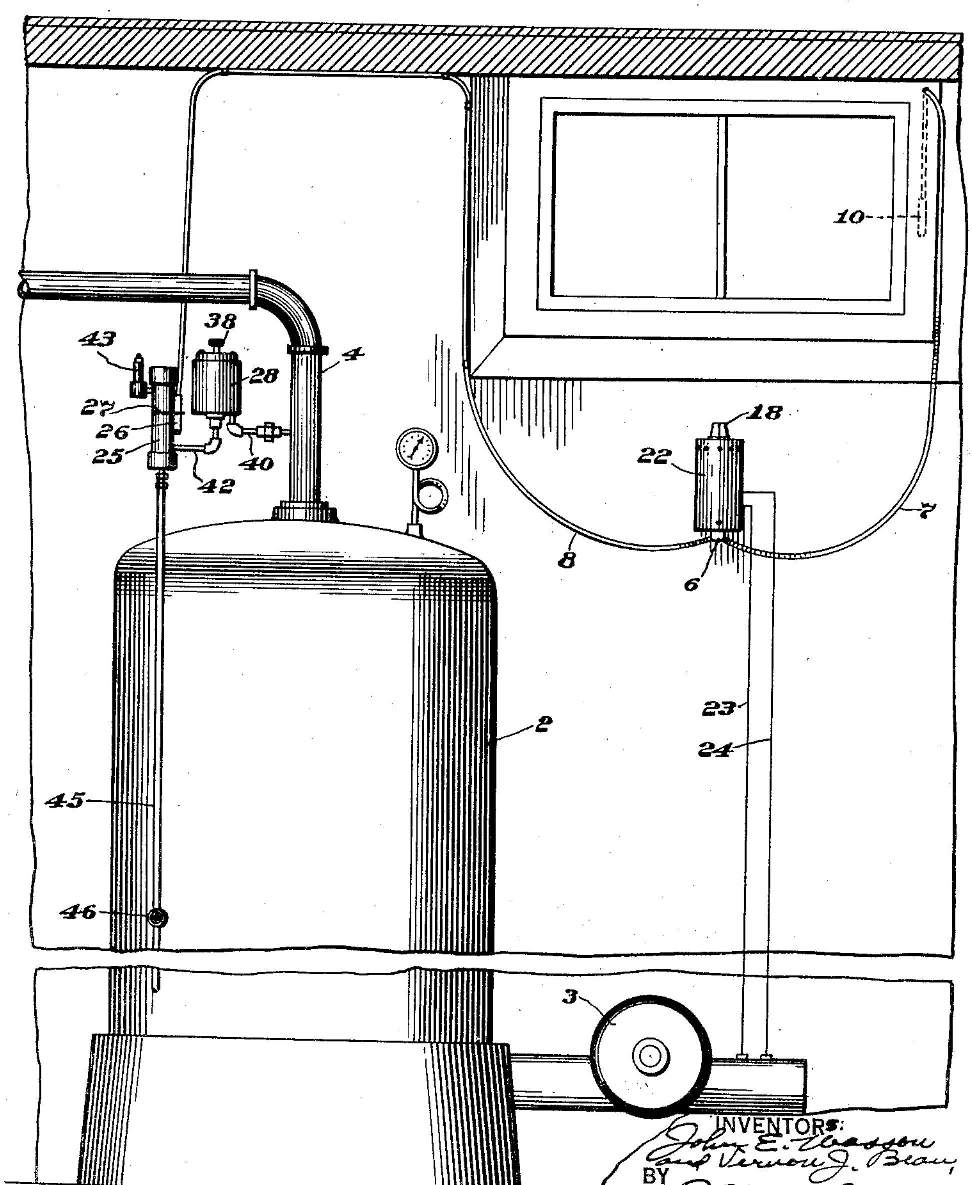
Aug. 2, 1938. J. E. WASSON ET AL 2,125,839

STEAM HEATING SYSTEM

Filed April 16, 1936 4 Sheets-Sheet 1

Fig.1



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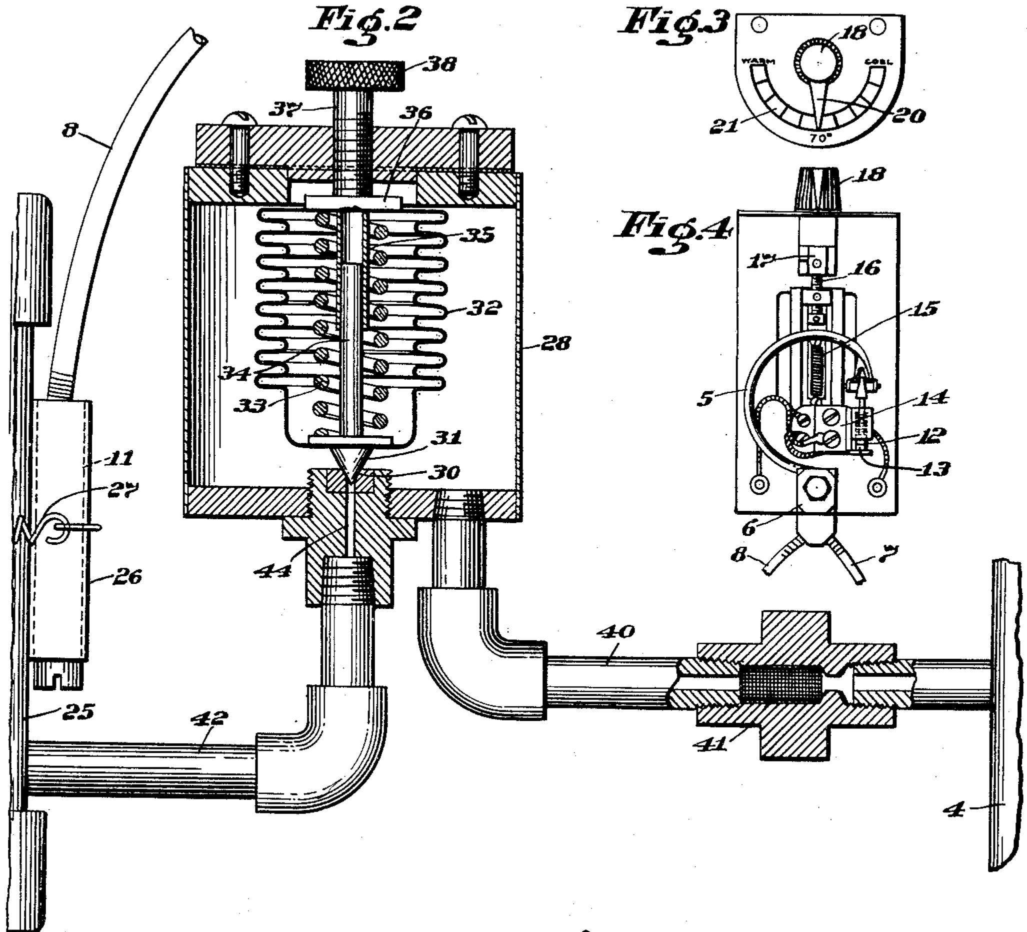
STEAM HEATING SYSTEM

Filed April 16, 1936 4 Sheets-Sheet 2

Fig. 2 Fig. 3 Fig. 4



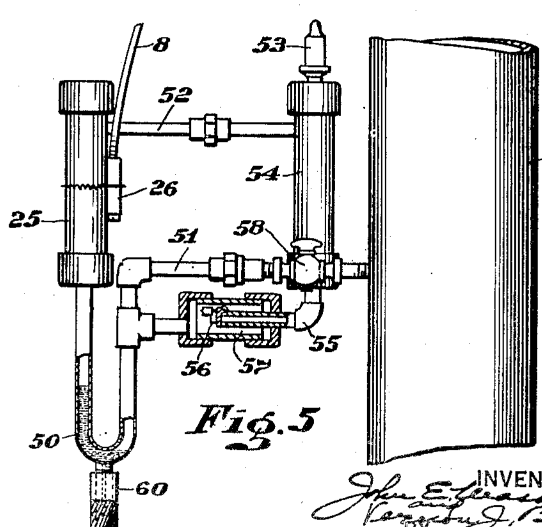


Fig. 5

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STEAM HEATING SYSTEM

Filed April 16, 1936 4 Sheets-Sheet 3

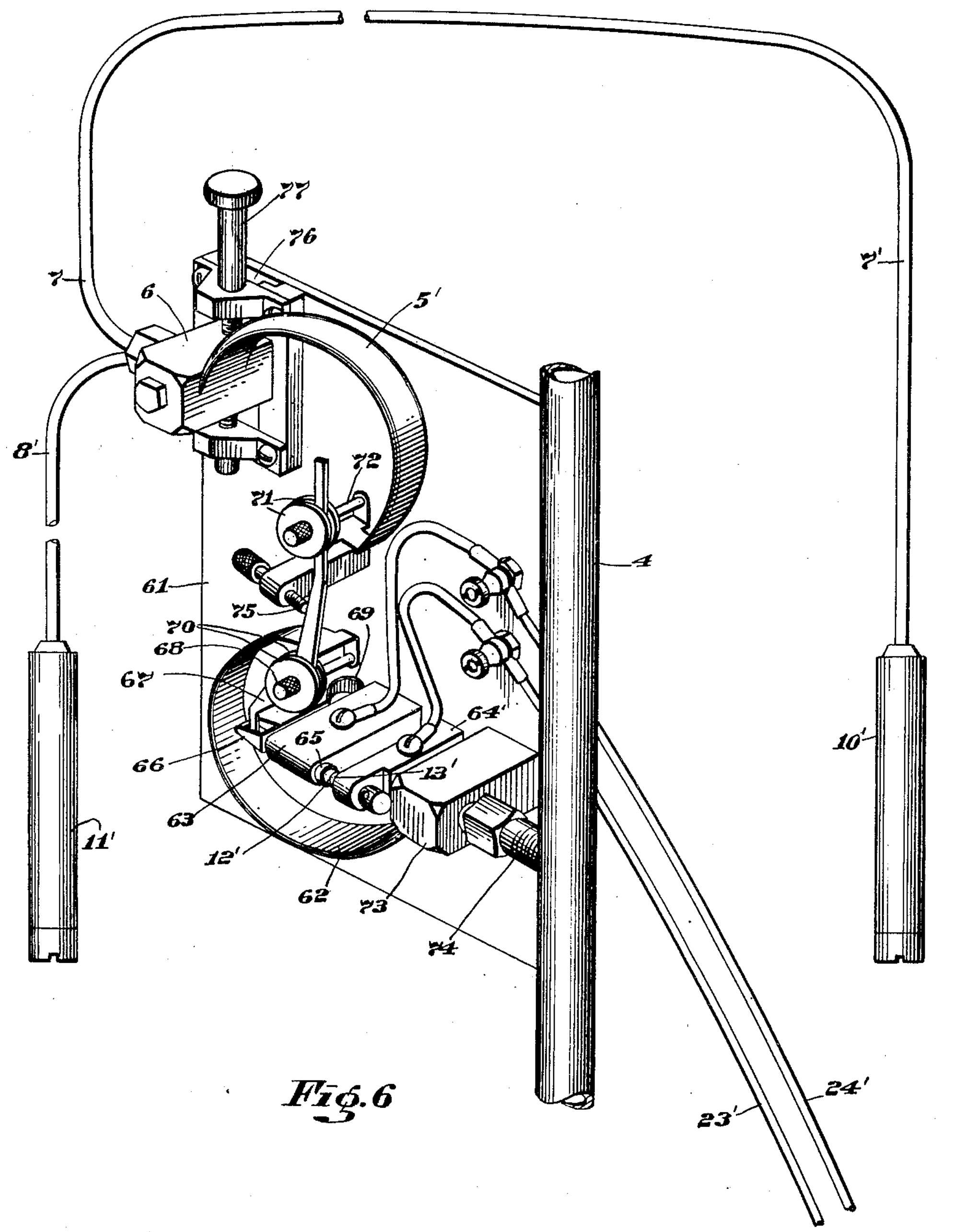

Fig. 6

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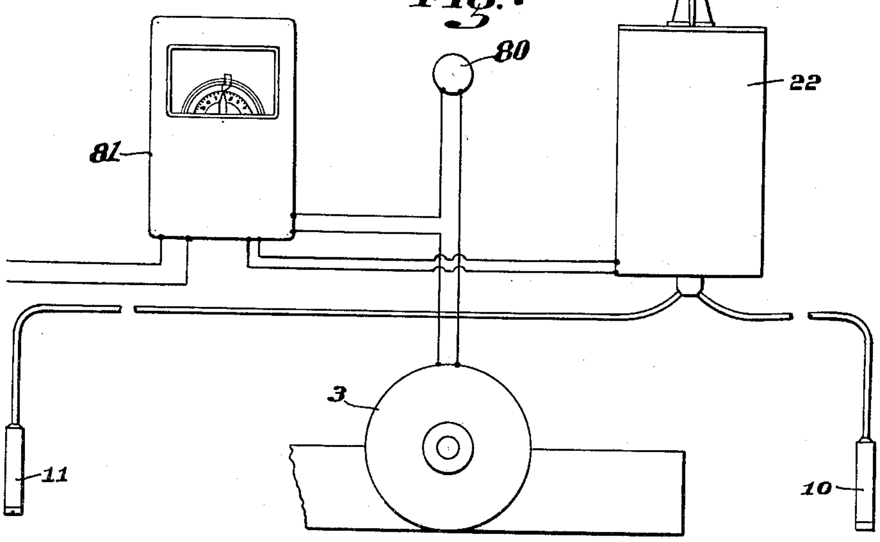
STEAM HEATING SYSTEM

Filed April 16, 1936 4 Sheets-Sheet 4

Fig. 7



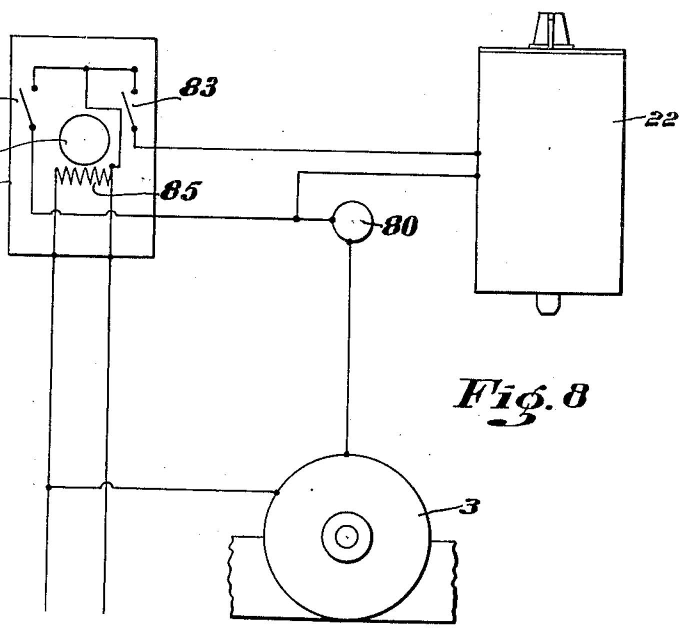


Fig. 8

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UNITED STATES PATENT OFFICE

2,125,839

STEAM HEATING SYSTEM

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Application April 16, 1936, Serial No. 74,718

6 Claims. (Cl. 236—91)

This invention relates to steam heating systems, and is more especially concerned with the control of the operation of such systems.

While the invention is applicable to heating systems used for a great variety of purposes, it will be herein disclosed as applied more especially to such systems designed for use in apartment houses, office buildings, and other situations in which essentially the same problems are involved. Installations of this character present difficult problems of control because of the fact that many of the radiators necessarily are located at much greater distances from the boiler, or other source of steam supply, than are others. Consequently, there is always a tendency, especially in severe weather, for the nearer radiators to rob those located more remotely. If a sufficient supply of steam is maintained to heat the rooms farthest from the boiler, then those located closer to it will be overheated, while if the steam supply is regulated to suit the requirements of the latter, the former will not heat sufficiently.

It has been attempted heretofore to remedy these difficulties by providing automatic means for effecting the control in response to temperature changes at some key room in the building which, it may be assumed, represents an average of the requirements for the entire building. In some cases this control has been combined with an outdoor thermostatic element so that the operation of the boiler would respond not only to temperature conditions inside the building, but also to those out of doors. A further modification of this type of control has been produced by either adding a third thermostatic element responsive to temperature changes in the radiator most remote from the boiler, or by placing the key room thermostat on, or close to, such a radiator. None of these arrangements, however, has proved satisfactory, largely because the requirements for heat vary so much in different parts of the building, and are affected to such an extent by changes in the wind, that the demands are constantly changing also in different locations. In addition, when a multiple control has been provided responsive to temperature conditions at different points, one of which is a remote radiator, or some other point on the steam heating system, the thermostatic element responsive to changes in temperature at this point is likely to assume an undesirable degree of control of the operation of the whole system. Upon a call for heat, the steam supply in the system is increased rapidly until it reaches the control point just mentioned, at which time there is a sudden increase in temperature in this part of the system from perhaps room temperature, or a value somewhat higher, to 212° F. The thermostatic element at this control point, therefore, quickly responds to this change in temperature and shuts off the steam supply before the radiators have had an opportunity to heat the remote rooms sufficiently.

The present invention is especially concerned with these considerations and the problems presented by them, and it aims to improve both the methods of controlling heating systems and the apparatus for performing these functions with a view to overcoming the difficulties above mentioned and providing a far more uniform control than has been produced heretofore.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawings,

Figure 1 is a side elevation, somewhat diagrammatic in character, illustrating a portion of a heating system and a controlling apparatus embodying features of this invention;

Fig. 2 is a larger view, partly in section, of parts of the control apparatus illustrated in Fig. 1;

Figs. 3 and 4 are plan and side views, respectively, of the head of the thermostatic controlling unit;

Fig. 5 is a side view, with parts in section, of another control apparatus;

Fig. 6 is a perspective view of another form of controlling apparatus.

Fig. 7 is a diagrammatic showing of a controlling apparatus embodying features of this invention, and a supplementary control arranged to cut the main control into and out of operation at predetermined times, and

Fig. 8 is a wiring diagram of the arrangement shown in Fig. 7.

Referring first to Figs. 1 to 4, the apparatus there shown comprises a steam generator including a boiler **2** equipped with an oil burner **3**. This installation may be of any suitable type, or it may be replaced with any other source of steam supply, such as that furnished by a central heating station. Leading from this generator is a riser or main pipe **4** for conducting steam to the distributing pipes leading to the various radiators.

A thermostatic control is provided for this steam supply, and this instrument also may take various forms, that shown preferably being essentially of the construction illustrated in the patent application of John E. Wasson, Serial No. 694,430, filed October 20, 1933. It comprises a Bourdon tube 5, Fig. 4, the lower end of which is secured rigidly to the upper end of a hollow cylinder or fixture 6 from which extend two capillary tubes 7 and 8, the former running to a bulb 10 located out of doors, and the latter to another bulb 11, Fig. 2, positioned at any desired location inside the building. The parts 5 to 11 are all filled with a temperature responsive liquid which may be of any suitable character as, for example, alcohol or petroleum distillate. A rise in temperature of this liquid will expand the Bourdon tube 5 and cause its free end to lift the movable contact 12 away from the stationary contact 13 and thus to open the circuit controlling the motor 3. This operation may be performed either directly or through the operation of an intermediate electric magnetic switch. The stationary contact 13 is mounted on a slide 14 working in a suitable guideway, and a spring 15 acts on this slide in a direction to hold it upwardly. The extent to which it can be raised, however, is controlled by the engagement of a screw 16 carried by the slide with a cam 17 mounted to revolve about a vertical axis, a knob 18 being secured to the upper end of the cam shaft and carrying a pointer 20, Fig. 3, riding over a scale 21, so that the operator or attendant can conveniently adjust the control to the desired temperature. Initial adjustment of the apparatus may be made by turning the screw 16 up or down. The cam face of the member 17 is positioned horizontally and overlies the upper end of the screw. Consequently, when the knob 18 is turned in a clockwise direction, Fig. 3, it brings a higher portion of the cam face over the screw 16 and results in moving the stationary contact 13 into a higher position, so that an increased pressure is required in the Bourdon tube 5 in order to lift the movable contact 12 away from the relatively stationary contact 13. The operating parts of this control instrument preferably are enclosed in a casing 22, Fig. 1. The contacts 12 and 13 are connected, respectively, to the conductors 23 and 24, Fig. 1, leading to the motor.

With this arrangement the closing of the circuit through the contacts 12 and 13 which occurs upon a reduction in temperature, and a consequent contraction of the tube 5, closes the circuit through the motor 3 and starts the generator into action. It will continue to run until the control circuit is opened by a rise in temperature sufficient to lift the contact 12 out of engagement with the contact 13.

So far as the foregoing arrangement is concerned, this construction is much like those used in prior control systems. It differs from these prior constructions, however, in that the indoor bulb 11, instead of being mounted in a key room, or on a remote radiator, or some similar location, is held substantially in contact with a small, supplemental steam radiator or chamber 25, the bulb being supported in a holder 26 which is held against the part 25 by a spring 27. It will be evident from Figs. 1 and 5 that the supplemental steam radiator 25 is so small by comparison with the riser 4 as to heat very quickly when steam is once admitted thereinto.

Steam is not allowed to enter this auxiliary radiator 25 at the same time that it flows into the rest of the system. On the contrary, an important feature of this invention resides in so controlling the admission of steam to this auxiliary chamber that the thermostatic element 11 will not be heated by the increased steam flow until such a length of time has elapsed as to ensure a flow of steam throughout the entire heating system. This result is conveniently accomplished by preventing any flow of steam into the chamber 25 until after a steam pressure has been created in the system sufficient to ensure its travel through all the radiators.

Referring to Fig. 2, the arrangement there shown for effecting this result comprises a pressure responsive valve indicated, in general, at 28 for controlling the flow of steam from the riser 4 to the chamber 25. This valve includes a seat 30, valve plunger 31 cooperating with said seat, a flexible diaphragm 32 in the form of a bellows, arranged to be operated by the steam pressure, and a spring 33 acting on the plunger 31 to hold it normally seated. The valve plunger stem 34 is guided in a tube 35 secured to the metal block 36 to which the upper end of the bellows also is fixed, and this block is secured to the lower end of a screw 37 which is threaded through the top of the valve casing and is provided with a knurled head 38 by means of which it may be turned. Steam flows into the valve casing through pipe connections 40 with the riser 4, a strainer 41 preferably being included in these connections, and when the valve is opened the steam flows through additional pipe connections 42 into the chamber 25. An air vent 43, which may be like those used on steam radiators, is connected to the top of the chamber 25 to permit the escape of air from this device.

When the steam generator has been brought into action by the thermostatic control, as above described, it continues to operate until a sufficient pressure has been built up in the entire system to enable the steam in the valve 28, acting on the diaphragm 32, to lift the valve plunger 31 off its seat. Steam then flows slowly through the connection 42 into the auxiliary radiator or steam chamber 25. After a time it heats this chamber sufficiently to cause the bulb 11 to operate the thermostatic control and thus to open the control circuit for the burner 3 and thus to stop, or at least greatly reduce, the generation of steam. The burner will not be brought into operation again until the temperature responsive elements 10 and 11 of the thermostatic control produce this result by closing the circuit through the burner control leads 23 and 24. This action will be produced by a drop in temperature outdoors, or the cooling of the entire heating system, including the auxiliary radiator 25, or some combination of these two factors.

It should be observed, however, that in a heating system equipped with this control, an increase in the supply of steam in the system will be created only in response to substantially predetermined temperature conditions. Also, that when the steam generating action has been initiated, it will continue in operation until a predetermined pressure has been created in the system. In other words, the generator is brought into operation in response to a drop in temperature, and its action is interrupted by a predetermined rise in pressure in the system. In the particular arrangement shown, the increase in pressure operates through the thermostatic control to shut down the generator, but the same action could be effected independently of the thermostatic control.

Various changes may be made in the control arrangement to suit the requirements of individual or local conditions. In the particular construction shown it is assumed that the generator will be located in the basement of the building heated by the system, and that the thermostatic control may also be located in the same place, suitable adjustments of both the thermostatic control and the pressure responsive valve **28** being made as the result of experience to give the desired results. The temperature in the basement will be approximately that of one of the rooms heated by the installation, and the auxiliary radiator **25** will cool off after being heated up at approximately the same rate as the radiators upstairs. The outdoor bulb **10** serves to anticipate the effect indoors of changes in outdoor temperature and either to cause the thermostatic control to initiate the generation of steam at a higher inside temperature when the outdoor temperature drops more rapidly than otherwise would be the case, or to delay such initiation if the outdoor temperature rises. If it is desired to make the thermostatic control respond in part to temperature conditions in some room other than the basement, that can be done by equipping the apparatus with a third thermostatic bulb connected with the part **6** by a capillary tube, or by making the member **6** large enough to perform the functions of the third bulb and locating the head of the instrument in the room which it is desired to use for control purposes.

In some cases, also, it is desirable to have a certain time lag after the necessary steam pressure has been built up in the system before admitting sufficient steam to the chamber **25** to cause it to operate the thermostatic element **11**. This result may be accomplished by throttling the flow of steam between the valve **28** and the chamber **25**, either through the use of a suitable valve in the pipe connection **42**, or by making the discharge opening **44** of the valve **28** so small in diameter that the desired throttling action will be produced. This is of advantage, for example, in a situation in which it is known that two pounds of pressure on the system will drive the steam through the most remote radiators, but an additional time factor is required in order to enable the radiators to heat up thoroughly before the generator will be shut down. Usually, however, this same result can be effected by adjustment of the screw **38** so that an additional pressure must be created before the valve plunger **31** will be lifted.

Attention is particularly directed to the fact that with this control arrangement the sysem goes through a definite cycle which, when once initiated, is independent of the temperature conditions in the rooms. That is, the generator is brought into action in response to a call for more heat. After its operation has been initiated, it will not be shut down until the predetermined minimum of steam pressure for which the control apparatus is set has been created in the system. This pressure is sufficient to drive steam through all of the radiators and to heat them all up thoroughly. Consequently, approximately the same supply of steam is delivered to each radiator throughout the building. Shortly after this steam pressure has been created the generator is shut down, and the radiators all begin to cool off at roughly the same rate. And this action continues until the thermostatic apparatus again calls for heat. This call is made partly in response to temperature conditions outdoors and partly to those indoors. If the weather is cold the cycles will be repeated much more frequently than when the weather is mild, but in each cycle a sufficient steam pressure will be created to supply heat to all of the radiators before the burner will be shut down. Thus more uniform temperature conditions can be maintained throughout the building than would otherwise be possible with any prior form of automatic control of which we have been able to learn. In addition, the attendant can readily make those adjustments necessary to modify the action of the control apparatus to meet unusual weather conditions.

The water trapped in the auxiliary radiator **25** may be led back into the boiler tube through a return line **45**, Fig. 1, this line being equipped with a check valve **46** to permit flow toward the boiler only.

When a heating system is designed for unusually low pressures, the pressure responsive valve mechanism above described may be replaced by an arrangement such as that illustrated in Fig. 5. Here the valve per se is replaced by a trap **50** consisting of a U-tube containing a sufficient quantity of mercury to prevent the passage of steam therethrough until a predetermined pressure has been created. A pipe **51** connects this trap with the steam riser **4**. When the pressure is sufficient to displace the mercury, as shown in Fig. 5, steam will begin to bubble through the mercury and thus will enter the auxiliary steam chamber **25**. Air from this chamber is vented through the pipe **52** and the air valve **53** (like the valve **43**), both these parts communicating with an upright section of pipe **54** which serves as a condensing chamber. The water of condensation flows out of the chamber **54** through the small pipe **55**, the end of which normally is closed by the weighted flap valve **56**. This arrangement is such that the valve will open automatically when the head of water in the condensing chamber rises to a predetermined point. Then the water will flow by gravity into the chamber **57**. At the completion of the cycle and after the system has cooled down, a partial vacuum will be created in the riser **4**, at which time the water in the chamber **57** will be drawn into the riser and returned to the boiler through the pipe **51**. The valve **53** should be so adjusted that enough leakage will be provided under these conditions to prevent the partial vacuum from drawing the mercury into the boiler. A valve **58** may be included in the pipe **51** to shut off communication between the trap **50** and the riser, when desired. Also, the trap may have a tubular extension projecting from the lower end thereof to receive a reserve body of mercury, a cap nut **60** being threaded into this extension so that by adjusting this nut the quantity of mercury in the trap may be varied, as desired. This control apparatus operates in essentially the same manner as that shown in Figs. 1 to 4.

As above pointed out, the burner may be shut down after it has once been brought into operation by means entirely independent of the thermostatic control. One arrangement for accomplishing this result is illustrated in Fig. 6. It comprises a thermostatic element similar to that shown in Fig. 4 for initiating the operation of the burner **3**, this apparatus including a Bourdon tube **5'**, a supporting block **6'** for the tube, and bulbs **10'** and **11'** connected with the Bourdon tube by means of capillary tubes 7' and 8'. All of these parts correspond to those indicated by the same numerals in Fig. 4, the bulbs being located and mounted as in the case of the heretofore described bulbs 10 and 11. The Bourdon tube 5' is mounted on a base plate 61, and a second Bourdon tube 62 also is supported on this plate. Likewise the plate carries two blocks 63 and 64, the former being drilled to receive the plunger 65, on the lower end of which the contact 12' is secured, while the latter supports the relatively stationary contact 13'. A spring enclosed within the block 63 acts on the plunger 65 to force it toward the contact 13' and thus to hold the two contacts normally closed. At its upper end the plunger carries a yoke 66 in which the end of a lever 67 rests, this lever being fulcrumed on a pin 68 carried by the free end of the Bourdon tube 62. It lies between spaced disks 70 which serve to give it lateral support, and it is provided with a tail piece which lies between similar disks 71 carried by a pin 72 secured to the free end of the Bourdon tube 5'.

The arrangement is such that upon contraction of the Bourdon tube 5' occasioned by a demand for more heat, the lower end of the lever 67 will be moved toward the stationary contact 13' and thus will allow the spring in the block 63 to close the contacts, provided they are already open. These contacts are connected to the conductors 23' and 24' leading to the burner and therefore result in closing the burner circuit and bringing it into operation. The other Bourdon tube 62 communicates with the riser 4 from the boiler 2, such communication being provided through the supporting block 73 and the connector 74. Consequently, as the steam pressure in the boiler rises, such pressure is transmitted to the Bourdon tube 62 and the expansion of said tube will carry the pin 68 outwardly, thus causing the lever 67 to come into contact with, and then to fulcrum on, the end of the stationary, but adjustable, screw 75, and to operate through the yoke 66 to move the contact 12' toward the left, thus breaking its engagement with the contact 13' and shutting down the burner. The pressure at which the burner will be shut off can be controlled by adjusting the screw 75.

In this controlling arrangement, therefore, the operation of the burner is initiated by a change in temperature, and is shut down directly by an increase in pressure, whether such pressure increase is that normally occurring in the system, or a pressure rise within the boiler proper. Preferably the fixture 6' is mounted on a slide 76, and an adjusting screw 77 is threaded through it and held against axial movement so that rotation of this screw will move the slide up or down and thus vary the leverage exerted by the Bourdon tube 5' on the lever 67. It should be understood that when this lever rocks in a clockwise direction, due to the expansion of the Bourdon tube 62, at which time it engages the screw 75, the tail piece of the lever may slide between the disks 71 away from the pin 72.

In some installations the supply of steam, instead of being generated in the boiler, is furnished by a central heating system, and in both such an arrangement and also in some generators, the control varies from a very low pressure designed to maintain a certain supply of steam, to a high pressure which increases this supply upon a demand for additional heat. In the case of a burner there is thus a high fire and a low fire, the latter being insufficient to supply the normal demands of the heating system. Also, in coal burning furnaces it is customary to have the automatic control run to the damper or dampers instead of to the burner motor. The control system above described is applicable to all of these arrangements.

While we have herein shown and described preferred embodiments of our invention, it will be understood that the invention may be embodied in a great variety of other forms without departing from the spirit or scope thereof. Also, that while the invention has been above disclosed as applied to a steam heating system, it is equally applicable to the so-called "vapor systems", the latter being the equivalent of the former, so far as this invention is concerned.

In some cases, as for example in office buildings, it is desirable to cut off the supply of steam altogether after a certain time, say eight o'clock in the evening, and to bring on the steam again the next morning in time to heat up the building completely prior to some specified time, say 8:30 a. m. During this heating up period, it is preferable to cut out the thermostatic control and to maintain a full head of steam substantially continuously, the heating system being then simply under the control of a pressurestat, or similar pressure responsive apparatus, which will prevent the steam pressure overrunning a certain value.

Such an arrangement may be conveniently combined with the apparatus above described in the manner illustrated in Figs. 7 and 8. Here the thermostat 22 is like that shown in Figs. 1, 3 and 4, and it is associated with a pressurestat 80 and a time switch 81. This mechanism 81 may conveniently include an electric clock, such as the well known "Telechron" clock arranged to operate two switches 82 and 83, Fig. 8, the rotor of the clock being designated diagrammatically at 84 and the field at 85. A time operated mechanism of this type is readily available and is so arranged that either switch can be opened or closed at any desired time. With the circuit arrangement illustrated, the burner motor 3 may be controlled either exclusively by the pressurestat 80 as, for example, during the heating up period in the early morning, as above described, or the thermostat 22 may be switched on, when desired as, for example, at the end of said heating period, and it will function, together with some such pressure responsive apparatus as those illustrated in Figs. 1 to 6, to control the supply of steam in accordance with temperature conditions but subject to the cycling function provided by the pressure responsive apparatus, as above described in connection with Figs. 1 to 6.

In a typical twenty-four hour run the time switch 81 would open both switches 82 and 83 at, say, eight o'clock in the evening, thus shutting down the entire heating system. At a predetermined time in the morning the clock would close the switch 82, thus starting up the burner and causing it to run, subject only to the control of the pressurestat 80. This condition would continue until a later predetermined time, say 8:30 a. m., when the time mechanism would open the switch 82 and close the switch 83, thus placing the burner under the control of the thermostat 22. This control would be continued until eight o'clock in the evening when the switch 83 again would be opened and the cycle above described would be repeated. During the day, however, the burner would be controlled by the thermostat 22 and the pressure apparatus used with it, exactly as above described in connection with Figs. 1 to 6. While this thermostat is in series with the pressurestat 80, the latter would not affect the operation of the other control since the pressurestat 80 opens the burner circuit only when necessary to prevent the maximum operating pressure in the system from being exceeded, and this would never happen except in emergencies so long as the apparatus 22 were in control of the situation.

Having thus described our invention, what we desire to claim as new is:

1. A controlling apparatus for steam heating systems comprising temperature responsive means controlling the increase and reduction in the supply of steam to the system, a steam chamber connected with said system to receive steam therefrom, said means including a temperature responsive element positioned to respond to changes in temperature of said chamber, and means for delaying the admission of steam to said chamber after an increase in the supply of steam to said system has been initiated and until a predetermined minimum steam pressure has been created in said system.

2. A controlling apparatus for steam heating systems comprising temperature responsive means controlling the increase and reduction in the supply of steam to the system, a steam chamber connected with said system to receive steam therefrom, said means including a temperature responsive element positioned to respond to changes in temperature of said chamber, and also including another thermostatic element responsive to outdoor changes in temperature, and means for delaying the admission of steam to said chamber after an increase in the supply of steam to said system has been initiated and until a predetermined minimum steam pressure has been created in said system.

3. A controlling apparatus for steam heating systems comprising temperature responsive means controlling the increase and reduction in the supply of steam to the system, a steam chamber connected with said system to receive steam therefrom, said means including a temperature responsive element positioned to respond to changes in temperature of said chamber, a valve controlling the admission of steam from said system to said chamber, said valve normally preventing such admission but being constructed and arranged to open automatically when the pressure in said system reaches a predetermined value.

4. In a steam heating system, the combination with a steam generator for said system, thermostatic means controlling the operation of said generator, a steam chamber connected with said generator to receive steam therefrom, said thermostatic means including an element positioned to respond to changes in the temperature of said chamber and also including another thermostatic element responsive to changes in outdoor temperatures, and means for delaying the admission of steam to said chamber after said generator has been brought into action until a substantially predetermined pressure has been created in said system.

5. In a steam heating system, the combination with a steam generator for said system, thermostatic means controlling the operation of said generator, a steam chamber connected with said generator to receive steam therefrom, said thermostatic means including an element positioned to respond to changes in the temperature of said chamber and also including another thermostatic element responsive to changes in outdoor temperatures, and a pressure responsive valve controlling the admission of steam from said generator to said chamber and normally closed to prevent such admission but operative to open automatically when a predetermined pressure has been created in said system.

6. In a steam heating system, the combination with a steam generator for said system, thermostatic means controlling the operation of said generator, a steam chamber connected with said generator to receive steam therefrom, said thermostatic means including an element positioned to respond to changes in the temperature of said chamber and also including another thermostatic element responsive to changes in outdoor temperatures, means for delaying the admission of steam to said chamber after said generator has been brought into action until a substantially predetermined pressure has been created in said system, an air vent for said chamber, and means for returning the water of condensation from said chamber to said generator, the latter means including a check valve for preventing a reverse flow of said water of condensation into the chamber.

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