Dec. 17, 1957 C. D. HERRESHOFF 2,816,712

AUTOMATIC CONTROL OF VENTILATION MEANS

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FIG. 1.

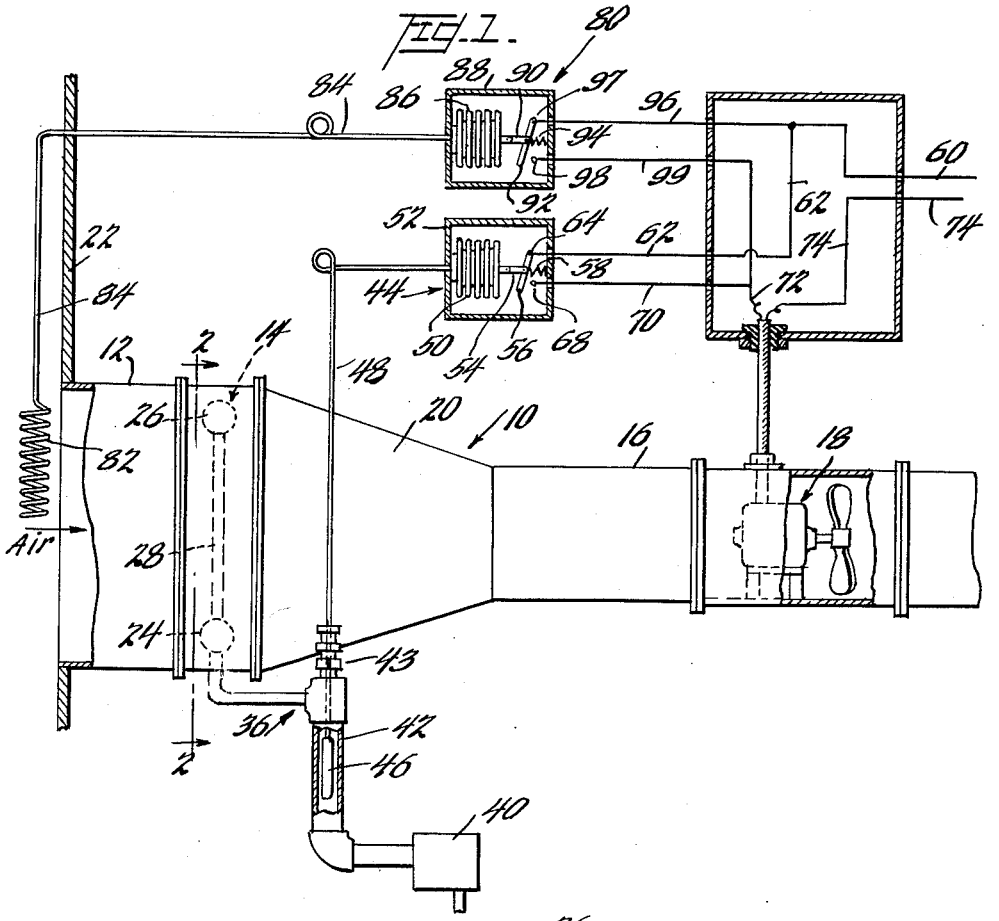
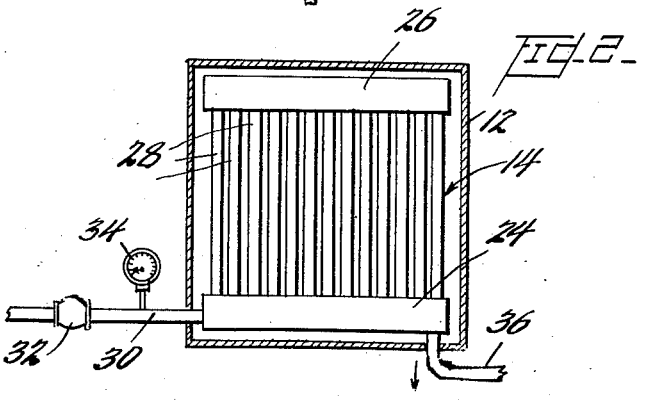


FIG. 2.



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AUTOMATIC CONTROL OF VENTILATION MEANS

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without payment of any royalties thereon or therefor.

This invention relates to thermostatic controls and particularly to thermostatic controls for heating and ventilating systems. More particularly, this invention relates to automatic controls for preventing the freezing of condensate in steam heating coils should the steam supply be reduced beyond a safe point.

Although not so limited, this invention has particular application to heating and ventilating systems aboard ice breakers and similar vessels. With such vessels, during normal cold weather operation, sufficient steam is supplied to keep the heater coils filled with steam except for a film of condensate on the inner surface thereof. The condensate drains off at a temperature only a few degrees below the steam temperature. Should the steam supply be reduced, the coils may be only partially filled with steam and the film of condensate in certain areas may freeze before draining to the coil header. If the steam supply remains inadequate over a considerable period, ice builds up on the inner surface and eventually brusts the coil. Service reports indicate that excessive pressure drops in steam heating lines occur frequently. This may be due, for example, to: (*a*) insufficient boiler capacity for the load; or (*b*) a reduction in steam generating capacity when one of two heating boilers is secured for overhaul.

Reports of arctic voyages on ice breakers indicate that air supply fans, in ventilation systems provided with preheaters, are generally stopped manually when the steam pressure is known to be down. Freezing is avoided by stopping the fans manually. However, in view of the difficulty in determining when the steam pressure at the coils is so low that there is danger of freezing, manual stopping of fans is not good insurance against damage to the heating coils. In addition, certain sections of the ship may be deprived of ventilation and heat over long periods to avoid freezing, when actually the weather temperature and steam pressure are such that the fans could be run safely. Another disadvantage of stopping fans manually to avoid coil damage is the additional training of personnel and complication to operating procedure entailed.

It is therefore an object of this invention to provide an automatic, anti-freeze control for heating and ventilating systems.

It is a further object of this invention to provide an automatic control for an air propeller or fan of a heating and ventilating system.

A further object of this invention is to provide an automatic control for stopping operation of a fan responsive to a low temperature condition.

A still further object of this invention is to provide an automatic control for starting a ventilating fan responsive to a rise in ambient temperatures.

Briefly, in accordance with this invention, provision is made for automatically stopping the air supply fan in a heating and ventilating system when the temperature of steam condensate in the heating coil drain falls below normal. An immersion type thermostat is installed in the heater drain between the heater and the trap. The thermostat actuates a switch to open the fan motor circuit and stop the fan when the temperature of the condensate falls below some predetermined point such as 150° F. By stopping the fan, air flow over the heater coil is stopped and heat transfer between the coil and ambient air becomes insignificant. Any condensate accumulating in the coil can then drain off before cooling to the freezing point.

Also, in accordance with this invention, provision is made for automatically bypassing the above mentioned thermostatic switch and maintaining the fan in operation for ventilation when there is no danger of freezing condensate in the heating coil. This second feature of the instant invention is accomplished by the provision of a second thermostatic switch in the fan circuit in parallel with the first switch and arranged to close this second fan circuit upon a rise in ambient temperature, as during moderate or warm weather operation when the steam supply valve is closed to the heating coil and there is no hot condensate in contact with the temperature sensing bulb of the first thermostat.

Other objects and advantages of the invention will hereinafter become more apparent from the following description and accompanying drawing, which illustrates a preferred embodiment, and wherein:

Fig. 1 is a diagrammatic view of a heating and ventilating system incorporating the present invention; and

Fig. 2 is a transverse vertical section taken on line 2—2 of Fig. 1.

The heating and ventilating system shown in the drawing includes an air duct **10** having a section **12** of relatively large cross section for the reception of a heating coil **14**, a section **16** of smaller cross-section for the reception of a motor-fan unit **18**, and a connector or reducing section **20**. As shown in Fig. 1, the inlet end of section **12** of the air duct is open and it projects through a weather bulkhead or outside wall **22**, while the outlet end of section **16** is connected to a suitable distribution system of ducts, not shown.

The heating coil **14** may be of any desired form and is shown in Fig. 2 as a steam coil including a lower header **24**, an upper header **26** and a plurality of risers **28**. A conduit **30**, having a thermostatic valve **32** and a pressure guage **34** therein, supplies steam from a suitable source to the inlet end of header **24**, while a drain conduit **36**, having a steam trap **40** therein, conveys condensate from the outlet end of header **24** to a condensate return or the like, not shown.

In accordance with this invention, the condensate drain **36** is provided with a somewhat enlarged vertical section **42** in which is located a temperature sensing bulb **46** of a thermostat **44**, which sensing bulb is held in proper position within section **42** of the condensate drain by a coupling, indicated generally by numeral **43**. The thermostat **44**, which is charged with a fluid that expands with rising temperature, includes the temperature sensing bulb **46** connected by a capillary tube **48** to an expansible-contractible bellows **50**. The bellows **50** is fixed at one end to a housing **52** and the other or free end is provided with a plunger **54** pivotally connected to an electric switch **56**, which switch is pivotally mounted within the housing and is biased toward open position by a spring **58**, which spring is provided with suitable adjusting means, not shown.

The electric switch **56** is adapted to open and close an electric circuit to the motor-fan unit **18**, which circuit includes a conductor **60** connected to a suitable source of electric current, a conductor **62**, a terminal **64**, switch blade **56**, a terminal **68**, a conductor **70**, a conductor **72**, the motor of the motor-fan unit **18** and a conductor **74**, back to the source of electric current. The thermostat **44** has a temperature range adjustable between 120° F.

and 210° F., is designed to close the switch 56 on a rise in temperature and, as pointed out hereinafter, in the particular installation is adjusted to open the motor-fan circuit and stop the fan when the temperature of condensate in drain 36 drops below 150° F.

A second thermostat 80, also in accordance with this invention, includes a temperature sensing element 82, connected by a capillary tube 84 to an expansible-contractible bellows 86. As shown in Fig. 1, the temperature sensing element 82 is placed in position to be contacted by outside air entering section 12 of the air duct, and, so as to have sufficient air contact or heat transfer surface, this sensing element is made in the form of a coil. The bellows 86 is fixed at one end to a housing 88 and the other or free end is provided with a plunger 90 pivotally connected to an electric switch 92, which switch is pivotally mounted within the housing and is biased toward open position by a spring 94, which spring is provided with suitable adjusting means, not shown.

The electric switch 92 is adapted to open and close a second and parallel circuit to the motor-fan unit 18, which second circuit includes the conductor 60, a conductor 96, a terminal 97, switch blade 92, a terminal 98, a conductor 99, conductor 72, the motor of the motor-fan unit 18 and conductor 74, back to the source of electric current. The thermostat 80 has a temperature range adjustable between 35° F. and 95° F., is designed to close the switch 92 on a rise in temperature and, as pointed out hereinafter, in the particular installation is adjusted to close the circuit and insure fan operation when the outside or weather temperature rises above 40° F.

In operation, assuming that the heating and ventilating system is operating in subfreezing temperatures, and, although the throttle valve in the steam line is open, insufficient steam is supplied to the heating coil so that, should the motor-fan unit continue to draw cold air over the coil, the condensate formed therein may freeze and burst the coil. Under these conditions when the temperature of condensate flowing over the sensing bulb 46 drops below 150° F., the thermostat bellows 50 contracts whereupon spring 58 opens the switch 56 thereby stopping the fan. By so stopping the fan, air flow over the heating coil is stopped and heat transfer between the coil and ambient air become insignificant. Any condensate accumulating in the heating coil can then drain off before being cooled to the freezing point. Following the opening of the fan circuit due to insufficient steam supply to the heating coil, when the steam supply is adequate and the temperature of condensate therefrom reaches 150° F., the circuit to the motor fan unit is again closed by the thermostat 44.

During moderate or warm weather operation when there is no hot condensate in contact with sensing bulb 46 of thermostat 44 and when the ambient temperature rises above 40° F., such temperature rise is reflected through sensing coil 82, capillary tube 84 and bellows 86 of thermostat 80, with the result that the switch 92 in the second motor-fan circuit is closed, the fan is energized and air for ventilation is circulated through the duct system.

It will now be observed that the present invention provides a simple and compact control for preventing the freezing of heating coils when insufficient steam is supplied thereto during freezing weather operations while providing for ventilations during warm weather operations.

While a single embodiment of the invention is herein illustrated and described, it is to be understood that various modifications may be made in the construction and arrangement of elements without departing from the spirit or scope of the invention. Therefore, without limiting myself in this respect, the invention is defined by the following claims.

What is claimed is:

1. A heating and ventilating system for an enclosure comprising an air duct having an air inlet open to outside air and an air outlet open to said enclosure, a heating element within said air duct, means for supplying steam to said heating element, conduit means for draining condensate from said heating element, an electric fan in said air duct for circulating outside air over said heating element and into said enclosure, and automatic control means for said electric fan, said control means including a first electric circuit for said fan, a first thermostatic switch in said first electric circuit and having a temperature sensing element in contact with condensate in said drain conduit for operating said switch for opening the first circuit to said electric fan responsive to a low temperature of condensate to thereby stop said fan, a second electric circuit for said electric fan, a second thermostatic switch in said second electric circuit and having a temperature sensing element in contact with outside air for operating said second switch for closing said second circuit to said electric fan responsive to a predetermined rise in temperature of outside air to thereby energize said fan.

2. A heating and ventilating system comprising a heating element, means for supplying steam to said element, means for circulating air over said element whereby the air is heated and the steam is condensed, means for draining condensate from said element, automatic control means operative responsive to the temperature of condensate drained from said element for controlling the operation of said air circulating means, said air circulating means includes an electric fan and an electric circuit for supplying current thereto, said automatic control means includes a thermostatic switch operative responsive to the temperature of condensate from said heating element for opening and closing the electric circuit to said fan, a second electric circuit for supplying current to said fan, and said automatic control means includes a second thermostatic switch operative responsive to the temperature of air circulated by said fan for opening and closing the second electric circuit to said fan.

3. A heating and ventilating system comprising a heating element, means for supplying steam to said element, means for circulating air over said element whereby the air is heated and the steam is condensed, means for draining condensate from said element, automatic control means operative responsive to the temperature of condensate drained from said element for controlling the operation of said air circulating means, said air circulating means includes an electric fan and an electric circuit for supplying current thereto, said condensate drain includes a conduit for draining condensate from said heating element, said automatic control means includes a fluid thermostat having a temperature sensing element in said condensate conduit in intimate contact with condensate flowing therethrough, a power element connected to said sensing element and operative responsive to changes in temperature of said sensing element as influenced by condensate flowing thereover and an electric switch in said electric circuit and operative by said power element for opening and closing the circuit to said electric fan, an additional and parallel circuit for supplying electric current to said fan, and said automatic control includes a second fluid thermostat having a temperature sensing element in contact with air prior to its circulation over said heating element, a power element connected to said temperature sensing element and an electric switch connected to said power element and operated thereby for opening and closing said parallel circuit.

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