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[54] **HEAT EXCHANGER**

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[51] **Int. Cl.**..**F24h 1/20**

[58] **Field of Search**..........165/1, 104, 111, 140, 145; 122/28, 31; 126/360 A

[56] **References Cited**

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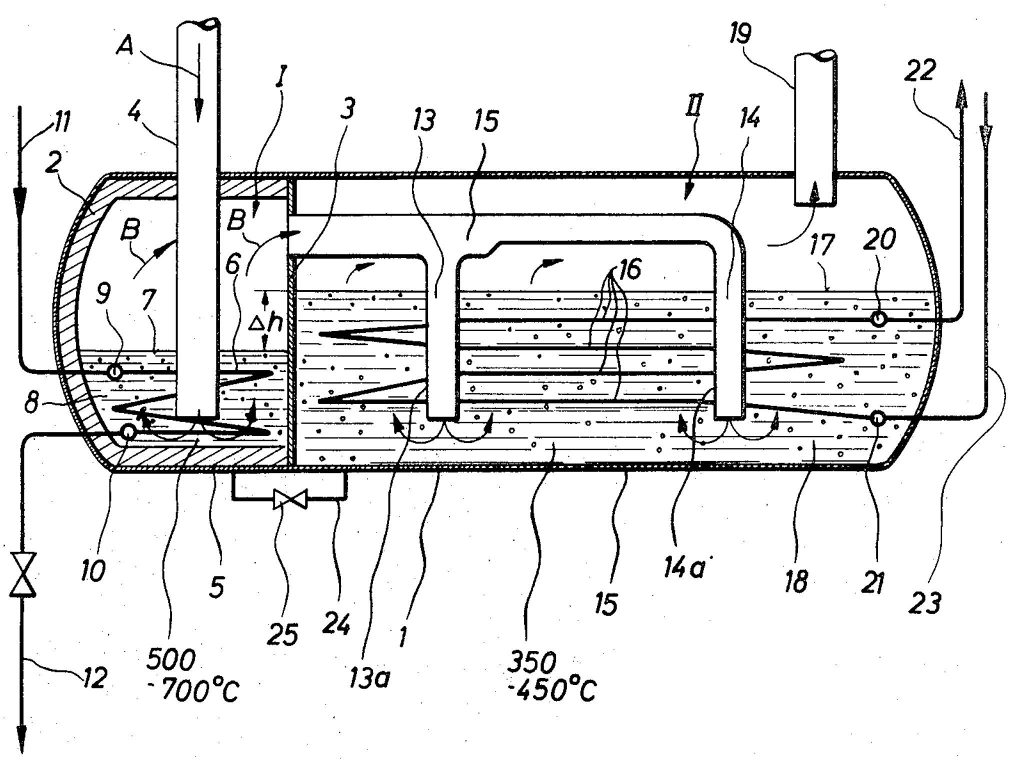
[57] **ABSTRACT**

A heat exchanger for cooling hot inert gases in a metal bath while producing steam in two serially arranged chambers each containing a metal bath and heat exchanging surfaces, the arrangement being such that the gases are introduced into the respective metal bath from above and the withdrawal of the gases from said chambers is effected above the level of the metal bath while the heat absorbing medium flows through the chambers in counter-current flow to the gases, and the exchanger surfaces are so designed that the metal bath temperature in the serially first chamber is the highest.

5 Claims, 2 Drawing Figures



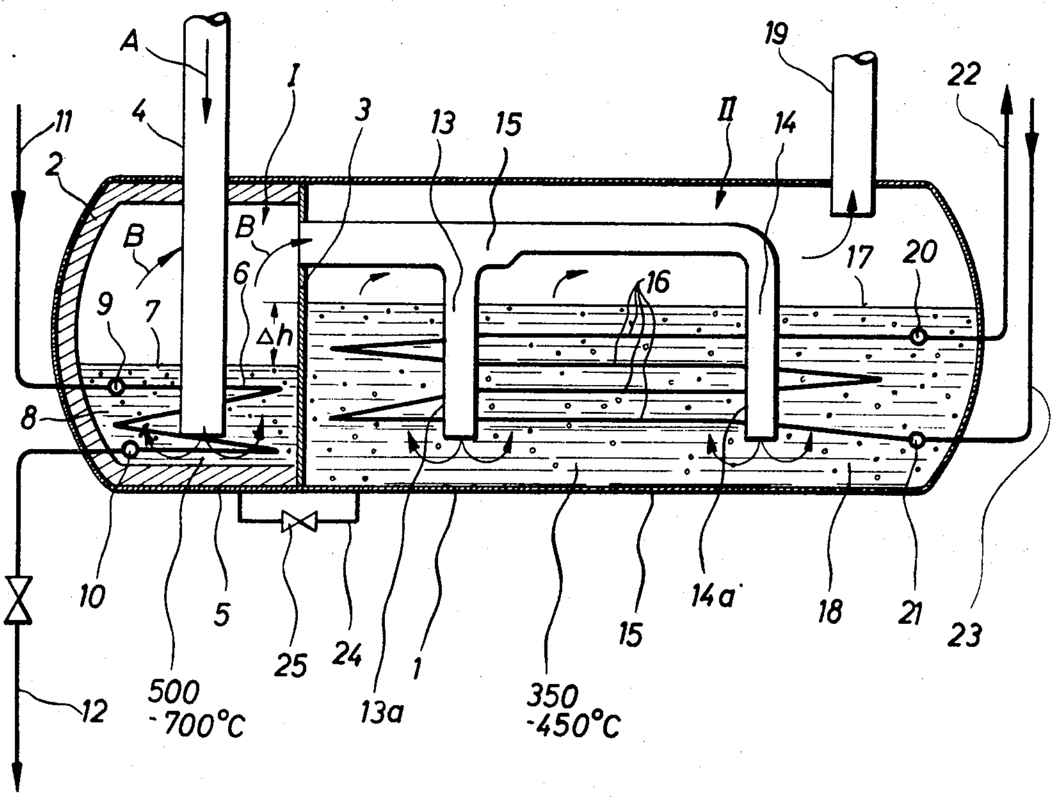


Fig. 1

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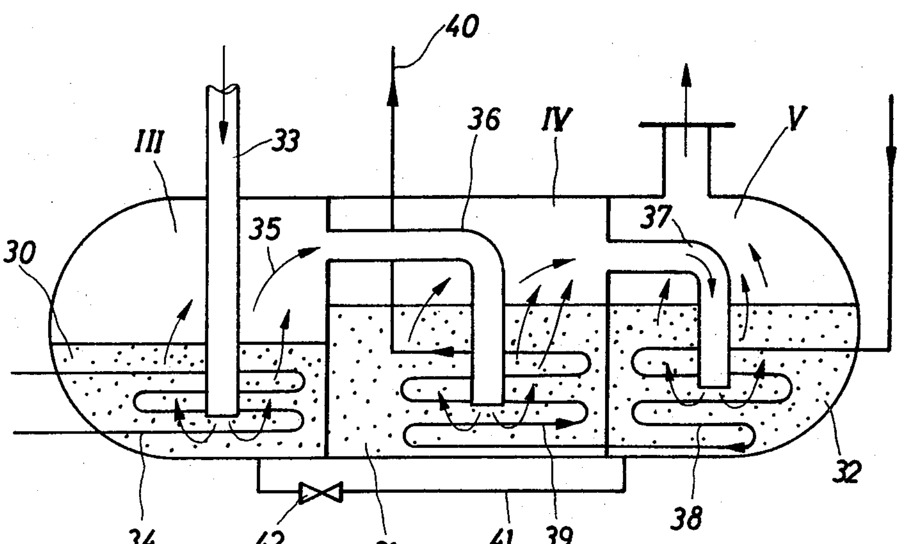
Fig.2



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HEAT EXCHANGER

The present invention relates to a heat exchanger for cooling hot inert gases in a metal bath while producing steam in two serially arranged chambers respectively receiving a metal bath with heat exchanger surfaces (preheater, evaporator, superheater). It is known to employ liquid metal as intermediate carrier between a heating medium and a working medium, for instance water or steam. For generating steam, it is known to carry out the transfer of the heat content of a hot inert gas, for instance a gas for cooling a nuclear reactor, to a liquid metal in two serially arranged chambers respectively receiving a metal bath with heat exchanger surfaces, such as preheater, evaporator and superheater. In this connection, for securing a good heat transfer between the media, the metal is circulated in the individual chambers while employing the Mammut pump principle (secondary air lifting means). The said Mammut pump principle is based on the following physical behavior. Compressed air or compressed gas is in a riser mixed with the liquid to be conveyed and thereby reduces the specific weight of the liquid so that the latter will rise in view of the effect exerted by the outer atmospheric pressure acting upon the level of the liquid. The employment of the Mammut pump principle will with metal baths always result in a circulation and conveying of the liquid metal (see German Auslegeschrift No. 1,201,856).

It is an object of the present invention to provide a heat exchanger of the above mentioned type which will have a simplified construction and an improved degree of efficiency and which during the discharge of the cooled gases from the heat exchanger will not carry off metal particles.

This object and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing diagrammatically illustrating a section through a heat exchanger according to the invention.

The heat exchanger according to the present invention is characterized primarily in that the gases are introduced into the metal bath of the individual chambers from above while the withdrawal of the gas above the level of the metal bath is effected in each chamber and while the heat absorbing medium passes in counter flow to the gases through the chambers, the heat exchanger surfaces being so designed that the temperature of the metal bath of the first chamber adjacent the gas is the highest temperature.

The present invention differs in its operation from heretofore known heat exchangers with liquid metal as exchanging medium in that according to the invention the liquid metal is not circulated and the heat transfer is not effected by a heat transport. According to the present invention, the liquid metal is at rest and the heat transfer is effected by heat conduction within the liquid metal. In this way, all means for transporting the liquid metal, including the insulation of such transporting means, will become superfluous.

In contrast to the possibility at the gas side to provide a heat exchanger ahead of the metal bath, the heat exchanger according to the invention yields the advantage that, for instance when employing fission gas as heat releasing medium, the usually extensive soiling of the heat exchanger will be avoided. When introducing such gas into a liquid metal bath, soiling particles will float on the surface of the metal bath without affecting the heat exchange in the interior of the bath.

According to a further development of the invention, the chambers are interconnected through a connecting line with a control valve. The metal which at a temperature of the metal bath of from 500° to 700° C is carried away from the bath in the first chamber passes through immersion pipes into the metal bath of the second chamber. An equalization of the quantity of metal in both chambers may be effected by means of the above mentioned connecting line and the control valve. For the transport of the liquid metal in the connecting line, advantage may be taken of the difference in the level of the baths in both chambers.

Preferably, the two chambers are arranged in a common tank which is separated by a partition into which the end of the immersion pipes is inserted. The chamber which receives the superheater pipes may be insulated by a special insulating lining.

The two chambers may be followed by a third chamber containing a metal of a lower melting point than that of the metal in the two preceding chambers. A preheating of the feed water may be effected in the metal bath with the lower melting temperature.

FIG. 1 is a diagrammatic view showing features in accordance with the present invention.

FIG. 2 is a diagrammatic view showing a modified embodiment of the present invention.

Referring now to FIG. 1 of the drawings in detail, the heat exchanger illustrated therein comprises a horizontally arranged boiler **1** one end portion of which is provided with an inner insulating layer **2**. This insulating layer **2** together with a partition **3** defines the chamber I. A feeding pipe **4** extends into the chamber I for the hot gas which at a temperature of approximately from 800° to 900°C flows in the direction of the arrow A. This hot gas represents the heat releasing medium. As will be seen from the drawing, the lower end **4*a*** of the pipe **4** extends into the vicinity of the bottom **5** or the lining thereof while the lower section of the pipe **4** is surrounded by superheater pipes **6**. These pipes **6** as well as the said pipe section are so arranged that when the level of the metal bath **8** has the height customary for the operation of the heat exchanger, the said parts are located below the level of the bath. The superheater pipes **6** are through headers **9, 10** in communication with corresponding feeding and withdrawing pipes **11, 12** for the saturated steam and the superheated steam respectively.

The second chamber II which is separated from the chamber I by a wall or partition **3** does not require a lining and comprises the immersion pipes **13, 14** which through a common immersion line **15** are in communication with each other. The pipe **15** ends in the wall **3** so that the gas which is above the metal bath **8** can pass through conduit **15** to the immersion pipes **13, 14**. The lower end **13*a*, 14*a*** of the pipes **13, 14** is again located slightly above the bottom **15** of the chamber II while the lower section of the pipes **13, 14** is surrounded by evaporator pipes **16**. The lower ends **13*a*, 14*a*** of the pipes **13, 14** and the pipe **16** are so arranged that these parts will during the operation of the heat exchanger be located below the level **17** of the metal bath **18** in chamber II.

A discharge connection **19** for the inert gas which with regard to the metal in chambers I and II has been cooled to 330° to 400°C extends into the chamber II.

The connection **19** may be followed by a conduit with a feed water preheater, and there may furthermore be provided in this conduit a blower or compressor which produces the necessary pressure for the gas which is pressed through the heat source in which the inert gas is heated again to a temperature of from 800° to 900°C and is also pressed through the metal baths **8, 18** of the heat exchanger.

The headers **20, 21** of the evaporator pipe **16** communicate with the feeding and discharge lines **22, 23** respectively. The two chambers I and II are in communication by means of a connecting line **24** adjacent the bottoms **5, 15** of the two chambers. This connecting line **24** has interposed therein a control valve **25.** When the levels of the baths **7, 17** differ from each other by Δh, a corresponding pressure difference is obtained as a result of which liquid metal can be passed from chamber II into chamber I. As a result thereof, the quantity of metal carried away by the gas in the direction of the arrows B and flowing into the chamber II, can again be compensated for.

If desired, the illustrated heat exchanger with, for instance, a bath of lead or a bath of a lead compound may be followed by another heat exchanger the metal of which may have a lower melting temperature than lead, for instance, tin.

As inert gas for operating the heat exchanger, preferably fission or synthesis gas or helium may be employed which are heated directly or indirectly in a nuclear reactor or fission furnace.

With the embodiment according to FIG. **2**, a container or vessel consists of three chambers III, IV, and V, whereby the chamber III is partially filled with a lead bath **30** and both chambers IV and V are partially filled each with a lead bath **31** and **32.** A supply tubing **33** projects into the chamber III; the tubing lower end dips into the lead bath **30** in which on the other hand the overheating tube means **34** is provided. After the supplied gas has bubbled through the bath by way of the supply tubing **33**, the same reaches the chamber IV in the direction of arrow **35** in the dip conduit **36** of which the lower end emanates in the bath **31.** The gas bubbles again through this bath and reaches the dip conduit **37** of the chamber V where the lower end of the dip tubing **37** dips into the bath **32.** In the bath **32** there lie the tube means **38** which form the exchange surfaces and by way of which the heat-receiving medium for instance water, respectively water vapor is supplied. The tube means **38** proceed into the exchanger tubes **39** of chamber IV. From these tubes the saturated vapor, respectively hot steam is withdrawn at **40.**

Between the last chamber V and the first chamber III there is a connection conduit **41** provided in which a valve **42** is arranged and by way of which an equalization of the metal parts drawn therewith is created so that these parts collect in the chamber V.

It is, of course, to be understood that the present invention is, by no means, limited to the particular showing in the drawing but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. A heat exchanger which guarantees a sufficient heat transfer for cooling hot inert gases passing through tubing in a standing liquid metal bath while producing steam, which includes: container means having at least first chamber means wherein temperature is higher and separate second chamber means, a standing liquid metal bath received and contained in each of said first and second chamber means, first conduit means leading into said first chamber means near the bottom thereof for conveying hot gases into the standing liquid metal bath in said first chamber means, second conduit means extending from above into and through the lower portion of said first chamber means for conveying saturated steam into and discharging superheated steam from said second conduit means, immersion pipe means leading from the upper portion of said first chamber means to said second chamber means near the bottom thereof for conveying hot gas above the standing liquid metal bath in said first chamber means into the standing liquid metal both in said second chamber means, evaporator pipe feeding and discharge lines extending in part through the standing liquid metal bath in said second chamber means, and discharge conduit means communicating with the upper portion of said second chamber means for withdrawing therefrom inert gas cooled relative to the metal bath in said first and in said second chamber means while avoiding any circulating metal bath and avoiding any Mammut-pumping effect and bubbling in any column through the liquid metal bath.

2. A heat exchanger according to claim **1**, which includes equalizing means communicating with a bottom portion in said first chamber means and a bottom portion in said second chamber means for equalizing the level of the metal baths in said first and second chamber means respectively.

3. A heat exchanger according to claim **2**, in which said equalizing means includes conduit means interconnecting said first and second chamber means and check valve means interposed in said last mentioned conduit means.

4. A heat exchanger according to claim **1**, which includes tank means common to and containing said first and second chamber means, and partition means separating said first and second chamber means from each other.

5. A heat exchanger according to claim **1**, which includes another metal bath, third chamber means following said second chamber means for receiving the further metal bath having a lower melting point than the metal baths to be received in said first and second chamber means.

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