June 28, 1960 E. B. STONEBURNER 2,942,858

HEAT EXCHANGE APPARATUS

Filed April 21, 1958

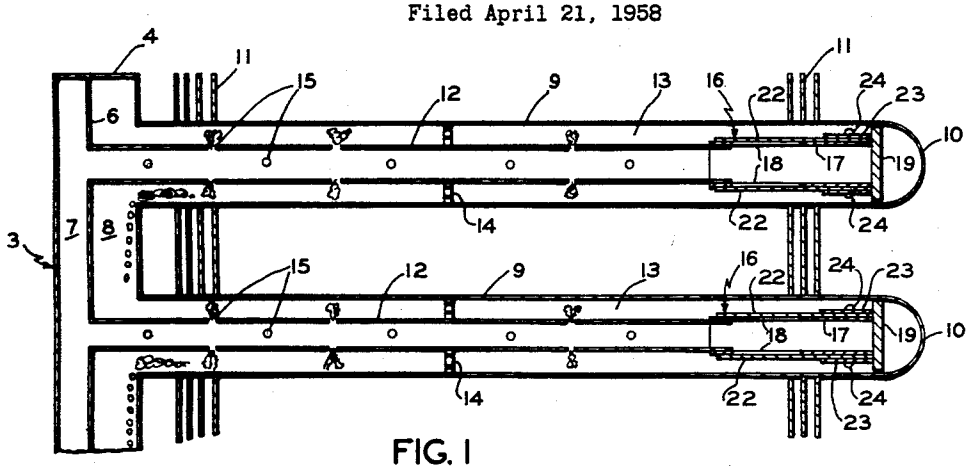


FIG. 1

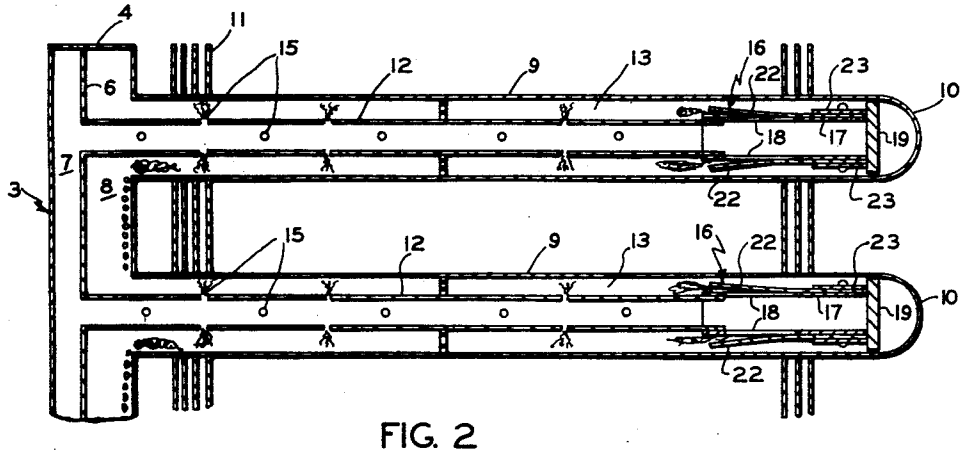


FIG. 2

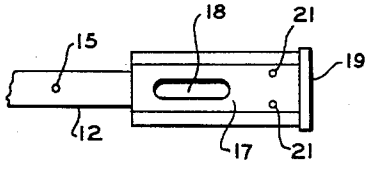


FIG. 3

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HEAT EXCHANGE APPARATUS

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3 Claims. (Cl. 257—306)

This invention relates to heat exchange apparatus and more particularly to improved heat exchange apparatus of the type which utilizes a fluid such as steam to heat a medium such as air.

For a number of years heat exchange devices have been known which have included outer conduit arrangements over which a medium to be heated can be passed, the outer conduits each having disposed therein an inner conduit connected to a steam supply source. In some of these outer-inner conduit heat exchange arrangements, the inner conduits have been provided with open ends to permit the steam to pass to the outer conduits, the inner conduits often being provided further with spaced holes therealong in an attempt to obtain uniform steam distribution along the length of the outer conduits in order to avoid condensate freezing problems. In this latter arrangement, however, the pressure differential between inner and outer conduits has been so small that the great majority of the steam has flowed out the ends of the inner conduits. When the demand on such an arrangement has been high, the resulting flow pattern has been of little consequence since the outer conduits have been flooded with steam. On the other hand, when the demand on this arrangement has been low, only a small portion of steam flows with undesirable hot spots occurring at the open ends of the inner conduits.

In still another long known outer-inner conduit arrangement for heat exchange devices, the ends of the inner conduits opposite the ends connected to the steam supply source have been closed or capped and steam has been forced into the outer conduits through a plurality of spaced holes positioned along the lengths of the inner conduits. To obtain desirable steam distribution in this arrangement, it has been necessary to maintain the spaced holes in the inner conduits as ones of small cross-sectional area at the sacrifice of the total capacity of the heat exchange apparatus.

The present invention recognizes the numerous disadvantages of past outer-inner conduit heat exchange arrangements and eliminates these disadvantages to provide an outer-inner conduit type heat exchange structure which has desirable steam distribution characteristics over a broad range of operations to avoid condensate freezing problems. Further, the present invention provides a structure without a restriction in the total capacity of the unit. Moreover, the present invention provides a heat exchange structure which operates with a minimum rise of entropy in the face of a rising demand thereon, which is straight forward and economical in its construction and operation and which can be efficiently and readily serviced.

Various other features of the present invention will become obvious to one skilled in the art upon reading the disclosure set forth herein.

More particularly, the present invention provides a heat exchange apparatus comprising a header including a steam supply section and a steam condensate discharge section, a plurality of spaced outer conduits over which a medium to be heated can be passed, each of the outer conduits

having one end thereof communicating with the discharge section of the header and having extending longitudinally therein an inner conduit providing a passage therebetween, each of the inner conduits having one end thereof communicating with the steam supply section of the header and the other end closed, a plurality of small steam distributing orifices spaced along the lengths of each of the inner conduits to provide efficient steam distribution during low demand operation of the heat exchange apparatus, and steam release means cooperating with each of the inner conduits to release additional steam into the outer tubes at high demand operation of the apparatus.

It is to be understood that various changes can be made in the arrangement, form, and construction of the apparatus disclosed herein without departing from the scope or spirit of the present invention.

Referring to the drawing which discloses one advantageous embodiment of the present invention:

Figure 1 is a diagrammatic elevational view, in section, disclosing the outer-inner conduit heat exchange device with the inventive improvement, during low flow operations;

Figure 2 is a diagrammatic elevational view, in section, similar to that of Figure 1, disclosing the apparatus during high flow operations;

Figure 3 is a broken, partial plan view, disclosing a portion of the inner conduit of Figures 1 and 2.

Referring to the drawings in detail, Figure 1 discloses the improved heat exchange apparatus as including a main header portion **3** sealed at one end **4** and having its interior divided by a longitudinally extending wall **6** to provide a steam inlet header **7** and a condensate discharge header **8**. Inlet header **7** is connected opposite sealed end **4** to a source of steam (not shown) and discharge header **8** is connected opposite end **4** to a suitable condensate sump or return piping (not shown). Connected to condensate discharge header **8** in direct communication therewith are a plurality of outer conduits **9**, these outer conduits being provided with closed ends **10**. As is known in the art, the outer conduits **9** have mounted thereon in a rigid manner the heat exchange fins **11**.

Disposed within each of outer conduits **9** is an inner conduit **12**, one end of each of the inner conduits being connected to the steam inlet header **7**. The outer diameter of each of the inner conduits is less than the inner diameter of the outer conduit with which it is associated so as to form an annular passageway **13** therebetween, a ring shaped perforate spacer member **14** being provided in the passageway between the inner and outer conduits to hold the inner conduit in proper position. As will be seen hereinafter, the passageways **13** receive steam from the inner conduits **12**, the steam condensate passing off to the condensate discharge header **8**.

Each of the inner conduits **12** is provided with a plurality of small holes **15** spaced along the length of the conduit; and, opposite that end of the conduit **12** which is connected to the steam distributor inlet header **7** is a steam release means broadly designated by reference numeral **16**. This steam release means constitutes one of the principal features of the present invention. In the advantageous embodiment of the invention disclosed, the steam release means includes the pipe fitting **17** which is integrally attached in some suitable fashion such as welding with the inner conduit **12**. Each of the fittings **17** is provided with at least one aperture **18** which advantageously can be shaped in the form of an elongated slot. In the embodiment disclosed, each fitting **17** is provided with two such apertures **18**, one on either side of the fitting. The end of each of the fittings opposite that end connected to the inner conduit is provided with a seal member **19** integral therewith, the member **19** serving to seal off steam flow from such end. In this connection, it is to be noted

also that seal **19** is of a cross-section corresponding to the inner cross-section of outer conduit **19**, the seal serving as a further support for inner conduit **12** to hold the same in proper position within outer conduit **9**.

Each of fittings **17** is tapped as at **21** (Figure 3) so as to be able to receive screws **24** therein. To close off apertures **18** of each of the fittings, there is provided for each aperture a resilient valve means in the form of a reed member **22**. This member can be made from any one of a number of suitable resilient metal materials of corrosion resistant nature. One end of the reed is maintained free to cover aperture **18** and yieldabley seal it off from passageway **13**. The other end of reed **22** is held in place by a facing plate **23** superimposed over the end of member **22** and held in place by the screws **24** engaging in tapped holes **21**.

It is to be understood that reeds **22** can be of different masses so that each reed will have a different natural frequency, thus avoiding any undesirable vibration at like frequencies with resulting "singing." It further is to be understood that, if desired, a number of steam release means similar to that described above can be provided along the length of each of the inner conduits. Fnally, it is to be understood that the reeds can be designed so as to be of sufficient thickness to maintain the apertures closed below any one of a number of preselected pressure points and to yield only at pressures above such a preselected point so as to open the apertures **18** into communication with conduits **9**.

In a typical embodiment of the invention, a heat exchange apparatus can be provided, with outer conduits having ⅞ inch inner diameter and the inner conduits having ⅜ inch outer diameter. Holes spaced at two inch centers along the length of the inner conduits can measure approximately 1/32 inch across to insure effective steam distribution in the outer conduit at low operating levels, such effective steam distribution being insured even when the flow rate of steam is as low as 0.5 pounds per hour. Covering the apertures in the steam release means, which apertures can measure ¾ inch in length and ¼ inch across, can be a resilient brass or stainless steel reed of .015 inch thickness. The reed can be engineered so as to yield at a predetermined pressure differential between the inside of conduit **12** and the annular passageway **13** and, in the typical embodiment described, a setting of .5 p.s.i. can be used. Thus, when the flow rate of steam is increased during higher operating demands, the reeds are forced open and steam is allowed to escape through the apertures. It is to be understood that the yield pressure point for the reed can be set high enough so that the distribution pattern will remain constant even through the reeds are open. It further is to be understood that the present invention is not restricted to the dimensions and pressures as set forth above but that these pressures and dimensions can be varied to meet the demands of the particular situation at hand.

The invention claimed is:

1. A heat exchange apparatus comprising an outer conduit over which a medium to be heated can be passed, an inner conduit extending within said outer conduit and providing an annular passage therebetween, said inner conduit communicating at one end with a source of steam and being closed at the other end, a plurality of continuously opened small steam distributing orifices spaced along the length of said inner conduit to provide efficient steam distribution during low demand operations of said apparatus, and a steam release aperture adjacent the closed end of said inner conduit, said aperture having cooperating therewith a resilient valve means to maintain said aperture closed during low demand operations of said heat exchange apparatus when the pressure differential between said inner and outer conduits is below a preselected pressure point and to release steam therethrough upon high demand operations when the pressure differential between said inner and outer conduits rises above said preselected pressure point.

2. A heat exchange apparatus comprising a header including a steam supply section and a steam condensate discharge section, a plurality of spaced outer conduits over which a medium to be heated can be passed, each of said outer conduits having one end thereof communicating with said discharge section of said header and having extending longitudinally therein an inner conduit providing a passage therebetween, each of said inner conduits having one end thereof communicating with said steam supply section of said header and the other end closed, a plurality of continuously opened small steam distributing orifices spaced along the length of each of said inner conduits to provide efficient steam distribution during low demand operations of said heat exchange apparatus when the pressure differential between said inner and outer conduits is below a preselected pressure point, and steam release means cooperating with each of said inner conduits to release additional steam into said outer conduits at high demand operations of said apparatus when the pressure differential between said inner and outer conduits rises above said preselected pressure point.

3. A heat exchange apparatus comprising a header including a steam supply section and a steam condensate discharge section, a plurality of spaced outer conduits over which a medium to be heated can be passed, each of said outer conduits having one end thereof communicating with said discharge section of said header and having the other end closed, inner conduits extending longitudinally into each of said outer conduits and forming an annular passageway therebetween, each of said inner conduits having one end thereof communicating with said steam supply section of said header and the other end closed, a plurality of continuously opened small steam distributing orifices spaced along the length of each of said inner conduits to provide efficient steam distribution during low demand operations of said heat exchange apparatus, steam release apertures adjacent the closed ends of said inner conduits, and resilient reed members cooperating therewith to maintain said apertures closed during low demand operations of said heat exchange apparatus when the pressure differential between said inner and outer conduits is below a preselected pressure point and to release steam therethrough at high demand operations when the pressure differential between said inner and outer conduits rises above said preselected pressure point.

References Cited in the file of this patent

UNITED STATES PATENTS

2,229,032	Ashley	Jan. 21, 1941
2,463,996	Polk	Mar. 8, 1949
2,611,584	Labus	Sept. 23, 1952