

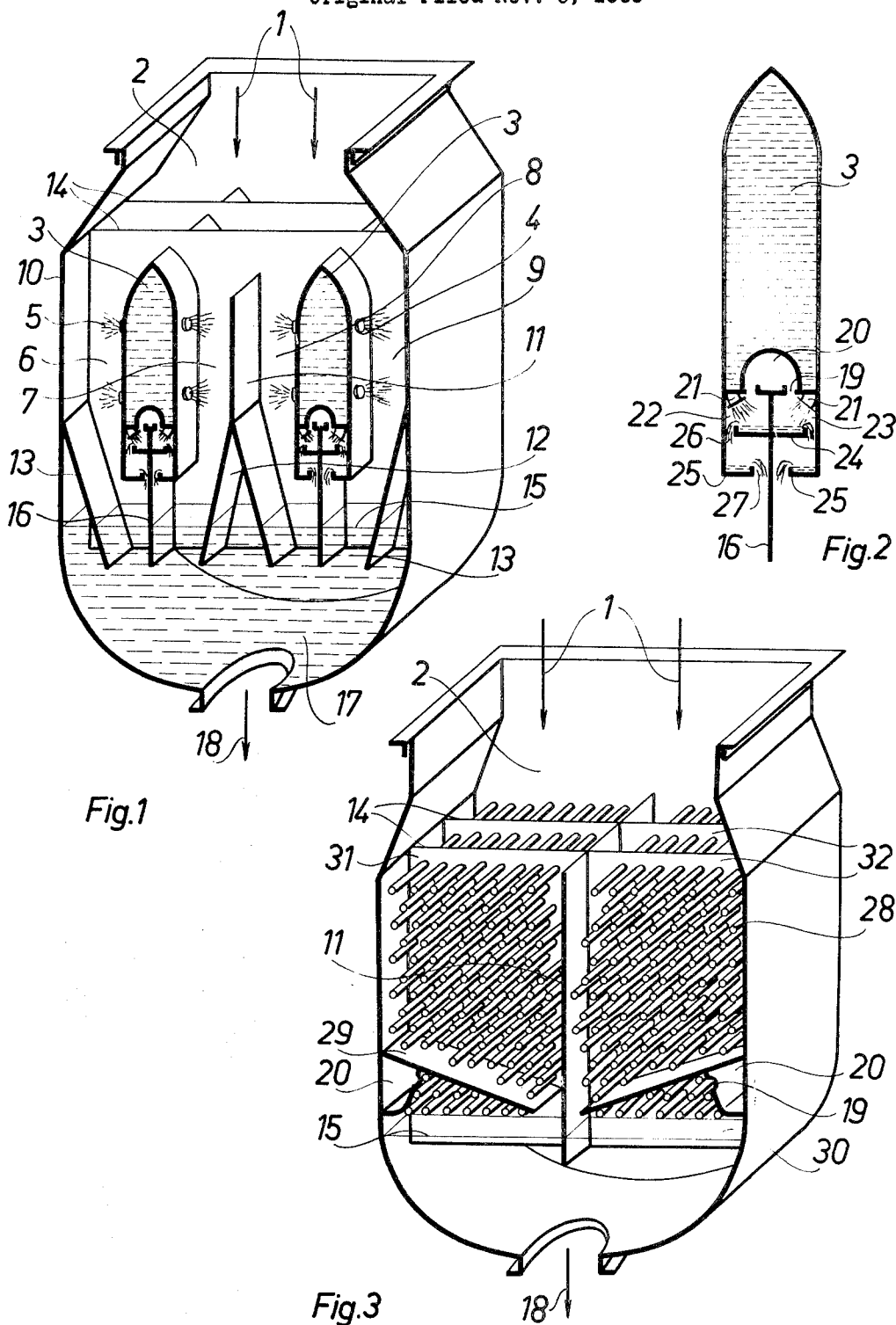
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HEAVY DUTY CONDENSER

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HEAVY DUTY CONDENSER

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8 Claims

ABSTRACT OF THE DISCLOSURE

A heavy duty condenser divided into a plurality of steam channels and having a gas abducting means at the downstream extremity of each of said steam channels.

This application is a continuation of my copending application Ser. No. 506,622, filed on Nov. 3, 1965 for a Heavy Duty Condenser, now abandoned.

This invention relates to steam heated heat exchangers, more particularly condensers, provided with means for abducting noncondensing gases therefrom.

Heat power engineering uses various apparatus in the interior of which steam is condensed in consequence of heat exchange. The precipitation issuing from the steam as well as noncondensing gases present in the interior of the apparatus have to be removed therefrom so as to ensure heat exchange continuity. Whatever steam is employed for operating an apparatus, the density of the resulting precipitation is always a multiple of the steam density. Accordingly, the precipitation collects at the bottom of steam chambers so that its abduction is feasible without difficulties. On the other hand the density of noncondensing gases only very slightly differs from the density of mostly employed steams, wherefore such gases are very difficult to remove from steam chambers without a substantial amount of steam being withdrawn together therewith.

The presence of noncondensing gases in the steam chamber of steam heated heat exchangers, e.g., condensers, has two reasons. On the one hand, the heating steam—as a rule—contains gases which do not precipitate at the temperature prevailing in steam chambers. Therefore such gases are brought in by the heating steam. On the other hand, air can penetrate into the steam chamber through leakages or deficient sealings if it is under a pressure lower than the atmospheric one, e.g., under vacuum. However, whatever the origin of noncondensing gases in steam heated heat exchangers, they have to be removed and abducted therefrom either by blowing off into the ambieny with apparatus operated at higher than atmospheric pressures or by suitable pumps in case of apparatus operated with vacuum.

Practically, however, the abduction of noncondensing gases from steam chambers strikes on great difficulties, since—due to the slight density difference between gases and heating steam—the place at which such gases will collect cannot be ascertained with suitable accuracy. It has been suggested to generate particularly strong cooling action in one or several small portions of the steam chamber well delimited at various parts thereof so as to increase the partial pressure of chamber and to dispose in each a passage serving to abduct noncondensing gases therefrom.

The aforesaid system which is widely used in steam condensing techniques is, however, not quite satisfactory, viz, it often occurs that—for reasons not quite known—a flow arises in the steam chamber by which noncondens-

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ing gases are carried off to places other than where abducting passages are located on basis of precalculation so that abduction becomes incomplete and operation of the condenser partly impaired by decreasing heat exchange.

The main object of the present invention is to exactly predetermine where noncondensing gases shall reliably be abducted. The invention consists in that the condensing portion of the steam chamber of a heat exchanger is subdivided by juxtaposed partitions so as to form gas channels one extremity of which is open to receive steam to be precipitated whereas its other extremity is closed so as to prevent a steam flow, the steam channels having each a gas abducting passage near their closed extremity the discharge area of which is relatively narrow with respect to the cross-sectional area of its associated steam channel. The extremity of the steam channels being closed for a steam flow, as much steam can penetrate into each channel as is capable to precipitate there.

With surface heat exchangers and condensers, respectively, this amount depends on the number of cooling pipes which cross the individual channels, and on the amount and temperature of cooling water flowing there-through. With mixing condensers, on the other hand, the amount of steam capable of precipitating in the individual steam channels is dependent on the amount and temperature of the cooling water injected into the channels. Accordingly, the ratio between the inlet cross-sectional areas of the individual steam channels and the amount of cooling water injected therein should be equal to the ratio between the common inlet cross-sectional area of all steam channels and the total amount of cooling water supplied into the condenser. Thereby, the same inlet flow speed of steam in each channel is obtained independent of turbulences which are unavoidable at the inlet stubs of mixing condensers.

As precipitation of steam in the channels takes place, the flow speed decreases. Accordingly, the steam channels may have cross-sectional areas contracting from their open extremities to their closed ones. At the closed extremities of the steam channels cold cooling water may be introduced and the mixture of steam and gas—more and more enriched with noncondensing gases—may be led in counter-current with such cooling water in a direction towards said gas abducting passages which may be connected by one or several gas pipes with a common outlet stub and vacuum pump.

The noncondensing gases will preferably be abducted uniformly from the group of steam channels for which purpose the cross-sectional area of the gas abducting pipes will be much larger than that of the gas abducting passages so that their flow resistance be considerable with respect to the flow resistances in the gas pipes.

The precipitated steam mixed with the cooling water collects at the bottoms of the steam channels and has to be abducted therefrom for which purpose the confining walls of the channels must not prevent the water flowing towards outlet passages.

Further objects and details of the present invention will be described by taking reference to the accompanying drawings which show, by way of example, two embodiments of the heat exchanger according to the invention and in which:

FIG. 1 is a perspective view of one embodiment partly in section,

FIG. 2 shows a longitudinal sectional view of a detail of FIG. 1 on a relatively larger scale. Finally,

FIG. 3 is a perspective view partly in section of the other exemplified embodiment of the invention.

Same reference characters refer to similar details throughout the drawings.

FIG. 1 shows a mixing condenser which is generally used with steam turbines. In such condensers the steam of a steam turbine is precipitated by direct contact with cooling water, such precipitation resulting in a condensate. In FIG. 1 the dead steam of the turbine flows vertically downwards as indicated by arrows 1 into a distribution chamber 2 which is a part of the steam chamber of the condenser. Cooling water is introduced through conduits 3 the sides of which are provided with atomizing nozzles 4. Due to such nozzles 4, suitably atomized water jets 5 are present in the interior of the condenser. The entering dead steam mixes with such atomized water and precipitates whereas the resulting mixture of condensate and cooling water flows down to the bottom of the condenser.

With the represented embodiment, the precipitating steam is bifurcated by each conduit 3 and subdivided between channels 6, 7, 8 and 9 confined, on the one hand, by a casing 10 of the condenser and, on the other hand, by the water conduits 3 and a partition 11 bifurcated, in turn, so as to form a pair of obliquely disposed plates 12 and thereby to contract the channels 7 and 8 in the direction 1 of steam flow. The channels 6 and 9 are likewise contracted by the provision of obliquely disposed plates 13. The condenser, besides being longitudinally subdivided into several channels 6, 7, 8, 9 by said water conduits 3 and by the partition 11, comprises transverse partitions 14 as well which form with the former channels subdividing the total cross sectioned area of the condenser. However, the flow velocity of the steam flowing into the condenser in direction 1 is not uniform as regards the whole of such cross-sectional area. This is partly due to the outlet speed of the steam being already nonuniform in the last crown of blades of the turbine. On the other hand, turbulences appear in the pipe conduit which connects the turbine with the condenser and in which sharp directional changes are inevitable. Thus, if besides subdividing the steam chamber of the condenser in the aforesaid manner no further expediences were made, the individual channels would receive various amounts of steam independent of the amount of water in the water jets and, thus, independent of the amount of steam which the individual channels are capable to precipitate. Obviously, there would be channels which would receive more steam than could be precipitated by atomized water. Such steam returned at the bottom of the condenser would try to flow from below into channels which receive less steam from above and, therefore, have more cooling water present than needed for precipitating the steam therein. By such not exactly calculable flow noncondensing gases present in the condenser would be carried off to places which—likewise due to the aforesaid uncertainties—cannot be predetermined either.

In order to avoid such inconveniences, the channels 6, 7, 8, 9 may be arranged so that they do not communicate at their lower extremities as regards steam. For this purpose, a water level 15 is maintained in the steam chamber by damming the mixture of condensate and cooling water prior to its flowing out. Therefore, pumping out of water from the condenser is regulated in such a manner as to keep the water level 15 constant. On the other hand, the walls 12, 13, 14 of the channels 6, 7, 8, 9 will penetrate downwards below the water level 15 as shown in FIG. 1. Plates 16 fixed to the bottom of the water conduits 3 serves to separate the steam chamber 6, 7, 8 and 9 from one another. They likewise penetrate below the water level 15. The mixture of condensate and cooling water collects in a chamber 17 at the bottom of the condenser. The plates 12, 13, 14 and 16 obviously must not extend to the bottom of the condenser since then no flow of water would take place in the direction of arrow 18. The juxtaposed steam channels closed at their end as regards steam flow receive each an amount of steam which will be able to precipitate there in accordance with the amount of injected cooling water. Dif-

ferences in steam velocities otherwise always experienced at the inlet cross-sectional areas of condensers are compensated thereby.

Obviously, care has to be taken that noncondensing gases may be withdrawn from the individual steam channels 6, 7, 8 and 9. This is, in the instant case, obtained by gas abducting passages 19 associated each with an individual channel 6, 7, 8 and 9 and connected by a common gas pumping conduit 20 (see FIG. 2). In operation, the water conduits 3 are constantly full with cold cooling water so that—through water spray nozzles 21 disposed in their walls—water is injected into chambers 22 and 23 which, actually, are the ends of the steam channels 6, 7, 8 and 9 and are partly separated from one another by a tray 24. Herefrom the mixture drops onto trays 25 and, therefrom, into the water collecting in the bottom 17 of the condenser. It can be seen that the chambers 22, 23 of the steam channels 6, 7, 8 and 9, where noncondensing gases collect, are exposed to a very strong cooling action so that a thorough separation of steam and gas takes place there. The gas abducting conduits 20 extend through the whole length of the condenser and of the cooling water conduits 3, and are connected through the wall of the condenser to an air pump, not shown. With the represented exemplified embodiment there are a pair of such gas abducting channels 20 the number of which may, however, be higher or lower as the case may be.

The arrangement described above permits a reliable operation wherein the gases in chambers 22 and 23 which are separated from other portions of the condenser cannot be mixed with steam any more. Mixing which has possibly taken place in the channels 6, 7, 8 and 9 is of no significance where the partial pressure of steam is high and that of the gases low. In the chambers 22 and 23, however, the situation is the reverse so that no flow-back of a mixture of steam and gas into the steam channels 6, 7, 8 and 9 may be permitted. Such backflow is prevented by trays 24 and 25 with discharge areas 26 and 27 left free for the upward flow of steam and gas. The ratio between the discharge areas 26 and 27 and the cross-sectional areas of the steam channels 6, 7, 8 and 9 will preferably amount to at most $\frac{1}{10}$ whereby the gases are reliably prevented from flowing back from the chambers into the steam channels.

Since each steam channel 6, 7, 8, 9 requires at least one gas abducting passage 19, obviously a plurality of such passages has to be employed. Preferably, the cross-sectional area of the gas abducting channels 20 will be at least the double of the total cross-sectional area of the gas abducting passages 19 whereby a uniform withdrawal of the noncondensing gases is obtained.

Gas abduction as described above becomes self-regulating, viz, if a lower amount of air flowed through one of the gas abducting channels 20 than through others, the resistance against the flow of air in the first mentioned gas abducting channel 20 at the gas abducting or inlet passage 19 would diminish and thereby the amount of abducted gas be automatically increased. On the other hand, if more gas withdrew through one of the gas abducting passages 19 than was collected in the chambers 22 and 23, then together with the gas also a considerable volume of steam would withdraw. Such increased flow would, however, increase the flow resistance at the narrow inlet passage 19 and, thereby, decrease the rate of flow. It is thus possible to employ a common single vacuum pump for serving all gas abducting channels 20.

FIG. 3 shows an exemplified embodiment of the heat exchanger apparatus according to the invention in the form of a surface condenser likewise used with steam turbines. Dead steam withdrawing from a steam turbine, not shown, enters the distribution chamber 2 provided in the upper portion of the condenser in the direction of the arrows 1. The cooling water required for precipitat-

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ing the steam flows through pipe conduits 28 and the steam precipitates also on the outer surface of the latter. The chamber occupied by the cooling water pipe conduits 28 is subdivided on the one hand by the longitudinal partition 11 and, on the other hand, by transversal partitions 14 into juxtaposed channels 31 and 32. All partitions extend from the bottom portion of the distribution chamber 2 below the water surface level 15 maintained in the bottom portion of the condenser. The water collected here withdraws through an outlet stub as indicated by the arrow 18. As shown in the drawing, the steam channels 31 and 32 are again open at the top. Partitions 29 disposed near the closed extremities of the steam channels 31 and 32 confine chambers 30 separated from other portions of the channels and penetrated likewise by pipe conduits 28 of cooling water. These are portions of the condenser where noncondensing gases collect. They are connected through gas inlet or gas abducting passages 19 with gas abducting channels 20 which extend through the whole length of the condenser as was the case with the previous embodiment.

Hereinbefore, a mixing condenser and a surface condenser have been described to show how to reliably abduct noncondensing gases therefrom. Obviously, any other type of steam heated heat exchangers may be built up in a like manner.

What we claim is:

1. A heavy duty condenser comprising, in combination, a casing enclosing a steam chamber between an inlet stub and an outlet stub, a distribution chamber in the upper portion of said casing and communicating with said inlet stub, a water chamber in the lower portion of said casing and communicating with said outlet stub, a plurality of longitudinal and transverse partitions extending from the side walls of said casing between said distribution chamber and said water chamber, each partition extending so as to reach below the surface of water permitted to collect in said water chamber but above the bottom wall of said casing, said partitions defining a plurality of steam channels, steam condensing means within each of said steam channels, and gas abducting channel means at the down stream extremities of and communicating through gas abducting passages with each of said steam channels said partitions preventing the passage of steam between said channels.

2. A heavy duty condenser as recited in claim 1, including water spray nozzles at the down stream extremities of each of said steam channels, the water spray nozzles associated with each of said channels being adapted to introduce cooling water in an amount proportional to the inlet cross-sectional area of its respective steam channel.

3. A heavy duty condenser as recited in claim 1, in-

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cluding water spray nozzles at the down stream extremities of each of said steam channel means, said water spray nozzles being arranged in front of said gas abducting passages.

4. A heavy duty condenser as recited in claim 3, including further partition means disposed within each of said channels to define an upwardly extending portion of each of said channels at the down stream extremity thereof, said water spray nozzles being disposed within said upwardly extending portion of said channels, said steam and gas remaining in said channel portion passing upwardly in counter-current to the cooling water from said nozzles toward said gas abducting passages.

5. A heavy duty condenser as recited in claim 4, including overlapping tray means disposed in said upwardly extending portion of each of said steam channel means, discharge areas remaining between said tray means and said partitions to permit a discharge of water from said tray means and the upward passage of remaining steam and gas.

6. A heavy duty condenser as recited in claim 5, wherein the cross sectional area of each of said discharge areas between said tray means and said partitions is at most one tenth of the cross sectional area of said steam channels.

7. A heavy duty condenser as recited in claim 1, wherein at least one of said partitions in each of said steam channels is at least in part obliquely oriented to contract each of said steam channels in a direction of steam flow.

8. A heavy duty condenser as recited in claim 1, wherein the inlet cross sectional area of each of said steam channels is larger than the cross sectional area of the respective gas abducting passage defining the outlet of said channel.

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