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HEAT PRODUCTION CONTROL ARRANGEMENT

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Fig. 1

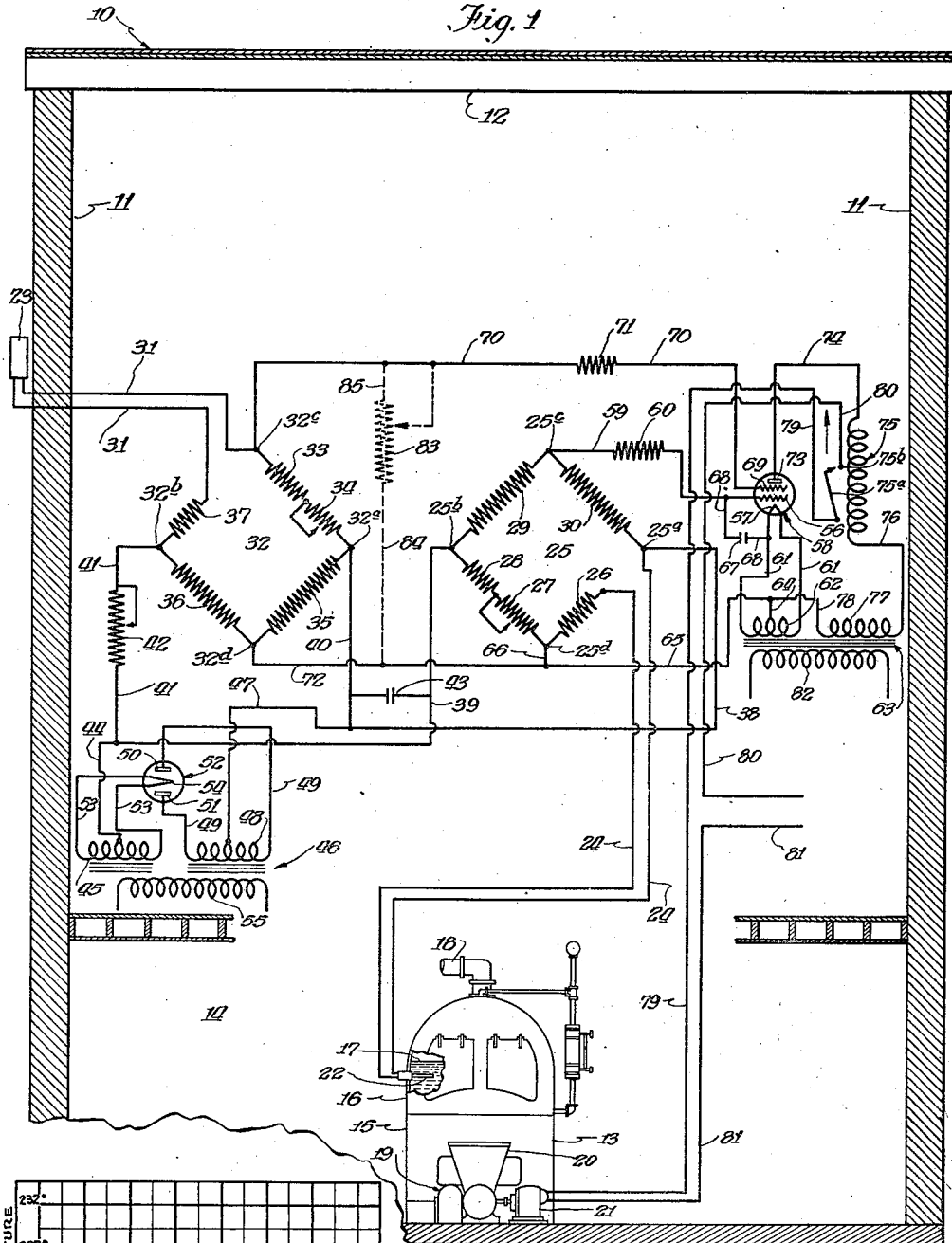
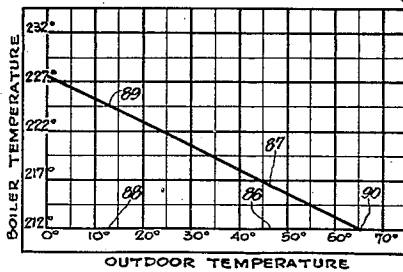


Fig. 2

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HEAT PRODUCTION CONTROL
ARRANGEMENTFrederick J. Weyher, Chicago, Ill., assignor to
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7 Claims. (Cl. 236—91)

My invention relates to an improved heat production control arrangement by means of which the rate heat is supplied to the interior of an enclosed structure is made approximately equal to the rate heat is lost from the structure to the outside at a certain desired inside temperature, whereby the interior of the structure is automatically maintained at the desired temperature.

It is an object of my invention to provide an improved heat production control arrangement of the type described, by means of which a building such as an office or apartment building may be economically heated with little or no variation of inside temperature notwithstanding the changeable external weather conditions to which the building is subjected.

It is another object of my invention to provide a heat production control arrangement of this type in which the adjusting means may be calibrated readily to cover the variety of conditions likely to be met in practice.

It is also an object of my invention to provide an arrangement of this type in which the latitude of adjustment in a single embodiment of the arrangement is such that it can be used with a variety of different types of heating systems, for example, with both steam and hot water.

It is a further object of my invention to improve arrangements of this type in sundry details hereinafter pointed out. The preferred means by which I have accomplished my several objects are illustrated in the drawing and are hereinafter specifically described. That which I believe to be new and desire to cover by Letters Patent is set forth in the claims.

In the drawing:

Fig. 1 is a vertical sectional view of a building structure having associated therewith an embodiment of my improved heat production control arrangement; and

Fig. 2 is a graph showing the relation between the outside temperature and the boiler water temperature for maintaining a certain steam heated building at a predetermined temperature.

Referring now to Fig. 1 of the drawing, 10 indicates a building structure which is enclosed by side walls 11 and a roof 12. The structure has a heating system therein which in the illustrated arrangement is of the steam variety and which includes a furnace 13 in the basement 14 of the structure. The furnace comprises a fire-box 15; a boiler 16 partially filled with water, the upper surface of the water or the water line being indicated at 17; and an outlet main 18 by means of which steam is fed from the boiler to the vari-

ous radiators (not shown) in the structure. The furnace 13 is equipped with an electrically operated stoker 19 which comprises a hopper 20, adapted to hold finely divided fuel such as coal, and an electric motor 21.

My improved arrangement is provided with two thermo-responsive regulating members, a boiler member 22 which projects into and through a side of the boiler 16 and an outside member 23 which is positioned outside of and adjacent the structure 10 on one of the side walls 11. Both of the thermo-responsive members are positioned such that they will be as closely as possible at the temperature of the immediate surroundings. The boiler member 22 is preferably a few inches below the water line 17 in the boiler and is not immediately adjacent to the flues. The outside member 23 is preferably located such that it is not exposed to the sun and is not unduly exposed to the wind. The regulating members 22 and 23 each comprise, in the illustrated embodiment of my arrangement, a resistance element which has a comparatively high temperature coefficient of resistance; that is, the change of resistance of each member is comparatively great with a change of the surrounding temperature.

The boiler member 22 is connected by means of leads 24 into one arm of a Wheatstone bridge structure 25 comprising resistance elements 26, 27, 28, 29 and 30. The outside member 23 is connected by means of leads 31 into a similar Wheatstone bridge structure 32 comprising resistance elements 33, 34, 35, 36 and 37. As is shown, the resistance elements 27 and 34 are adjustable; that is, their resistance values may be changed at will. A uni-directional electric potential is applied across one diagonal of each of the bridges, across bridge 25 between points 25a and 25b by means of leads 38 and 39 and across bridge 32 between points 32a and 32b by means of leads 40 and 41. An adjustable resistor 42 in lead 41 is connected in series with the bridge 32, and a filter condenser 43 is connected between leads 39 and 40, as shown. Leads 39 and 41 are commonly connected to a lead 44 which is center-tapped to a secondary winding 45 of a transformer 46. Leads 38 and 40 are commonly connected to a lead 47 which is center-tapped to another secondary winding 48 of the transformer 46. The terminals of the secondary winding 48 are connected by means of leads 49 with the plates 50 and 51, of a double wave rectifier tube 52. Leads 53 connect the cathode 54 of the tube 52 with the secondary winding 45,

the cathode being supplied with current thereby. The primary winding 55 of the transformer 46 is connected to a source of alternating current of a suitable voltage and frequency.

The bridge 25 across its diagonal between points 25c and 25d is connected in series with and between the control grid 56 and the cathode 57 of a gaseous discharge tube 58. The grid 56 is connected to point 25c by means of a lead 59 having therein a stabilizing resistor 60. The cathode 57 is connected to the point 25d by means of leads 61, the secondary winding 62 of a transformer 63, and leads 64, 65 and 66. As shown, the lead 64 center-taps the secondary winding 62 which by means of leads 61 supplies energy to the cathode 57 for heating it. Between the cathode 57 and the grid 56 is connected a condenser 67 by means of leads 68, as shown.

The bridge 32 across its diagonal between points 32c and 32d is connected in series with and between the control grid 69 and the cathode 57. The grid 69 is connected to the point 32c by means of a lead 70 having therein a stabilizing resistor 71. The cathode 57 is connected to the point 32d by means of leads 61, the transformer winding 62, and leads 64, 65 and 72. Connected to the plate 73 of the tube 58 by means of a lead 74 is a relay 75. In series with the relay by means of lead 76 is connected a secondary winding 77 of the transformer 63, the winding 77 being in turn connected to the center-tap 64 by means of a lead 78. The relay contactor 75a actuated by the armature (not shown) of the relay 75 is connected by means of lead 79 with the motor 21. Between the lead 80 which is connected to the stationary contactor 75b of the relay and the lead 81 which is connected to the motor 21 is applied a voltage having a value suitable for operation of the motor. The primary winding 82 of the transformer 63 is connected with a source of alternating current of a suitable frequency and voltage.

The adjustable shunting resistance 83 which is connected between leads 70 and 72 by means of leads 84 and 85 may be used instead of or in addition to the adjustable resistor 42 and for the same purposes which are hereinafter stated.

My improved arrangement maintains a substantially constant inside temperature by causing the rate of heat supplied to the interior of a structure to vary with the outside temperature and to be maintained approximately equal to the rate of heat loss of the structure at the desired inside temperature. In Fig. 2, for a certain steam-heated building, as an example, I have shown a graph illustrating how the boiler temperatures should be varied as the outside temperature varies in order that the rate of heat supplied will be properly varied. My improved arrangement automatically causes the temperature of the supply to vary properly with the outside temperature.

The rectifier comprising the tube 52, the transformer 46, and the filter condenser 43 is of an ordinary and well-known type and supplies a substantially unilateral voltage across the diagonals of the bridges 25 and 32 between their points 25a and 25b and between 32a and 32b, respectively. In the embodiment of the control arrangement shown, the voltages of points 25b and 32b are positive with respect to points 25a and 32a, respectively.

Normally the bridges 25 and 32 are unbalanced such that there is a voltage across the diagonals of the bridges between points 25c and 25d and

between 32c and 32d. Since points 25c and 32c are connected to grids 56 and 69, respectively, and since the points 25d and 32d are connected to the cathode 57, the voltages across the diagonals of the bridges formed by these points are impressed between the grids 56 and 69, respectively, and the cathode 57.

The gaseous discharge tube 58 is so constructed that an arc will not be formed between the cathode 57 and the plate 73, and hence no plate current will flow, unless the effective sum of the bias voltages between the grids 56 and 69 and the cathode 57, both voltages being reduced to a common base, is sufficiently positive. Depending on the construction of the tube, one grid may exert more influence than the other; that is, a change of one volt in the positive direction on grid 56 may cause the plate current to flow while it may require a change of two volts in a positive direction on grid 69 to accomplish the same result. For this reason, in order to reduce the bias voltages to a common base and to determine their effective sum, it is necessary to multiply each value by an appropriate constant before adding. In any event, if the voltage on one grid is constant, the voltage on the other grid must be more positive than a certain critical value in order that plate current may flow. In the illustrated form of my arrangement, a gaseous discharge tube having negative break-down characteristics is used; that is to say, a tube in which the grid biases are negative at break-down for most of the values of plate voltage which may be used.

The stabilizing resistors 60 and 71 are used to protect the tube 58 by limiting the current to the correct values in the grid circuits. The condenser 67 is used to hold the voltage on the grid 56 steady in spite of the plate to grid capacitance and is particularly useful in protecting the tube against voltage surges.

The temperature of the outdoor thermo-responsive member 23 determines its resistance, the magnitude of the unbalance of the bridge 32, and thus the voltage on the grid 69 with respect to the cathode 57. The temperature of the boiler thermo-responsive member 22 determines, similarly, the voltage on the grid 56 with respect to the cathode. Assuming that the heat production control arrangement has been adjusted to correspond to the curve shown in Fig. 2, the method of adjustment being hereafter described, and assuming that the outside temperature is constant, for example at a point 86 on the graph of Fig. 2, if the boiler water temperature is slightly higher than the corresponding point 87 on the curve, the resistance of the boiler member 22 is comparatively high and there is a comparatively large unbalance in the bridge 25. The voltage bias on the grid 56 is then more negative than the critical discharge value for that grid at that particular outside temperature and at the corresponding voltage on the grid 69, and no plate current flows. However, when the water in the boiler portion has lost a certain part of its heat, for example to a point slightly below the point 87, the boiler thermo-responsive member has decreased in resistance, producing a smaller unbalance of the bridge 25 and a voltage more positive than the critical value is impressed on the grid 56. Plate current now flows; the relay is energized; the contacts 75a and 75b are closed; and the circuit comprising the motor 21 and the source of alternating current applied between the leads 80 and 81 is completed. The

motor then is operative and fuel from the hopper 20 is fed into the fire-box 15 of the furnace. The added fuel produces a hotter fire and the temperature in the boiler 16 becomes higher.

When the water in the boiler 16 has risen to a point slightly above the point 87, the resistance of the boiler member 22 is increased, and the bridge 25 is more greatly out of balance with a resultant more negative voltage bias on the grid 56. At this point the grid bias is more negative than the critical value for that grid at the particular outside temperature, the discharge and plate current through the tube will have ceased, similar to any ordinary gaseous discharge tube with plate and cathode connected to an alternating current source, and the contactors 75a and 75b will have been opened by a spring (not shown) in the relay 75. The motor then will have stopped, and no more fuel will be fed into the fire-box 15. When the boiler water again cools to slightly below point 87, the cycle of operations is repeated. Thus the bridge 25 and the boiler thermo-responsive member 22 function to maintain the boiler temperature on an average at a point 87 on the graph of Fig. 2, this point corresponding to the outside temperature indicated at 86.

When the temperature of the outside thermo-responsive member 23 falls, to a point 88 for example on the graph, the resistance of the member is less; there is less unbalance of the bridge 32; and the grid 69 becomes more positive. This change of bias voltage causes the critical voltage on the grid 56 to change and become more negative. Assuming the tube operative, the water in the boiler 16 must now become hotter to a point slightly above the point 89, corresponding to the point 88, thus producing a greater unbalance of the bridge 25 before the voltage on the grid 56 is sufficiently negative to cause the discharge through the tube to cease. By the action of the bridge 25 and the boiler member 22 the boiler temperature is kept on an average at the higher value 89; the resultant average steam pressure is higher; and more heat is being delivered to the interior of the building. When the outside temperature rises again to the point 86, for example, the resistance of the outside member 23 is higher, there is a greater unbalance of the bridge 32, and the grid 69 becomes more negative. This causes the critical voltage of grid 56 to again become more positive with a resultant decrease in the average boiler temperature to the corresponding point 87. The average boiler pressure and the quantity of the heat delivered to the interior of the building are correspondingly decreased. In effect then, the outside temperature responsive member 23 and the bridge 32 function to set the rate or pace of heat production, or in other words cause the average temperature of the boiler to be changed as the outside temperature changes, the average boiler temperature at any particular time being that shown corresponding to the outside temperature at that time.

Each of the bridges 25 and 32 may be adjusted to the correct magnitude of unbalance by means of adjustable resistors 27 and 34, respectively. Referring to the graph of Fig. 2, adjusting the resistor 34 has the effect of moving the point 90, as well as the curve as a whole either to the left or to the right, the point 90 being the intersection of the curve with the horizontal axis of the graph. Adjusting the resistor 27 has the effect of moving the point 90 as well as the whole curve

either up or down and selects the range of water temperatures at which the heating system shall operate. Adjusting the resistor 42 has the effect of rotating the curve either clockwise or counter-clockwise about the point 90 or in other words it changes the number of degrees rise of the water in the boiler corresponding to 1° drop of the outside temperature. Functionally the resistor 42 acts to change the voltage input to and the voltage output of the bridge 32 and also the rate at which the critical voltage value of the grid 56 changes with the outside temperature.

My improved heat production control arrangement does not rely on a change of inside temperature to cause a change in the rate heat is supplied, but rather maintains a substantially constant inside temperature by causing the rate heat is supplied to vary properly with the outside temperature. The heating system operates economically since the excess heat losses of the building at higher than normal inside temperatures are avoided. My improved arrangement may be quickly and easily installed since the adjusting means may be readily calibrated, and the latitude of adjustment in a single embodiment of my arrangement is such that it can be used with a variety of different types of heating systems.

While I prefer to employ the form of arrangement as shown in my drawing and as above described, it is to be understood that my invention is not to be so limited except only in so far as certain of the appended claims may be so limited, as it will be understood that changes in the form of arrangement may be made without departing from the spirit of my invention.

I claim:

1. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means for adjusting the relation between the responses of said input circuits to said heat source and outside temperatures.

2. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means including a resistor connected in shunt to one of said input circuits for adjusting the relation between the responses of said input circuits to said heat source and outside temperatures.

3. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube pro-

vided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, a potential source connected to energize said bridge circuits, and means including a resistor connected between said potential source and one of said bridge circuits for adjusting the relation between the responses of said input circuits to said heat source and outside temperatures.

4. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means for adjusting the rate at which the voltage of one of said input circuits changes in response to change in temperature.

5. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another

bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means for adjusting the rate at which the voltage of said outside temperature responsive input circuit changes in response to change in outside temperature.

6. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means including a capacitor connected in shunt to one of said input circuits for protecting said electron tube against surges in the voltage applied thereto.

7. In a system for controlling the heat supplied to a heated structure from a source provided with temperature control means including an electric switch, the combination of an electron tube provided with an output circuit including means for controlling said switch and with a pair of input circuits, means including one bridge circuit for applying to one of said input circuits a potential which is responsive to the temperature of said heat source, means including another bridge circuit for applying to the other of said input circuits a potential which is responsive to a temperature outside said structure, and means for adjusting the magnitude of the unbalance of said bridges.

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