

[54] **HEAT EXCHANGER STRUCTURE FOR STEAM GENERATORS**

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[56]

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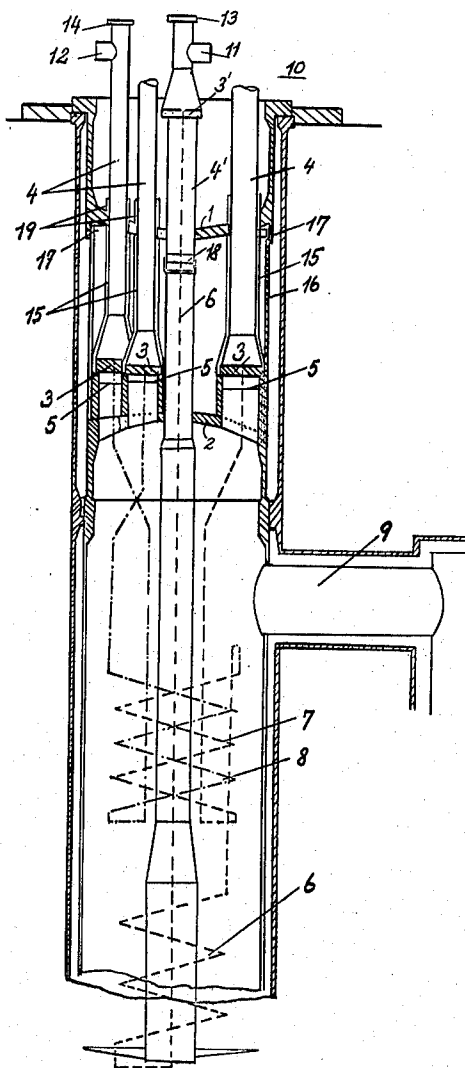
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ABSTRACT

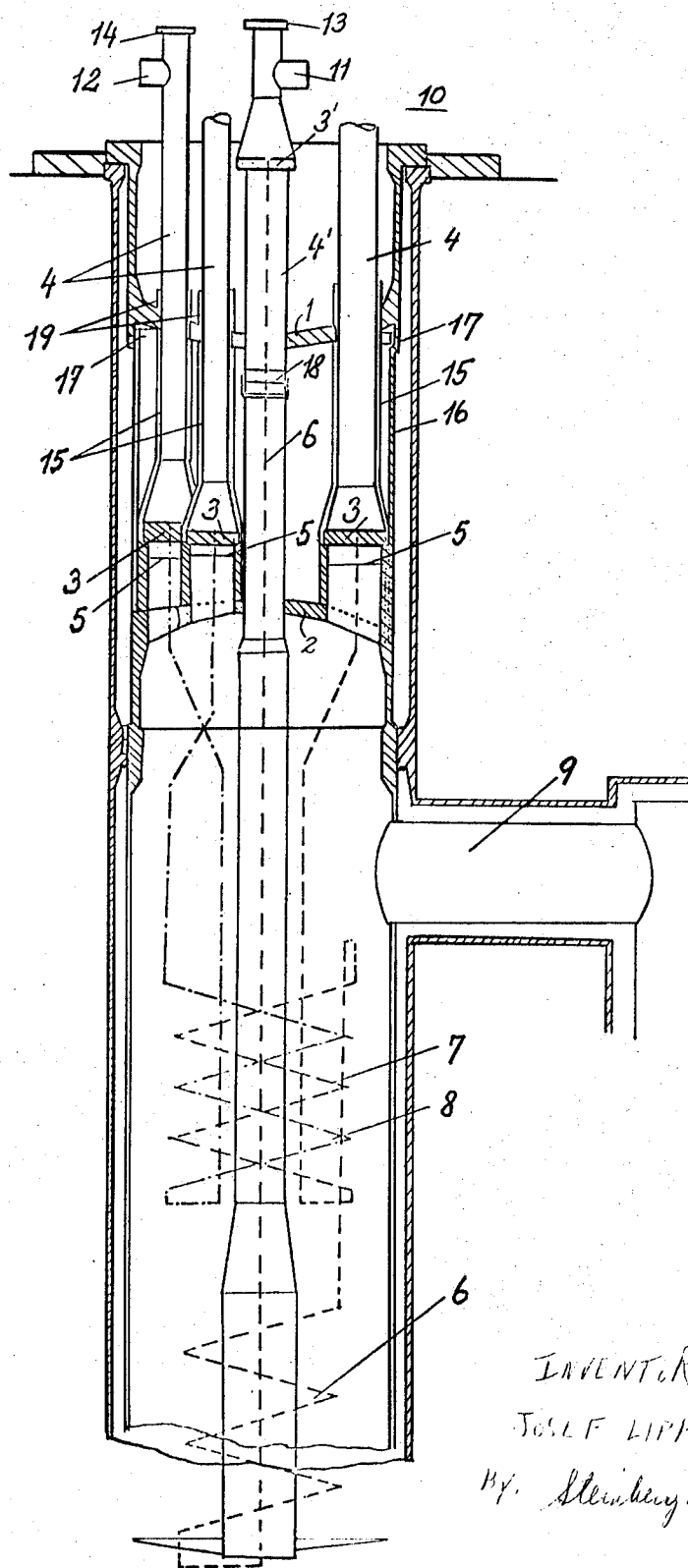
Heat exchanger structure for steam generators to be used with nuclear installations, chemical installations, such as petrochemical plants and the like. The steam generator has primary and secondary pressure barriers between which connecting pipes extend, and within the latter pipes are heat-exchanging tubes which extend from tube sheets which are situated within the connecting pipes. At least part of these tube sheets form parts of the primary and secondary pressure barriers.

8 Claims, 1 Drawing Figure



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HEAT EXCHANGER STRUCTURE FOR STEAM GENERATORS

BACKGROUND OF THE INVENTION

The present invention relates to steam generators.

In particular, the present invention relates to steam generators which are capable of being used in plants where the heat is derived from a nuclear reactor, or in chemical installations where the heat is derived from chemical equipment, such as in the case of the petrochemical industry.

In installations of the above type the heat for the steam generator is derived from hot gases which are directed into the heat exchanger so that the feedwater which is fed into the boiler tubes will be vaporized to form steam which can then be superheated.

With installations of this type a problem is encountered when failures occur. Thus, when failure occurs the space in which the steam generator is located can become rapidly filled with hot gas creating extremely dangerous situations which may be highly injurious to personnel and equipment. Moreover, even if it is possible under such circumstances to cut off the source of the hot gases so that access may be had to the faulty steam generator, it is not always possible to efficiently and inexpensively work on the steam generator so that the source of the faulty operation thereof can be corrected. For example, it may be that one or more tubes of the heat exchanger unexpectedly start to leak. Under such conditions it is not always possible to place such leaky tubes in a condition where they no longer participate in the operation of the heat exchanger, so that under these circumstances even if a relatively small number of tubes are the source of trouble, it may be necessary to shut down an entire installation until proper repairs can be effected.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a construction which will avoid the above drawbacks.

In particular, it is an object of the invention to provide a construction which will afford an opportunity to shut off the supply of hot gases, in the event that faulty operation of a steam generator, in installations of the above type, is encountered.

Also, it is an object of the invention to provide a construction which will make it possible to prevent faulty tubes from participating in the operation of the heat exchanger without necessarily requiring dismantling of the entire heat exchanger structure.

In particular, it is an object of the invention to provide a construction which makes it easily possible to plug up those particular tubes which are the source of a faulty operation, without removing such tubes from the installation, so that it is possible very quickly and inexpensively to resume operations with the steam generator.

Furthermore, it is an object of the invention to provide a construction where the parts are capable of expanding and contracting in response to temperature changes without providing undesirably great stresses on the structure.

According to the invention the steam generator has a heat-exchanging structure which includes primary and secondary barriers spaced from each other. Connecting pipes extend at least in part between the primary and secondary barriers, and heat-exchanging tubes are situated within these connecting pipes and extend from tube sheets which are also situated within the connecting pipes. These tube sheets themselves form, at least partly, parts of the primary and secondary pressure barriers.

BRIEF DESCRIPTION OF DRAWING

The invention is schematically and fragmentarily illustrated by way of example in the longitudinal sectional elevation of a heat exchanger which forms part of a steam generator.

DESCRIPTION OF A PREFERRED EMBODIMENT

The heat-exchanger structure which is shown in elevation in the drawing is designed for use with nuclear installations.

However, the invention is not limited to such use and can be used with chemical installations, in particular in the petrochemical industry. The heat-exchanger illustrated forms a steam generator. It includes a primary pressure barrier 1 and a secondary barrier 2. The heat-exchanger tubes in which the actual heat exchange takes place are in the form of bundles of tubes, 6, 7, and 8. These bundles of tubes are schematically illustrated. The bundle of tubes 6 serves to preheat the liquid and also, according to the particular operation, to vaporize the liquid, while the bundle of tubes 7 which receives the fluid from the tubes 6 serves to superheat the steam which is generated. The bundle of tubes 8 serves as an intermediate superheater, but the presence of several bundles of tubes is not essential to the invention.

The heat is derived from a gaseous medium which flows into or out of the heat exchanger through the conduit 9. This conduit 9 serves in the illustrated example to provide communication between the heat exchanger and an unillustrated reactor. This gaseous medium fills the entire inner space of the heat exchanger. It flows through leakage places of the secondary barrier 2, such leakage places being formed by cracks, clearances, and the like at the secondary pressure barrier 2. As is indicated in the drawing, the bundles of tubes 7 and 8 extend from tube sheets 3 which are connected by plugs 5, which respectively extend from these plates 3, with relatively short connecting pipes extending from and through the barrier 2 and forming part of the latter with these tube sheets 3 also forming part of the secondary pressure barrier 2. Thus, due to the possibility of leakage of the hot gas through the secondary pressure barrier 2, it is possible for this hot gas to flow into the chamber between the primary and secondary pressure barriers.

An important safety purpose is served by the division of the structure into primary and secondary pressure barriers. Thus, in the event of failure of the primary pressure barrier 1, in particular at the cover of the heat exchanger, there will not be an immediate escape of the gaseous medium into the space 10 around the heat exchanger. In the event that there is a failure of the primary pressure barrier, the secondary pressure barrier 2 takes over the functions of the primary pressure barrier at least for a length of time sufficient to separate the source of the hot gas from the heat exchanger or to terminate the operation of the reactor.

The tube sheets 3 are situated within connecting pipes 4 which are connected in a gas-tight manner with and extend through the primary pressure barrier 1. Those pipes 4 which serve to convey a hot medium which flows therethrough are provided with heat insulation 15. These connecting pipes 4 are provided at their connections with the tube sheets with an enlarged diameter so that it is possible to situate plugging machines in the pipes 4 in order to close off damaged tubes which are connected to the tube sheets 3. In this way it becomes possible for the faulty tube or tubular coil to be placed in a condition where the cooling medium no longer flows through such tubes. The several bundles of tubes 6-8 are, for example, welded into openings which are formed in the tube sheets 3. Thus, just above these tube sheets 3 for the bundles of tubes 7 and 8 the connecting pipes 4 form collecting chambers in which the medium which flows in the interior of the tubes collects, and these collecting chambers formed by the connecting pipes 4 serve to direct the fluid through the primary pressure barrier 1. Outside of and beyond the primary pressure barrier 1 the connecting conduits 11 and 12 communicate with the connecting pipes 4, these conduits extending perpendicularly with respect to the pipes 4. Thus, the conduit 11 serves as a supply conduit for a liquid such as water which will be converted into steam while the conduits 12 are discharge conduits through which the steam flows to any con-

sumer units which utilize the steam. The top ends of the pipes 4 are covered by closure plates 13 and 14, so that it is a simple matter upon removal of such closure plates to have easy access to the connecting pipes 4. As a result of this easy access to the connecting pipes 4 it is possible to easily introduce the plugging machine into a connecting pipe 4 in order to plug up a damaged or defecting tube. In this way such tubes can be closed so that they will no longer participate in the operation of the heat exchanger.

The central or innermost collecting chamber of the heat exchanger has a construction which is somewhat different from the other chambers formed by the connecting pipes 4. Thus, it is this central or innermost connecting pipe 4' in which the bundle of tubes 6 is accommodated. In this case the tube sheet 3' into which the heat-exchanger tubes are rolled forms a special part of the primary pressure barrier 1. Thus, it is apparent from the drawing that the uppermost tube sheet 3' illustrated therein is the only one of the tube sheets which is situated at and forms part of the pressure barrier 1. Within this central or innermost connecting pipe 4' there is beneath the tube sheet 3' therein a second plate which is similar to a tube sheet, this plate 18 forming part of the secondary pressure barrier 2, while the remaining tube sheets 3 situated at the lower elevation illustrated in the drawing also form parts of the secondary barrier 2. This plate 18 is formed with a plurality of bores passing therethrough so that the bundle of heat exchanging tubes 6 can extend through these bores. In this case also the plate 18 is formed with clearances, which may take the form of cracks, gaps, or the like, so that upon failure of the primary pressure barrier the hot gaseous medium can only escape slowly. With this construction there is moreover an outer cylinder 16 which surrounds the heat-exchanger structure which extends between the primary and secondary pressure barriers. This cylinder 16 is fixedly connected with the secondary pressure barrier 2. However, it has a pin-and-slot connection 17 with the primary pressure barrier 1. It is therefore possible for the cylinder 16 and the primary pressure barrier 1 to move axially one with respect to the other in response to expansion and contraction due to temperature changes.

Those connecting pipes 4 which form collecting chambers for hot fluid medium are provided at the locations where they pass through the pressure barrier 1 with surrounding sleeves 19 which form heat traps, so that heat is conducted away only to a small extent in the primary pressure barrier 1.

The plug-type of connection formed by the plugs 5 which respectively extend from the lower tube sheets 3 where the latter are connected with the short connecting pipes of the secondary barrier 2, have a slidable engagement with the interior of these short connecting pipes, so that it is possible to provide for free expansion and contraction of the pipe connections 4, which serve as the collecting chambers, with respect to the pressure barrier 2, as a result of the possibility of free axial shifting between the lower tube sheets 3 and the secondary barrier 2 at the plugs 5 which are freely slidable with respect to the relatively short connecting pipes of the pressure barrier 2. In this way undesirable additional stressing of the secondary pressure barrier 2, as a result of heat stresses, is avoided. In the same way, this latter feature results in lesser

stressing of the primary pressure barrier 1 as a result of non-uniform heat stresses.

For the means 5 which provides the slidable or shiftable connection between the lower tube sheets 3 and the short connecting pipes of the secondary pressure barrier 2, it is preferred to use around the piston-shaped plugs piston sealing rings which provide the slidable connection.

At the innermost pipe connection 4' there will in general be cold feedwater which is fed to the heat exchanger which forms the steam boiler. This feedwater is vaporized into steam without being removed from the surrounding pressure vessel. The pipe connections 4, in particular those through which the hot fluid flows out of the heat exchanger and in which the hot fluid is collected, or in other words those pipe connections 4 in which steam is conveyed, are provided with heat-insulating surrounding casings 15 in order to avoid heat losses between the primary and secondary pressure barriers.

What is claimed is:

1. In a steam generator, primary and secondary pressure barriers, a plurality of connecting pipes extending at least in part between said barriers, and plurality of tubes and tube sheets within said pipes, said tube sheets being situated between said primary and secondary pressure barriers and at least part of said tube sheets forming parts of said primary and secondary pressure barriers.

2. The combination of claim 1 and wherein said secondary barrier forms an inner cover of a heat-exchanger pressure vessel, a plurality of pipe connections respectively connecting at least some of said tube sheets with said inner cover, and means providing between said tube sheets and pipe connections a shiftable joint so that the latter pipe connections and tube sheets are capable of shifting one with respect to the other.

3. The combination of claim 1 and wherein said pipes connect said tube sheets with said primary pressure barrier in a gas-tight manner.

4. The combination of claim 3 and wherein said pipes extend through said primary barrier, said pipes respectively having in the region of said tube sheets diameters larger than the diameters of said pipes where they pass through said primary pressure barrier.

5. The combination of claim 3 and wherein said pipes are straight at the regions thereof which extend between primary and secondary pressure barriers.

6. The combination of claim 1 and wherein an outer cylinder surrounds and interconnects said primary and secondary barriers, and pin-and-slot means interconnecting said outer cylinder with said primary barrier.

7. The combination of claim 3 and wherein an insulating means coacts with said pipes between said primary and secondary barriers for insulating the latter against heat losses.

8. The combination of claim 1 and wherein said tubes include an innermost bundle of tubes and an innermost tube sheet from which said innermost bundle of tubes extend, said innermost tube sheet being the only one of said sheets which form part of said primary pressure barrier, and a second tube sheet through which said innermost bundle of tubes extend with clearance, said second tube sheet forming a part of said secondary pressure barrier.

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