Feb. 5, 1963 H. J. COLES ET AL 3,076,443

HEAT EXCHANGER

Filed June 17, 1959 3 Sheets-Sheet 1

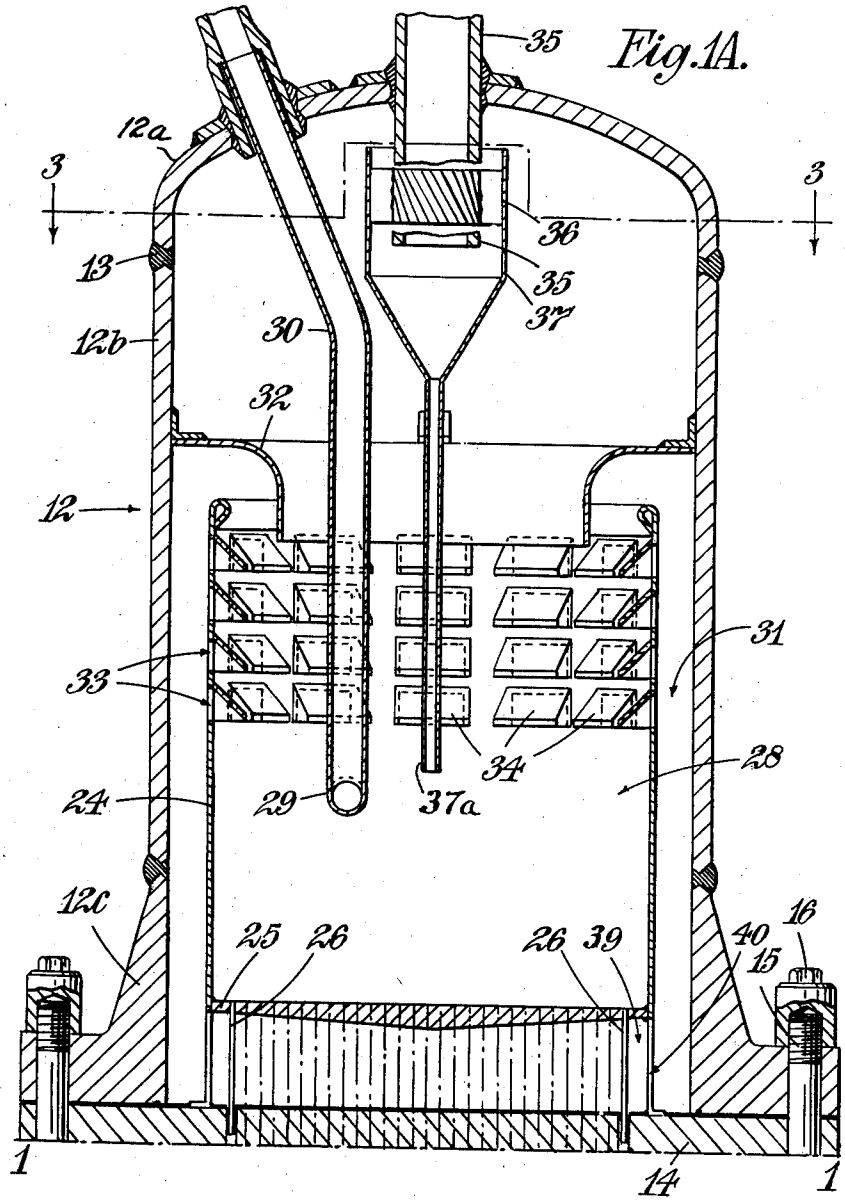


Fig. 1A.

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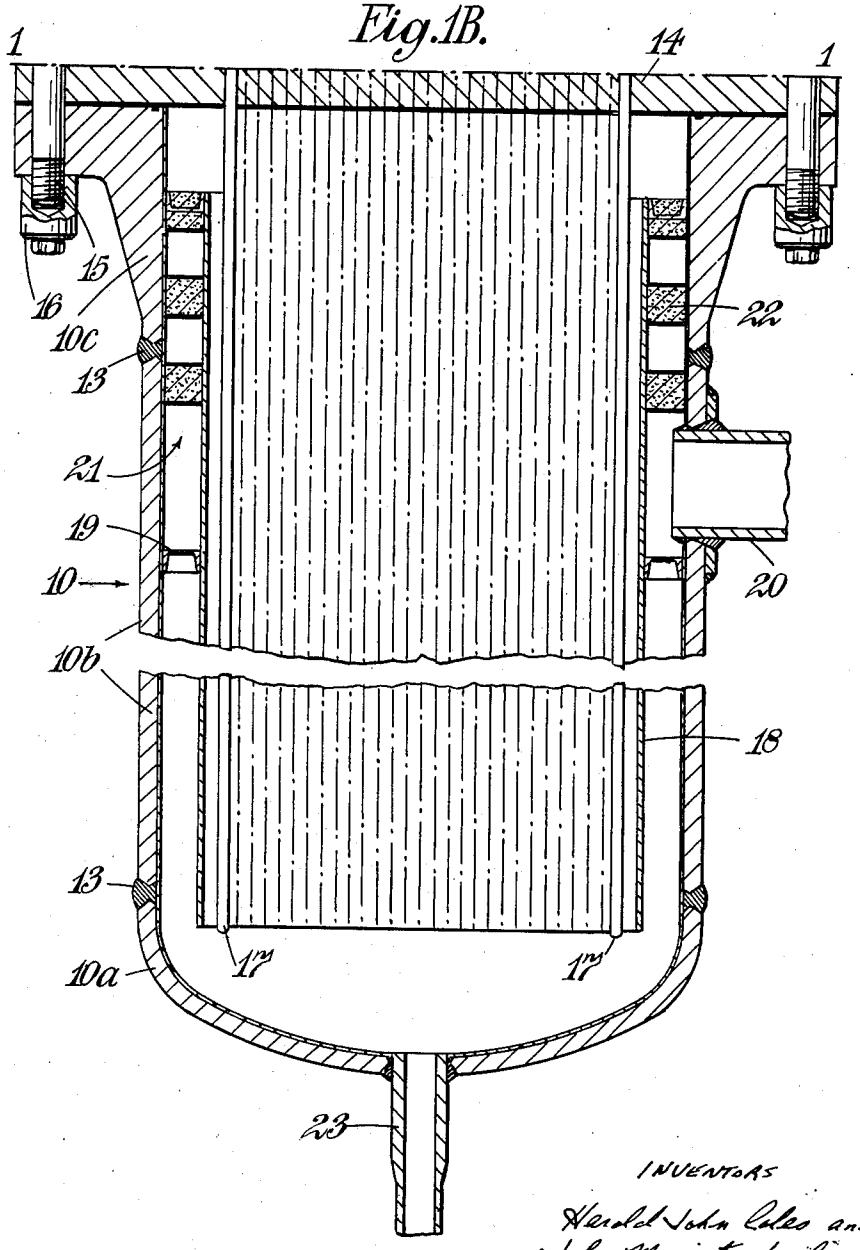
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Fig. 1B.



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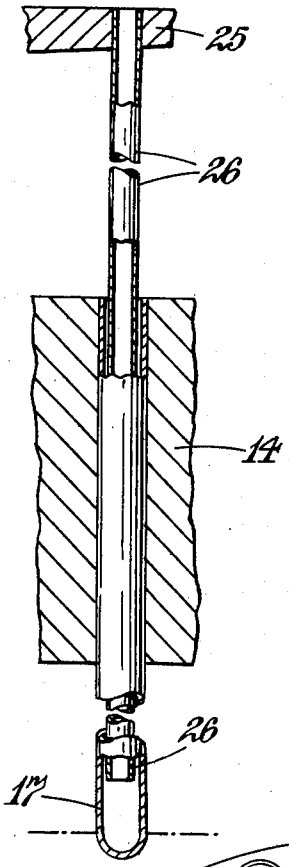
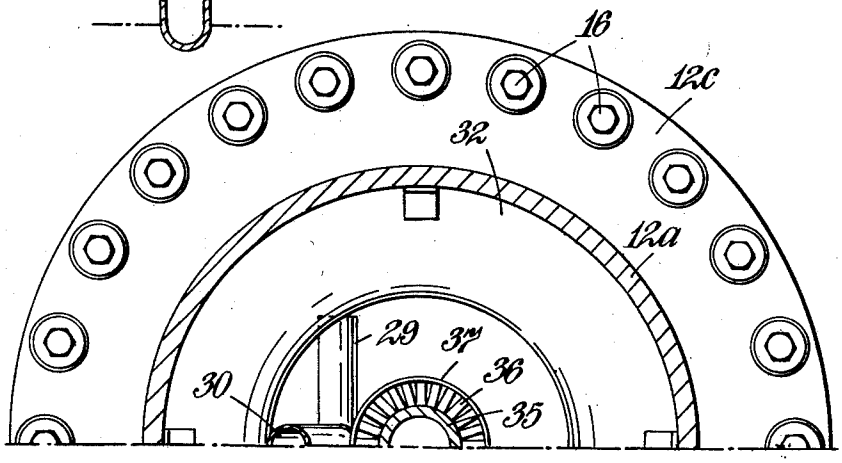


Fig.2.

Fig.3.



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United States Patent Office 3,076,443 Patented Feb. 5, 1963

3,076,443

HEAT EXCHANGER

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Filed June 17, 1959, Ser. No. 820,941
Claims priority, application Great Britain June 19, 1958
3 Claims. (Cl. 122—34)

This invention relates to heat exchangers.

According to the present invention a heat exchanger comprises a lower casing and a first tube plate secured to the upper end of the casing to define therewith a closed chamber, said chamber having an inlet thereto and an outlet therefrom for one of the media between which heat exchange is to be effected, a plurality of first tubes sealed in holes in the tube plate and extending downwardly towards the lower end of the casing, said first tubes opening at their upper ends to above the tube plate and being closed at their lower ends, a second tube plate mounted above the first tube plate in spaced relation thereto, a plurality of second tubes sealed in holes in the second tube plate and extending downwardly therefrom coaxially into the first tubes to adjacent their lower ends, each second tube being open at each end, and means to deliver a second of the media between which heat exchange is to be effected, to the upper ends of the second tubes and to receive the media from the upper ends of the first tubes.

The second medium receives heat principally while it is in the first tubes (that is, in the annular space surrounding the second tubes), through the walls of the first tubes, and, presuming it to have a positive coefficient of thermal expansion or that substantial vaporization occurs a circulation is promoted or generated downwardly through the second tubes and upwardly in the spaces between the first and second tubes.

A heat exchanger constructed according to the invention may be used with advantage in conjunction with nuclear reactors in which a primary heat-exchange medium is radioactive after passing through the reactor. In this circumstance, it is desirable that the heat-exchanger be mounted so that parts to which the radioactive primary heat-transfer medium has access are located within a shielding wall surrounding the reactor against escape of radiation. Also difficulties due to the fact that parts exposed to radioactive material have to be constructed of, or at least their surfaces clad in stainless steel, which has a coefficient of thermal expansion different from materials such as mild steel which are conveniently used for structural members, are lessened since the tubes are suspended by one end from the tube plates thus enabling them to expand and contract freely, independently of any expansion of the casing.

A preferred embodiment of the invention is adapted for use where the primary heat transfer medium is steam generated, for example, by a boiling water reactor, and the secondary heat transfer medium is also steam (or water).

In one arrangement suitable for this use, the means to deliver and receive the second medium comprises an upper casing secured to the first tube plate and forming therewith a second chamber enclosing the second tube plate, a cylindrical baffle within the second chamber in spaced relation to the upper casing and extending upwardly from the periphery of the second tube plate to form a well, a liquid supply pipe delivering the liquid into the well, an outlet from the upper end of the chamber for the vaporised liquid, said outlet communicating with the open ends of the first tubes through the space between the tube plates and the space between the cylindrical baffle and the upper casing, and baffle means in

the flow path of the vaporised liquid from said space between the cylindrical baffle and the upper casing and said outlet from the second chamber.

According to a feature of the invention, the path of the primary steam may include passage through a catalyst such as active platinized material capable of recombining free oxygen and hydrogen in the primary steam produced by dissociation under the action of high-energy particles or radiation in the reactor. Such catalyst may be provided in one or more beds located within an annular space between the casing and a baffle member directing the primary steam as described to the upper part of the chamber.

In a construction in which steam is used as the secondary heat-transfer medium, such medium may be fed as water on to the top of the second (upper) tube plate, whence it can pass down the inner tubes. Steam generated from this water as it passes up the outer tubes may, after emerging from the tops of the outer tubes, be conducted to a steam-water separator for drying purposes. Preferably, such a separator is housed above the upper tube plate whereby condensate from the separator joins the feed water to the exchanger tubes, and dry steam is led off, for example, to a turbine.

The lower ends of the outer tubes may each be sealed off separately, or they may lead into a common header which is free to move with the tubes and independently of the casing surrounding the same.

One specific form of heat exchanger embodying this invention will now be described with reference to the accompanying drawings, in which:

FIGURES 1A, 1B together form a vertical cross-section through the heat exchanger, the figures being joined on the line 1—1,

FIGURE 2 is part of FIGURES 1A, 1B drawn to a larger scale, and

FIGURE 3 is a section on the line 3—3 of FIGURE 1A.

The heat exchanger illustrated is suitable for generating steam from water, by heat exchange with steam which has been produced in cooling a nuclear reactor.

The heat exchanger comprises a lower casing **10** of mild steel having a stainless steel lining **11**, and an upper casing **12** also of mild steel. Each casing comprises a domed end portion **10***a*, **12***a*, a cylindrical centre portion **10***b*, **12***b* and a bolting flange portion **10***c*, **12***c*, the portions of each casing **10**, **12** being welded together as indicated at **13**.

The two casings **10**, **12** are disposed with their bolting flanges **10***c*, **12***c* adjacent and a tube **14** is sandwiched between the two casings, the casings **10**, **12** and plate **14** being secured together by a ring of studs **15** receiving nuts **16**.

The tube plate **14** is formed with a large number of tube-receiving holes into which project the upper ends of stainless steel tubes **17**. The tubes **17** are brazed or welded in position in the holes with their upper ends flush with the upper surface of the tube plate **14** (FIGURES 1B, 2) and they project downwardly to adjacent the bottom of lower end of the cylindrical portion **10***b* of the casing **10**. The upper ends of the tubes **17** are open and their lower ends are closed so that the bores of the tubes are only in communication with the interior of casing **12**.

The tubes **17** are surrounded by a cylindrical baffle **18** which is held in position in spaced relation to the casing **10** by a channel section ring **19** secured to the casing **10** and the baffle **18** at about the mid length of the baffle. The ends of the baffle **18** are spaced from the plate **14** and from the end portion **10***a*.

A primary steam inlet pipe **20** is secured in the casing portion **10***b* just above the ring **19** to open to the space **21** between the casing **10** and baffle **18**, and this space also

accommodates, above the ring 19, a series of catalyst beds 22 which consist for example of platinized granular material. Any dissociated hydrogen and oxygen in the entering steam is recombined in passing through the catalyst beds 22. The domed end 10*a* has fitted in it a condensate outlet pipe 23.

The space within the upper casing 12 houses a cylindrical baffle 24 (FIGURE 1A) which extends upwardly from the tube plate 14 part way along the length of the casing. The baffle 24 has an upper tube plate 25 mounted in it at a short distance above its lower end, and the plate 25 has in it a series of holes aligned with the tubes 17, each hole having fitted in it an open ended tube 26 whereof the upper end is flush with the top surface of the plate 25 and which projects downwardly into the aligned tube 17 to adjacent its lower end (FIGURE 2). The baffle 24 and plate 25 together provide a well 28 into which water is fed from a perforated end portion 29 (FIGURE 3) of a water supply pipe 30 mounted in the end portion 12*a* of the casing 12. The space 39 below the plate 25 communicates through cutaways 40 in the baffle 24 with annular space 31 between the baffle 24 and the casing 12.

An annular baffle 32 is secured to the casing 12 above the upper end of the baffle 24 and the inner edge of the baffle 32 is downturned to project into the upper end of the baffle 24 in spaced relation thereto.

The baffle 24 has a series of rings of circumferentially disposed holes 33 in it above the level of the perforated pipe portion 29 and each of these holes is provided internally of the baffle 24 with a downwardly open shroud 34.

The end portion 12*a* of the upper casing 12 has an outlet pipe 35 fitted in it, the pipe projecting downwardly into the larger diameter portion of a funnel member 37, there being a ring of swirl vanes 36 supported in the annular space between the pipe 35 and the funnel member 37, the lower delivery portion 37*a* of which is of small bore and extends downwardly to adjacent the portion 29 of the water inlet pipe 30.

In operation, the primary steam, which may be wet, dry or superheated steam, is fed to pipe 20 and it flows upwardly through space 21 and the catalyst beds 22 where any dissociated hydrogen and oxygen are recombined, and then flows downwardly within the baffle 18 over the external surfaces of the tubes 17 to heat the secondary fluid flowing in these tubes. The steam is condensed and the condensate leaves the casing 10 through outlet pipe 23.

The secondary fluid, which is feed-water which is to be converted to steam, is fed through pipes 29, 30 into the well 28 at such a rate that the water level in the well is maintained below the holes 33 but above the pipe portion 29 and the lower end of the portion 37*a* of the funnel member 37. The water flows from the well 28 downwardly through pipes 26 and then upwardly through the annular spaces between the tubes 26, 17 and is thereby heated and vaporised. The steam generated in the tubes 26, 17 rises more rapidly than any water in the spaces between the tubes 17, 26 and the steam flows from the tubes 17 into space 39 through cutaways 40 into space 31, and then flows from the space 31 around the annular baffle 32 and through the holes 33 into the upper part of the casing 12. The baffle 32 and shrouded holes 33 act to separate any water from the rising steam, and any water so separated is returned to the well 28 to be recirculated through the tubes 17, 26. The steam then flows to the outlet pipe 35 through the swirl vanes 36 and any water remaining in the steam is separated out and flows down through the funnel member 37 into the well 28.

We claim:

1. A heat exchanger wherein a liquid is vaporized by heat exchange with a hot fluid medium, comprising a lower casing having a closed lower end, an upper casing having a closed upper end, a first tube plate secured between and separating the casings to define therewith lower and upper closed chambers, the lower chamber having an inlet thereto and an outlet therefrom for the fluid medium, a plurality of first tubes sealed in holes in the tube plate and extending downwardly towards the lower end of the lower chamber, said first tubes being open at their upper ends to the upper chamber and being closed at their lower ends, a second tube plate mounted within the upper chamber above and in spaced relation to the first tube plate, said second tube plate having its periphery spaced from the upper casing, a plurality of second tubes sealed in holes in the second tube plate and extending downwardly therefrom coaxially into the first tubes to adjacent their lower ends, each second tube being open at each end, a cylindrical baffle accommodated within the upper chamber and extending upwardly from the periphery of the second tube plate in spaced relation to the upper casing, said cylindrical baffle and said second tube plate together defining a well, said cylindrical baffle having an upper edge spaced vertically away from the upper end of the upper casing, a liquid supply pipe having an outlet delivering the liquid into the well at a level substantially below said upper edge of the cylindrical baffle, an outlet from the upper end of the upper casing for the vaporized liquid, said outlet communicating with the open ends of the first tubes through the space between the first and second tube plates and the space between the cylindrical baffle and the upper casing, and an annular baffle secured to the upper casing at a level above said upper edge of the cylindrical baffle, the annular baffle extending inwardly beyond said upper edge and having a downturned inner edge portion projecting into the well to a level between said outlet of the liquid supply pipe and the upper edge of the cylindrical baffle.

2. A heat exchanger according to claim 1, the cylindrical baffle having therein a circumferentially disposed series of holes, the holes being above the level of the said outlet of the liquid supply pipe, and said cylindrical baffle also having projecting from it inwardly into the well a corresponding series of downwardly-open shrouds, one for each of the holes.

3. A heat exchanger as claimed in claim 1, the outlet from the upper chamber comprising a pipe projecting downwardly from the upper end of the upper casing and open at its upper end, and there being a funnel member having a large diameter upper portion surrounding the pipe in spaced relation thereto and a small bore delivery portion extending downwardly into the well to adjacent the outlet of the liquid supply pipe, and a ring of swirl vanes accommodated within the space between the outlet pipe and the large diameter upper portion of the funnel member.

References Cited in the file of this patent

UNITED STATES PATENTS

163,100	Orme	May 11, 1875
1,067,010	Dunn	July 8, 1913
2,064,317	Oxley	Dec. 15, 1936
2,871,108	Knapp	Jan. 27, 1959

FOREIGN PATENTS

392,428	France	Nov. 26, 1908