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METHOD FOR PURIFYING STEAM

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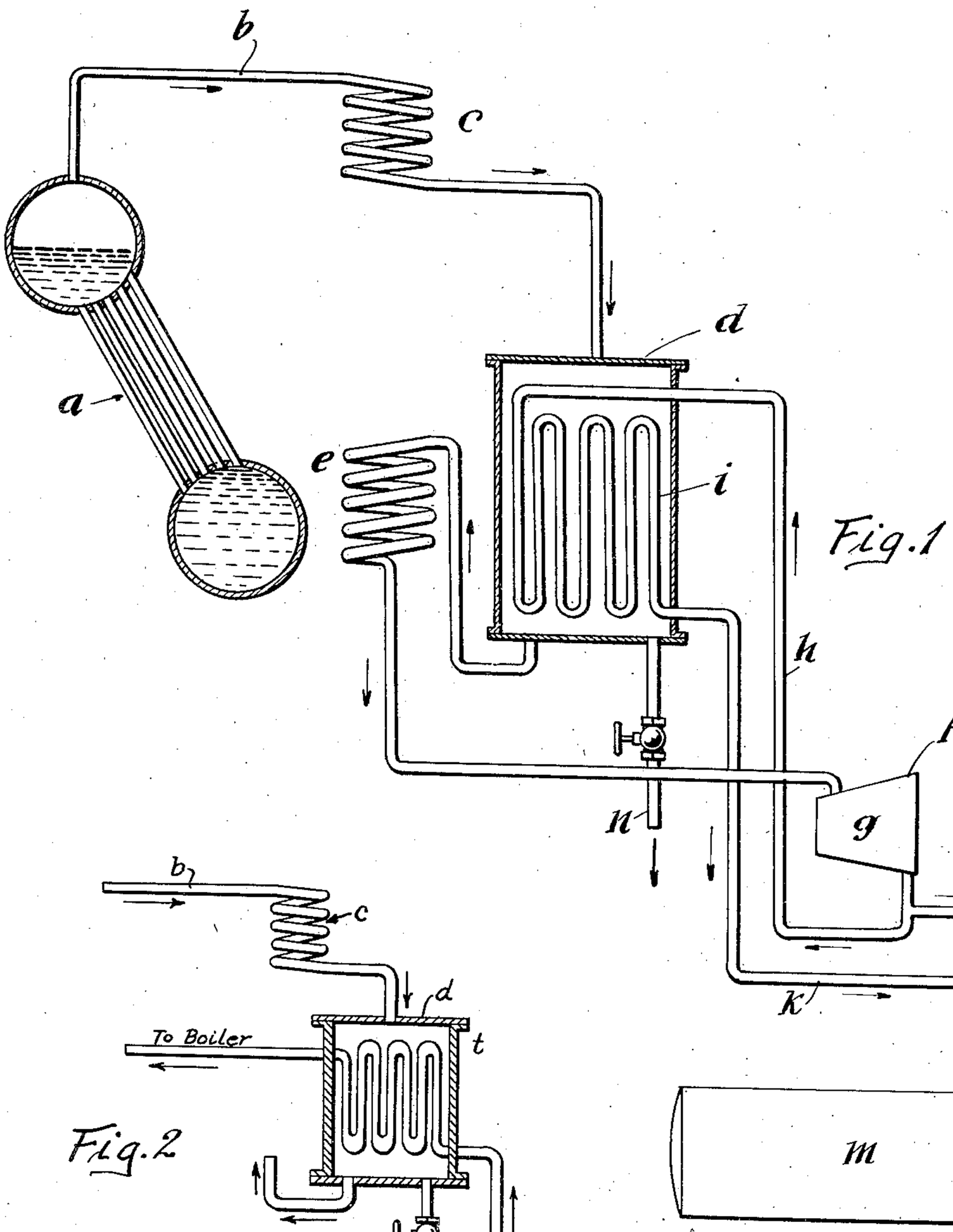

Fig. 1

Fig. 2

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METHOD FOR PURIFYING STEAM

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1 Claim. (Cl. 122—459)

In the operation of high pressure steam plants a difficulty has been found resulting from the fact that materials, particularly salts, contained in the boiler water are carried along by the steam as it is generated, such materials getting into the superheater, the steam line and the turbines and there form deposits. As is well known, when steam is generated, water in finely divided form is carried along. This moisture content of the steam contains solids in the form of minute particles held in suspension or in solution. These solids are removed from the steam by the removal of the moisture by means of a steam separator. In addition, however, there are in the steam other materials which assume a gaseous form in the steam boiler as the steam is generated. These materials, which are mainly salts, flow in the form of salt vapor or superheated gas to the prime mover together with the superheated steam and cannot be removed by a steam separator.

The operating steam for driving the prime mover is in other words, not pure water vapor but is a mixture of water vapor, and salt vapor or sublimates. The salts (sublimates) can be condensed and changed from their gaseous state to solid state by suitably cooling them. Such cooling to the point where they segregate out in solid form occurs ordinarily during the expansion of the steam in the turbine. During the flow of the steam through the blades and nozzles the salts are therefore deposited on these parts thereby cutting down the free cross area between blades and in the nozzles and interfering with the operation of the turbine.

Up to the present time operators have been forced when the efficiency of a turbine began to diminish from this cause, to take the turbine out of operation and to wash it out with clean distilled water, removing the salts (sublimates) which had become deposited.

Such a procedure is possible only where the turbine can be shut down at fairly short intervals. In many cases, e. g. in the case of power plants, however, turbines which are in service must be kept on the line from 6,000 to 8,000 hours without interruption.

Different means have been tried to remove these objectionable salts. It has been suggested, for example to send the saturated steam coming from the boiler through a steam washing device where such steam is washed with feed water on its way to the boiler which is substantially free of salts. Again steam separators have been used in connection with the boilers to reduce the amount of moisture contained in the steam to a fraction of one percent on the assumption that if the water content is small, the salts carried along must also be small in amount. These attempts, however, have not been completely successful.

It has also been proposed to remove the salts from the high pressure steam by cooling it again after it has been generated and superheated. For this purpose a nozzle or diffuser was provided forming a means for expanding and again compressing it, a separating device such as a groove with a collecting channel being provided between these two operations to catch and carry away the moisture and impurities separated out. The present invention also proposes to purify the high pressure steam by cooling it. In accordance with it, however, a non-contact heat exchanger is used in which the steam is cooled down so far by means of cooling surfaces that salts are deposited on the cooling surfaces. The temperature of these cooling surfaces is kept below that of saturated steam of the same pressure as the superheated high pressure steam being purified. The steam from which the salts have been removed is again superheated in a second superheater.

The salts in such a device are deposited in a form similar to ice crystals deposited in winter on free objects. For this purpose the velocity of flow must be relatively small, to allow the formation of the deposits of the salt particles (sublimates). Such action is easy to obtain in a surface heat exchanger in which the superheated steam is cooled, the velocities in such a device being low. In addition, such a surface heat interchanger readily accommodates means whereby salts which are deposited can be caught and removed.

In practicing the invention a suitable cooling medium for the heat exchanger is the interstage steam on its way from one expansion stage of the turbine to a lower pressure stage. The temperature of this steam will definitely be below the saturation temperature of the high pressure steam to be purified.

Another cooling medium that may be used is feedwater on its way to the boiler. In this case the water from the economizer is sent to the heat exchanger at a temperature also lower than the saturated temperature of the operating steam.

It is not necessary that all of the steam itself should be cooled down to the temperature at which the gaseous salts become deposited as solids. This deposit will occur even if the steam

remains of higher temperature provided the gaseous salts (sublimates) come into contact with the cooled surfaces.

Fig. 1 is a diagrammatic view of a steam plant embodying the present invention, and

Fig. 2 is a diagrammatic view illustrating a modification of part of the system.

A simple form of apparatus to carry out the invention is shown in the accompanying drawing. Here *a* is a high pressure boiler. The steam generated in this boiler flows through the pipe *b* to the first superheater *c* in which the entrained water and salts are completely vaporized. The mixture of superheated steam and sublimate is then led to the heat interchanger *d* in which the superheated steam is cooled by coming into contact with the surfaces *i* which are kept cool by means of interstage steam from the turbine *g*. The purified steam is taken from the heat interchanger and carried to the secondary superheater *e* where it is brought up again to the desired superheat temperature for use in the high pressure stage of the two-stage turbine.

The exhaust steam from the high pressure stage is conveyed through pipe *h* to cool the surfaces of the heat exchanger and is then carried through the pipe *k* to the second stage *l*. The exhaust from this second stage is then carried to the condenser *m*.

As illustrated in Fig. 2 the feed water on its way to the boiler is employed as the cooling medium in the heat interchanger *d*. The feed water forced through line *p* and heated in the economizer *s* of the boiler passes through the coils *t* of the heat interchanger and is then directed to the boiler through the line *u*.

The salt (sublimate) deposited on the cooled surfaces of the heat exchanger is removed at intervals preferably by permitting saturated steam to condense on the cooling surfaces the resulting condensate dissolving and washing off the deposited salts. The dissolved salts can then be removed from the heat exchanger through the drain *n*.

What we claim is:

The process of purifying superheated high pressure steam containing salts in gaseous form coming from a boiler comprising the steps of causing the steam to flow in contact with one side of a wall of heat conductive material, cooling the wall by causing a fluid to flow in contact with the other side of the wall of a temperature and in quantity sufficient to keep said wall at a temperature below that of saturated steam of the same pressure as the superheated steam, whereby the salts are deposited in solid form on said first side of the wall, and periodically washing said deposits off, the said periodic washing being effected by bringing saturated steam from the boiler into contact with the first side of the wall and permitting it to condense to form the water to wash off the salts.

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