1,400,935. S. BROWN, HIGH HEAT LEVEL EVAPORATOR SYSTEM. PATENTED DEC. 20, 1921.

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Inventor

By his Attorneys
Cenno, Davis, Marvin, Edmonds
To all whom it may concern:

Be it known that I, STANLEY BROWN, a citizen of the United States, residing at Garden City, in the county of Nassau, State of New York, have invented certain new and useful Improvements in High-Heat-Level Evaporator Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

This invention relates to improvements in evaporator systems of the character employed principally for furnishing pure water for boiler feeds and in central stations, industrial plants, on ships, etc., wherever steam power in large quantity is used.

Where steam power in any quantity is generated, particularly where large steam engines are employed, it is the practice to return the condensed steam from the condenser or engines to the boiler feed, the boilers and engines forming a closed circuit in which the water is repeatedly used. There are, however, losses incidental to the apparatus, due not only to the losses from leakage, etc., but to the use of the steam from the main boilers for running auxiliary apparatus which cannot entirely be returned to the system, or for heating water for industrial plants or similar purposes, and this loss is made up by the distillation of "raw water" in order that no scale-forming or injurious impurities be carried into the boilers.

This additional water to maintain the desired quantity for the boiler feed is usually supplied by evaporators in which the heating medium is steam from the main boilers, and it will be readily understood that if the quantity of water to be made up is any material per cent. of the boiler capacity, the heat losses incidental to vaporizing such a quantity of water will very materially reduce the efficiency of the power plant as a whole unless proper provision is made to return to the system the heat diverted to the evaporator system.

It has heretofore been proposed to condense the vapor from the evaporators in feed water heaters for the boiler feed, thereby conserving the latent heat of vaporization, but in power plants utilizing high pressure steam and high pressure evaporators the condensed vapor from the evaporators and the condensed steam from the evaporator coils are at high temperature and hence contain a large quantity of sensible heat the loss of which would materially lower the efficiency of the plant as a whole if wasted. To avoid this it has been proposed to deliver all the condensed vapor and steam from the evaporator and its coils and other apparatus from which the exhaust is returnable, along with the condensed steam from the engines to a common "open heater" where the heat from the high pressure apparatus, as well as the auxiliary exhaust steam, will be absorbed by the water at lower temperatures from the main engines. In some instances this arrangement is satisfactory, but in many installations the resultant temperature from mixing the returns from the several apparatus raises the temperature of the open heater above atmospheric boiling point so that the ordinary open heater cannot be used.

It has also been proposed to utilize the condensed steam from the evaporator coils in the feed water heater which serves as a condenser for the vapor from the evaporator, but this practice also has disadvantages as it raises the temperature of the vapor from the evaporator and hence decreases the temperature difference between the evaporator coils and the water in the evaporator shell, lowering the output of the evaporator or necessitating a greater coil surface for the same output.

By means of my present invention I utilize the heat in the coil drains and also from the condensed vapor without carrying the temperature of the open heater above atmospheric boiling point, and also without loss of efficiency in the evaporators.

My invention also has the advantage of adding little in the way of additional apparatus to the necessary units for a power plant evaporator installation.

The accompanying drawings illustrate diagrammatically typical power plant installations. Figures 1 and 2 of the drawings showing somewhat different modifications of my invention applied thereto.

Referring to Fig. 1 of the drawings, 1 indicates the first effect of the evaporator plant which utilizes as its heating medium live steam from the main boilers. The second effect of the evaporator, which is indicated...
at 2, utilizes the vapor from the first effect as its heating medium, and should therefore be operated at a temperature sufficiently lower than the temperature of the first effect for efficient operation of the first effect. The vapor from the second effect passes through the line 3 to the condenser 4 where it is condensed by the boiler feed pumped from the open heater 6 by the pump 7, the condensed vapor being delivered to the open heater 6 through pipes 5 and trap 11.

To allow a sufficient temperature difference in the second effect for efficient operation the back pressure on the vapor line 3 must obviously be kept low enough to maintain the second effect at a still lower operating temperature and with a corresponding reduction in temperature for each effect employed, so that where several effects are employed the vapor from the last effect will be at a much lower temperature than the condensate from the evaporator coils. If the make-up required from the evaporators is any material per cent. of the boiler feed the heat from the evaporator coils, or "coil drains," cannot be conserved in the condenser 4 without raising the temperature of the condenser to a point such that the necessary temperature difference for economical operation between the coils and liquid in the evaporator cannot be maintained.

To obviate this difficulty and at the same time avoid overheating the plant open heater which should be kept at a temperature not above 212 degrees, I take advantage of the difference in temperature between the "coil drains" and the vapor from the second effect by providing a separate feed water heater, marked 8 in Fig. 1, connected to the boiler feed line between the heater 4 and the boiler in which the "coil drains" constitute the heating medium. Any suitable form of heat exchanger may be employed and the drawing is not intended to indicate any particular type of apparatus.

In the installation shown, the drains from the feed heater 8 are delivered to the condenser 4 through a trap 9. After passing through the heater 8, however, the temperature of the coil drains is so reduced as not to contribute sufficient heat to produce any material back pressure on the vapor line from the final effect of the evaporator.

No particular regulating apparatus is required to maintain the necessary temperature differences in the several apparatus for efficient operation. The usual steam traps 10 will be installed in the line carrying the coil drains to hold the separate effects at their respective pressures, notwithstanding the delivery of the drains to the common heater, while the trap 11 will insure the condensation of all the vapor in the condenser 4.

In Fig. 2 I have shown a somewhat different arrangement of apparatus for accomplishing the same results. As here shown, I employ a condenser for the second feed heater and deliver to it only a portion of the coil drains in the form of steam or "flash" vaporized by a portion of the contained heat in the coil drains. Also, the condensate from the second feed heater is not passed through the first heater, i.e., the main condenser 4 but a portion of it, determined by the difference in working pressures of the two condensers, is allowed to "flash" into vapor which is condensed with the vapor from the last effect evaporator in the condenser 4.

Referring to Fig. 2, it will be noted that the coil drains from the two effects of the evaporator plant are delivered to a common pipe 12 from which a riser or flash line 13 passes to the second feed heating condenser 8', a trap 14 being set in the pipe 12 beyond the riser. The connection of the riser 13 with the condenser serves to relieve the pressure on the liquid with the result that a portion of the liquid flowing in the pipe 12 is "flashed" into vapor by the contained heat. That is, the heat represented by the difference in temperature between the liquid in the pipe 12 and the temperature corresponding to the working pressure of the condenser 8" is converted into latent heat, and the temperature of the drains in the pipe 12 correspondingly reduced. The condensate is returned from the condenser 8' through a trap 20 and a pipe 15 to the main pipe 12 at the other side of the trap 14, and beyond the pipe 15 a riser 16 leads to the vapor line from the second effect so that a second portion of the coil drains may flash into vapor to condense in condenser 4 with a reduction of the temperature of the remaining liquid which is delivered through a trap 17 to the plant open heater, at substantially the same temperature as the condensate from the condenser 4. By the arrangement shown in Fig. 2, the feed heaters 8" and 4 receive only vapor from the evaporator system, and will consequently be smaller and more efficient than when the entire returns are passed through them as in Fig. 1.

The traps interposed at different points in the common drain line 12 automatically maintain pressures harmonious to the working pressures of the auxiliary feed water heater 8' and main heater 4, respectively, which operating temperatures may vary with the operating conditions without necessitating any adjustment whatsoever of the system. Only so much of the fluid from the coil drains will flash to the feed water heaters as can be condensed therein at the temperature conditions existing at any moment of operation. All the heat which can be economically extracted from the coil drains will thus be absorbed in the feed water heaters without auxiliary apparatus except the
necessary piping and traps. Hand operated valves could replace the traps but the operation would cease to be automatic.

Variations in installation will be made in accordance with the particular conditions to be met with, the basic idea of my invention being the utilization in a separate unit between the main feed water heater and vapor condenser heretofore used and the boilers, of the heat from the coil drains from the evaporators which are at an efficient temperature difference over the feed water previously heated in the main heater to thereby avoid back pressure on the main condenser with a relative reduction of the temperature differences in the evaporator units.

I claim:

1. In a boiler feed system, the combination of a feed water heater, an evaporator plant, connections from the vapor line of the evaporator plant to the feed water heater whereby the heater serves as a condenser for the vapor, and a second feed water heater arranged to further heat the feed water, and connections from the heating chamber of the evaporator to said second heater whereby the drains from the evaporator heating space serve as the heating medium for the second heater.

2. In a boiler feed system, the combination of a feed water heater, an evaporator plant, connections from the vapor line of the evaporator plant to the feed water heater whereby the heater serves as a condenser for the vapor and a second feed water heater arranged to further heat the feed water, connections from the heating chamber of the evaporator to said second heater whereby the drains from the evaporator heating space serve as the heating medium for the second heater.

3. In a boiler plant system, the combination of a feed water heater for the boiler, an evaporator plant, connections from the vapor line of the evaporator plant to the feed water heater whereby the vapor from the evaporator serves as the heating medium for the feed water heater, a second feed water heater arranged in series with the first heater to further heat the feed water, means for receiving the condensed steam from the evaporator heating passages and causing a portion of it to be vaporized by its contained heat, connections whereby such vapor is conveyed to said second feed water heater and forms the heating medium therefor, means for causing a further portion of said evaporator drains to be vaporized by its contained heat upon a further reduction in temperature, and connections for causing said second vaporized portion to be condensed in said first mentioned feed water heater.

4. In a boiler plant system the combination of a feed water heater for the boiler, an evaporator plant, connections from the vapor line of the evaporator plant to the feed water heater whereby the vapor from the evaporator serves as the heating medium for the feed water heater, a second feed water heater arranged in series with the first heater to further heat the feed water, means for receiving the condensed steam from the evaporator heating passages and causing a portion of it to be vaporized by its contained heat, connections whereby such vapor is conveyed to said second feed water heater and forms the heating medium therefor, means for collecting the re-condensed vapor from said second feed water heater and causing a further vaporization of a portion thereof upon a further reduction in temperature, and means for condensing said second vaporized portion in said first feed water heater.

5. In an evaporator system, an evaporator, a drain pipe for the condensed vapor from the heating chamber of the evaporator, a condensing heater and means for vaporizing a portion of the condensed steam in said pipe to be vaporized by its contained heat, means for causing a further portion of said drains to be vaporized by a portion of its contained heat and means for conducting such vapor to said condensing heater to thereby conserve the heat therein.

6. In an evaporator system, an evaporator, a drain pipe for the condensed steam from the heating chamber of the evaporator, a condensing heater, means for causing a portion of the condensed steam in said drain pipe to be vaporized by the contained heat thereof, and means for conducting the re-vaporized steam to said heater, a second condensing heater, means for causing a further portion of said drains to be vaporized, on a further reduction in temperature, and means for conducting said secondly vaporized portion to said second heater to be condensed.

7. In an evaporator system, an evaporator, a drain pipe for the condensed steam from the heating chamber of the evaporator, a condensing heater, means for causing a portion of the condensed steam in said drain pipe to be vaporized by the contained heat thereof, and means for conducting the re-vaporized steam to said heater, a second condensing heater, means for causing a further portion of said drains to be vaporized, on a further reduction in temperature, and means for conducting said secondly vaporized portion to said second heater to be condensed.
heat therein, and means for conducting the vapor from the evaporator to said heater to be condensed.

9. In an evaporator system, an evaporator, a drain pipe for the condensed steam from the heating passages of said evaporator, a trap in said pipe, a second trap in said pipe, a condensing heater for condensing the vapor from said evaporator and a connection from said pipe between said traps to the vapor space of said condenser whereby a portion of said condensed steam will be re-vaporized by the contained heat of said condensate and will be re-condensed in said condensing heater.

10. In an evaporator system, an evaporator, a drain pipe for the condensed steam from the heating passages of said evaporator, a trap in said pipe, a second trap in said pipe, a condensing heater, a connection from said pipes between said traps to the vapor space of said heater, a third trap, a condensing heater for condensing the vapor from said evaporator and a connection from said pipe between said second and third traps to the vapor space of said condenser whereby portions of said condensed steam will be re-vaporized by the contained heat of said condensate and will be re-condensed in said condensing heaters.

In testimony whereof I affix my signature.

STANLEY BROWN.