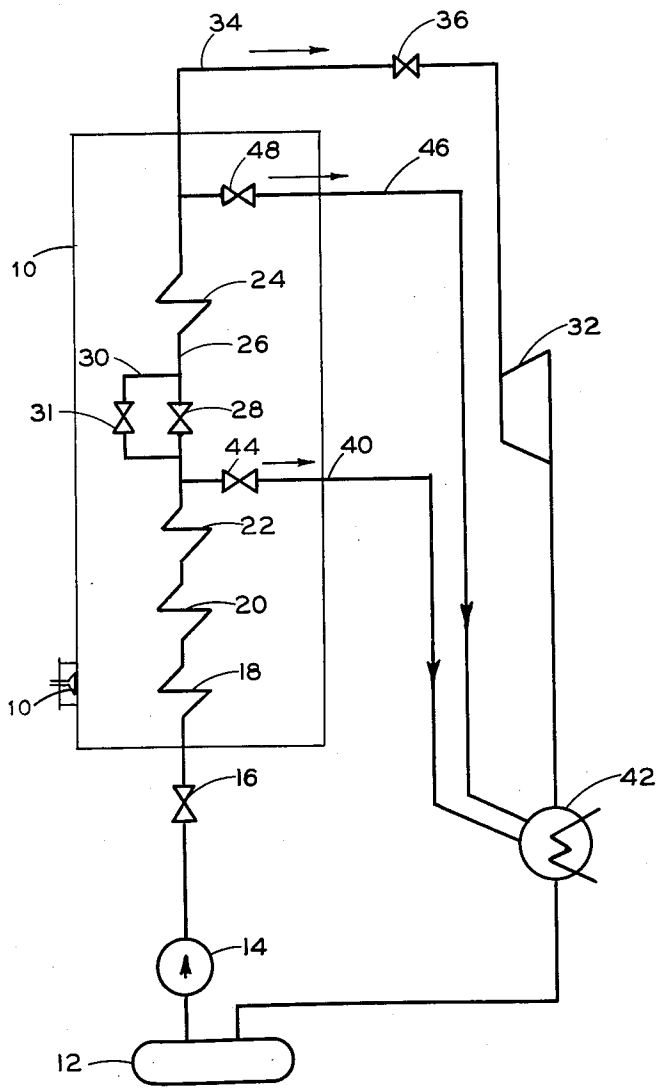
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ONCE-THROUGH VAPOR GENERATOR

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ONCE-THROUGH VAPOR GENERATOR

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This invention relates in general to forced flow, once-through vapor generating units and more particularly to apparatus for starting up and shutting down forced flow, once-through vapor generators.

In starting up and shutting down forced flow, once-through vapor generators it is important to use care in controlling the way in which the sections of the unit exposed to high temperatures are heated or cooled to avoid any damage resulting from extreme differential thermal stresses. Further, it is also important to avoid the deposition of solids within these portions of the unit to prevent tube failure due to overheating resulting from the presence of the deposited solids.

In the past, it has been proposed to place a flash drum and shut-off valve between the primary and secondary superheaters so that the heating surfaces which they separate could be started up independently. The flash drum arrangement, however, is disadvantageous due both to the cost of the heavy plate required and the size of the drum which substantially increases the size and cost of the vapor generator. The present invention avoids these disadvantages by providing a simple and relatively inexpensive arrangement which permits the secondary superheater to be heated or cooled during starting-up or shutting down operations, respectively, independently from the remainder of the heating surfaces.

It is, therefore, the object of this invention to provide apparatus whereby the secondary superheater may be separately heated or cooled during starting-up or shutting-down, respectively, of the vapor generators, and in addition, to provide that only steam is permitted to flow through the secondary superheater.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

The invention will be described in greater detail with reference to the accompanying drawing which is a schematic showing of the arrangement of the apparatus in the present invention.

In the drawing a forced flow, once-through vapor generator **10** receives a flow of heating gases from a burner **11**. Feed water is supplied to the vapor generator **10** from the feed water tank **12** by means of a feed water pump **14**.

The flow of feed water to the vapor generator **10** is controlled by an inlet valve **16** and under normal operating conditions it flows serially through an economizer section **18**, a vapor generating section **20**, a primary superheater **22** and a secondary superheater **24**. The primary superheater **22** and secondary superheater **24** are connected by means of a main flow passageway **26**. A shut-off valve **28** is located in the main flow passageway **26** to close off flow into the secondary superheater. A conduit **30** supplies a by-pass around the shut-off valve to permit the flow of heated feed water from the primary to the secondary superheater when the valve **28** is closed. A valve **31** is located in the by-pass conduit **30** to regulate the amount of flow passing therethrough.

The secondary superheater **24** is connected to a turbine **32** by means of an outlet passageway **34**. An outlet valve **36** is disposed in the passageway **34** to govern the flow of superheated steam to the turbine **32**. A first take-off conduit **40** is connected at one end to the flow passageway **26** upstream from the valve **28** and at its other end to a condenser **42**. A valve **44** is positioned in the conduit **40** to regulate the flow therein. A second take-off conduit **46** is connected at one end to the flow passageway **34** and at its opposite end to the condenser **42**. A valve **48** controls the flow through this second take-off conduit to the condenser.

The method of starting up the once-through vapor generator of the present invention is carried out in the following manner: first, the valve **28** in the main flow passageway **26**, the valve **31** located in the by-pass conduit **30** and the outlet valve **36** are closed and the valves **44** and **48** in the first and second take-off conduits **40** and **46**, respectively, are opened. Next, the feed water pump **14** is started up and the amount of feed water delivered to the vapor generator is regulated by means of the inlet valve **16** and the delivery of heating gases to the heating surfaces is commenced. With the valves arranged in this manner, the feed water absorbs heat as it circulates through the economizer section **16**, the vapor generating section **18**, and the primary superheater **20** and then passes off through the take-off conduit **40** to the condenser **42**. From the condenser, the feed water returns to the feed water tank **12** to complete the circuit. The pressure required for this portion of the starting-up operation is achieved by regulating the valve **44** in the first take-off conduit **40**.

When the circulation through primary superheater has reached the desired pressure and temperature, the quantity of heating gases are increased and valve **31** in by-pass conduit **30** is opened slightly to admit a small quantity of the heated feed water under pressure to the secondary superheater **24**. Since the valve **48** is open, there is no pressure maintained in the secondary superheater and a pressure drop occurs through the valve **31**. Due to this pressure drop and the elevated temperature of the feed water it expands and vaporizes as it passes through the valve. Since the temperature and pressure of the feed water in the portion of the vapor generator upstream of the valve has been regulated it is possible to maintain the feed water in a vapor state within the secondary superheater. In this manner, by maintaining differential pressure across the valve **31**, it is possible to assure the presence of steam within the secondary superheater at all times. In this way, the final vaporization occurs before the feed water enters the secondary superheater and the possibility of any deposition of solids therein is avoided.

As the amount of heating gases delivered to the vapor generator is increased, the temperature of the feed water rises and the valve **31** is opened wider to permit additional flow to the secondary superheater **24**. At the same time, the valve **48** in the second take-off conduit is regulated to maintain the pressure drop across the valve **31** in the by-pass conduit. When the steam temperature on either side of the valve has been equalized the pressure in the secondary superheater **24** is adapted to that in the primary superheater **22** by regulating the valve **48**. At this point in the starting-up operation, the valve **28** in the main flow passageway **26** is opened and the valve **31** in the by-pass conduit and the valve **44** in the first take-off conduit **40** are closed. When the desired starting-up temperature and pressure have finally been achieved, the regulating valve **48** is closed and the outlet valve **36** leading to the turbine **32** is opened and the once-through vapor generator is ready for operation.

In the shutting-down procedure for the forced flow, once-through vapor generator of the present invention, the temperature and pressure of the vaporizable fluid is

regulated to properly cool the secondary superheater surfaces and to avoid the deposition of solids therein. After lowering the steam capacity and the superheated steam temperatures as much as possible, the shutting-down procedure is as follows: first, the valve 48 in the second take-off conduit is opened and the outlet valve 36 is closed thereby shutting off the flow of superheated vapor to the turbine. Next, the valve 44 is opened gradually and the valve 48 is regulated to maintain the pressure within the secondary superheater. The heated feed water now flows through the first and second take-off conduits, 40, 46 to the condenser 42. With the flow arranged in this way, the flow of heating gases over the heating surfaces is discontinued and the valve 28 in the main flow passageway 26 is closed and the flow to the secondary superheater is admitted by way of the valve 31. By adjusting valve 48 the pressure in the secondary superheater is lowered and a pressure differential is maintained across the valve 31 so that only vapor is admitted to the secondary heater. When the secondary superheater surfaces have been sufficiently cooled flow therethrough is discontinued by closing valves 31, 48.

Now the operating medium flows through the vapor generator as far as the primary superheater 22 and then off through the take-off conduit 40 to the condenser 42. When these surfaces have been sufficiently cooled, the feed water pump 14 is turned off and the shutting-down operation is completed. In both the starting-up and shutting-down operations the deposition of solids is avoided within the secondary superheater surfaces and the heating or cooling of these high temperature surfaces is controlled to avoid any failures resulting from excessive differential thermal stresses.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A method of starting up a forced flow once-through vapor generator having first heating surfaces including a primary superheater and second heating surfaces including a secondary superheater serially connected therein, a point of use connected to said second heating surfaces, a vaporizable fluid flowing through said first and second heating surfaces wherein it is vaporized and superheated by the passage of heating gases thereover so that only vapor flows through said second heating surfaces, the invention comprising starting up with the flow of said vaporizable fluid through only said first heating surfaces and then condensing and recirculating it while commencing the passage of heating gases over said first and second heating surfaces, heating said vaporizable fluid as it flows through said first heating surfaces to a selected temperature and pressure, gradually increasing the flow of heating gases over said first and second heating surfaces, by-passing a portion of said vaporizable fluid from said first heating surfaces to said second heating surfaces, throttling said portion of said vaporizable fluid entering said second heating surfaces so that it flashes into a vapor, condensing and recirculating the vapor flowing through said second heating surfaces progressively increasing the flow of vaporizable fluid from said first heating surfaces to said second heating surfaces in direct relationship to said increase in heating gas flow to maintain only vapor flowing through said second heating surfaces until the desired conditions of temperature and pressure for starting the unit are attained, admitting the flow of vaporizable fluid directly from said first heating surfaces to said second heating surfaces and discontinuing by-passing said vaporizable fluid from said first heating surfaces to said second heating surfaces, passing the vapor from said second heating surfaces to said point of use, and at the same time discontinuing the flow from said first and second heating surfaces to be condensed and recirculated.

2. A method of shutting down a forced flow once-through vapor generator having first heating surfaces including a primary superheater and second heating surfaces including a secondary superheater serially connected therein, a point of use connected to said second heating surfaces, a vaporizable fluid flowing through said first and second heating surfaces wherein it is vaporized and superheated by the passage of heating gases thereover so that only vapor flows through said second heating surfaces, the invention comprising shutting off the flow of said vaporizable fluid to said point of use, condensing and recirculating the flow of said vaporizable fluid from both said first and second heating surfaces, regulating the flow withdrawn from said second heating surfaces to maintain only vapor flowing therethrough while shutting off the flow of said vaporizable fluid from said first heating surfaces directly to said second heating surfaces and at the same time by-passing a portion of the flow of said vaporizable fluid passing through said first heating surfaces to said second heating surfaces so that only vapor enters the second heating surfaces, suspending the passage of heating gases over said heating surfaces, discontinuing the by-pass flow of said vaporizable fluid to said second heating surfaces when said second heating surfaces are sufficiently cool and subsequently discontinuing flow of said vaporizable fluid to said first heating surfaces when said first heating surfaces are sufficiently cool to shut down operation of the once-through vapor generator.

3. A forced flow once-through vapor generator having a vaporizable fluid flowing therethrough to be vaporized and superheated comprising first heating surfaces including a primary superheater, second heating surfaces including a secondary superheater serially connected to and receiving vaporizable fluid from said first heating surfaces, a valve for shutting off flow of said vaporizable fluid from said first heating surfaces to said second heating surfaces, a by-pass conduit connecting said first and second heating surfaces around said valve, means located in said by-pass conduit for expanding vaporizable fluid flowing therethrough from said first heating surfaces so that only vapor enters said second heating surfaces, means for flowing said vaporizable fluid from said first heating surfaces to be condensed and recirculated, and means for flowing vapor from said second heating surfaces to be condensed and recirculated.

References Cited in the file of this patent

UNITED STATES PATENTS

2,858,807	Strange	Nov. 4, 1958
2,901,887	Buri	Sept. 1, 1959

FOREIGN PATENTS

941,291	Germany	Apr. 5, 1956

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,019,774 February 6, 1962

Herbert Beyerlein

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 2 and 12, and in the heading to the printed specification, line 4, for "Dunwerke", each occurrence read -- Durrwerke --; column 4, line 62, name of inventor, for "Strange" read -- Stange --.

Signed and sealed this 31st day of July 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents