SYSTEM AND METHOD FOR DETERMINING WHETHER DRAIN CONDUTS FOR DRAINING CONDENSATE FROM THE TURBINE CASING ARE CLOGGED AND CLEARING THE CONDUTS IF THEY ARE

Filed: March 19, 1971
Appl. No.: 126,188

U.S. Cl. 60/105, 415/118, 415/168, 60/67
Int. Cl. F01d 25/32, F01b 25/16
Field of Search 60/67, 89, 105, 415/168, 169, 415/118

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Primary Examiner—Martin P. Schwadron
Assistant Examiner—Allen M. Ostrager
Attorney—A. T. Stratton, F. P. Lyle and F. Cristiano, Jr.

ABSTRACT
A drain system and method for determining whether a drain conduit for draining condensate from a turbine casing to a condenser is clogged, and clearing the conduit, if it is clogged, the drain conduit being in communication with a main steam supply and having sensors disposed therein, the sensors being responsive to a rise in temperature in the drain conduit, caused by steam flowing therethrough, to indicate the drain conduit is clear. Valves are appropriately disposed to section off the drain conduit, so that steam pressure from the main supply can be imposed on any portion thereof found to be clogged, to unclog it.

12 Claims, 1 Drawing Figure
SYSTEM AND METHOD FOR DETERMINING WHETHER DRAIN CONDUITS FOR DRAINING CONDENSATE FROM THE TURBINE CASING ARE CLOGGED AND CLEARING THE CONDUITS IF THEY ARE

BACKGROUND OF THE INVENTION

This invention relates to drain conduits for steam turbines and more particularly to a drain system and method for determining whether a drain conduit for draining condensate from the lower portion of the turbine casing is clogged and clearing the conduit, if it is clogged. Many problems have been caused by condensate collecting in the lower portion of the casing during the start-up period, or when the turbine is operating at low loads. The condensate prevents proper heating of the submerged portion of the casing, causing thermal stresses and distortion therein. The distortion may result in the rotating parts rubbing against the stationary parts, and may cause severe damage to the turbine. While drain lines are provided, they have not completely remedied the problem, because they become clogged, or inadvertently are not opened. When operating at low loads, the steam flow through the turbine is not sufficient to heat the drain conduits so that temperature sensors cannot be used to indicate whether the drain conduits are clear and operable.

SUMMARY OF THE INVENTION

A drain system for a steam turbine made in accordance with this invention generally comprises a drain conduit in communication with the lower portion of the turbine casing and with a heat exchanger associated with the turbine, a supply conduit for supplying pressurized fluid to the drain conduit, a first valve disposed in the drain conduit between the connection with the supply conduit and the heat exchanger, and a third valve disposed in the supply conduit. Such a drain system also comprises a first sensor responsive to the flow of pressurized fluid in the drain conduit, and disposed adjacent the turbine end of the drain conduit, and a second sensor responsive to the flow of pressurized fluid in the drain conduit and disposed adjacent the heat exchanger end of the drain conduit. A response from both sensors is indicative of a clear drain line.

BRIEF DESCRIPTION OF THE DRAWING

The objects and advantages of this invention will become more apparent from reading the following detailed description in connection with the accompanying drawing, in which:
The sole FIGURE diagrammatically shows a steam turbine having a drain system made in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing in detail, a drain system for a steam turbine made in accordance with this invention comprises a drain conduit 1, in communication with the lower portion of the turbine casing 3, for draining condensate collected therein to a heat exchanger 5 associated with the turbine, i.e., a condenser or feedwater heater. A strainer 6 is normally disposed in the drain conduit adjacent the turbine end thereof to prevent foreign matter from entering the drain conduit. A supply conduit 7 connected to a main steam supply 8 for the turbine supplies pressurized fluid, or motive steam to the drain conduit. The supply conduit 7 is connected to the drain conduit 1 in the vicinity of its midpoint.

As shown in the drawing, valves 9 and 11 are appropriately disposed to section off the drain conduit, so that steam pressure from the main steam supply 8 may be imposed on any portion of the drain conduit found to be clogged, to unclog it. The first steam drain valve 9 is disposed in the drain conduit, between the supply conduit 7 and the turbine casing 3. The second drain valve 11 is disposed in the drain conduit, between the supply conduit 7 and the condenser 5. A third valve or steam supply valve 13 is disposed in the supply conduit. An orifice 15 is disposed between the supply valve 13 and the drain conduit 1 for limiting the quantity of steam flowing into the drain conduit, however the orifice will allow the pressure in a clogged portion of the drain conduit to build up to the pressure of the motive steam supply for the turbine, to dislodge foreign material clogging the drain line. A fourth valve 17, utilized as a remotely operable drain control valve, is disposed in the drain conduit adjacent the condenser 5. Sensors 19 and 21, responsive to a flow of steam accompanied by a temperature rise, are disposed adjacent opposite ends of the drain conduit to indicate that the drain conduit is clear. The sensor 19 is disposed adjacent the turbine casing 3 and the sensor 21 is disposed adjacent the condenser 5. The sensors 19 and 21 are connected to an annunciator 23 via lines 25 and 27, respectively. The annunciator is located in the control room and transforms the electrical signal generated by the sensors to an audible or visual sense perceptual signal which will indicate to an operator that steam is flowing through the drain lines and therefore, they are not clogged.

As shown in the drawing, the drain control valve 17 and the steam supply valve 13 are both pneumatically operated. The steam supply valve 13 closes when the air supply thereto is shut off, while the drain valve 17 opens when the air supply thereto is shut off, thus making both valves fail safe.

Pressurized air is supplied to valves 13 and 17 via the air supply conduit 31. A solenoid valve 33 disposed in the air supply conduit 31 allows compressed air to flow to the steam supply valve 13 when the solenoid valve 33 is energized and a solenoid valve 35 disposed in the supply conduit 31 in parallel with solenoid valve 33 allows air to flow to the drain control valve 17 when the solenoid valve 35 is energized.

Electrical conductors L1 and L2 supply the electrical potential necessary to operate the annunciator 23 and the solenoid valves 31 and 35. The solenoid valve 33 is connected in parallel with conductors L1 and L2 via conductors 37 and 39. Conductor 37 has a push-button switch 41 mounted in series with a normally closed switch 43. The normally closed switch 43 is interlocked with the turbine controls and opens when the oil pressure in the turbine control system reaches approximately 50 psig, which is indicative of the turbine being up to speed and operating. Thus, the conductor 37 is opened when the turbine is operating and depressing
the push-button switch 41 will not operate the solenoid valve 33 to allow motive steam to flow to the turbine, when the turbine is operating. The solenoid valve 35 is electrically connected to conductors L1 and L2 via conductors 45 and 47. A switch 49 is mounted in conductor 45 in series with the solenoid valve 35. The switch 49 is located in the control room so that the drain control valve 17 may be operated from the control room.

The method of operating the drain system to determine whether the drain conduit 1 is clogged, and to unclog it if it is, comprises the following steps:

opening the drain control valve 17 by operating the switch 49 located in the control room;

opening the steam supply valve 13 supplying steam from the motive steam supply to the drain conduit 1 by depressing the push-button switch 43;

sensing a temperature rise adjacent the turbine and adjacent the condenser ends of the drain conduit;

transforming the rise in temperature adjacent the ends of the drain conduit to visual or audible signals such as those produced by the annunciator, to indicate to an operator that the drain conduit is clear;

reacting to the signals provided by the annunciator indicating that the drain conduit is clear to release the push-button 43, which closes the steam supply valve 13 interrupting the flow of steam to the drain conduit;

upon failing to receive a signal from the annunciator indicating the sensor adjacent the condenser senses a rise in temperature, which indicates the drain conduit adjacent the condenser is clogged, closing the first drain valve 9 to impose motive steam pressure on that portion of the drain conduit between the drain valve 9 and the condenser 5, to dislodge foreign material clogging that portion of the drain conduit;

upon receiving a signal from the annunciator indicating that the sensor adjacent the condenser senses a temperature rise in the drain conduit adjacent the condenser, which indicates the portion of the drain conduit adjacent the condenser is unclogged, opening the first drain valve 9;

upon failing to receive a signal from the annunciator indicating the sensor adjacent the turbine senses a rise in temperature in the drain conduit adjacent the turbine casing, which indicates the portion of the drain conduit adjacent the turbine is clogged, closing drain valve 11 to impose motive steam pressure to the turbine end of the drain conduit to dislodge foreign material clogging that portion of the drain conduit, alternatively, remotely closing the drain control valve 17 would also impose motive steam pressure to the turbine end of the drain conduit to dislodge foreign material clogging that portion of the drain conduit;

upon receiving a signal from the annunciator indicating the sensor adjacent the condenser senses a temperature rise in the drain conduit adjacent the turbine casing, which indicates the portion of the drain conduit adjacent the turbine is unclogged, opening the drain valve 11 or alternatively, opening the drain control valve 17, if it were closed to unclog the drain conduit;

and

upon receiving a signal from the annunciator indicating the sensors sense a rise in temperature adjacent both ends of the drain conduit, which indicates the entire drain conduit is clear, allowing switch 41 to open, closing the steam supply valve 13 to interrupt the flow of steam to the drain conduit.

While in the control room, the operator can check the drain conduits to determine if they are clear and unplug them, if necessary, before heating the turbine and bringing it up to speed, thus minimizing the possibility of starting the turbine with clogged drains, which cause condensate to collect in the lower portion of the casing and result in uneven heating of the casing, distortion and possibly rubbing between the rotating and stationary portions thereof.

What is claimed is:

1. A condensate drain system for a steam turbine having a casing and a heat exchanger associated therewith, said drain system comprising:

a. a drain conduit in communication with a lower portion of the turbine casing for draining condensate therefrom and in communication with the heat exchanger,

b. a supply conduit for supplying pressurized fluid to the drain conduit,

c. a first valve disposed in said drain conduit between the connection with said supply conduit and said turbine,

d. a second valve disposed in said drain conduit between said connection with said steam supply conduit and said heat exchanger,

e. a first sensor responsive to flow of said pressurized fluid in said drain conduit, said first sensor being disposed between said first valve and said turbine;

f. a second sensor responsive to a flow of pressurized fluid in said drain conduit, said second sensor being disposed between said second valve and said heat exchanger,

g. said first and second sensors each responding to a fluid flow in said drain conduit to cooperatively indicate a clear drain conduit.

2. A drain system as set forth in claim 1 and further comprising means for translating signals from the sensor to sense perceptive signals at a location remote from the drain conduit.

3. A drain system as set forth in claim 1, further comprising means for translating signals from the sensor to sense perceptive signals at a location remote from the drain conduit, and a third valve operable from a remote location generally the location of the sense perceptive signal, said third valve being operable to interrupt the flow of fluid from the supply conduit.

4. A drain system as set forth in claim 1, wherein the turbine has a control system and said drain system further comprises a third valve operable to allow the pressurized fluid to flow to the drain conduit and interlocked with said control system so that said third valve will not operate when the turbine is operating.

5. A drain system as set forth in claim 1 and further comprising a fourth valve disposed in the drain conduit adjacent the heat exchanger, the fourth valve being operable remotely.

6. A drain system as set forth in claim 1, further comprising means for translating signals from the sensors to sense perceptive signals at a location remote from the drain conduit, a third valve operable to supply pressurized fluid to the drain conduit and interlocked with the turbine so that it is only operable when the turbine is not operating, and a fourth valve disposed in the
drain conduit adjacent the heat exchanger, said third and fourth valves being operable remotely generally from the location of the sense perceptive signal.

7. A drain system as set forth in claim 1, wherein the sensors are responsive to a rise in temperature in the drain conduit and the pressurized fluids supplied thereto is high temperature steam.

8. A drain system as set forth in claim 1 and further comprising an orifice disposed in the supply conduits for limiting the flow of pressurized fluid to the drain conduit.

9. A drain system as set forth in claim 1 and further comprising a strainer disposed in the drain conduit adjacent the turbine casing.

10. A method for determining whether a drain conduit in communication with a lower portion of a turbine casing and a heat exchanger associated with said turbine is clogged and clearing said drain conduit if it is clogged, said method comprising:

supplying pressurized fluid to said drain conduit,
sensing said flow of pressurized fluid through said drain conduit adjacent said turbine casing,
sensing said flow of said pressurized fluid through said drain conduit adjacent said heat exchanger,
upon sensing said flow of fluid in said drain conduit adjacent said turbine and adjacent said heat exchanger, interrupting said supply of fluid,
on failure to sense a flow of fluid through said drain conduit adjacent said heat exchanger, when pressurized fluid is being supplied to said drain conduit, closing a first drain valve disposed in said drain conduit between said fluid supply to said conduit and said turbine,
leaving said first valve closed until a fluid flow is sensed in said drain conduit adjacent said heat exchanger,
then opening said first valve,
on failure to sense a fluid flow in said drain conduit adjacent said turbine, when pressurized fluid is being supplied to said drain conduit, leaving said second valve closed until a fluid flow is sensed in said drain conduit adjacent said turbine, then opening said second valve, and
upon sensing a flow of fluid through said drain conduit adjacent said turbine and adjacent said heat exchanger, interrupting said supply of fluid.

11. A method for determining whether a drain conduit in communication with a lower portion of a steam turbine casing and in communication with a heat exchanger associated with said turbine is clogged and clearing said drain conduit if it is clogged, said method comprising:

supplying steam from a motive steam supply for said turbine to said drain conduit,
sensing a rise in temperature in said drain conduit adjacent said turbine casing,
sensing a rise in temperature in said drain conduit adjacent said heat exchanger,
on failure to sense a temperature rise in said drain conduit adjacent said heat exchanger when steam is being supplied thereto, closing a first drain valve disposed in said drain conduit between said supply of steam to said drain conduit and said turbine,
leaving said first valve closed until a temperature rise is sensed in said drain conduit adjacent said heat exchanger,
then opening said first valve when said temperature rise is sensed in said drain conduit adjacent said heat exchanger,
on failure to sense a temperature rise in said drain conduit adjacent said turbine, when steam is being supplied thereto, closing a second drain valve disposed in said drain conduit between said supply of steam to said drain conduit and said heat exchanger,
leaving said second valve closed until a temperature rise is sensed in said drain conduit adjacent said turbine,
then closing said second valve, and
upon sensing a temperature rise adjacent both said turbine and said heat exchanger, interrupting said supply of steam.
upon sensing a rise in temperature in said drain conduit adjacent said turbine and adjacent said heat exchanger, closing said steam supply valve.

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