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Schwarzenbach

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[54] **CONDENSATION PLANT FOR A STEAM TURBINE**

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[51] **Int. Cl.** **F01k 19/10,** F01b 31/08

[58] **Field of Search** ..... 60/73, 95 A, 95 R, 96

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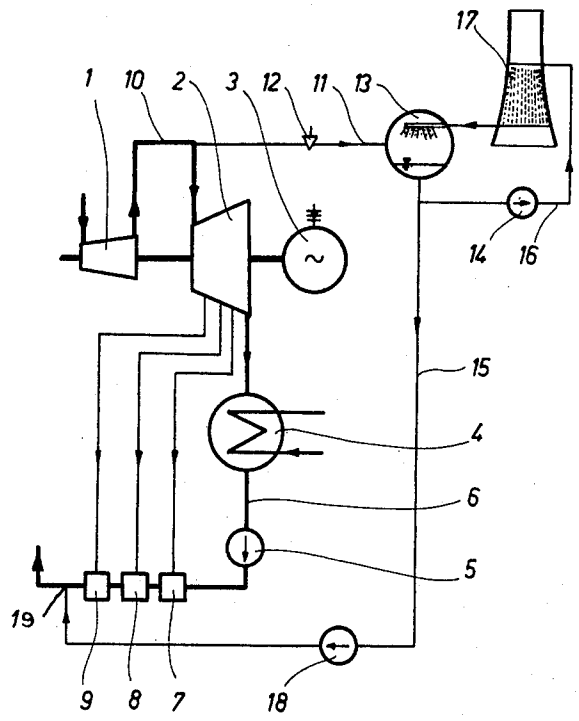
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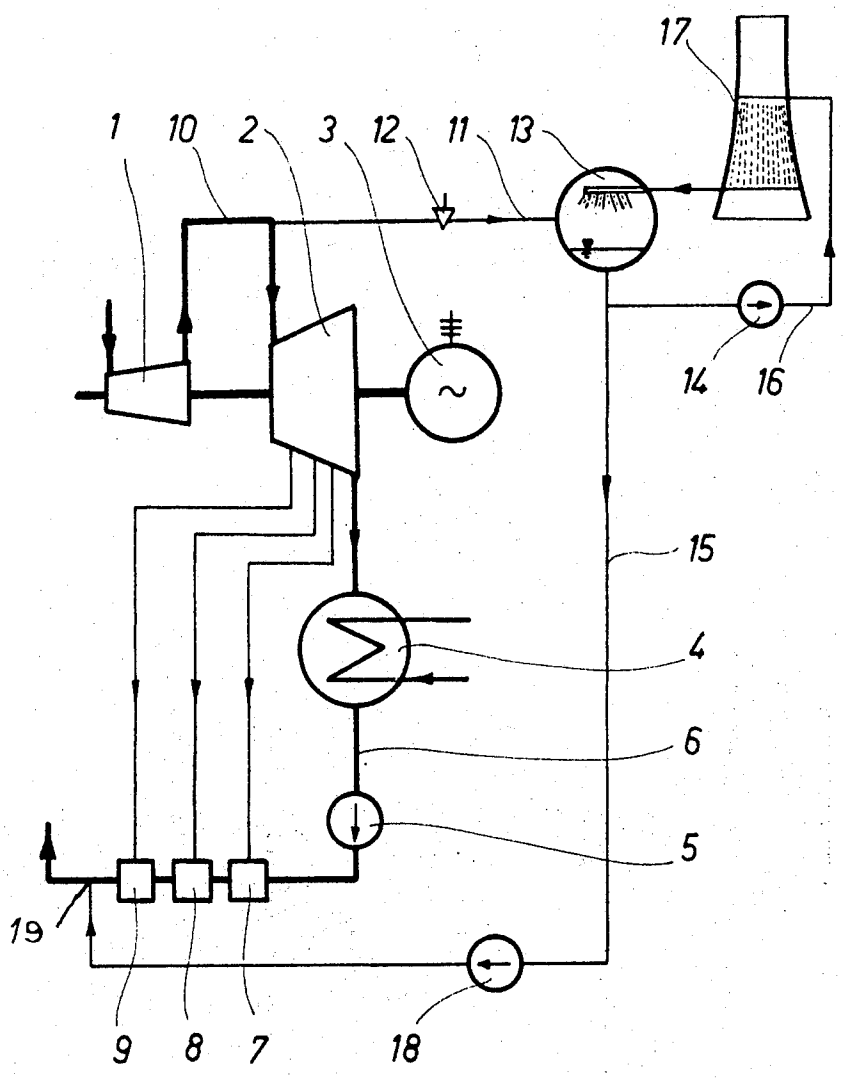
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[57] **ABSTRACT**

A steam power plant consisting of high and low pressure turbine sections coupled together to drive a load such as an electric generator is provided with a composite condensing system which consists of a water-cooled main condenser connected to the steam discharge of the low pressure turbine section and an air-cooled auxiliary condenser connected to receive steam from the steam flow path intermediate the high and low pressure turbine sections. Steam flow to the auxiliary condenser can be controlled by valve means operated manually or automatically, as required, depending upon various limiting environmental parameters related to the available water supply for the main condenser.

4 Claims, 1 Drawing Figure




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CONDENSATION PLANT FOR A STEAM TURBINE

This invention relates to an improvement in the condensation system of a steam turbine plant which functions to condense the steam after leaving the turbines for return to the boiler to be again heated to vaporization and re-cycled through the turbines.

Every thermal power plant requires a heat sink to give up heat at the lower process temperature. Hitherto sufficient water from rivers, lakes or the sea has been available for this purpose in most industrialized countries. As a result of antipollution measures, restrictions are increasingly being imposed on the maximum permissible temperature rise of the water. In the summer months the water in many rivers is in short supply and, furthermore, the ambient temperature can be so high that the permitted temperature rise in the water is quite small. Instead of a rise of 12° C, for example, only 5° – 6° C may be acceptable in summer. The power station output must therefore be lowered accordingly, although the power demand still remains very high because a great deal of electricity is used by air conditioning systems, especially in summer.

The known systems for condensing the steam are as follows:

a. Surface condenser always supplied with fresh water, i.e., water drawn cold from a river, lake or sea. b. Surface condenser cooled by water which in turn is cooled by evaporation in a condenser. c. As (a), except that the heated water is cooled in a cooling tower before being discharged. d. Fixed-flow condenser, the condensate of which is cooled partly in a dry cooling tower and then sprayed back into the condenser. e. Cooling tower with direct heat exchange between steam and air.

So long as there is sufficient water available for 90 percent of the operating time, solution (a) above is undoubtedly the most economical. In cases where there is an acute shortage of water throughout the year, one of solutions (b) to (e) is unavoidable, although they are all economically inferior.

The objective of the present invention is, by employing additional, economically acceptable means, to produce the highest possible output from steam turbine installations with water-cooled condensers at those times when there is insufficient cooling water available, or the permitted temperature rise of the cooling water is restricted.

This objective is achieved in that when the cooling capacity of the main (water) condenser is restricted, a partial flow of the working steam is diverted from the turbine before expanding to condenser pressure and the heat to be removed from this steam to achieve condensation is given up to the ambient air.

A composite steam condensing system in accordance with the invention, i.e., one which is operative both with water and ambient air as the cooling mediums, comprises a conventional main, water-cooled condenser receiving steam exhausted from the low pressure turbine unit and an auxiliary directly or indirectly air-cooled condenser to which steam is supplied by way of a branch pipe having a cut-off valve therein which leads off the flow path of the steam through the turbine units at a point prior to expansion of the steam to the pressure of the main condenser, the steam condensed in the auxiliary air-cooled condenser being returned to the line connecting the outlet of the main, water-cooled condenser with the inlet to the boiler.

In an advantageous embodiment of the invention, the steam flow diverted from its main flow path to the auxiliary air-cooled condenser is controlled as a function of an operating characteristic of the main water-cooled condenser.

It is further beneficial, in accordance with the invention, if the respective flows of condensate from the main and auxiliary condensers mix at approximately the same temperature level.

A principal advantage of the composite condenser system according to the invention lies particularly in the fact the air-cooled condenser system is supplementary and is used only as needs require. Whereas before it has been necessary to reduce the working steam flow rate because of the limited cooling capacity of the main condenser, the full steam flow can now be utilized up to the pressure at the point of diversion, while the main, water-cooled condenser receives only the permissible, reduced steam flow. Beyond the branch point the diverted partial flow does no more work, which is a loss thermodynamically and as regards efficiency, but the deciding factor is the power generated which, owing to the air-cooled auxiliary condenser, is in sum greater than without this condenser. The higher pressure in the auxiliary condenser also results in a higher temperature than that in the main condenser so that all the heat exchange surfaces are small and the costs of the auxiliary system, which is used only for short periods, can be kept low.

The auxiliary, air-cooled condenser can be connected or disconnected by hand or by an automatic control system when, for example, the condenser pressure or the cooling-water discharge temperature exceeds a certain limit. The condensate flows can be brought together immediately after the two condensers or at any other point, but it is of benefit if they mix at approximately the same temperature level because the flow from the auxiliary condenser is hotter and a thermodynamic loss is incurred if it is cooled by mixing with the cooler condensate stream.

A preferred embodiment of the invention is described in detail below and illustrated in the accompanying drawing, the single view of wyich is a schematic representation of a steam power plant equipped with an auxiliary air-cooled condenser of the mixed flow type.

With reference to the drawing, the steam power plant shown consists essentially of the high and intermediate-pressure section **1** and the low pressure section **2** of the steam turbine, which together drive the electrical generator **3.** Steam leaving the low pressure section **2** is condensed in the water-cooled main condenser **4.** The condensate from condenser **4** is conveyed by condensate pump **5** through pipe line **6** by way of the bleeder steam-heated feedheaters **7, 8, 9** to the boiler (not shown) for reheating to produce steam for driving the turbines.

The interconnecting pipe **10** between the intermediate-pressure section **1** and low pressure section **2** of the turbine incorporates a branch pipe **11** which can be closed by valve **12.** This branch pipe leads to auxiliary condenser **13** which, in the example shown, is in the form of a mixed-flow condenser. With the aid of a circulating pump **14** connected to the outlet from the auxiliary condenser **13,** a part of the condensate is withdrawn and fed through pipe **16** to cooling tower **17,**

where it is cooled by air and then flows back into the auxiliary condenser **13.**

The remainder of the condensate from the auxiliary condenser **13** is conveyed by return pump **18** in pipe line **15** to the main condensate return line **6.** The two flows are best brought together at a junction point **19** at which the condensate from the main condenser **14** has already been heated to some extent by the feed-heaters **7, 8, 9.** In this way, mixing of the two condensate flows takes place at at least approximately the same temperature level.

Valve **12** can be variable-setting throttle valve, but it is cheaper, and will in most cases be sufficient, to use a simple open/close valve.

I claim:

1. A steam turbine plant comprising steam turbine means receiving pressurized steam from a boiler, and a composite condensing system for the steam comprising a main water-cooled condenser to which steam is delivered after passing completely through said turbine means, a main condensate return pipe line extending from said water-cooled condenser back to the boiler, an air-cooled auxiliary condenser, an auxiliary pipe line connected into the steam flow path through said turbine means at a point prior to final expansion of the steam to the operating pressure of said water-cooled condenser and which leads to said air-cooled auxiliary condenser, controllable valve means located in said auxiliary pipe line, said valve means being opened to divert a portion of the steam from said turbine means for flow through said air-cooled auxiliary condenser in response to a reduction in the cooling capacity of said main water-cooled condenser below the normal value established for handling the total amount of steam normally passing through said turbine means and an auxiliary condensate pipe line returning the condensate from said air-cooled auxiliary condenser back to the boiler.

2. A steam turbine plant as defined in claim **1** wherein the respective condensates from said main and auxiliary condensate pipe lines are mixed together at a point where they have substantially the same temperature.

3. A steam turbine plant as defined in claim **1** wherein said controllable valve means located in said auxiliary pipe line connected into the steam flow path through said turbine means is constituted by a variable setting throttle valve.

4. A steam turbine plant as defined in claim **1** wherein said controllable valve means located in said auxiliary pipe line connected into the steam flow path through said turbine means is constituted by an open-close valve.

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