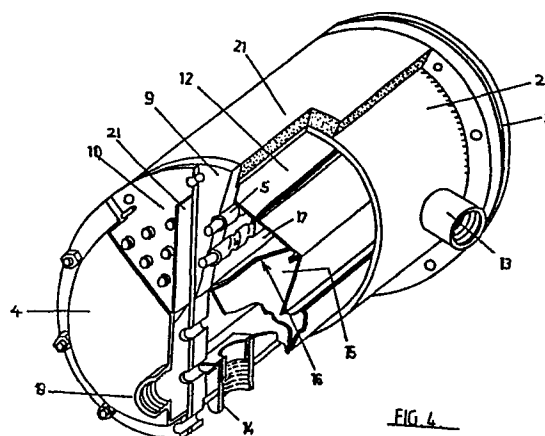
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(54) **A heat exchanger.**

(57) A heat exchanger having an outer casing (2), end plates (9, 10) at each end of the casing (2) and baffles (12) confining groups of the tubes (5) passing between plenum chambers defined by end caps (3, 4) fixed to the end plates (9, 10). The baffles (12) in the casing (2) are arranged so that there is a single pass for refrigerant gas from a refrigerant inlet (13) to a refrigerant outlet (14), and baffles (21) in the plenum chambers are arranged so that there is a single pass of liquid from an inlet (19) to an outlet (20) with a contra-flow between the refrigerant gas and the liquid flow.



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A HEAT EXCHANGER

This invention relates to a heat exchanger particularly designed for use with a refrigerant gas to remove heat therefrom into a suitable exchange fluid, normally a liquid.

5 Shell and tube heat exchangers are well known, and in the simplest form have an outer casing with a fluid plenum chamber at either end and a plurality of conduits carrying the fluid, normally a liquid such as water, from one chamber to the other. A liquid inlet leads into one plenum chamber
10 and a liquid outlet is provided from the other plenum chamber. The medium from which heat is to be extracted, for example a refrigerant gas, is passed through the body of the casing with the inlet for the gas usually at the end remote from the outlet to cause the gas to move along the body over
15 the tubes and thus effect the heat exchange.

In another type of heat exchanger it is well recognised that efficiency can be improved with a contra-flow single pass exchange. The conventional design of this type of heat exchanger is a tube within a tube, and frequently for
20 space considerations this tube assembly is formed as a coil.

One object of the present invention is to ensure that the volume and space factors of the shell and tube heat exchanger can be combined with the efficiencies normally available with the conventional single pass contra-flow heat
25 exchanger.

The invention as claimed is intended to remedy some drawbacks of the known types and is concerned with features which make the heat exchanger safer, and in particular which avoid contamination of the liquid should there be a
30 failure in the tube carrying the liquid being heated. This is particularly necessary if the liquid is water and it is desired to maintain the apparatus to a standard where potable water is produced therefrom.

Accordingly the present invention consists in a heat exchanger having an outer casing, end plates at each end of said outer casing, each said end plate incorporating a plurality of tube receiving apertures, a plurality of
5 substantially parallel tubes, having their ends sealably engaged in the apertures and extending between said end plates, an entrance for a heat exchange gas to enter the casing and to pass over the tubes and an exit from the casing for said heat exchange gas, an end cap incorporating
10 a fluid inlet mounted on one end plate to define a first plenum chamber and an end cap with a fluid outlet mounted on the other end plate to define a second plenum chamber, characterised in that the tubes are grouped together with a substantially equal number of tubes in each group and with
15 baffles located between the groups of tubes with said baffles ported so that there is a single passage over the groups of tube between the gas inlet and gas outlet, and with baffles in the plenum chambers with the baffles arranged so that there is a single pass through the groups of tubes from
20 the fluid inlet in one end cap to the fluid outlet in the other end cap with a contra-flow to the direction of that of the heat exchange gas.

One specific embodiment of the invention is described in detail below with reference to the drawings in which:-

25 Figure 1 is a side elevation of a heat exchanger according to the present invention,

 Figure 2 is an end view of the heat exchanger shown in

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figure 1,

Figure 3 is a detail showing the end cap in the heat exchanger and in particular a venting arrangement,

Figure 4 is a partially diagrammatic perspective view of the heat exchange according to the present invention showing a break-away section so that some of the components therein are more readily observed,

Figure 5 is a view of the baffling in one plenum chamber, and

Figure 6 is a view of the baffling in the opposite plenum chamber.

In the preferred form of the invention a heat exchanger 1 has a casing preferably made up as a cylindrical metal body section 2 engaged in metal end plate assemblies which will be described in detail hereunder and having fitted thereto end caps 3 and 4 which togetherwith the remaining end assembly define plenum chambers for a fluid to be used in the heat exchanger. For convenience the fluid will be described as water although it is to be understood that any acceptable heat exchange medium can be used in the present invention.

The end cap 4 incorporates a water inlet 19 and the end cap 3 a water outlet 20.

The water is carried between the plenum chambers in a plurality of tubes 5. These tubes extend through and have a sealed association with the end assembly so that water can be carried from the first plenum chamber to the second plenum chamber through the tubes.

In the preferred form of the invention each tube is a twin wall tube with the inner conduit of the tube formed from stainless steel and the outer conduit formed from copper. The two tubes are associated one with other by a spiral groove wound in the tube. The dimensions of the two

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tubes are selected in a manner such that there is a fluid path between the two tubes but the tubes are close enough particularly through the added association caused with the spiral grooving so that there is an acceptable heat exchange
5 path through the walls of the tube.

The means by which the tube is associated with the end assembly is more particularly illustrated in figure 3. The end assembly consists of a split end plate with the inner part of the plate 9 welded to the casing 2 and having
10 apertures therethrough which will receive and form a sealable association with the outer copper tube 8 which is stopped short of passing through the section 9. The outer part 10 of the end plate has apertures which sealably engage with the inner stainless steel conduit 6. In this case the
15 stainless steel conduit would project slightly through the outer part 10.

There is provided a path by way of grooves or other suitable means between the outer part 10 and inner part 9 of the end plate. In this way any refrigerant gas which might
20 enter the venting between the conduit 6 and conduit 8 because of a failure in the conduit 8 would pass along the conduit and then out between the inner and outer parts of the plate. Similarly if there was a failure in the inner conduit 6 the water would escape in a like manner. This
25 construction means that a failure becomes apparent because the leak can be visibly detected. However, it would be possible to incorporate a detecting means which could be actuated upon either the water or the refrigerant gas leaking. The significant feature of this construction is
30 that the likelihood of contamination between the water and the refrigerant gas is dramatically reduced.

It is extremely unlikely that there would be a combined failure in the inner and outer tubes and hence the present

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construction avoids pollution of water which is being heated using a heat exchanger according to the present invention.

The present invention may be improved if the venting passageway is protected where the tube engages with the end
5 plates by forming a groove into the wall of the tube. A normal construction technique would expand this tube into engagement with the end plates and such a supplementary groove which may for example be a spiral groove or a groove ensures that the venting or leak passage is preserved to
10 achieve the function detailed above. Other means of course can be employed provided the vent passage is maintained. There is a preference to ensure the grooves are formed in the softer material, that is the copper, as if the reverse is the case the copper will tend to flow and fill the
15 grooves in the stainless steel during the manufacturing techniques where the tubes are expanded into the end plates.

The twin wall tube can also be formed having a protective or outer skin on the copper. This construction is desirable in a medium hostile to copper, for example
20 ammonia, which is a common refrigerant. In a number of large installations where the present invention will have application in this instance a thin wall outer casing of stainless steel, for example having a thickness of for example .7 of a millimetre can be employed. This of course
25 can be varied but it is sufficient for the purpose above outlined. In this instance the outer skin of stainless steel is stopped at the point where the copper tube stops and otherwise the venting is achieved in a manner as above specified.

30 In figure 4 the general constructional details of the heat exchanger become more visible. The conduits 5 are grouped together in groups of six triangularly arranged as is illustrated in figure 4. Each bundle or group of six

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tubes is confined within a triangular partition 12. The triangular partitions are sized and shaped so that they fit neatly together within the casing 2. The partitions are formed from folded metal which can be suitably joined and
5 when the five sections are assembled complete what essentially finishes as a five sided cylinder. The baffles are fixed together, for example, by welding and then have the end faces machined so that these faces will in use abut against the end plate assemblies previously described,
10 minimising any leakage or bypass of the refrigerant between the different baffle sections. This configuration is able to be modified depending upon the shape of the outer casing and the number of passes required in the operation.

The partitions 12 included ports or openings so that the
15 refrigerant gas is caused to have a single pass path through these partitions. An inlet 13 allows the refrigerant gas to be introduced through the casing and into the first of the partitions 12. The porting between the partitions causes the gas to flow backwards and forwards along the casing
20 until it is finally discharged through the gas outlet 14. More specifically the refrigerant between these two outlets moves along the partition indicated in the drawings by numeral 15 to pass through a port or opening 16 into the partition identified by numeral 17 and so on until it has
25 completed the single passage to be discharged from outlet 14.

The heat exchanger according to the present invention also has baffles located in the plenum chamber again maintaining the division corresponding with the grouping of
30 conduits that are contained within the partitions or baffles located guiding the refrigerant gas. The baffles which are used in the end plenum chambers to achieve this are illustrated in figures 5 and 6. In this way water which is

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passed through the water inlet 19 is caused to flow through one group of conduits 5 and by the division in the other plenum to come back on a path which is a contra-flow path to the path of the refrigerant as previously described, 5 ultimately to be discharged from the water outlet as hot water.

The baffles in the plenum chamber are fixed to the end caps as is illustrated in figures 5 and 6 and have been overlaid with the dotted outline of the partitions 10 containing the groups of tubes so that the manner by which the water is caused to move across and then return back down the next set of conduits is illustrated.

The outer casing 2 is preferably sheathed in an appropriate layer of insulation 21 which can have a hard 15 outer surface to give a decorative and aesthetically pleasing finish.

The use or operation of the present invention will be apparent from the foregoing description. The heat exchanger is connected in use with the gas from which heat is to be 20 removed for example refrigerant gas coupled to pass through the exchanger and hence on a single pass through the partitions 12 and over the walls of the tubes 5. The water is also connected and has a single contra-flow passage, thus combining the advantages of the known contra-flow heat 25 exchangers with the shell and tube heat exchangers while also incorporating the safety factor by minimising the likelihood of contaminating between the gas and water.

CLAIMS:

1. A heat exchanger having an outer casing (2), end plates (9,10) at each end of said outer casing, each said end plate incorporating a plurality of tube receiving apertures, a plurality of substantially parallel tubes (5), having their ends sealably engaged in the apertures and extending between said end plates, an entrance (13) for a heat exchange gas to enter the casing (2) and to pass over the tubes and an exit (14) from the casing for said heat exchange gas, an end cap (4) incorporating a fluid inlet (19) mounted on one end plate to define a first plenum chamber and an end cap (3) with a fluid outlet (20) mounted on the other end plate to define a second plenum chamber, characterised in that the tubes (5) are grouped together with a substantially equal number of tubes in each group and with baffles (12) located between the groups of tubes (5) with said baffles ported so that there is a single passage over the groups of tube between the gas inlet (13) and gas outlet (14), and with baffles (21) in the plenum chambers with the baffles (21) arranged so that there is a single pass through the groups of tubes (5) from the fluid inlet (19) in one end cap (4) to the fluid outlet (20) in the other end cap (3) with a contra-flow to the direction of that of the heat exchange gas.
2. A heat exchanger as claimed in Claim 1, characterised in that the tubes (5) are each twin wall tubes comprising an inner conduit (6) and an outer conduit (8), and the end plate (9,10) separating each plenum chamber from the casing (2) is a split plate with the inner conduit (6) projecting through and forming a seal with the outer part (10) of the plate and the outer conduit (8) stopped in the inner part (9) of the plate so that any leakage between the walls in the tubes (5) may pass out of the joint between the inner (9) and outer (10) parts of the plate.

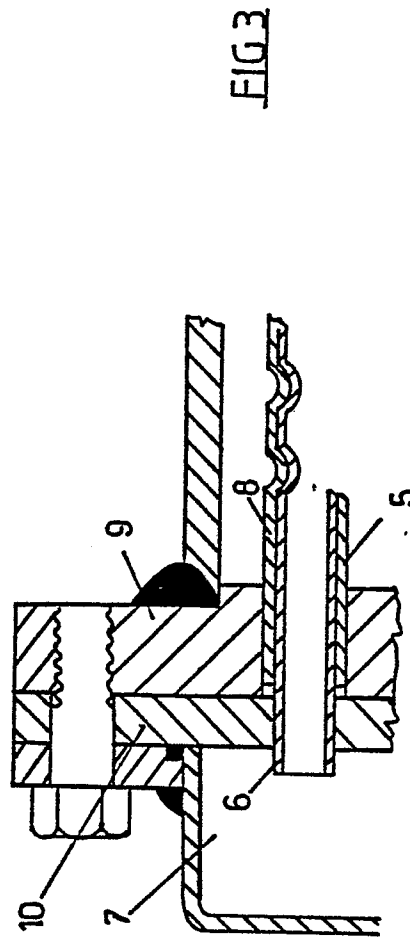
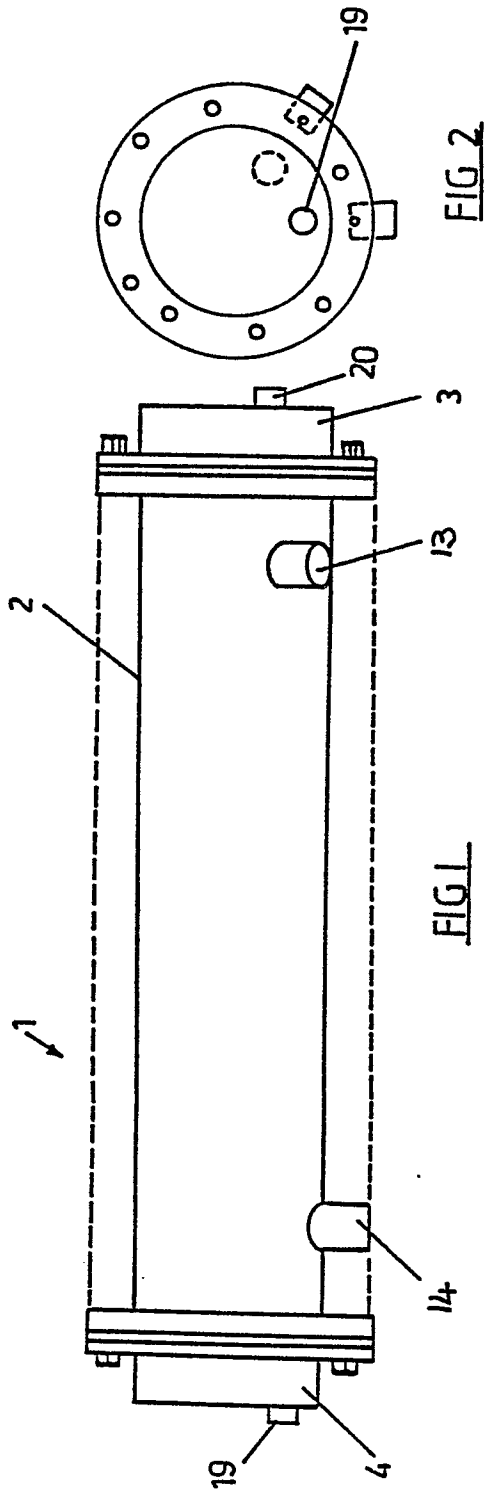
3. A heat exchanger as claimed in Claim 2, characterised in that the inner conduit (6) of each twin wall tube (5) is a stainless steel conduit and the outer conduit (8) is a copper conduit with a spiral groove formed in the twin wall tube and the tolerance between the conduits such that a vent path is formed to enable either gas or liquid to pass along between the conduits in the event of a failure in the wall of either conduit.

4. A heat exchanger as claimed in Claim 3, characterised in that each tube (5) comprises a three walled tube having an outer stainless steel cover over the outer copper conduit (8).

5. A heat exchanger as claimed in Claim 2 or Claim 3, characterised in that where each twin wall tube (5) passes through the inner part (9) of each end plate, it has supplementary groove means to maintain the vent passage therethrough.

6. A heat exchanger as claimed in any one of Claims 1 to 5, characterised in that the tubes (5) are symmetrically arranged in groups of six to fit within triangular baffle sections (12) located within the outer casing (2) which is of cylindrical form.

7. A heat exchanger as claimed in Claim 6, characterised in that the baffles (21) in the plenum chamber span two of the baffled divisions of the tubes (5) in the casing (2) and so divert the fluid flow as to maintain a single pass flow from the fluid inlet (19) in one end cap (4) to the fluid outlet (20) in the other end cap (3).



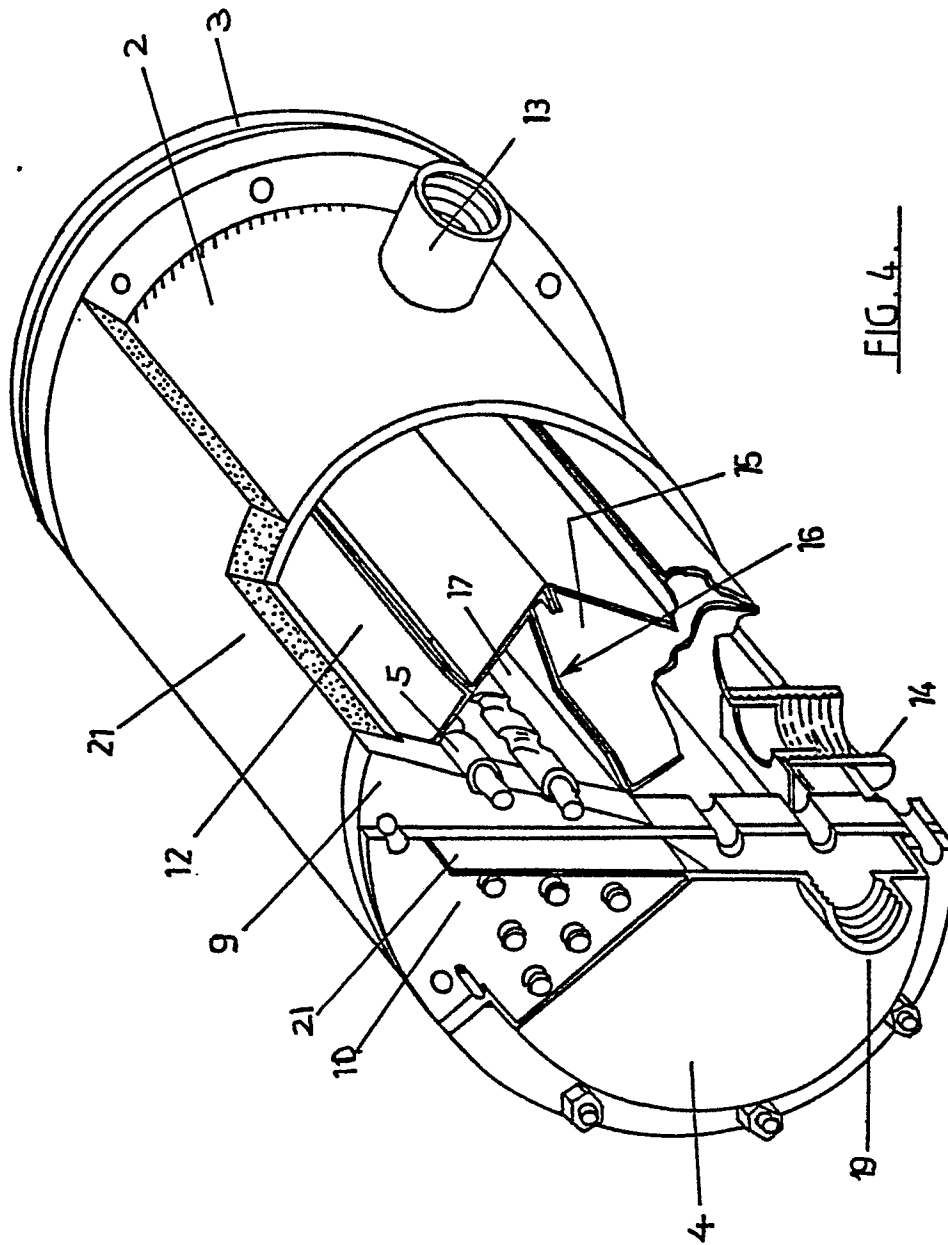


FIG. 4.

