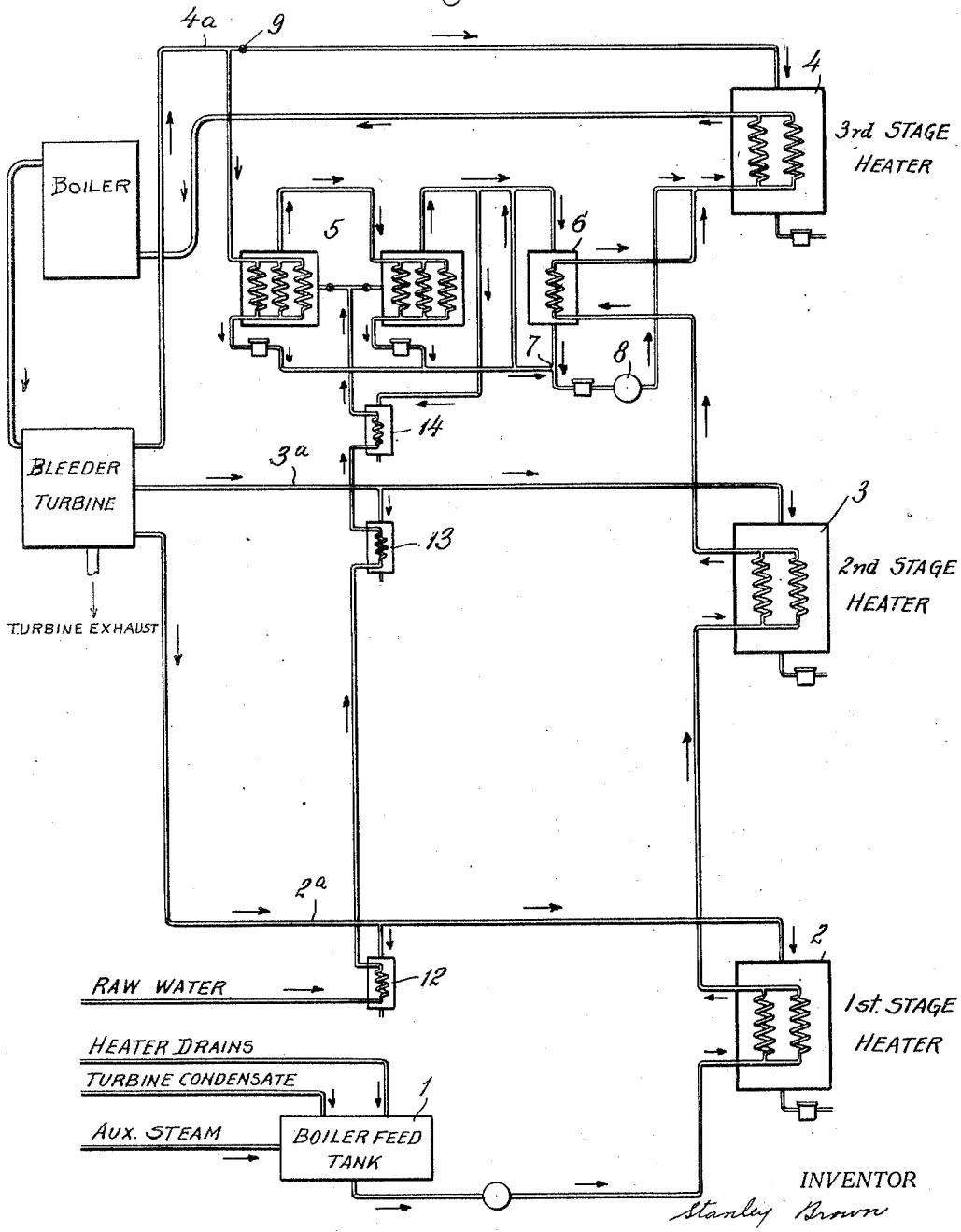
Feb. 23, 1932. S. BROWN 1,846,047

EVAPORATOR SYSTEM

Filed May 14, 1925 2 Sheets-Sheet 1

Fig. 1.



INVENTOR
Stanley Brown

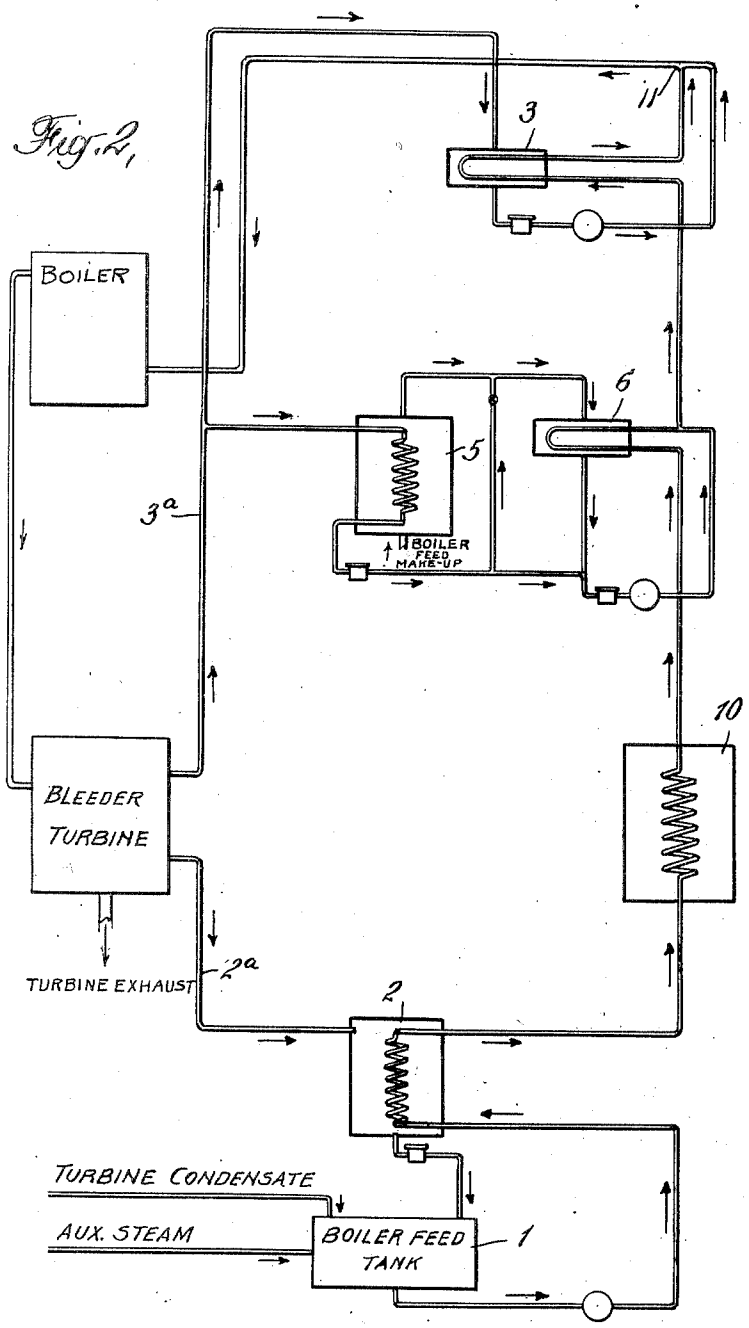
BY
Pennie, Davis, Marvin & Edmonds
ATTORNEY

Feb. 23, 1932. S. BROWN 1,846,047

EVAPORATOR SYSTEM

Filed May 14, 1925 2 Sheets-Sheet 2

Fig. 2.



INVENTOR
Stanley Brown

BY
Pennie, Davis, Marvin & Edmonds
ATTORNEY

Patented Feb. 23, 1932 1,846,047

UNITED STATES PATENT OFFICE

STANLEY BROWN, OF GARDEN CITY, NEW YORK, ASSIGNOR TO THE GRISCOM RUSSELL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

EVAPORATOR SYSTEM

Application filed May 14, 1925. Serial No. 30,194.

The present invention relates to steam power systems applicable to central stations, industrial plants, marine installations, or the like, wherever steam for power is to be used in considerable quantities, and has to do particularly with a method of introducing into such a system an evaporator unit for the purpose of supplying purified boiler feed make up to the system.

In modern steam systems much attention has been given to the efficient utilization of the various returns from the auxiliary apparatus and other steam utilizing units of the system. The available heat in the various returns is usually transferred insofar as is possible to the boiler feed water and thus serves to preheat the water before admission to the main boilers. Frequently the steam available for preheating the boiler feed occurs at two or more different conditions of pressure and temperature, and accordingly it has been proposed to transfer independently to the boiler feed water the heat from these various sources of steam at substantially the respective pressures and temperatures of the steam sources. A plant laid out along these lines comprises two or more heat transferring elements operating at different pressures, the boiler feed water passing successively through these heaters as condensers from the lowest pressure to the highest. The circuit between the steam generating system and the steam utilizing apparatus of the plant is a closed circuit and it is the intent of such a system to repeatedly return to the boiler all of the fluid medium which is supplied to the steam utilizing apparatus of the plant. There are, however, certain unavoidable losses due to leakage and the like, and these losses must be made up by supplying to the boiler a corresponding additional quantity of feed. This purified make up water is commonly derived from one or more evaporators employed to distill over the raw water supplied to the system in order that the make up as conducted into the boilers will be substantially free from scale forming impurities. The available heat in the vapor output and the drains from the heating coils of the evaporator should, of course, be accommodated in the system.

Many of the latest steam power stations are equipped with so-called "bleeder" turbines, which turbines are equipped to deliver at two or more stages partially used steam for the purpose of heating the boiler feed water at successive steps at the proper pressure and temperature conditions. The bleeder type turbine is commonly the principal power developing unit of the plant and receives its steam supply at a relatively high initial pressure. The turbine is so designed as to operate most efficiently when a certain amount of steam is tapped off or "bled" from certain designated stages of the turbine. In case the steam taken from any bleeder stage of the turbine is materially lesser or greater in amount than that for which the turbine is designed, a corresponding loss in power will be experienced. For instance, if say from one of the higher pressure stages of the turbine an insufficient amount of bleeder steam is withdrawn the portion which should have been withdrawn passes on through the next lower stages of the turbine and of course gives up a certain increment of power to the turbine wheel, but at the same time produces an excess of steam in the successive stages of the turbine and correspondingly reduces the efficiency of its operation.

It is a principal object of this invention to provide a steam power system wherein the steam available at various pressures for preheating the boiler feed water, and also the various heat returns from the system, may be employed to give up to the boiler feed whatever available heat they possess in such manner as to utilize all of the available energy to the best advantage.

It is also an object to provide a system of this class employing as heating medium for the boiler feed predetermined quantities of steam at different pressures, which system provides for the introduction of evaporators without affecting the operation of the system or necessitating any portion of the available steam or of the heat returns from the evaporators to be disadvantageously used.

It is a further object to provide a system

of the class described which is particularly adapted to installations employing a bleeder turbine designed to deliver predetermined quantities of steam from certain of its stages, and which system is of such nature that the return to the system of the available heat in the evaporator output and drains will not alter the respective quantities of steam withdrawn from the turbine or effect any heat loss due to the manner in which this bleeder steam is utilized.

It is a still further object to provide a steam system of this type which will efficiently receive and utilize in the manner above described returns from the system and the steam available for preheating the boiler feed for variously modified installations, such as for instance where special apparatus, for example an economizer, is employed.

In a sense the present application constitutes an improvement and a development over the "high heat level evaporator system" shown and described in the patent to Stanley Brown, No. 1,400,935, of December 20th, 1921. The boiler feed water is heated successively by passing it through a series of heaters operating at different temperatures and pressures, and the drains from the various heaters may be accommodated in a plant open heater or a boiler feed tank in the manner described in that patent. Where quantities of steam at different pressures are employed as heating medium for the boiler feed, such as is the case in a bleeder turbine installation, the steam is brought into heat transferring relation with the feed water and its available heat utilized at pressures corresponding to the pressures of the various steam sources. In the introduction of one or more evaporator units to the system I employ as heating medium for the evaporator a certain quantity of the steam which would otherwise be utilized directly in preheating the boiler feed. The steam thus used as heating medium for the evaporator coils is preferably drawn from the source at the highest available pressure; that is, in the case of steam drawn from a bleeder turbine the evaporators will preferably be supplied from the steam derived from the highest pressure bleeder stage of the turbine. That portion of the high pressure steam not used in the evaporator heating elements may be conducted into heat transferring relation with the boiler feed water and caused to there give up its available heat under the proper temperature and pressure conditions. The evaporator vapor output and the hot drains from the evaporator coils are brought into heat exchanging relation with the boiler feed at a point intermediate the boiler feed water heater utilizing the high pressure steam and the condenser utilizing the steam from the next lower bleeder stage. Thus the respective quantities of steam withdrawn from the various stages of the turbine will not be changed from the conditions which would exist were no evaporators employed at all. In fact, the various quantities of steam bled from the respective stages of the turbine are not affected either individually or collectively and no power decrement can be ascribed to the system.

I have illustrated a preferred embodiment of my invention in the accompanying drawings in which

Figure 1 is a diagrammatic view showing a typical plant layout embodying my invention;

Figure 2 shows a somewhat modified system embodying my invention;

Referring to the drawings and particularly to Fig. 1, the system shown is designed to heat the feed water in successive steps on its way to the boilers. The main boiler feed tank 1 receives the turbine condensate and employs as its heating medium exhaust steam from the various auxiliary apparatus of the plant, and the drains from the other feed water heaters. The water is pumped from the main heater 1 through a series of heaters or condensers 2, 3 and 4 arranged to transfer heat to the boiler feed at successively higher pressures and temperatures. With this type of system it is, of course, necessary that steam suitable for heating the feed water at successively higher temperatures be available. The installation here shown draws its steam for heating the boiler feed water from a turbine T of the bleeder type, lines 2^a, 3^a, and 4^a indicating the respective piping for tapping off and conveying to the system the quantities of bleeder steam to be derived from different stages of the turbine. The condensate from the heaters 2, 3 and 4 flows through the heater drains $1a$ to the boiler feed tank 1.

Many of the modern steam power stations are designed to utilize bleeder turbines of this type equipped to deliver at two or more stages partially used steam for the purpose of heating the boiler feed water in successive steps. The bleeder turbine is so designed that it operates most efficiently when there is withdrawn from it at the different bleeder stages that quantity of steam which the turbine was designed to furnish. In case a greater or lesser amount of steam is withdrawn at any one of the bleeder stages a certain loss necessarily results due to the fact that this departure from the best operating conditions means that a certain amount of steam will not be utilized to the best advantage. In the drawings I have shown a system employing bleeder steam into which an evaporator unit has been introduced without disadvantageously affecting the utilization of the bleeder steam. The evaporator unit here shown is a two effect system indicated at 5. Any desired number of effects may be

employed, however, since for the purposes of this invention the battery of evaporators may be considered as a single heating unit utilizing a certain amount of steam and delivering certain heat returns which should be somehow accommodated in the system. The first effect evaporator is arranged to derive its heating steam from the line 4^a carrying bleeder steam from the highest pressure stage, and the vapor output from this effect serves as heating medium for the second effect. The vapor output from the second effect is passed to a separate condenser 6 utilizing the boiler feed water as its cooling medium. The drains from the heating coils of the two effects are joined as indicated at 7 with the condensate issuing from the heater 6, and a pump 8 is here shown for the purpose of returning the drains from the evaporator system to the boiler feed line.

If the evaporator unit were so arranged with respect to the remainder of the system that the amount of bleeder steam which was designed to be withdrawn from each of the respective bleeder stages would be altered it is apparent that the introduction of the evaporator system would result in a certain power decrement due to the fact that a portion of the delivered steam would not be utilized to the best advantage. To eliminate the possibility of such a power decrement I place the condenser 6 for absorbing the heat from the evaporator output intermediate the boiler feed heaters 3 and 4; that is, the heat returns from the evaporator unit are transferred to the boiler feed water at a point intermediate the heater 4, which is supplied with steam derived from the same source as is the steam passed to the evaporators, and the next preceding heater 3. With this arrangement the introduction of the evaporator system does not affect, either individually or collectively, the respective amounts of steam which may be withdrawn and utilized at each of the bleeder stages. The operation of the bleeder stages 2^a and 3^a takes place exactly as though the evaporator system were not present and the quantity of bleeder steam which would otherwise be withdrawn through the stage 4^a and used directly for heating the boiler feed, is employed in evaporating raw water but nevertheless gives up all its available heat to the boiler feed water at some temperature higher than that maintaining in the heater 3. The introduction of the evaporator system will thus not alter the effect on the heating of the feed water, or, conversely, if the feed water is to be heated to a desired temperature an amount of steam will be withdrawn from the last bleeder stage 4^a which is identical with that which would be required to produce the desired temperature of boiler feed water if the available heat in the steam from the bleeder stage 4^a were transferred entirely in the heater 4. This is, of course, neglecting the small radiation losses which are incident to the evaporator system.

To illustrate in what manner the evaporator system could be incorporated into the system so that a power decrement would result I may consider the situation which would result if, in the system shown in Fig. 1, the evaporator vapor output were condensed in heater 2 or heater 3 instead of in a separate heater 6. If, for instance, the evaporator output were condensed in the second stage heater 3 the amount of steam which could be tapped from the bleeder stage 3^a would be reduced by an amount corresponding to the available heat in the evaporator output. The amount of steam thus prevented from being withdrawn at the bleeder stage 3^a will, of course, traverse the successive lower stages of the turbine contributing a certain increment to the power of the turbine but losing most of its usefulness due to the fact that the lower stages of the turbine are not designed to receive this additional amount of steam, and the excess will consequently be passed through the turbine to outside circulation and will lessen the power output with respect to the total available energy present in the steam supplied to the system. Furthermore, if in order to compensate for this loss which would result were the evaporator output condensed in the lower stage heaters 2 and 3, a corresponding amount of steam were withdrawn from the high pressure stage 4^a, the increment which this excess of steam would impart to the power of the turbine between the pressure and temperature limits represented by the stages 4^a and 3^a would be lost. It is true that in order to produce a desired temperature of feed water a somewhat lesser quantity of steam would have to be withdrawn from the stage 4^a than would have to be withdrawn from the stage 3^a, but at any rate the work which this excess quantity would be capable of doing in passing from the stage 4^a of the turbine and the stage 3^a would be lost to the system. Similarly, if the condenser 6 employed for transferring to the boiler feed water the heat available in the evaporator output were positioned at another point in the system, for instance intermediate the heaters 2 and 3, the temperature of the boiler feed water would be prematurely raised before being admitted to the second stage heater 3, with the result that a quantity of steam less than normal from the bleeder stage 3^a would be utilized. A power decrement would result in the manner above described.

In a system embodying my invention the steam serving as heating medium for the evaporators may be withdrawn from any desired bleeder stage but it will ordinarily be preferable to utilize for this purpose steam from the highest pressure stage as shown.

The piping is so arranged that the evaporators may receive their supply of steam in preference to the supply conducted to the high heat level condenser 4 so that in case at any time there is a deficiency in the quantity of steam available at this stage the evaporators will nevertheless be permitted to retain their full quota. To accomplish this purpose a valve 9 may be provided to regulate the amount of bleeder steam passing to the heater 4. The same result may also be obtained by arranging the system so that the entire vapor output from the bleeder stage which supplies the evaporators will be first passed through the evaporators and only the excess steam not required in the evaporators sent on to the heater 4.

In Figure 2 I have shown a somewhat modified system particularly adapted to a plant wherein it is desired to employ an economizer for utilizing in the heating of the boiler feed water a portion of the heat in the flue gases after issuing from the boiler. In this system the preliminary heating of the boiler feed is accomplished in a main boiler feed tank 1, after which the feed water is successively heated in heaters 2 and 3 deriving their heating steam from the respective bleeder stages 2^a and 3^a of the turbine. The number of bleeder stages employed will depend on the circumstances of a given plant and does not affect the advantages arising from the incorporation of my invention into the system. The economizer 10 may be introduced into any system at the desired point and is here shown intermediate the heaters 2 and 3. The evaporator unit is here illustrated as a single effect evaporator 5 deriving its heating steam from the high pressure bleeder stage 3^a of the turbine and passing its vapor output to the condenser 6 wherein the contained heat of the vapor is transferred to the boiler feed water. The operation of the system is entirely similar to that of the system of Figure 1 above described, the chief distinction being that in Figure 2 the system is so modified that an economizer can be used. In this figure the condensate discharged from the heaters 3 and 6 and from the evaporator heating elements are returned to the boiler feed line at the proper points. For instance, the drains from the high pressure heater 3 are returned to the boiler feed line as indicated at 11, after the feed has traversed the heater 3 inasmuch as the temperature of the condensate is as high or higher than that of the boiler feed as it issues from the heater. If desired the heater drains may be returned to the main boiler feed tank in the fashion employed in Figure 1, due to the fact that the available heat in these drains is so small that it may not prove practicable to supply the necessary pumps and apparatus for returning the drains to the boiler feed line at the theoretically proper points.

It will be understood that various modifications may be introduced into the embodiments of the invention shown. For instance, in the plant layout indicated in Figure 1, the raw water supplied to the evaporators is preheated in three successive heaters 12, 13 and 14, the heating steam employed in the heaters 12 and 13 being derived directly from the bleeder stages 2^a and 3^a while that utilized in the third heater 14 is drawn from the vapor output of the second effect evaporator. It may be that the saving effected by thus preheating the evaporator feed in three stages, utilizing steam from the three respective bleeder stages of the turbine, will not warrant the necessary expenditure in providing three separate heaters for the evaporator feed, in which case it will, of course, be advisable to substitute for the three heaters shown a single heater deriving its source of heating steam from the last effect evaporator or other convenient source. Conceivably the raw water might in suitable cases be supplied to the evaporator without preheating. Furthermore, the evaporator system drains returned to the boiler feed supply through the medium of the pump 8 may be sent to any other point in the system, such as to the next preceding heater or to the boiler feed tank, without incurring a material loss, and it is understood that such disposition of the drains may be resorted to in case the expenditure involved in providing the pump 8 and associated parts be sufficient to warrant incurring a small loss by otherwise disposing of the drains. The boiler feed tank may also be located elsewhere in the system where circumstances demand, and its particular location is immaterial to the problem of introducing the evaporator unit without disadvantageously affecting the operation of the system. Various other modifications may be introduced within the scope of the appended claims.

Claims:

1. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, a plurality of boiler feed water heaters connected to receive steam therefrom at progressively increasing pressures, a boiler feed water line connecting said heaters in series, the boiler feed water being heated progressively on its way to the boiler, an evaporator connected to receive steam from said steam utilizing apparatus, and means independent of said feed water heaters for transferring to the boiler feed water the available heat from the evaporator.

2. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increas-

ing pressures, boiler feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, a boiler feed water line connecting said heaters in series, the boiler feed water being heated progressively on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, and means independent of said feed water heaters for transferring to the boiler feed water the heat from the vapor produced by the evaporator.

3. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, a plurality of boiler feed water heaters connected to receive steam therefrom at progressively increasing pressures, a boiler feed water line including said heaters connected in series, the boiler feed water being heated progressively on its way to the boiler, an evaporator connected to receive steam from said steam utilizing apparatus, an evaporator condenser connected in said boiler feed water line, means for conveying the vapor from said evaporator to said condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said boiler feed water line.

4. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increasing pressures, boiler feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, a boiler feed water line including said heaters connected in series, the boiler feed water being heated progressively on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, an evaporator condenser connected in said boiler feed water line, means for conveying the vapor from said evaporator to said condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said boiler feed water line.

5. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, a plurality of boiler feed water heaters connected to receive steam therefrom at progressively increasing pressures, a boiler feed water line including said heaters connected in series, the boiler feed water being heated progressively on its way to the boiler, an evaporator, means for supplying heating steam to said evaporator, an evaporator condenser connected in said boiler feed water line, means for conveying the vapor from said evaporator to said evaporator condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said boiler feed water line.

6. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increasing pressures, boiler feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, a boiler feed water line connecting said heaters in series, the boiler feed water being heated in a series of steps on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, an evaporator condenser connected in the boiler feed water line to transfer the available heat in the vapor output of the evaporator to the boiler feed water, and means for conveying to the boiler feed line at a point beyond said condenser the drains from the heating element of the evaporator and the condensate from said condenser.

7. In a steam power plant, a boiler, a turbine receiving steam from said boiler, a plurality of extraction steam water-heating systems receiving heating steam extracted from said turbine at progressively increasing temperatures and pressures, each of said extraction systems including a heater for boiler feed water, said heaters being connected in series and said water being heated progressively on its way to the boiler, an evaporator associated with said water-heating systems, means for supplying raw make-up water to said evaporator, means for supplying heating steam to said evaporator from one of said extraction systems, and means for transferring the heat from the vapor produced by said evaporator to the feed water independently of each of said other extraction systems.

8. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge steam at a plurality of pressures, heaters for the boiler feed water employing respectively as a heating medium the steam discharged at said plurality of pressures whereby the boiler feed water is heated in a series of steps on its way to the boiler, an evaporator deriving its heating steam from the steam occurring at one of said pressures, preheating means for the raw water supplied to said evaporator deriving their respective steam supplies from the steam available at said respective pressures, and means independent of said feed water heaters for transferring to the boiler feed water the available heat from said evaporator.

9. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, heaters for the boiler feed water employing respectively as heating medium the

steam discharged at said plurality of pressures whereby the boiler feed water is heated in a series of steps on its way to the boiler, an evaporator deriving its heating steam from the steam occurring at one of said plurality of pressures, an evaporator condenser connected to said boiler feed water line independently of said feed water heaters for transferring to the boiler feed water heat of the vapor from said evaporator, means for conveying into said boiler feed water line the drains from said evaporator, and the condensate from said evaporator condenser, and means for utilizing a portion of the vapor output of the evaporator for preheating the raw water supplied to said evaporator.

10. In a steam power plant, a boiler, a turbine receiving steam from said boiler, a plurality of extraction steam water heating systems respectively receiving heating steam extracted from said turbine at progressively increasing pressures, each of said extraction systems including a heater for the boiler feed water, a boiler feed water line including said heaters connected in series, said water being heated progressively on its way to the boiler, an evaporator associated with said water-heating systems, means for supplying heating steam to said evaporator from one of said extraction systems, and evaporator condenser connected in said boiler feed water line on the high temperature side of the feed water heater of the next lower pressure extraction system, means for conveying the vapor from said evaporator to said evaporator condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said boiler feed water line.

11. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge steam at various pressures, heaters for the boiler feed water employing respectively as heating medium the steam discharged at said various pressures whereby the boiler feed water is heated in a series of steps on its way to the boiler, an evaporator unit deriving its heating steam from the steam occurring at one of said several pressures, the excess of steam at the said pressure not accommodated in the evaporator unit being conducted into one of said boiler feed water heaters, preheaters for the raw water supplied to said evaporator unit deriving their respective steam supply from the steam available at said respective pressures, means for transferring to the boiler feed water the available heat in the vapor output from the evaporator unit at a point intermediate the heater accommodating said excess of steam and the next preceding heater, and means for conveying to the boiler feed line at a point beyond the heater wherein the available heat in the vapor output of the evaporator is transferred to the boiler feed water, the drains from the heating elements of the evaporator unit and the condensate from said last named heater.

12. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at various pressures, heaters for the boiler feed line employing respectively as heating medium the steam discharged at said various pressures whereby the boiler feed water is heated in a series of steps on its way to the boiler, an evaporator unit deriving its heating steam from the steam occurring at one of said several pressures, the excess of steam at the said pressure not accommodated in the evaporator unit being conducted into one of said boiler feed water heaters, means for transferring to the boiler feed water the available heat in the vapor output from the evaporator unit at a point intermediate the heater accommodating said excess of steam and the next preceding heater, and means for utilizing a portion of the vapor output from the evaporator unit for preheating the raw water supplied to said evaporator.

13. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge steam at various pressures, heaters for the boiler feed water employing respectively as heating medium the steam discharged at said various pressures whereby the boiler feed water is heated in a series of steps on its way to the boiler, an evaporator deriving its heating steam from the steam occurring at one of said several pressures, the excess of steam at the said pressure not accommodated in the evaporator being conducted into one of said boiler feed water heaters, means for transferring to the boiler feed water the available heating the vapor output from the evaporator at a point intermediate the heater accommodating said excess of steam and the next preceding heater, and means for conveying to the boiler feed line the drains from the heating elements of the evaporator and the condensate from said last named means.

14. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, a boiler feed water heating system including a plurality of feed water heaters connected to receive heating steam from said apparatus at progressively increasing pressures and to heat the feed water progressively on its way to the boiler, an evaporator connected to receive heating steam from said steam utilizing apparatus, and means independent of said feed water heaters for transferring the available heat from the evaporator to the feed water after said water

has been heated in that feed water heater which receives heating steam from said steam utilizing apparatus at the next lower pressure than that supplied to the evaporator.

15. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increasing pressures, a boiler feed water heating system including a plurality of feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, the feed water passing through said heaters in series and being heated progressively on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, and means independent of said feed water heaters for transferring the heat from the vapor produced by the evaporator to the feed water after said water has been heated in that feed water heater which receives heating steam from said steam utilizing apparatus at the next lower pressure than that supplied to the evaporator.

16. A steam power system of the class described comprising a boiler for generating steam, steam utilizing apparatus arranged to discharge used steam at a plurality of pressures, a boiler feed water heating system including a plurality of feed water heaters connected to receive heating steam from said apparatus at progressively increasing pressures, and to heat the feed water progressively on its way to the boiler, an evaporator connected to receive heating steam from said steam utilizing apparatus, an evaporator condenser connected in said feed water heating system succeeding the feed water heater which receives its heating steam at the next lower pressure than the evaporator, means for conveying the vapor from said evaporator to said condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said feed water heating system.

17. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increasing pressures, a boiler feed water heating system including feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, the feed water passing through said heaters in series and being heated progressively on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, an evaporator condenser connected in said feed water heating system succeeding the feed water heater which receives its heating steam at the next lower pressure than the evaporator, means for conveying the vapor from said evaporator to said condenser, and means for conveying the drains from said evaporator and the condensate from said condenser into said feed water heating system.

18. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of discharge outlets for discharging used steam at progressively increasing pressures, a boiler feed water heating system including feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom the feed water passing through said heaters in series on its way to the boiler, an evaporator connected to receive heating steam from one of said discharge outlets, an evaporator condenser connected in said feed water heating system succeeding the feed water heater which receives its heating steam at the next lower pressure than the evaporator to transfer the available heat in the vapor output of the evaporator to the boiler feed water, and means for conveying to the feed water heating system at a point beyond said condenser the drains from the heating element of the evaporator and the condensate from said condenser.

19. A steam power system of the class described comprising a boiler for generating steam, steam expansion means for receiving steam from said boiler and having a plurality of outlets for discharging used steam at progressively increasing pressures, an evaporator, means for supplying heating steam to said evaporator, and a heating system for heating the raw water supplied to said evaporator including a plurality of feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom at progressively increasing pressures, the feed water passing through said heaters in series and being heated progressively on its way to the evaporator.

20. A steam power system of the class described comprising a boiler for generating steam, a prime mover utilizing steam and having a plurality of outlets for discharging used steam at progressively increasing pressures, a boiler feed water heating system including feed water heaters connected to a plurality of said discharge outlets to receive heating steam therefrom, the feed water passing through said heaters in series and being heated progressively on its way to the boiler, an evaporator, means for supplying heating steam to said evaporator, and preheating means for the raw water supplied to said evaporator including a plurality of water heaters connected to receive heating steam respectively from a plurality of said outlets.

In testimony whereof I affix my signature.

STANLEY BROWN.

8

CERTIFICATE OF CORRECTION.

Patent No. 1,846,047. Granted February 23, 1932, to

STANLEY BROWN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 63, for the word "condenser" read heater; page 4, line 35, for the word "any" read the, and in the same line, for "the" read any; page 6, line 108, claim 13, for "heating" read heat in; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 31st day of May, A. D. 1932.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)