June 4, 1929. R. C. JONES 1,715,456

MULTISTAGE OPEN HEATER

Original Filed July 28, 1924 2 Sheets-Sheet 1

Fig. 1.

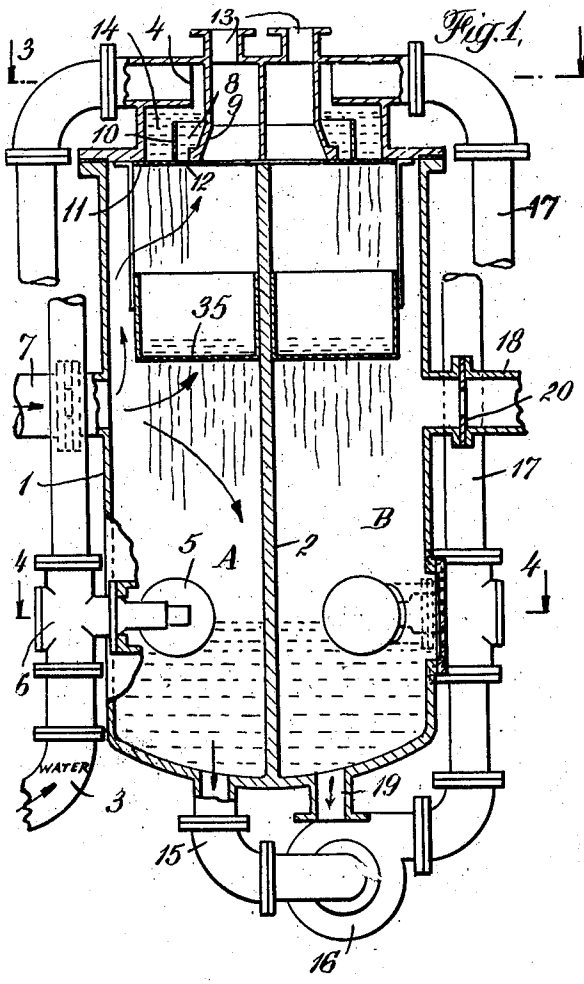


Fig. 2.

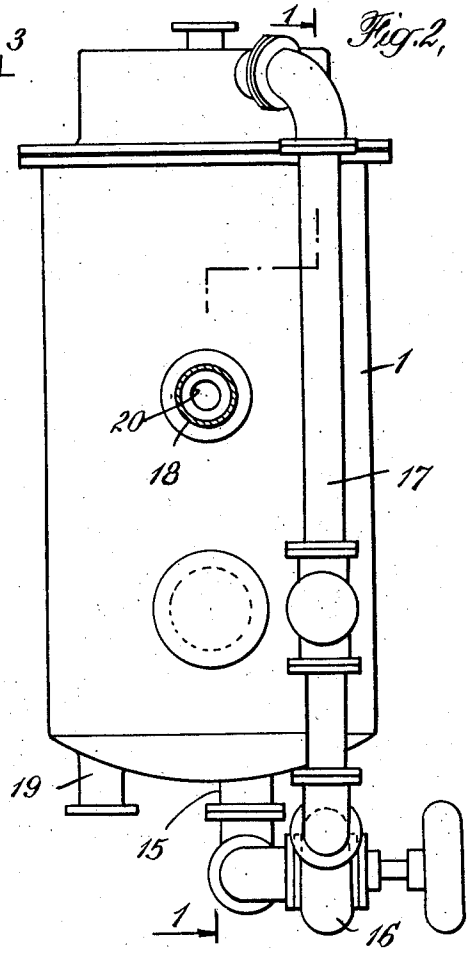


Fig. 3.

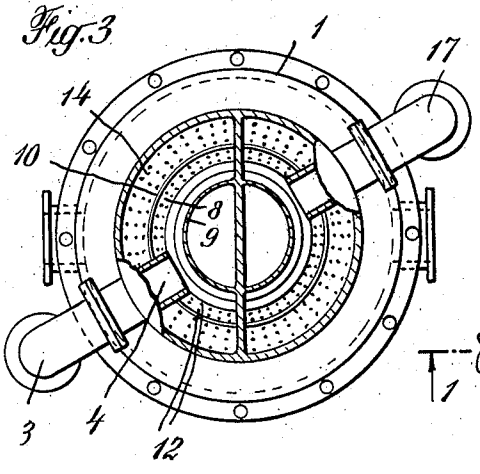
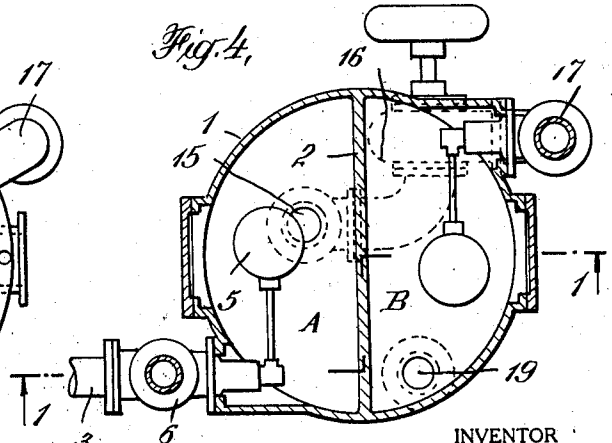


Fig. 4.



INVENTOR
Russell C. Jones
BY
Dennis Davis Marvin & Edmonds
ATTORNEY

June 4, 1929. R. C. JONES 1,715,456

MULTISTAGE OPEN HEATER

Original Filed July 28, 1924 2 Sheets-Sheet 2

Fig. 5,

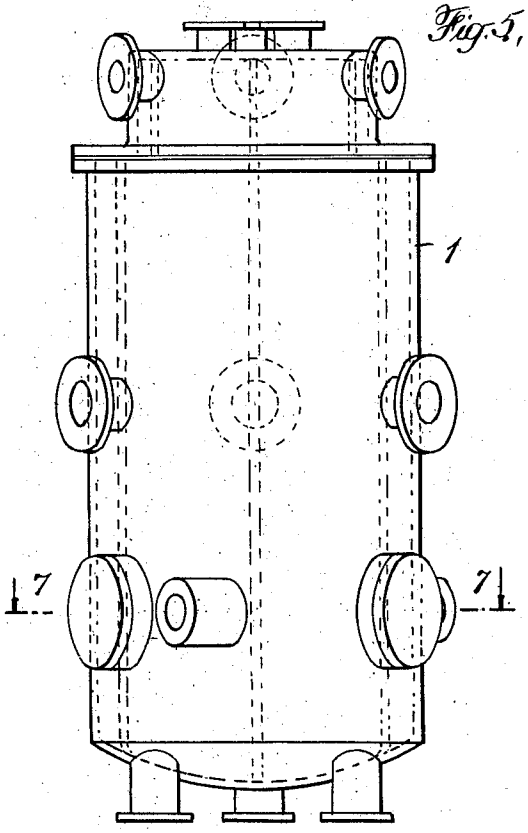


Fig. 6,

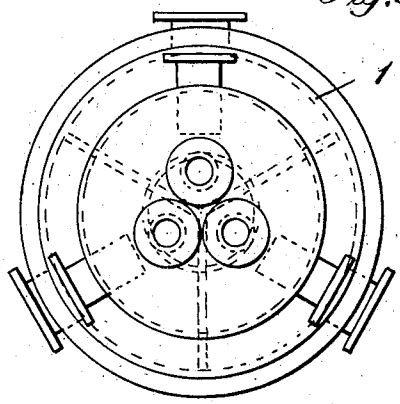
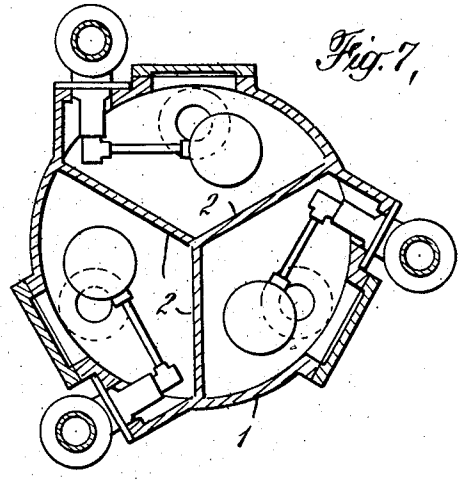


Fig. 7,



INVENTOR
Russell C. Jones
BY
Dennis Davis Marinelli & Edwards
ATTORNEY

Patented June 4, 1929. 1,715,456

UNITED STATES PATENT OFFICE.

RUSSELL C. JONES, OF BRONXVILLE, NEW YORK, ASSIGNOR TO THE GRISCOM-RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

MULTISTAGE OPEN HEATER.

Application filed July 28, 1924, Serial No. 728,654. Renewed September 17, 1928.

The present invention relates to a steam generating system and has to do particularly with the preliminary heating of feed water on its way to the boilers.

The auxiliary apparatus and other steam utilizing devices of a power generating plant invariably furnish a considerable quantity of relatively low pressure steam which must be utilized in the system in order to avoid heat losses. This quantity of steam is usually accommodated by passing it into heat transferring relation with the boiler feed water, thus imparting to the feed water before it enters the boiler heat which would be lost if the heating fluid were discharged to waste.

Modern steam power plant practice tends toward the use in the heating of boiler feed water of both exhaust steam from the various apparatus of the plant and steam withdrawn or "bled" at different pressures from various stages of the plant turbine. According to the common prevailing practice, each of the different sources of steam is passed independently into heat exchanging relation with the boiler feed water. The boiler feed water is passed into heat transferring relation with the respective sources of heating steam in the order of their ascending pressures and temperatures, that is, the feed water first receives heat from the source of steam at the lowest pressure and is successively treated by the other sources of steam at successively higher pressures. Each operation of transferring heat between the heating steam and the boiler feed water is conducted as an independent operation in a separate surface type heat exchanger provided for the purpose.

It is an object of this invention to provide a heater for preheating the boiler feed water which is adapted to receive steam from the plant turbine, or other sources, at different pressures and utilize to advantage the available heat of such steam, yet which involves but a single unitary apparatus possessing the distinct advantages of moderate initial cost, minimum space requirements, notable operating efficiency and convenience of operation.

In steam generating systems of the type referred to the supply of boiler feed water commonly consists of low temperature turbine condensate together with whatever water from the evaporators is necessary to supply the required make-up of the system. The heating steam is commonly exhaust steam from steam engines or steam "bled" from one or more stages of a turbine. Due to the fact that neither the boiler feed water nor the supply of heating fluid contains objectionable impurities, it is permissible to mix these fluids and the present invention contemplates a heat exchange between the respective fluids accomplished by actually intermixing the fluids and thus effecting the heat transfer by direct contact of the fluids.

The invention contemplates the provision of a plurality of compartments in the open heater. The heating fluids from the several sources are admitted to the respective compartments at their respective pressures and suitable provision is made for passing the boiler feed water thru the respective compartments in series relation. The fluid which is pumped from each compartment to the next succeeding compartment consists of the fluid which was initially admitted to the compartment and in addition the condensate produced by the heating steam which was admitted to that compartment and which was condensed by reason of its contact with the cold feed water.

It is an object of the invention to arrange the various chambers or compartments in which the heat transfer takes place in such fashion that the apparatus has a marked flexibility of design, thus adapting it for incorporation into whatever space is available, and in such fashion that transfer of fluid from one chamber to the next may be conveniently and effectively accomplished. In carrying out this idea, the compartments are arranged at the same height, so that the number of compartments may be increased by increasing the lateral dimension, for instance the diameter, of the heater.

It is a still further object of the invention to provide a multi-stage open heater of the class referred to of such construction that danger of water from the heater backing up into the turbine or other apparatus where it would cause damage is effectively avoided. To this end the liquid in each of the heat transferring chambers is introduced at substantially the pressure of the incoming heating steam. As a further precaution, one embodiment of the invention contemplates an overflow control adapted to discharge water from each chamber into the next lower chamber in case an excessive amount of liquid accumulates.

By way of example I have illustrated in the accompanying drawings an apparatus embodying my invention. In said drawings:

Fig. 1 is a vertical section of a feed water heater embodying my invention;

Fig. 2 is an elevation taken at right angles to the view shown in Fig. 1;

Figs. 3 and 4 are transverse sections taken respectively on line 3—3 and line 4—4 of Fig. 1;

Fig. 5 is an elevation of a modified form of heater;

Fig. 6 is a top view of the modification shown in Fig. 5; and

Fig. 7 is a transverse section taken on line 7—7 of Fig. 5.

Referring to the drawings, 1 indicates the containing shell or housing of the heater and 2 is a vertical partition placed diametrically of the shell to divide the heater into two compartments A and B. The boiler feed water is admitted through the feed line 3 and is discharged into the upper end of compartment A through the inlet 4 from whence it finds its way down through the apparatus and accumulates in the bottom of the compartment. A float 5 operating a valve 6 in the feed line 3 regulates for a substantially constant liquid level in the compartment A. Heating steam is admitted through the inlet line 7 and circulates about freely within the compartment A coming into direct contact with the cold incoming feed water to thereby impart its available heat to the feed water and at the same time be condensed and mingled with the feed water in the form of liquid condensate.

In order to facilitate the intermixture of the heating steam and the feed water and to accomplish an efficient and effective heat transfer between the two mediums, special provision is made for distributing the incoming liquid throughout the compartment. The incoming water entering through the inlet 4 falls into a compartment 8 formed between the wall 9 of the air vent passage 13 provided on the apparatus and a semi-cylindrical vertical partition 10. The bottom of the chamber 8 consists of a portion of a flat perforated plate 11 which extends across the top of the heater. One or two rows of perforations 12 are provided at the bottom of the chamber 8, so that the water from the chamber will pass down into the lower part of the compartment A in the form of a curtain of falling rain having a semi-cylindrical conformation and interposing a sheet of liquid between the steam inlet 7 and the air vent 13 thus making it impossible for steam to escape through the vent 13 without first passing into intimate contact with the incoming liquid.

The overflow from chamber 8 is accommodated in a chamber 14 formed between the annular partition 10 and the outer wall of the shell 1. The bottom of chamber 14 is also perforated to discharge liquid down into compartment A as a curtain of falling rain and it is from chamber 14 that the greater portion of the liquid will ordinarily be discharged. The smaller chamber 8 is provided particularly for operation at light loads to insure a complete curtain of falling liquid through which the heating steam must pass before it can escape from the heater. At light loads, if the annular partition 10 were not employed and the incoming liquid were not discharged into the chamber 8, the incoming liquid might have some tendency to spread out in a layer on plate 11, but most of the liquid would pass through the plate at a point substantially beneath the inlet 4 and the supply of incoming water would not be sufficient to form a closed curtain of falling drops extending entirely around the chamber and thus presenting a solid curtain of water with which the heating steam must contact.

With this situation, it would be possible for steam to find its way through the gaps in the curtain of falling liquid and escape uncondensed through the outlet 13. A perforated distributing plate 35 may be provided to check the falling liquid and redistribute it before permitting it to pass on to the principal body of liquid in the lower portion of the compartment. The steam entering at the inlet 7 circulates about as indicated by the arrows coming into intimate contact with the falling liquid until it is completely condensed. Uncondensible vapors rise to the top of the shell and find their way out at the vent 13.

The boiler feed water is passed successively through compartments A and B. The feed water entering compartment A is heated by reason of the heating steam supplied to that compartment and this heated water, together with the condensed heating steam formed in the compartment which has become intermixed with the original supply of feed water, is withdrawn at the bottom of the compartment A through the discharge line 15 and by means of a suitable pump 16 is passed through line 17 into the upper end of compartment B in the same fashion as in compartment A. Heating steam for compartment B is admitted through inlet line 18 and imparts its available heat to the supply of partially heated liquid entering from compartment A. In compartment B the feed water is further heated and is augmented by the condensate derived from the heating steam supplied to this compartment. The liquid, consisting of feed water and commingled condensate, is discharged from compartment B through an outlet 19 from whence it is passed to the boilers.

The heating steam supplied to the respective compartments A and B is derived from independent sources usually at different pressures. For instance, in modern steam plants where bleeder steam from one or more stages of

the main turbine is used for heating the boiler feed water, the feed water may be heated successively by steam at atmospheric pressure from the exhaust steam line of the plant and by bleeder steam from the turbine at some other pressure, say, at 30 lbs. per square inch absolute. In this instance, the steam at atmospheric pressure would be admitted to compartment A and the heated feed water from compartment A together with the condensed exhaust steam would then be transferred into compartment B, which compartment would receive the bleeder steam at 30 lbs. per square inch pressure. The compartments A and B are maintained respectively at substantially the pressures of the respective sources of heating steam. The pump 16 serves to transfer the water from the lower to the higher pressure. By thus maintaining each compartment of the heater at substantially the pressure of the incoming heating steam, danger of backing up of the water into the turbine or other apparatus furnishing the heating steam is avoided. In bleeder steam heaters commonly in use at the present time, the heating steam is ordinarily passed inside the heating tubes and the water surrounds the tubes at a much higher pressure than is maintained inside the tubes. With this situation, a leaky tube may readily result in the discharge of a large quantity of high pressure water into the steam space, with the result that the water will back up into the turbine and probably cause serious damage to the turbine rotor.

For the purpose of controlling the supply of steam admitted to the respective compartments of the heater, an orifice may be successfully used. I have here shown an orifice plate so interposed in the heating steam line at the point where the heating steam enters the heater. The orifice plate is inserted at a joint in the piping and contains a circular orifice of predetermined size adapted to deliver the proper amount of steam into the heater. The pressures of the respective supplies of heating steam remain substantially constant and, with this condition, a constant flow of heating steam into the respective compartments will be maintained by means of the controlling orifice. It will be understood, however, that the orifice control is merely a matter of convenience and is not essential to the operation of the device.

The apparatus shown in Figures 5 to 7 is provided with three compartments separated by vertical partitions 2 extending the length of the shell 1. Cold liquid and heating steam at different pressures are admitted to the various compartments in the same fashion as above described and float controlled valves are provided for maintaining a substantially constant liquid level in each compartment. The feed water is preferably pumped through the three compartments in succession, the liquid leaving each compartment being augmented by the condensate formed from the heating steam admitted to that compartment.

While preferred embodiments of my apparatus have been illustrated and described above, certain structural changes may be made and certain variations in the steam generating system may be effected. For instance, the heater of the present application accomplishes a considerable amount of deaeration of the boiler feed water, but the heater may readily be employed in combination with any of the different types of deaerators at present in use. While the heating steam employed is ordinarily free from impurities, suitable provision may be made for separating oil from the steam or water from low pressure steam before admission to the heater if desired. Other changes may be made within the scope of the appended claims.

I claim:

1. In a steam generating system, a heater for heating boiler feed water comprising a vertical cylindrical tank sub-divided vertically by partitions into a plurality of compartments, means for supplying heating steam at progressively higher pressures to said respective compartments, and means for passing boiler feed water successively through said compartments, and a cap for the upper end of said tank having vertical partitions corresponding in position to the partitions in said tank, and forming compartments in said cap corresponding to the compartments of the tank, each of said compartments having an outlet for uncondensible gases and an inlet for water to be heated surrounding said gas outlet, and means associated with each of said water inlets for distributing the incoming water in a curtain of spray surrounding the gas outlet.

2. In a steam generating system, a heater for heating boiler feed water comprising a vertical cylindrical tank subdivided vertically by partitions into a plurality of compartments, means for supplying heating steam at progressively higher pressures to said respective compartments, a cap for the upper end of said tank having vertical partitions corresponding in position to the partitions in said tank and forming compartments in said cap corresponding to the compartments of the tank, each of said compartments having an outlet for uncondensible gases and an inlet for water to be heated surrounding said gas outlet, means associated with each of said water inlets for distributing the incoming water in a curtain of spray surrounding the gas outlet, water outlet connections for the compartments of said tank, water inlet connections for the compartments of the cap, and an external pipe joining one of said outlet connections with one of said inlet connections, and means therein for increasing the

pressure on the boiler feed water to substantially that of the higher pressure of the next compartment.

3. In a steam generating system, a heater for heating boiler feed water comprising a vertical cylindrical tank subdivided vertically by partitions into a plurality of compartments, means for supplying heating steam at progressively higher pressures to said respective compartments, and means for passing boiler feed water successively through said compartments, each of said compartments having an outlet near the top thereof for uncondensible gases and an inlet for water to be heated surrounding said gas outlet, and means associated with each of said water inlets for distributing the incoming water in a curtain of spray surrounding the gas outlet.

4. In a steam generating system, a heater for heating boiler feed water comprising a vertical cylindrical tank subdivided vertically by partitions into a plurality of compartments, means for supplying heating steam at progressively higher pressures to said respective compartments, each of said compartments having an outlet near the top thereof for uncondensible gases and an inlet for water to be heated surrounding said gas outlet, means associated with each of said water inlets for distributing the incoming water in a curtain of spray surrounding the gas outlet, and means comprising a series-flow external pipe arranged between two of said compartments which are at progressively higher pressures, and means therein for increasing the pressure on the boiler feed water to substantially the pressure of the compartment having the higher pressure.

5. In a steam generating system, a heater for heating boiler feed water comprising a vertical cylindrical tank subdivided vertically by partitions into a plurality of compartments, means for supplying heating steam at progressively higher pressures to said respective compartments, each of said compartments having an outlet near the top thereof for uncondensible gases and an inlet for water to be heated surrounding said gas outlet, means associated with each of said water inlets for distributing the incoming water in a curtain of spray surrounding the gas outlet, and means comprising a series-flow external pipe arranged between two of said compartments which are at progressively higher pressures, and a pump therein for increasing the pressure on the boiler feed water to substantially the pressure of the compartment having the higher pressure.

In testimony whereof I affix my signature.

RUSSELL C. JONES.