Sept. 14, 1965 A. PESCATORE 3,205,869

COOLING PARTS OF A STEAM GENERATOR BY FEEDWATER

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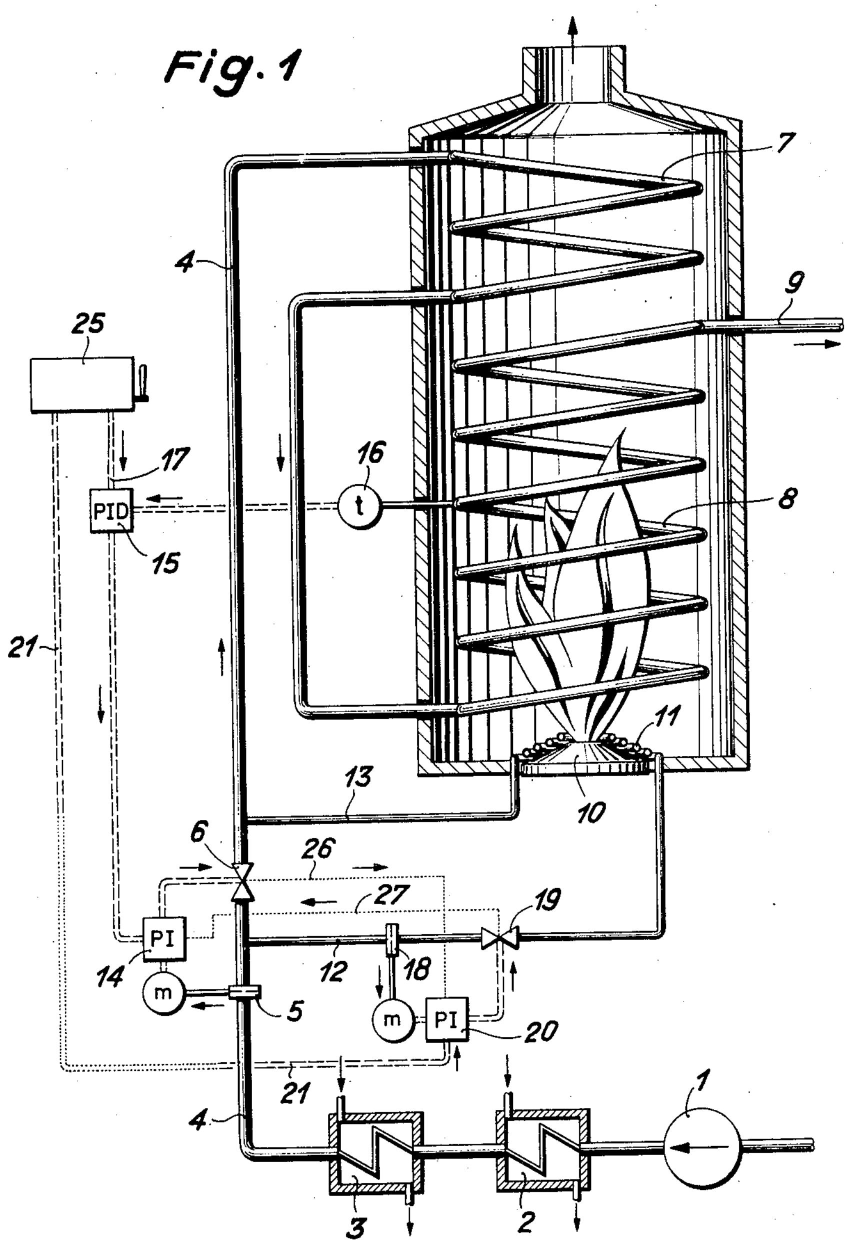
Fig. 1



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COOLING PARTS OF A STEAM GENERATOR BY FEEDWATER

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Fig. 2

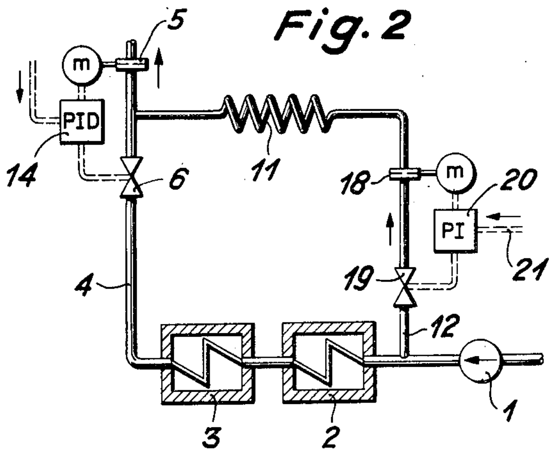
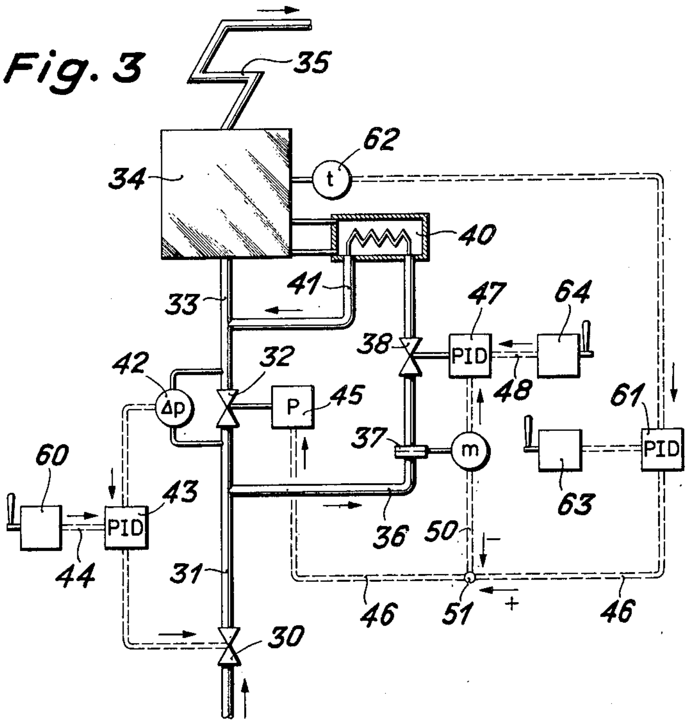


Fig. 3



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COOLING PARTS OF A STEAM GENERATOR BY FEEDWATER

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The present invention relates to arrangements for cooling parts of a steam generator by means of feedwater.

It is known to use feedwater as a coolant for cooling structural elements of a steam generator, for example burners, or various support elements, or to use the feedwater for cooling heat exchange surfaces, for example, of coolers for regulating purposes. The feedwater which has been used as a coolant is returned to the feed pipe. The conventional arrangements cause additional loss of pressure of the feedwater and sometimes require special pumps for maintaining the desired feedwater flow.

It is an object of the present invention to provide arrangements for cooling parts of a steam generator by feedwater whereby the aforedescribed shortcomings of conventional cooling arrangements are avoided. In an arrangement according to the invention the pipe for conducting the feedwater which is used as a coolant is connected to the main feed pipe upstream of a device for throttling the feedwater for controlling the flow rate thereof. The portion of the feedwater used as a coolant is conducted to the part or parts of the steam generator which must be cooled and is returned to the main feed pipe downstream of said throttling device.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawing wherein:

FIG. 1 is a diagrammatic part-sectional illustration of an arrangement according to the invention.

FIG. 2 is a diagrammatic part-sectional illustration of a modified arrangement according to the invention.

FIG. 3 is a diagrammatic part-sectional illustration of a further modification.

Referring more particularly to FIG. 1 of the drawing, numeral **1** designates a feed pump for pumping feedwater consecutively through high pressure preheaters **2** and **3**, a feed pipe **4** provided with an orifice plate **5** for measuring the rate of feedwater flow and with a feedwater flow regulating valve **6** to an economizer **7** of a steam generator. The feedwater flows from the economizer to an evaporator and superheater **8**, the produced superheated steam leaving the steam generator through a live steam pipe **9**. The steam generator is provided with a burner **10** which is protected from the heat in the combustion chamber of the steam generator by means of a tube coil **11** which is, for example, wound to form a double spiral, as shown. The coil **11** is supplied with feedwater through a pipe **12** which is connected to the main feed pipe **4** between the orifice plate **5** and the feedwater regulating valve **6**. The feedwater leaving the coil **11** is returned to the main feed pipe downstream of the valve **6** through a pipe **13**.

The feedwater flow control valve **6** is actuated by a regulator **14** in response to control signals produced by a flow rate measuring device operatively connected to the orifice plate **5**. The regulator **14**, which may have a proportional, integral (PI) characteristic, receives a set point signal from a control device **15** which may have a proportional, integral, differential (PID) characteristic and which compares the signal produced by a temperature sensitive device **16** with a set point signal received through a conduit **17**, for example, from a load regulating device **25** which may be manually operated.

The rate of flow of feedwater through the coil **11** is regulated by an arrangement comprising an orifice plate **18**, a throttling device **19** and a regulator **20**. The latter may have a proportional, integral (PI) characteristic and compares a signal which corresponds to the flow rate through the orifice plate **18** with a set point signal supplied through a conduit **21** which signal may be constant or which may be altered in dependence on the load on the steam generator, or which may be produced by a temperature sensitive device, not shown, connected to the burner **10**. The throttling device is actuated in response to a signal produced by the regulator **20** and corresponding to the result of the comparison of the flow rate signal with said set point signal.

There is always a pressure drop at the valve **6** when the steam generator is in operation. This pressure drop is used for flowing the cooling water through the pipes **12**, **13** and the coil **11**. As explained above, the flow rate of the cooling water is controlled by the regulator **20**. No special pump is necessary for maintaining flow of the cooling water. Since the already present pressure drop is utilized for maintaining flow of the cooling water no additional pressure drop is caused by the flowing cooling water. The arrangement according to the invention has the additional advantage that the rate of flow of feedwater through the valve **6** is reduced and the size of the valve **6** may be reduced accordingly. In order to increase the speed of reaction of the control of the valve **6** signals may be supplied through conduits **26** and **27** to form a so-called feed forward system. A signal conducted through the conduit **26** influences the regulator **20** in dependence on the setting of the valve **6** and a signal conducted through the conduit **27** influences the regulator **14** in dependence on the setting of the throttling device **19**.

FIG. 2 shows an arrangement wherein the sequence of the feedwater regulating valve **6** and of the orifice plate **5** is reversed. This makes it possible to connect the cooling water pipe **12** to the main feed pipe upstream of the preheaters **2** and **3** so that cooler water is supplied to the coil **11**. In this case the regulator **14** may have a proportional, integral, differential characteristic. Otherwise the arrangement shown in FIG. 2 functions in the same manner as that shown in FIG. 1.

FIG. 3 shows an arrangement wherein a pressure difference or pressure drop regulating valve **30** is arranged in series relation with a feedwater control valve **32**. The feedwater flows from the valve **30** to the valve **32** through a pipe **31** and flows from the valve **32** through a pipe **33** into a steam generator **34** and therefrom through a superheater **35**. A cooling water pipe **36** is connected to the pipe 31, an orifice plate 37 and a throttling device 38 being arranged in series relation in the pipe 36. The cooling water controlled by the device 38 flows through a cooler 34 of the steam generator. The cooler 34 may be of the indirect type for regulating the temperature of the operating medium of the steam generator, as is conventional in modern steam generators. The cooling water is returned to the main feed pipe 33 through a pipe 41.

The pressure drop across the valve 32 is measured by a pressure sensitive device 42 producing a signal which is conducted to a regulator 43. In the latter, which may have a proportional, integral, differential (PID) characteristic, the pressure signal is compared with a set point signal supplied through a conduit 44 from a set point signal producing device 60 which may be manually operated. The signal corresponding to the result of the comparison and produced in the regulator 43 controls the operation of the pressure difference or pressure drop regulating valve 30. The control is usually so effected that the pressure drop across the valve 32 is controlled by the valve 30 and is, for example, maintained constant at a predetermined load so that the rate of flow of feedwater through the valve 32 is proportional to the opening or flow area of the valve 32.

The feedwater regulating valve 32 is actuated by a regulator or motor operator 45 which may have a proportional (P) characteristic and which receives a control signal through a conduit 46 from a regulator 61. The control signal produced by the regulator 61, which may have a proportional, integral, differential (PID) characteristic, corresponds to the result of a comparison of a signal produced by a device 62 which is responsive to a temperature within the steam generator and of a set point signal produced in a device 63 which may be manually operated.

The throttling device 38 in the pipe 36 is actuated by a regulator 47, which may have a proportional, integral, differential (PID) characteristic, in response to signals corresponding to the rate of flow of cooling water through the orifice of the plate 37 and to a set point signal supplied through a conduit 48 from a set point setting device 64 which may be manually operated. The signal produced by the orifice plate 37 is also conducted through a conduit 50 and superposed, in a negative sense, at 51 on the signal conducted through the conduit 46.

Flow of cooling water through the pipes 36, 41 and the cooler 40 is controlled by the aforedescribed arrangement consisting of an orifice plate 37, a throttling device 38 and a regulator 47, as in FIG. 1. The difference between the arrangements shown in FIG. 1 and FIG. 3 is the additional control of the regulator 45 in response to the signal produced by the orifice plate 37. This makes the control more steady.

The pressure drop regulating valve 30 in FIG. 3 may be arranged downstream of the valve 32 without changing the functioning of the control system.

A particular advantage of the system shown in FIG. 3 is less disturbance of the flow of cooling water through the cooler 40 by the flow of feedwater through the main feed pipe. The pressure drop control valve 30 maintains the pressure drop across the valve 32 constant for a predetermined load range. If a constant flow of cooling water is desired, as for simple cooling requirements, the control means associated with the pipe 36 may be omitted or replaced by a simple, preset throttling device.

If the pressure drop across the valve 32 is insufficient for effecting the desired cooling water flow, the pipe 36 may be connected to the pipe 31 upstream of the valve 30 so that the entire pressure drop across the valves 30 and 32 is utilized for flowing the cooling water. It is also possible to bypass the cooling water pipe around the pressure difference valve instead of around the feedwater regulating valve. Although there is in this case a greater pressure drop variation this arrangement may be preferred, for example, if the pressure drop across the pressue drop control valve is consideably greater than the pressure drop across the feedwater regulating valve.

In the arrangements shown in FIGS. 1 and 2 the device for measuring the rate of flow of the feedwater is placed in series relation to the feedwater regulating valve and to the cooling water pipe. Therefore, the entire feedwater supply to the steam generator flows through the measuring device and changes of the rate of flow of the cooling water do not affect the feedwater supply to the steam generator.

I claim:

1. In a steam generating plant:
a feed pipe,
a valve in said feed pipe for regulating the feedwater supply,
a cooling water pipe,
a cooling device interposed in said cooling water pipe for passing the cooling water as a coolant,
said cooling water pipe being connected to said feed pipe upstream of said valve for receiving water from said feed pipe and being connected to said feed pipe downstream of said valve for returning water after passage as a coolant through said cooling device to said feed pipe, and
regulating means connected to said feed pipe for regulating the flow of feedwater therethrough,
said regulating means including a measuring device placed in said feed pipe for measuring the rate of feedwater flow therethrough, and a regulator including flow rate set point setting means, said regulator being operatively connected to said flow rate measuring device and to said valve for actuating said valve in response to the difference between the flow rate measured by said measuring device and the flow rate set by said set point setting means,
said measuring device being placed in series relation to said cooling water pipe and to said valve.

2. In a steam generating plant:
a feed pipe,
a flow rate regulating valve in said feed pipe for regulating the rate of flow of feedwater therethrough,
a pressure drop regulating valve in said feed pipe in series relation to said flow rate regulating valve for maintaining a predetermined pressure drop across said flow rate regulating valve,
a cooling water pipe, and
a cooling device interposed in said cooling water pipe for passing the cooling water as a coolant,
said cooling water pipe being connected to said feed pipe for bypassing one of said valves for receiving water from said feed pipe upstream of the bypassed valve and for returning water passed as a coolant through said cooling device to said feed pipe downstream of the bypassed valve.

3. In a steam generating plant:
a feed pipe,
a flow rate regulating valve in said feed pipe for regulating the rate of flow of feedwater therethrough,
a pressure drop regulating valve in said feed pipe in series relation to said flow rate regulating valve for maintaining a predetermined pressure drop across said flow rate regulating valve,
a cooling water pipe, and
a cooling device interposed in said cooling water pipe for passing the cooling water as a coolant,
said cooling water pipe being connected to said feed pipe upstream of one of said valves for receiving water from said feed pipe and being connected to said feed pipe downstream of the second valve for returning water after passage as a coolant through said cooling device to said feed pipe.

4. In a steam generating plant:
a feed pipe,

a valve in said feed pipe for regulating the feedwater supply,
a cooling water pipe,
a cooling device interposed in said cooling water pipe for passing the cooling water as a coolant,
said cooling water pipe being conencted to said feed pipe upstream of said valve for receiving water from said feed pipe and being connected to said feed pipe downstream of said valve for returning water after passage as a coolant through said cooling device to said feed pipe, and
regulating means connected to said cooling water pipe for regulating the flow of cooling water therethrough,
said regulating means including a flow rate measuring device placed in said cooling water pipe, a throttling device interposed in said cooling water pipe, and a regulator including flow rate set point setting means, said regulator being operatively connected to said flow rate measuring device and to said throttling device for actuating the latter in response to the difference between the cooling water flow rate measured by the former and the flow rate set by said set point setting means.

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