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2,160,004

DEVICE FOR INDICATING THE PRESENCE OF NONCONDENSABLE GASES IN STEAM SYSTEMS

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2 Sheets-Sheet 1

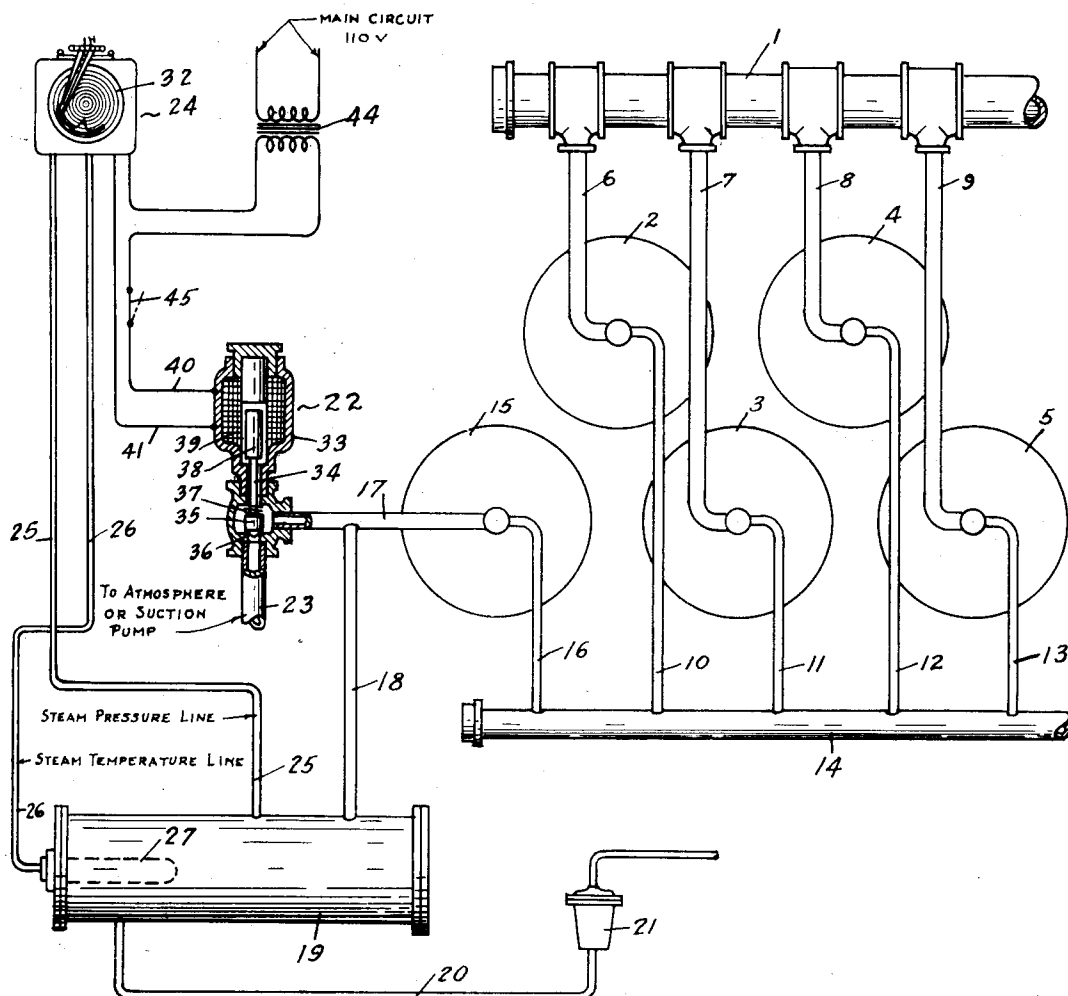


FIG. 1

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2 Sheets-Sheet 2

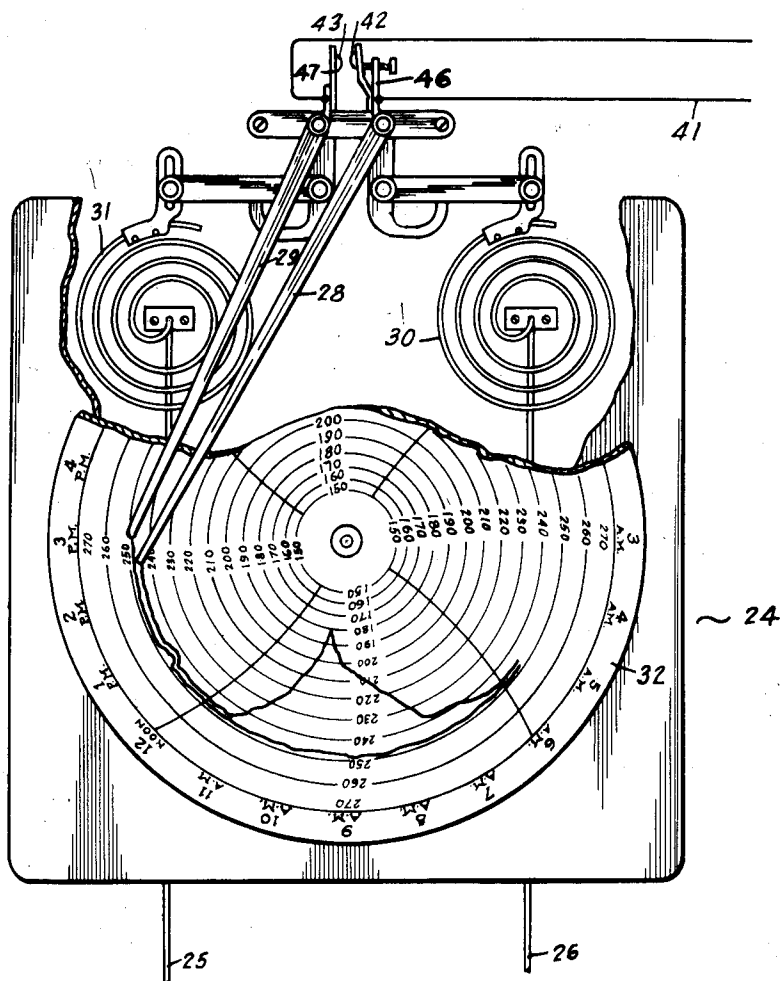


FIG. 2

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DEVICE FOR INDICATING THE PRESENCE
OF NONCONDENSABLE GASES IN STEAM
SYSTEMS

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Application February 21, 1936, Serial No. 65,169

4 Claims. (Cl. 237—68)

This invention relates to devices for detecting and indicating the presence of non-condensable gases such as air in admixture with condensable gases such as steam. More particularly stated, the invention relates to devices for detecting and indicating the presence of entrapped air in heating systems utilizing steam as the heating medium.

The invention also relates to devices for automatically removing or causing the escape of entrapped non-condensable gases such as air from heating systems containing steam.

Prior to the present invention most heating systems operated considerably below maximum efficiency due to the presence of entrapped air. This can be readily understood when it is considered that a single stroke of a bicycle pump will inject enough air into the drying apparatus of a paper-making machine to lower the temperature as much as 20° F. The keeping of entrapped air out of heating coils, evaporators and drying cylinders presented a serious problem due chiefly to the difficulty of detecting the presence of the air in admixture with the steam.

The principal object of the invention is to provide a relatively simple apparatus for detecting and indicating the presence of non-condensable gases such as air in admixture with condensable gases such as steam.

Another object of equal importance is to provide a device of relatively simple and inexpensive construction for detecting and indicating the presence of non-condensable gases such as air in systems containing steam.

Another object of the invention is to provide a device of relatively simple and inexpensive construction for indicating the amount of non-condensable gases present in an admixture of non-condensable gases such as air and condensable gases such as steam.

Another object of the invention is to provide a device of relatively simple and inexpensive construction for removing or causing the escape of entrapped air or other non-condensable gas from a system containing steam.

Still another object is to embody in a single instrument of relatively simple and inexpensive construction devices for performing any one or more of the foregoing objects and functions.

A further object is to provide a device for performing any one or more of the foregoing functions, of such construction that it can readily be applied to a heating system of conventional type without the necessity of making any radical changes in the construction of the system.

The invention is based upon the observation that the presence of air in a steam system causes a sharp drop in the temperature of the steam without materially affecting the steam pressure.

In its broadest aspects my invention consists in comparing the actual temperature of the system with the temperature that would prevail if no entrapped air were present. If the actual and theoretical temperatures of the steam are substantially the same, no air is present. If they are not the same, obviously an appreciable amount of air has been trapped and should be removed or permitted to escape. The difference between the two temperatures is a function of the amount of air present, and hence the drop in temperature affords a means for determining by the use of engineering data given in handbooks the amount of air that has been entrapped.

To summarize, my invention utilizes the simple principle of comparing two factors, one of which is the theoretical temperature corresponding to the actual steam pressure in the system and the other of which is the actual temperature prevailing in the system. In other words, I contemplate indicating the presence of entrapped air by showing the actual drop in steam temperature caused by the entrapped air.

The actual temperature prevailing in the system may be ascertained by means of a thermometer of conventional type or standard construction. The theoretical temperature corresponding to the steam pressure may be ascertained by means of a pressure gauge calibrated so as to indicate theoretical temperatures corresponding to steam pressures. The data for calibrating the gauge may be obtained from standard steam tables.

In one of the aspects of my invention, I contemplate incorporating the thermometer and the pressure gauge in a single compact instrument having a single common scale. In other words, I contemplate superimposing the readings of both devices on a single indicating scale, so as to facilitate comparing the two readings. The scale may advantageously take the form of a chart and the two devices may be provided with pens or other marking implements, in order that the differences in the two temperatures may be recorded for future reference. Of course, in the foregoing arrangement the two devices should be calibrated to the same scale, so that their readings may directly correspond with each other.

In another aspect of the invention, I contemplate utilizing the drop in temperature caused by the entrance of air into the steam system to open automatically a suitable form of valve to permit

the escape of the air. In using the device of the invention to operate a valve, it is not absolutely essential that a scale or chart be provided to indicate or record the differences between the actual and theoretical temperatures. Hence, the valve controlling device may be embodied into a very simple, inexpensive and compact instrument having no scale, chart and recording pens. However, I prefer for most practical purposes to construct the device with a chart and marking implements. Every automatic device requires a certain amount of watching and supervision, and a chart gives a daily record which will render certain that the device is operating satisfactorily and that the setting has not been accidentally changed. Furthermore, a condition will arise at various times when the air will accumulate in such quantities that the unit will not be able to cause its expulsion instantaneously. This condition will show on the chart, and as the air is expelled and the temperature brought back to normal a permanent record will be made thereof. The chart will therefore indicate the frequency with which the foregoing condition occurs as well as how close the operation is being handled. The device of the invention is applicable to various types of heating systems utilizing steam as the heating medium. For the purpose of illustrating the invention, they will be specifically described with reference to the drying apparatus of a papermaking machine.

Referring briefly to the drawings, Figure 1 is a view, more or less diagrammatic in its representation, of the device of the invention as applied to the drying apparatus of a papermaking machine, and

Figure 2 is a front view, partly broken away to show normally concealed portions, of the indicating and recording portion of the device.

Referring to the drawings in greater detail and more particularly to Figure 1 thereof, the numeral 1 designates the main header which supplies steam to each of the drying rolls 2, 3, 4 and 5 through the supply pipes 6, 7, 8 and 9 respectively. These drying rolls which will hereinafter be referred to as dryers discharge through their siphon pipes 10, 11, 12 and 13 respectively into the condensate header 14. The dryer 15 which is the first of the series of drying rolls shown in the drawings receives its steam directly from the condensate or return header 14 through the pipe 16, and in turn discharges its condensate through the return pipes 17 and 18 into the receiver 19, which serves as the control chamber for the device of the invention. The condensate from the receiver 19 passes to the hotwell (not illustrated) through the pipe 20 and the trap 21. Hence, any air which may be entrapped passes to the wet end of the paper machine and through the first dryer 15 into the control chamber 19.

It is to be noted that pipes 17 and 18 are joined so as to form a T, one horizontal end of the T being connected to the dryer 15 and the other end being provided with a valve which is indicated generally by the numeral 22. The construction of the valve will be hereinafter described. The valve may discharge either to the atmosphere or to a vacuum pump through the pipe 23.

The numeral 24 designates rather generally the detecting and indicating device. This device has two connecting lines 25 and 26 to the receiver or control chamber 19. The line 25 is a plain pipe connection between the chamber 19 and the pressure element of the device 24. Connection 26 is a

capillary tube from the temperature element in the device 24 to a sensitive bulb 27 which is positioned within the control chamber.

Referring now to Figure 2 of the drawings, it will be noted that the device 24 in its general form does not differ essentially from conventional forms of recording devices in general use in the industries for recording temperature or pressure readings. It will be further noted that the device is provided with two pens 28 and 29 and two actuating elements 30 and 31. The pen 28 is connected through suitable linkages to the actuating element 30 and the pen 29 is connected to the element 31. The element 30 is the temperature element and is connected to the capillary tube 26 while the element 31 is the pressure element and is connected to the connecting line 25. It is considered unnecessary to describe in detail the connections between the pens and their actuating elements as these are matters of design and do not constitute essential parts of my inventive concept. Likewise, it is not considered necessary to describe the clockwork mechanism for rotating the chart 32 on which the variations in readings are recorded. This chart is also of conventional form, being subdivided to indicate parts of a day and temperatures. As has been stated coil 30 is a temperature element and coil 31 is a pressure element. The coil 30 is calibrated so that the pen connected thereto records actual steam temperatures in the control chamber, while the coil 31 is calibrated so that the pen connected thereto records the theoretical temperature corresponding to the actual pressure in the control chamber.

As thus far described, the device may be used to indicate to the operator of the paper machine whether or not air has been entrapped in the system. He is therefore in a position to take the necessary steps to eliminate the air if it is shown to be present. For this purpose, the valve 22 may be of the manual type. For large plant operation, it is preferable that the valve be automatic in its operation or that it be capable of being operated both manually and automatically. Electrical valves of various types may be employed. The expansible diaphragm type of valve disclosed in Patent No. 1,225,887 issued May 15, 1917 to John H. Swan may be readily adapted for the purposes of the present invention.

Instead of using the type of valve disclosed in the aforesaid patent, I may employ a solenoid type of valve such as is illustrated in Figure 1 of the drawings. This valve is shown as having the body portion or casing 33, the stem or spindle 34, the valve disk 35 carried by the stem or spindle, the valve seat 36 to which the valve disk is normally urged by the spring 37 and the core 38 and the coil 39 of the solenoid which actuates the valve in order to expel the air which has been entrapped in the system. The numerals 40 and 41 indicate the wires carrying the source of current to the solenoid.

The wires 40 and 41 may be connected to suitable contacts 42 and 43 on the pens 28 and 29 and to a suitable source of electrical energy. The lighting circuit may, as shown in the drawings, be rendered suitable for the purposes of the invention by placing a transformer 44 in the circuit. A switch 45 may be interposed in the circuit so that the valve 22 may be rendered inactive whenever desired.

Referring to the contacts 42 and 43, it will be noted that they are carried by the arms 46 and 47 respectively. These arms constitute extensions

of the arms of the pens 28 and 29 respectively. Since they extend beyond the pivot points of the pen arms, it follows that the contacts tend to approach each other as the pen points separate and vice versa. In other words, as the actual steam temperature tends to drop, the contacts approach each other. One or both of the contacts may be adjustably mounted, so that they will touch at any given drop in actual steam temperature. For most purposes a setting so that the contacts will be closed when the actual steam temperature drops 10° F. is satisfactory.

The arm 46 should preferably be made of flexible material, preferably metal, so that after the contact has been made, the temperature pen may continue to drop if the temperature keeps on dropping. If both arms were of stiff material the temperature pen would be unable to drop any further after the contact is made. A stop may be provided to limit the travel of the temperature arm in case it is not considered necessary to record the drop in temperature below a given minimum.

In Figure 2 of the drawings the chart is illustrated as showing part of an actual day's record of the operation of the device. The outer wavy line is the theoretical steam temperature line and as should be expected is fairly constant, for the dryers of a papermaking machine are generally supplied continuously with steam at a constant pressure and this pressure is not appreciably affected by the presence of entrapped air. The inner line which represents the variations in actual steam temperatures shows a drop starting at about 6 A. M. which increases more or less rapidly until it reaches a maximum at about 10 A. M. This precipitous drop of about 70° clearly indicates that the unit was unable to expel all of the entrapped air as rapidly as it was being taken into the system. The chart also shows that the temperature rapidly went back to normal between 10 and 11 A. M., indicating that during this time the air was being rapidly expelled. Thereafter the actual temperature line followed the theoretical temperature line fairly closely, indicating that between 11 A. M. and 3 P. M. no appreciable amount of air was present in the system.

It will be understood from the foregoing description, that when the temperature pen 28 drops a predetermined amount depending upon the setting of the contact arms 46 and 47, the contacts 42 and 43 will be closed, actuating the solenoid and thus opening the valve 22 so that the entrapped air is permitted to escape. As soon as a sufficient amount of air is expelled to cause a separation of the contacts, the circuit is broken and the valve snaps shut. The opening and shutting of the valve is continued as often as sufficient air is entrapped and expelled to cause the requisite changes in actual steam temperature.

It is to be noted, as was previously pointed out, that when the device is to be used to actuate

an automatic or electric valve it is not absolutely essential that the device be provided with either an indicating or recording means. In other words, the two recording pens may be omitted, so that the two pivotally mounted contacts 42 and 43 are directly actuated by the coils 30 and 31. It is also to be noted that in actual practice, the actual temperature line may be recorded in blue or black ink, while the theoretical temperature line may be recorded in green or red ink to facilitate distinguishing between the two sets of readings.

The foregoing disclosure and description contain the essential and distinctive thought and concept which characterize my invention, but it is to be understood that my inventive thought and concept may be combined with other concepts and that its details may be modified in various ways or replaced by other details without affecting the peculiar results obtained and without departing from the spirit and the scope of the following claims, in which I intend to claim all the patentable novelty inherent in my invention.

I claim:

1. In a device of the character described, the combination with a system containing steam, an electrically operated valve to permit the escape of air from said system, a control chamber through which passes steam from said system, an electric circuit for actuating said valve, said circuit being normally open and having two movable contacts adapted to close said circuit, one of said contacts being actuated by changes in actual steam temperature within said control chamber and the other of said contacts being actuated by changes in actual steam pressure within said control chamber.

2. In the device defined in claim 1, each of said contacts being mounted on a pivoted arm.

3. In a device of the character described, the combination with a system containing steam, an electrically operated valve to permit the escape of air from said system, an electric circuit for actuating said valve, said circuit being normally open and having two movable contacts adapted to close said circuit, one of said contacts being actuated by changes in actual steam temperature within said system therefor and the other of said contacts being actuated by changes in actual steam pressure within said system therefor.

4. In a device of the character described, the combination with a system containing steam, an automatically operated valve to permit the escape of air from said system, a thermometer to measure the actual temperature of the steam within said system, a pressure gauge calibrated to indicate theoretical temperatures corresponding to actual steam pressures to measure the theoretical temperature corresponding to the actual steam pressure within said system and means controlled by a predetermined difference between the two measurements to actuate said valve.

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