May 2, 1961 H. L. VILLIERS ET AL 2,982,263

HEAT-EXCHANGE INSTALLATION OF LARGE CAPACITY FOR FLUID UNDER PRESSURE

Filed Dec. 3, 1957 3 Sheets-Sheet 1

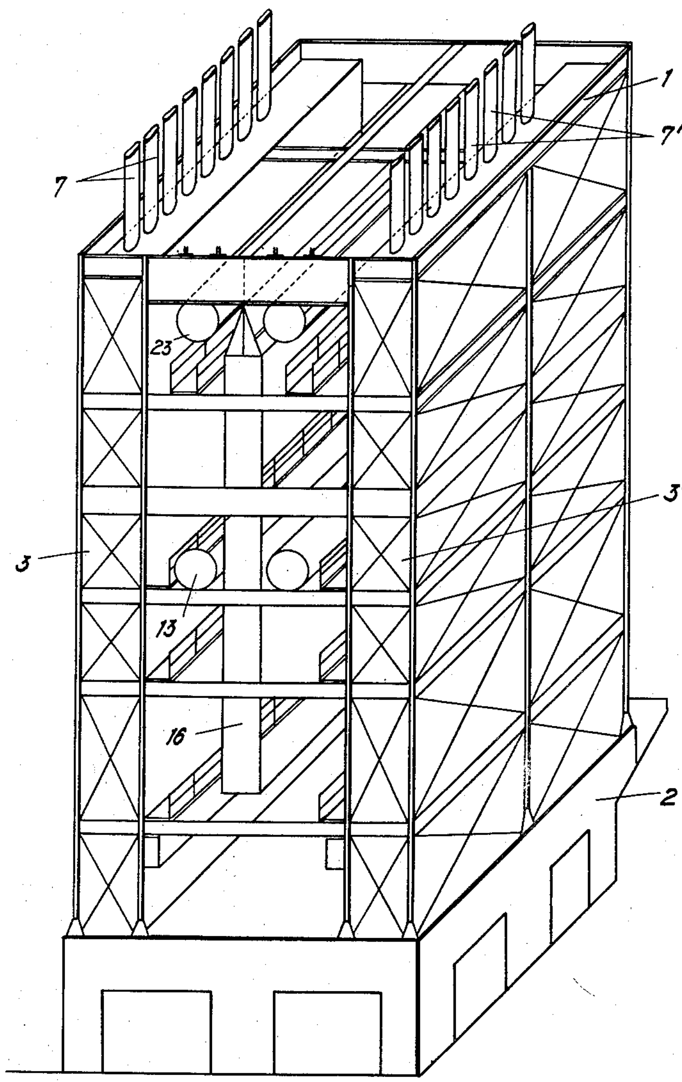

Fig. 1

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3 Sheets-Sheet 2

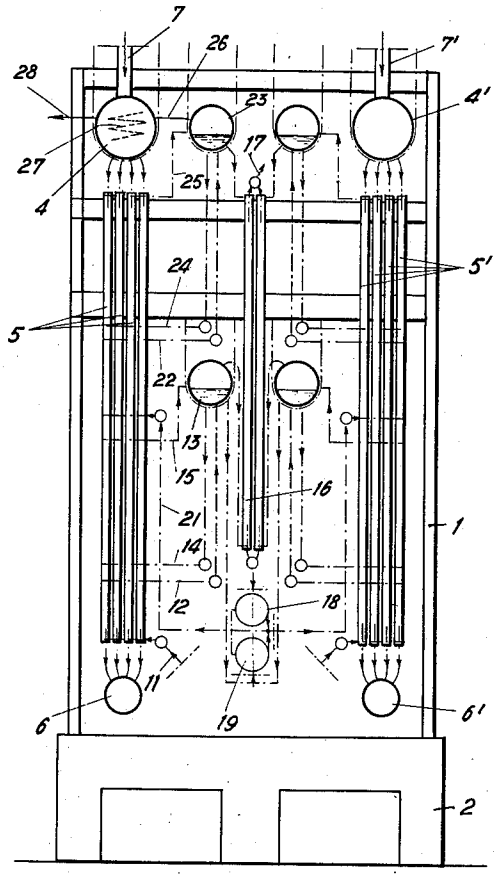

Fig. 2

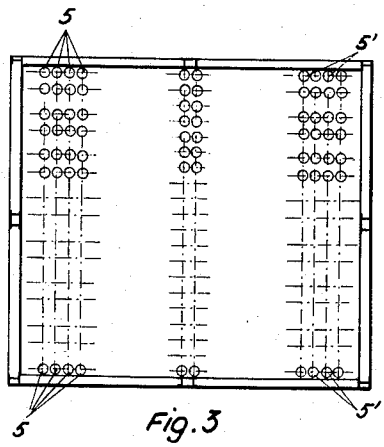

Fig. 3

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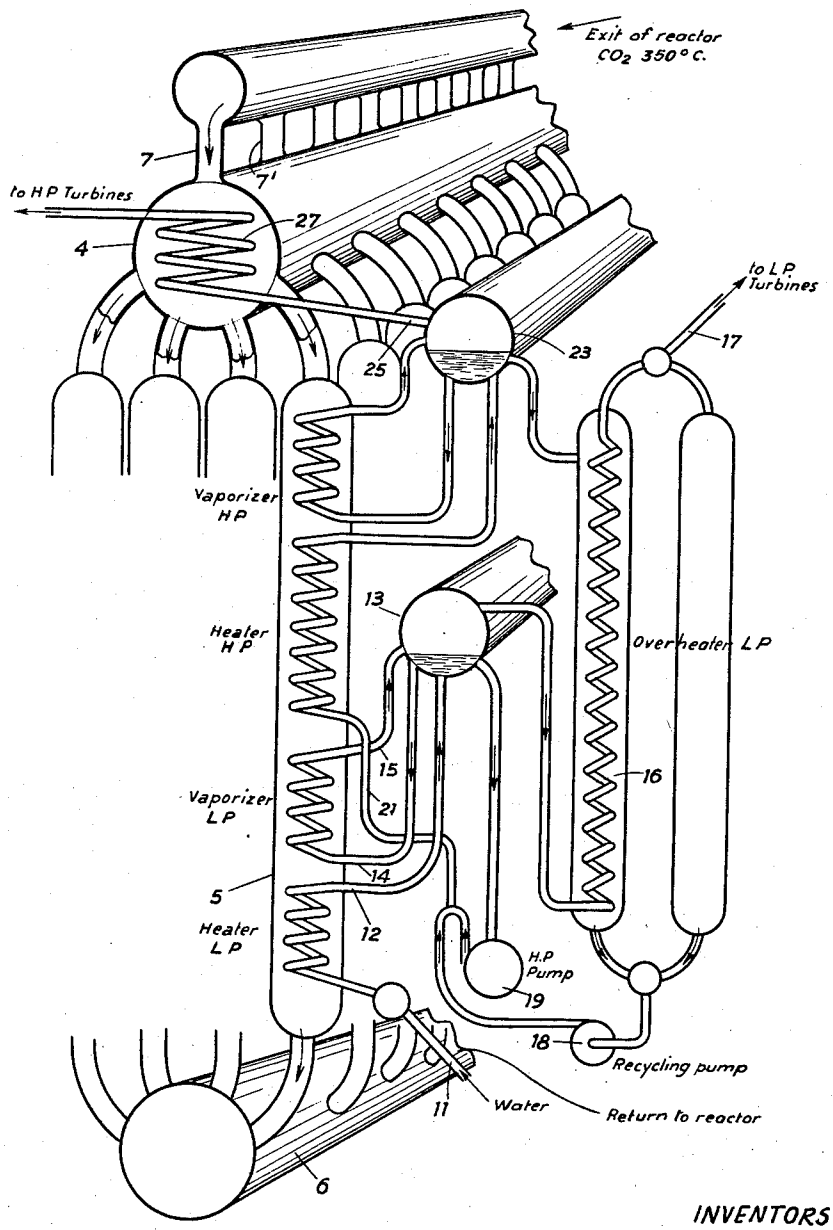
Fig. 2A



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HEAT-EXCHANGE INSTALLATION OF LARGE CAPACITY FOR FLUID UNDER PRESSURE

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3 Claims. (Cl. 122—32)

Heat exchangers of standard operation in which a hot fluid under pressure gives up its heat to apparatus for heating and evaporation of water for the production of steam present problems which are difficult to solve, in respect of their construction. This is especially the case in atomic power-stations in which the carbonic acid gas passes out of the reactor at a pressure of the order of about 30 kgs. and at a temperature of about 300 to 350° C. With this industrial scale of production of energy, when the exchange of heat is effected in a single chamber which contains the heating and evaporation apparatus for the cooling water, this single chamber must be closed by very thick metallic sheets which are extremely costly and are not a standard manufacture. The transport of these sheets and their erection on site are difficult. Special processes are required for welding and for annealing the same. The repair of any damage makes it necessary to stop the whole installation and repairs must be carried out in situ under difficult conditions since the chamber is almost entirely filled with devices leaving little space for workmen to pass. Finally, the installation has no flexibility in case of any change in the pressure and the temperature of the fluid for which it has been designed.

The present invention has for its object a heat-exchange installation of large capacity which provides a remedy for these drawbacks. It is characterized by the fact that it is sub-divided into a large number of elementary units formed by a series of parallel interchangeable and identical tubes or cylinders, each of which contains the essential parts of the heat-utilization devices and in which circulates the fluid under pressure which is to give up its heat, the distribution and the evacuation of the fluid being the only elements in common. In this way a plurality of heat exchanging arrangements is formed, each including individually removable heat exchanger structures.

The advantages of such an installation are very great. Each of the tubes or cylinders may be manufactured and repaired at the works. Neither its transport or its placing in position nor its removal present any special problems, and in particular the emplacement and removal can be carried out by means of normal types of lifting apparatus which travel on rails. The device can be manufactured from metal sheets of conventional manufacture and their welding and annealing are of a type as such operations normally carried out in industry.

The installation has in addition a very great flexibility: it is extremely simple and to dismantle quickly (and this is of particular advantage in the case of nuclear power-stations) for repairs one or two tubes or cylinders, without interfering with the general working of the installation, since the effect of such elimination on a total of 100 or 120 tubes for example, is not very appreciable. On the other hand, the accidental or deliberate irregularities which may take place in the reactor can be easily compensated by putting one or more tubes into or out of circuit. It may be an advantage during the course of construction, to provide a reserve of tubes or cylinders

which are not normally in operation and which can be put into service, as and when required.

In the case in which the fluid under pressure is employed for the production of steam, each of the tubes or cylinders contains in principle in its lower position a heater and a low-pressure evaporator, and in its upper portion a heater and a high-pressure evaporator. In accordance with a special feature of the invention, the high-pressure superheater may be housed in the distribution chamber or tank in which the fluid under pressure arrives from the outlet of the reactor, and from which it is distributed to the tubes or cylinders.

A form of construction of an installation in accordance with the present invention will now be described below and is illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a diagrammatic view in perspective of the masses of the whole of the installation.

Fig. 2 shown diagrammatically in elevation the circulation of the fluids which give up and which take up heat in this installation.

Fig. 2*a* is a fragmentary and partly sectional perspective view of the apparatus of Fig. 2 in semi-schematic representation.

Fig. 3 is a diagrammatic view in transverse cross-section.

The installation comprises a frame 1 suitably braced and resting on a base 2, the whole being contained in a large sphere in the case of an atomic installation. The frame comprises two lateral portions 3 and 3', each containing a manifold distribution means in the form of a distribution tank 4 and 4' (see Fig. 2), a battery of first heat exchange means in the form of tubes or cylinders 5 and 5' and manifold receiving means in the form of an evacuation tank 6 and 6'.

The tanks and the tubes have not been shown in Fig. 1, in order to avoid complicating this figure. Into the distribution tank 4, 4', pass the supply pipes 7 and 7' which bring in the first fluid under pressure, for example CO_2, which is to give up its heat by vaporising the second fluid, e.g. water; this fluid is distributed separately into the interchangeable tubes or cylinders 5 and 5' and then passes into the collector evacuation tanks 6 and 6'.

Each of the tubes or cylinders comprises in its lower portion a low-pressure zone, and a high-pressure zone in its upper part, the detail of which has not been shown as it is of usual construction.

The water or fluid to be heated passes into the tube at its base at 11, is heated in the lower part, the first portion, of this tube which acts as a heater, passes out of the tube at 12 and proceeds to the low-pressure tank 13, from which the water returns at 14 to the low-pressure evaporator of the tube. The stream passes out at 15 and passes from the tank 13 into the low-pressure superheater, the second heat-exchanger means, 16, which is suspended between the batteries of tubes. From thence, the low-pressure steam passes at 17 into the low-pressure turbines, and the superheating liquid is passed to the re-cycling pump 18. The high-pressure pump 19 supplies at 21 the high-pressure zone, the second portion, of the tube which comprises, like the low-pressure zone, a heater from which the liquid passes out at 22 and is directed into the high-pressure tank 23, from which it passes at 26 to the superheater 27 which, in accordance with the present invention, is contained in the distribution tank 4 of the gas under pressure. The right-hand side of Fig. 2 is symmetrical with the left-hand side.

What is claimed is:

1. A heat exchanging device, comprising, in combination, manifold distribution means connected to a source of supply of a first fluid; a plurality of heat exchanging ar-

rangements, each including first heat exchanger means; second heat exchanger means; means for passing said first fluid in a predetermined direction from said manifold distribution means through said first heat exchanger means; means for passing a second fluid through a first portion of said first heat exchanger means in heat exchange with said first heat exchanging fluid, whereby said second fluid will partly vaporize so as to form vaporized second fluid and heated second fluid; means for passing said heated second fluid through a second portion of said first heat exchanger means located upstream of said first fluid from said first portion so as to partly vaporize the same and form additional vaporized second fluid and additional heated second fluid; means for passing said additional heated second fluid through said second heat exchanger means and back into said second portion of said first heat exchanger means; means for passing said vaporized second fluid through said second heat exchanger means so as to be in heat exchange with said additional heated second fluid passing therethrough so as to further heat said vaporized second fluid; means for discharging said further heated vaporized second fluid on the one hand and said additional vaporized second fluid on the other hand; and manifold receiving means for receiving said first fluid from said plurality of heat exchanging arrangements after passage through the respective first heat exchanger means thereof.

2. A heat exchanging device, comprising, in combination, manifold distribution means connected to a source of supply of a first fluid; a plurality of heat exchanging arrangements, each including first heat exchanger means; second heat exchanger means; means for passing said first fluid in a predetermined direction from said manifold distribution means through said first heat exchanger means; means for passing a second fluid through a first portion of said first heat exchanger means in heat exchange with said first heat exchanging fluid, whereby said second fluid will partly vaporize so as to form vaporized second fluid and heated second fluid; means for passing said heated second fluid through a second portion of said first heat exchanger means located upstream of said first fluid from said first portion so as to partly vaporize the same and form additional vaporized second fluid and additional heated second fluid; means for passing said additional heated second fluid through said second heat exchanger means and back into said second portion of said first heat exchanger means; means for passing said vaporized second fluid through said second heat exchanger means so as to be in heat exchange with said additional heated second fluid passing therethrough so as to further heat said vaporized second fluid; a heat conductive conduit arranged in said manifold distribution means; means for passing said additional vaporized second fluid through said heat conductive conduit; means for discharging said further heated vaporized second fluid on the one hand and said additional vaporized second fluid on the other hand; and manifold receiving means for receiving said first fluid from said plurality of heat exchanging arrangements after passage through the respective first heat exchanger means thereof.

3. A heat exchanging device, comprising, in combination, manifold distribution means connected to a source of supply of a first fluid; a plurality of heat exchanging arrangements, each including an individually removable first heat exchanger structure; second heat exchanger structure; means for passing said first fluid in a predetermined direction from said manifold distribution means through said first heat exchanger structure; means for passing a second fluid through a first portion of said first heat exchanger structure in heat exchange with said first heat exchanging fluid, whereby said second fluid will partly vaporize so as to form vaporized second fluid and heated second fluid; means for passing said heated second fluid through a second portion of said first heat exchanger structure located upstream of said first fluid from said first portion so as to partly vaporize the same and form additional vaporized second fluid and additional heated second fluid; means for passing said additional heated second fluid through said second heat exchanger structure and back into said second portion of said first heat exchanger structure; means for passing said vaporized second fluid through said second heat exchanger structure so as to be in heat exchange with said additional heated second fluid passing therethrough so as to further heat said vaporized second fluid; means for discharging said further heated vaporized second fluid on the one hand and said additional vaporized second fluid on the other hand; and manifold receiving means for receiving said first fluid from said plurality of heat exchanging arrangements after passage through the respective first heat exchnger structure thereof.

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