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POWER STATION

Filed March 5, 1925

Fig. 1.

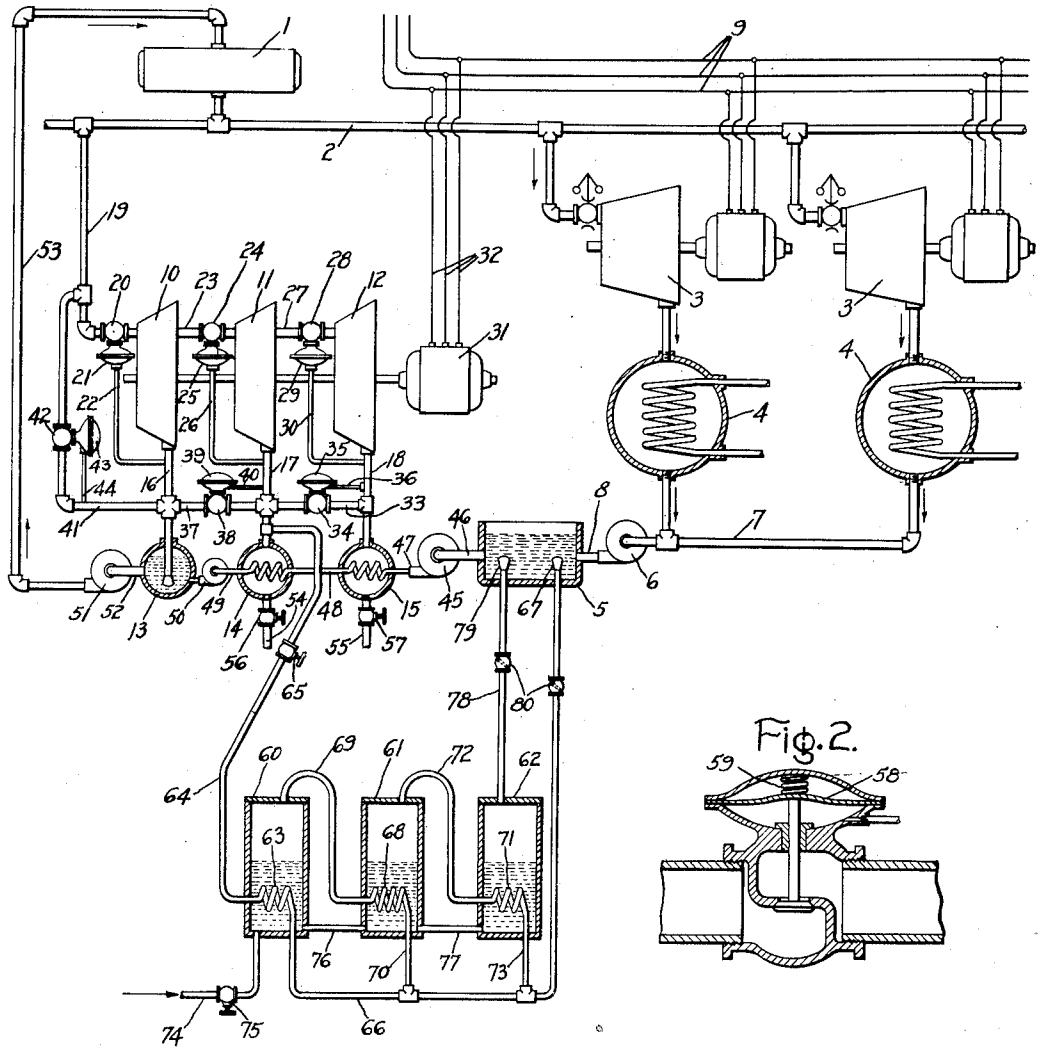
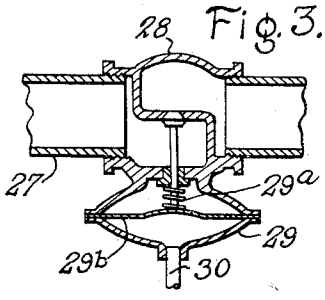


Fig. 2.

Fig. 3.



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POWER STATION.

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It is now well known in connection with power stations wherein a boiler or battery of boilers supplies elastic fluid to one or more condensing turbines and wherein the condensate from the turbine or turbines is used to feed the boiler or battery of boilers, to progressively heat the feed on its way from the condenser or condensers to the boiler or battery of boilers by means of successive feed heaters to which elastic fluid of successively higher temperatures is supplied for heating purposes, thereby approaching the regenerative process.

The present invention relates to power stations embodying progressive feed water heating and has for its object to provide an improved arrangement in a station of this type.

For a consideration of what I believe to be novel and my invention attention is directed to the accompanying description and the claims appended thereto.

In the drawing, Fig. 1 is a diagrammatic view of a power station installation embodying my invention, and Figs. 2 and 3 are sectional views of two types of pressure controlled valves which may be used.

The invention may be used in connection with a power station utilizing any desired elastic fluid. Usually, however, steam is employed, and as a matter of convenience the invention is described as a steam installation. It is to be understood, however, that it is not necessarily limited to use with steam.

Referring to the drawing, 1 indicates a steam boiler installation, comprising any suitable number of boilers, which supplies steam through a conduit or header 2 to a number of main turbo-generator sets 3, two such sets being indicated in the present instance. These turbo-generator sets may be of any suitable type and each is provided with a condenser 4. The condensate from condensers 4 is pumped from the condensers to a hot well 5 by a pump 6 through suitable suction and discharge pipes 7 and 8. From hot well 5 the water is returned to the boiler installation 1, being first, however, progressively heated. The generators of the turbo-generator sets 3 deliver energy to a main line or bus bars 9.

For progressively heating the feed water, I provide a special turbine the primary function of which is to furnish steam of successively higher temperatures for such heating, the power generated by this special feed water heating turbine being used in any advantageous manner, such as, for example, driving auxiliaries or furnishing power to the main line. In the present instance the feed water heating turbine is shown as comprising three sections 10, 11 and 12, and associated with such sections are three feed water heaters 13, 14 and 15, the feed water heaters 14 and 15 being indicated as being of the surface type while the feed water heater 13 is indicated as being of the direct contact type.

Feed water heater 13 is connected by a conduit 16 to the low pressure end of turbine section 10, feed water heater 14 is connected by a conduit 17 to the low pressure end of turbine section 11, and feed water heater 15 is connected by a conduit 18 to the low pressure end of turbine section 12. Conduits 16, 17 and 18 form, in substance, exhaust conduits for the respective turbine sections 10, 11 and 12, or, viewed from another aspect, they form extraction conduits for extracting steam for feed water heating purposes.

The feed water heating turbine comprising sections 10, 11 and 12 receives elastic fluid from the conduit or header 2 through a suitable conduit 19 in which is located a controlling valve 20 which regulates the flow of elastic fluid to the high pressure side of the first turbine section 10. Regulating valve 20 is controlled by the pressure in exhaust conduit 16, the valve being connected to a suitable pressure actuated device 21 which may be of the diaphragm type and which is connected by a pipe 22 to the conduit 16. This arrangement serves to maintain automatically a substantially constant pressure in conduit 16, in that as the pressure in conduit 16 increases and decreases valve 20 is adjusted to decrease and increase the amount of steam admitted to turbine section 10.

The low pressure end of turbine section 10 is connected to the high pressure end of turbine section 11 by a conduit 23 provided with a regulating valve 24 controlled by the pressure in conduit 17 by means of a pressure responsive device 25, which is connected to conduit 17 by a pipe 26. This arrangement thus serves to maintain substantially constant the pressure in conduit 17. Likewise the low pressure end of turbine section 11

is connected to the high pressure end of turbine section 12 by a conduit 27 in which is located a regulating valve 28 controlled by a pressure responsive device 29 connected to conduit 18 by a pipe 30, whereby the pressure in conduit 18 is automatically maintained substantially constant.

The pressure regulating means for valves 20, 24 and 28 may be of any suitable type, and in Fig. 3 a preferred form of the interior construction of valve 28 and its controlling means 29 is shown, 29^a being the spring which serves to bias the valve toward the open position and 29^b being a diaphragm which is acted upon by the pressure from pipe 30 to close the valve against the action of the spring. Valves 20 and 24 and the controlling means therefor are of the same construction. The arrangement indicated is however primarily diagrammatic and is shown only by way of example.

The feed water heating turbine is shown in the present instance as driving an electric generator 31 connected by lead wires 32 to the main bus bars 9 whereby the energy generated by the feed water heating turbine is delivered to the main bus bars in parallel with the main turbo-generators 3.

Conduits 17 and 18 are connected by a conduit 33 in which is a valve 34 regulated by a pressure responsive device 35 which is connected to conduit 18 by a pipe 36. Conduits 16 and 17 are connected by a conduit 37 in which is a regulating valve 38 controlled by a pressure responsive device 39 which is connected by a pipe 40 to conduit 17. Conduit 16 is connected with conduit or header 2 by a conduit 41 and conduit 19. In conduit 41 is located a regulating valve 42 controlled by a pressure responsive device 43 which is connected by a pipe 44 to conduit 41 beyond valve 42 as regards the flow of steam through conduit 41. Conduits 41, 37 and 33 form in substance a continuous conduit in which is interposed the valves 42, 38 and 34, the valve 42 being regulated in accordance with the pressure in conduit section 41, that is, in extraction conduit 16, valve 38 being regulated in accordance with the pressure in extraction conduit 17 and the valve 34 being regulated in accordance with the pressure in extraction conduit 18.

The feed water from hot well 5 is drawn off by a pump 45 through conduit 46 and is discharged through a conduit 47 to feed water heater 15. From feed water heater 15 it passes through a conduit 48 to feed water heater 14 and from feed water heater 14 it is discharged through a conduit 49 to feed water heater 13, a suitable pump 50 being provided in this conduit if found desirable. 51 is a feed water pump which takes water from feed water heater 13 through conduit 52 and discharges it through a conduit 53 to the boiler installation 1. Connected with feed water heaters 14 and 15 are discharge pipes 54 and 55 in which are suitable valves 56 and 57. Conduits 54 and 55 may lead to any suitable point and are for the purpose of conveying away condensate which collects in the surface type heaters 14 and 15.

The pressure responsive devices 35, 39 and 43 may be of the general type shown in Fig. 2, the pressure responsive device comprising a casing in which is located a diaphragm 58 which is biased toward open position by a spring 59 and which is normally held closed by the pressure conveyed to the underside of the diaphragm by the pipes 36, 40 or 44.

Associated with the feed water heater 14 is a distilling apparatus for providing make-up water. It comprises three casings 60, 61 and 62. In casing 60 is a heating coil 63 connected by a pipe 64 to extraction conduit 17, there being a suitable shut off valve 65 in pipe 64. The discharge side of heating coil 63 is connected by a conduit 66 to a discharge head 67 located in hot well 5. In casing 61 is a heating coil 68 having its admission side connected by a pipe 69 to the upper end of casing 60 and its discharge side connected by a pipe 70 to conduit 66. In casing 62 is a heating coil 71 having its admission side connected by a pipe 72 to the upper end of casing 61 and its discharge side connected by a pipe 73 to conduit 66. Connected to casing 60 is an inlet pipe 74 containing a regulating valve 75 and through which raw water is supplied to the distilling apparatus. The lower ends of casings 60 and 61 and of casings 61 and 62 are connected together by conduits 76 and 77 which serve to equalize the water levels in the three casings. The upper end of casing 62 is connected by a conduit 78 to discharge head 79 located in hot well 5. If found desirable, suitable non-return valves 80 may be provided in conduits 66 and 78 to prevent flow of water from the hot well through such conduits.

The operation is as follows:—Feed water from the condensers 4 of the main units 3 is collected in hot well 5 and from this hot well it is circulated through the feed water heaters 15, 14 and 13 on its way to the boiler installation 1. The valves 20, 24 and 28 and the regulating means for them are set so as to supply the desired amount of steam for heating purposes to each of the feed water heaters, and it will be clear that the steam extracted by conduit 16 for feed water heating has done work in the turbine section 10, that that extracted through conduit 17 for feed water heating has done work in turbine sections 10 and 11, and that that extracted through conduit 18 for feed water heating has done work in turbine sections 10, 11 and 12. The regulating valves 20, 24 and 28

serve to maintain the desired pressure in each of the extraction conduits 16, 17 and 18 whereby corresponding feed water temperatures will be maintained in each of the feed water heaters. Only so much work is performed by the feed water heating turbine as is supplied by the steam needed for feed water heating, no load regulator being used on this turbine. Its speed, of course, in the arrangement shown, is set by the speed of the main turbo-generator sets since it is tied in with them through the generator 31 and connections 32.

The pressure regulating means 35, 39 and 43 for valves 34, 38 and 42 are set so that as long as the desired pressure obtains in discharge conduits 18, 17 and 16 the valves 34, 38 and 42 will remain closed. In case, however, the pressure in conduit 41 drops below the desired value then valve 42 will be opened automatically to admit live steam from header 2 to said conduit and conduits 16 and 37. The successive feed water heaters will then under control of valves 38 and 34, receive heating medium from this source through valve 42 so as to maintain the desired pressures and temperatures in the feed water heaters.

With the foregoing arrangement it will be seen that the main turbo-generator sets 3 are not required to furnish steam for feed water heating. All the steam supplied to them, therefore, is utilized to the best advantage, the turbines being operated at their highest degree of efficiency. The feed water heating turbine on the other hand, is provided primarily for the purpose of supplying steam for feed water heating, the matter of generating power being of secondary importance in it. By thus separating the power supplying feature and the feed water heating feature from each other, certain of the turbines being primarily for power purposes and another for feed water heating purposes, there is obtained an increase in the over-all efficiency of the plant. Furthermore, by this arrangement the temperatures of the steam supplied for feed water heating does not vary with the load on the main units so that the feed water heating is carried on at the same degree of efficiency whether the load on the main units is heavy or light. Also, the number of feed water heating stages can be made greater than the number practical when the steam is extracted from a main power unit and the temperatures in the several heaters can be readily regulated and maintained at the desired values.

Referring now to the evaporator, steam from the extraction conduit 17 is fed through pipe 64 to heating coil 63 from whence it passes through pipe 66 to the hot well 5. In passing through heater coil 63 it vaporizes some of the water in casing 60. The steam formed in casing 60 is discharged through pipe 69 and heater coil 68 to pipe 66 and thence to hot well 5. The steam in passing through heater coil 68 evaporates water in casing 61, and the steam thus formed passes from casing 61 through pipe 72 and heater 71 to pipe 66 and thence to hot well 5. The steam in passing through heater coil 71 evaporates water in casing 62 and the steam thus formed is discharged through pipe 78 to the hot well 5. With this arrangement, it will be seen that the evaporator operates in parallel with one or more of the feed water heater stages and that the waste heat from the evaporator is supplied to the hot well or tank 5, so that the intermediate temperatures of the preheaters are made independent of the amount of additional water evaporated. This effects the distillation of the water in an economical manner and cooperates with the feed water heater in producing a power station wherein higher efficiency is obtained.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a power station, the combination with a number of multistage condensing elastic fluid turbines which constitute the primary power producing means for the station, of a multistage heater turbine for progressively heating the condensate from said first-named turbines, said turbine comprising successive sections each having a heating fluid outlet, a plurality of heaters associated with said heater turbine and connected with said heating fluid outlets, and means connected with each heating fluid outlet for regulating each heater turbine section in accordance with the demand for heating fluid therefrom, said means comprising a conduit interposed between each section, a supply conduit for the initial section, a regulating valve in each of said conduits and in the supply conduit, and a regulator responsive to a condition of the heating fluid connected with each of said valves to operate the same, whereby each section is controlled by a separate regulator, each regulator being connected with the heating fluid outlet of the section which it controls whereby the control of said section is effected thereby in response to changes in the condition of the heating fluid from said section.

2. In a power station, the combination with a number of multistage condensing elastic fluid turbines which constitute the primary power-producing means for the

station, of a multistage heater turbine for progressively heating the condensate from said first-named turbines, said turbine comprising successive sections each having a heating fluid outlet, a plurality of heaters associated with said heater turbine and connected with said heating fluid outlets, means connected with each heating fluid outlet for regulating each heater turbine section in accordance with the demand for heating fluid therefrom, and auxiliary means connected with each heating fluid outlet for supplying elastic fluid successively to the heaters in case the pressures therein fall below a predetermined value.

3. In a power station, the combination of a boiler installation, primary power-producing means which receives operating medium from the boiler installation, condenser means for the power-producing means, a plurality of heaters, means for passing condensate from the condenser means through said heaters to the boiler installation, a multistage elastic fluid heater turbine having successive heating fluid extraction sections, means connecting successive sections of said heater turbine to said heaters, and means for regulating the elastic fluid supply to the heater turbine sections in accordance with the demand for heating fluid therefrom, said means comprising a conduit interposed between each section, a supply conduit for the initial section, a regulating valve in each of said conduits and in the supply conduit, a pressure regulator connected with each of said valves to control the same whereby each section is controlled by a separate pressure regulator, and a pressure supply conduit connecting each regulator with the heating fluid outlet of the turbine section which it controls.

In witness whereof, I have hereunto set my hand this 13th day of February, 1925.

THEODOR STEIN.