This invention relates to heating systems and is for an automatic control by means of which a heating system can be operated in accordance with variations in outdoor temperature conditions to maintain substantially even indoor temperatures.

The present invention is applicable to various types of heating systems utilizing steam, hot water or hot air or any other fluids. It has particular utility where steam is used as the heating medium and where provision is made for the purchase of steam from a central power plant, and in multiple zone heating systems where the maximum boiler capacity may be kept to a minimum. In the present specification, the invention is referred to primarily in connection with such systems, but this is merely by way of illustration and not by way of limitation. Moreover, the invention has particular utility in connection with the heating of relatively large buildings, where it produces the most advantageous results, but it, of course, is applicable also to the heating of smaller buildings and establishments.

In the heating of buildings, such as hotels and office buildings, where steam is purchased from an outside source, it has been found uneconomical to have the steam radiators continuously connected with the steam supply lines. The reason for this is that individual rooms become overheated, and the occupants, instead of turning off the radiators, open the windows. Individual thermostat control for each room or for each radiator is not only very expensive, but requires considerable repair work in keeping the individual systems and thermostats in proper adjustment and proper working order. It is, therefore, the practice to turn the steam on intermittently. One way of doing this is to rely upon an engineer to turn on a central steam valve at predetermined intervals according to a pre-arranged schedule. Another system in wide usage is to provide a single thermostat in one room of a building. When the temperature in that room drops to a predetermined amount, the thermostat turns on the steam for the entire building or for that portion of the building which it is designed to control. When the temperature of the individual room becomes normal, the thermostat shuts off and the supply of heat is discontinued. This system has very definite disadvantages for the reason that the occupant of that room, feeling overheated, may open a window causing the thermostat to call for steam, whereupon the entire building may be excessively overheated. A further disadvantage is that during the night, the building is kept at a low temperature and in the morning the building has to be heated up. The thermostat will not shut off the steam until it has been brought up to temperature. When it reaches temperature, it shuts off the steam, but 5 the steam in the radiators condenses and the metal of the radiator itself has a considerable capacity, so that heat continues to be emitted for a considerable time after the thermostat shuts off, resulting in excessive overheating in the early part of the day.

The present invention contemplates the provision of a control whereby there is a periodical operating means for turning on the steam and whereby the length of time that the steam remains on is controlled by the outside temperature. That is to say, that as the weather outside becomes colder, the rate of heat loss from the building increases. The present invention compensates for this by increasing the length of time for which the steam is turned on during each operating interval with increasingly lower outside temperatures. The invention further contemplates that means may be provided through which the periodical operating means is regulated so that if the inside temperature is such that the building does not require heat for the full time or for any of the time during which the periodical operating means would ordinarily supply heat, the supply of heat will be reduced or the period of operation delayed or the actuation of the supply valve entirely omitted.

In the operation of heating systems, it is also practical to maintain the temperature of the rooms lower at night than during the daytime. This means that in the early morning there must be a heating up period wherein the temperature of the building is brought up to the temperature at which the building is to be maintained during the day. The present invention provides a means operating in conjunction with the first period operating means for keeping the heat on during this heating-up period over a long time interval and for a period which varies according to the outside temperature, the heat being turned on longer when the weather is cold than when the weather is moderate.

The invention further contemplates a system whereby an automatic cut-over from the temperature of day operation to the temperature of night operation and back to day operation, is provided according to a pre-arranged schedule. In addition to this, the system is manually adjustable for regulating the inside temperature, so that by manual adjustment more or less heat
can be secured according to the desires of the occupants or as conditions may demand. The means for effecting these results is relatively simple, positive in operation, and can be easily installed on present heating systems, and takes care of infinite variations in the outside temperature from a point well below zero to a point up to the maximum at which artificial heating of the building is required. That is to say, when the outside temperature is such that heat is not required in the building, no heat will be supplied. Over the range of temperatures at which the system is designed to supply heat, it will function over infinite variations. Moreover, the system is so arranged and constructed that it will accurately respond to very slight variations in the outside temperature.

Purchasers of heat are sometimes charged for the service on the basis of the maximum peak demand. If the building at its maximum demand requires a considerable quantity of steam, it is obvious that the power generating station must have a capacity for this maximum. The present invention contemplates a system wherein the maximum demand can be made very much lower, while the same quantity of heat in a given period of time is the same, thus enabling the purchaser to contract for the purchase of heat on the basis of a low maximum demand rather than on the basis of a high maximum demand. A similar saving is also possible in a building heated from its own boilers, as the maximum capacity of the boilers can be materially less.

This is effected according to the present invention by the dividing of the heating system into two or more zones, and the progressively turning on of the heat in the different zones, rather than supplying the maximum amount of steam to the entire system at one time.

The invention may be readily understood by reference to the accompanying drawings, in which Figure 1 represents a front elevation of a control panel embodying the present invention.

Figure 2 is a top plan view of the mechanism shown in Figure 1.

Figure 3 is a vertical transverse section in the plane of line III—III of Figure 2, showing the temperature arm in a position off the operating cams.

Figure 4 is a view similar to Figure 3 showing the temperature arm engaging one of the cams;

Figure 5 is a more or less schematic layout of the entire system, including the control panel, time switch and motor driven valve;

Figure 6 is a plan view of a modified form of control panel;

Figure 7 is a plan view of still a further modification of a control panel in which a cam instead of a time switch is used for changing from day to night operation, and vice versa;

Figure 8 is a side elevation of a part of the mechanism shown in Figure 7;

Figure 9 is a schematic view illustrating one form of valve operating mechanism and the circuit therefor, this view being complementary to Figure 5.

Referring first to Figures 1 to 5, inclusive, 2 designates a panel or supporting base. Mounted on this panel is an electric or other clock 3 which drives two concentric shafts similar to the two shafts for the hands of an ordinary clock. The outer shaft is a sleeve and carries a cam 4. The inner shaft is in the form of a spindle and it carries a second cam 5. The clock arrangement is such that the cam 4 is rotated through a complete circle every twenty-four hours, while the cam 5 is rotated through a complete circle at more frequent intervals. For purposes of illustration, it may be assumed that the cam 4 is rotated once every hour, although the frequency of rotation can be changed and shortened where desired, according to the demands of the particular building which is being heated. The clock arrangement is conventional and the speed at which the cam 5 is rotated can be determined by the construction of the clock. Ordinarily, however, it is desired that the cam 4 shall have an exact twenty-four hour period of rotation.

Secured to the base 2 is a bracket 6 having a 15 foot portion 7 which rests on the base and through which the screws or bolts which secure it in place are passed. This is best shown in Figure 2. The outer end of the bracket or arm 6 is provided with a horizontally extending portion 8 having an inwardly turned ear 9 at the free end thereof. Carried on this bracket structure and in longitudinal alignment with each other are opposed pivot members 10 which support a tiltable yoke member 11, the member 11 having two ears 12 thereon through which the inner ends of the pivots pass. The tiltable yoke member has a flat extension 13 thereon which carries two clips. In each of these clips are mercury tubes 14 and 15 of a type well known to those familiar with the art. As shown in Figure 2, the tube 14 has its contacts at one end while the tube 15 is arranged with its circuit closing contacts at the opposite end. One of these tubes, as shown in Figures 3 and 4, is always at an angle to the other. The balance of the pivoted yoke member 11 with its contact tubes is such that the member 11 normally assumes the position shown in Figure 3. In this position, the tube 14 is sloped downwardly away from its contacts, designated 14a, so that the mercury in the tube does not function to close a circuit through these contacts in this position. The tube 15 is so set that when the tilting yoke is in the position shown in Figure 3, the mercury within the tube closes the circuit across the contacts 15a of this tube. The yoke member 11 is somewhat in the form of a vertical plate, and projecting diagonally from one corner thereof is a guiding extension 11a, which is best seen in Figure 1.

Supported on the panel 2 is a temperature responsive device designated generally as 16. This device comprises a base member 16 which is pivotally supported on the panel 2 and which has an adjusting arm 16a thereon, the arm having a slot 17 which cooperates with an adjusting limit screw 18 on the panel. By movement of the arm 16a up or down the whole position of the temperature responsive device can be shifted within the limits permitted by the member 16 and thereby adjust the control for operation over a higher or lower temperature range as may be desired.

The base 16 carries an actuating means 19 of any known or preferred construction. I have shown it as being of the conventional expansible helix type commonly employed in temperature responsive devices. The member 19 actuates a lever arm 20. Pivotally supported on the outer end of the arm 20 is a second lever 21, the pivot connection being indicated at 22. A set screw 23 carried on the upper end of the lever arm 21 provides for adjusting the angularity of the member 21 with relation to the member 20 for the purpose of further adjusting and regulating the system.
ing the temperature responsive mechanism. The arm 21 is provided at its lower or free end with an inwardly turned extension or finger 21a, best shown in Figures 3 and 4, while the end of the arm extends below the vertical plate forming the main portion of the yoke 11.

The temperature responsive unit 16 is connected with an outdoor temperature responsive bulb 24 through a conduit 24a. The bulb 24 is preferably a bulb containing gas, inasmuch as the volumes of gas in the bulb 24 increases. This change of pressure is communicated to the coil 19 which tends to move the arm 20 with its associated lever 21 toward the left, as viewed in Figure 1. With a decrease in outdoor temperature, the arm 20 with its associated lever arm 21 tends to swing toward the right as viewed in Figure 1.

The arm 21 is slightly resilient, and it will be seen by reference to Figures 3 and 4 that the terminal portion 21a of the arm 21 passes through the plane in which the arms 4 and 5 revolve. As the outdoor temperature decreases, this terminal 21a moves in closer to the center of rotation of the arms and as the outdoor temperature increases, it moves away from this center.

Assuming that the arm 21 as viewed in Figure 1, is in the position shown when the cam 5 rotates to a point where the leading edge 5a of the cam 5 passes over the terminal portion 21a of the arm 21, it tends to spring the arm 21 outwardly in a direction normal to the plane of the cam. This outward movement of the lever 21, which is a movement toward the left as viewed in Figure 3, moves the trailing edge 5b of the cam. Whereas the leading edge 5a is substantially radial but preferably slightly curved, the curvature corresponding to the arc in which the terminal 21a moves. The trailing edge 5b defines an irregular spiral or involute curve, the exact shape of which is determined by the heat dissipating characteristics of the building in which the system is located and the capacity of the heating system to radiate stored heat after the steam has been shut off. The minimum travel which the cam can have in contact with the terminal 21a of the lever 21 is defined by the arc 5c. If the temperature responsive arm 21 is swung to the left beyond the point shown in Figure 1, it will, of course, not engage the cam 5 at all, and if it swings further in toward the center of the cam 5 it will be engaged by the cam 5 for a longer period of time, and if it swings sufficiently far toward the center of the cam 5 it is apparent that it would never be entirely clear of the cam.

When the terminal 21a of the lever 21 clears the trailing edge 5b of the cam 5, it snaps inwardly, which is in a direction toward the right as viewed in Figure 4, allowing the yoke 11 to swing back to the position shown in Figure 3, opening the circuit through the mercury tube switch 14 and closing it through the mercury tube 18. In the particular arrangement shown in Figure 5, the supply of heating fluid is controlled by a valve 25. The valve is of a conventional type and is provided with a conventional automatic opening and closing mechanism 26, this mechanism commonly including a motor and gearing which runs a predetermined amount sufficient to open or close the valve before shutting off. The valve and the motor form no part of the present invention. This electrically controlled valve mechanism is connected through the circuit shown in Figure 5 with current supply leads 27 and 28 through the mercury tube switches 14 and 15 and through the circuit indicated, this circuit including in the particular illustration shown in Figure 1 a thermostat mechanism. Where the thermostat mechanism is of the dual type intended to maintain a lower temperature during the night than during the day, the system as shown in Figure 5 also includes a time switch designated generally as 29, for controlling the switch-over from day to night thermostat and vice versa. Figure 9 hereinafter more fully described shows schematically one conventional valve operating arrangement of the character herein referred to, together with the circuit therefor.

The thermostat mechanism, such as the day and night thermostat mechanism just referred to is conveniently carried on the panel 2, as shown in Figure 1. The thermostat mechanism is designated generally as 30. It comprises two thermostatically operated circuit closing arms 31 and 32, the arrangement being well known to those skilled in the art and forming no part of the present invention. The time switch 23 is so connected with the thermostat switches 31 and 32 that during a predetermined period of time during the day the thermostat 31 will be connected to control the switch 26, whereas during the remainder of the twenty-four hours the thermostat 32 designated the night thermostat, will control the operation of the valve 26. Thermostats 31 and 32 are in parallel with each other and are in series with the mercury tube switch 14, the arrangement being such that if the arm 21 is actuated by the cam 5, or the cam 4, to trip the yoke 11 and close a circuit through the mercury tube switch 14, the automatic valve mechanism 26 will not function unless the circuit is completed through the thermostat mechanism, i.e., through the thermostat switch 31 or the thermostat switch 32. If the building to be controlled is already sufficiently warm, the thermostats will not close their switch contacts and the mechanism 26 will not, therefore, be operated. If, however, the building is not up to temperature the thermostat arms 31 and 32 will be in the circuit-closing position shown in Figure 1, and the circuit to the mechanism 26 will be completed. As previously stated, the determination of which of the two thermostats will control, is governed by the time clock unit 29.

The control panel can be designed to operate on any type of current or voltage. The particular panel illustrated is intended for operation on standard 110 alternating current circuits with a clock 3 of the synchronous electric type connected directly to the lines 27 and 28. The voltages through the mercury tube switches and thermostats are preferably lower than 110 volts, and I have shown the control panel as having a step-down transformer 30 through which the voltage current is supplied to the control system itself. This, of course, can be variously modified as will be well understood by those skilled in the art.
The arm 21 is operated by the cam 4 to trip the yoke 11 the same as it is operated by the cam 5. However, the cam 4 rotates only once every twenty-four hours, which means that it cannot engage the terminal 21a of the arm 21 oftener than once every twenty-four hours. The cam 4, of course, moves very slowly, so that a very few degrees of width on the cam 4 between the leading edge of the cam and the trailing edge, represents a considerably longer time interval than a corresponding number of degrees on the cam 5 would represent. However, at its outer end, the cam 4 has a very appreciable width. This width is determined by the heating system and the width of the cam generally increases toward the center of the cam. The leading edge of the cam is preferably serrated so that when it comes into contact with the terminal 21a of the lever arm 21, it will tend to cam or spring the arm 21. Were it not for these steps the motion of the cam would tend to slide the terminal 21a toward the outer end of the cam, as the arm 21 offers little resistance to movement in an arc since the temperature responsive mechanism is necessarily very delicate and therefore easily forced in one direction or the other.

Any such forcing of the temperature arm would obviously destroy the accuracy of the control panel. It will be noted that the leading edge of the cam 4 is the one which curves away from a radius passing through the center and outer end of the cam, the purpose of which is to cause the heating up operation to begin earlier in the morning as the weather becomes colder so that the building will always be ready for occupancy at a predetermined time.

Referring now to Figure 9, this view shows the valve 25 with a valve stem 25a, and a double cam follower 25b for reciprocating it. The motor 26, which is a uni-directional motor, drives a cam shaft 26a through a reducing gear as diagrammatically illustrated, and the cam shaft has a cam 26b thereon engaging the cam follower 25b for operating the valve. The cam shaft 26a also carries three cams; 26c which may be referred to as the "on" cam, 26d which may be referred to as the "off" cam, and 26e which may be referred to as the "maintaining" cam. Cams 26c and 26d are single lobe cams which are 180° out of phase, and cam 26e is a double lobe cam with the low points between the two lobes in phase with the high points of the cams 26c and 26d. Cooperating with each of the cams are spring contact switches 26c', 26d', and 26e' respectively.

Switch 26c' is connected with the "on" mercury switch 26c through a circuit which leads from one side of the transformer 35 through the transformer switch 14 and through one or the other of the thermostats 31 or 32 as determined by time and from the other side of switch 26e' a wire leads to motor 26 and from motor 26 to ground. One side of the "off" switch 26d' is connected to the motor and the other side is connected to the "off" mercury switch 15, the other side of the mercury switch 15 being connected to one side of the transformer. The maintaining switch which is operated by the cam 26e has one side connected to one side of the transformer and the other side connected to the motor 26.

In Figure 9 the valve 25 is open so that heat is being supplied to the heating system. At this time the "off" switch 26d' is closed by the cam 26d while the switches 26c' and 26e' are open. When the outside temperature control calls for the turning off of the heat, mercury tube 15 is rocked to close the circuit therethrough. A circuit is then completed from one side of the transformer through tube 15 through switch 26d' to the motor 26. The circuit is completed from the motor 26 to the transformer through the ground. This starts the motor 26 causing the cam shaft 26a to be rotated. After the motor 26 has operated for a short time, shaft 26a will have turned to a point where the maintaining switch 26c' will be closed and the "off" switch 26d' will be open. The motor will continue to operate through the circuit including the maintaining switch 26c' until the shaft 26a has been turned 180° at which time the valve 25 will be closed and the cam 26c will close the switch 26c'. The motor will be stopped at this point by reason of the switch 26c' riding off the cam lobe. Although the switch 26c' is closed at this point, the motor 26 will not operate because the circuit will not be closed through the mercury switch 14. When the control calls for heat, closing a circuit through the mercury switch 14 and opening the circuit through the mercury switch 15, current will flow from the transformer through the mercury switch 14, through one of the thermostats 31 or 32, as determined by the time switch, through the switch 26c to the motor 26 and thence to ground thereby initiating the operation of the motor to rotate the cam shaft 26a. After the motor has operated for a short time, the maintaining switch 26c' will be closed and the "on" switch 26d' will open, but the operation will continue until the parts have been returned to the position shown in Figure 9 where the heat will remain on until the next "off" cycle is started. It will be seen that if neither of the thermostats 31 or 32 is calling for heat while the mercury switch 14 is in an "on" position, the valve will not be operated to turn on the switch 26c'.
ward the right from the position shown in Fig.

ture 1, it engages the cam 4 where the cam 4 is relatively wide and where the velocity of the slowly moving cam is relatively slow. If the tem-
perature is milder, the arm 21 engages the cam nearer its outer end where the velocity is greater and where the width is less, and the heating up period is shorter.

After the initial heating up period, the cam 4 will clear the terminal 21a, and it will not again return to an operating position until the next morning. The cam 5, however, will periodically come into engagement with the terminal 21a and the yoke 11 will thereby be periodically tilted.

If the thermostat 31 or the thermostat 32, whichever is connected to the motor 26 through the time switch, is calling for heat when such operation occurs, heat will be turned on. With the cam 8 as with the cam 4, the velocity toward the center is less and, therefore, as the arm 21 moves further over toward the center of rotation of the cam 8 the longer will be the period of engagement between the cam 8 and the terminal 21a, and the arm 21 moves to the right far enough it will practically never leave the cam 5. This condition would prevail only, of course, in very severely cold weather. By reason of the shape of the cam, it is obvious that as the outside temperature is warmer at the left, the arm 21 moves to the left and the interval of engagement between the cam and the terminal 21a, and if the outside temperature is warm enough so that no heat is required, the terminal 21a will be entirely beyond the path of travel of the cam 8 and it will not be operated at all.

The purpose of the extension 11a on the yoke 11 is to permit the arm 21 to swing very considerably to the left of the position shown in Fig.

ture 1, without becoming disengaged from the yoke 11. In other words, the cam 4 might move very considerably to the left, and the purpose of the extension 11a is to act merely as a guide strip or keeper to retain the resilient arm 21 in place even when it swings very far to the left.

In any heating system a definite time interval is required for the heating fluid, such as steam, to travel from the source of supply, as the valve 25, to the radiators. The radiators have a definite capacity for storing heat so that a further time element is required after the radiator reaches the point of maximum heat. When the steam is turned off, the stored heat in the radiator will gradually dissipate into the room in which the radiator is located. An important feature of the present system is that both the cams 4 and 5, in any position where they engage the terminal 21a, have a sufficient minimum width to assure of the steam filling the system up to the radiators. In other words, the arc 8c of the cam 5, representing the minimum period of time in which the cam 5 and the member 10 are in engagement, is sufficient to assure of the heat going from the valve 25 into the heating system, filling the heating system up to the radiators but not sufficient to permit of much, if any, steam going into the radiators. Likewise, even at its outer end, the cam 5 is sufficiently wide and the speed of movement sufficiently slow to assure this result.

Once the heating system has been filled with steam, and the metal of the system has been raised to a heat-emitting temperature, the heating fluid can be turned off and the emission of heat will continue for a considerable period. In the case of steam, the steam which is in the system at the time the steam is turned off, condenses, and in so doing gives up heat. Moreover, the capacity of the heating system itself, i.e., the metal is roughly estimated at 100 B. u. per sq. ft. of radiation. In radiator, for instance, having 200 sq. ft. of radiation, it will, roughly estimated, emit 20,000 B. u. after the steam is turned off. It is because of this capacity of the heating system that a thermostat generally produces overheating. The cam in the present case in addition to having a portion which takes care of the time required for the heating system to fill up and begin to emit heat, is designed to anticipate the release of stored heat in the system after the heating fluid is turned off, so that it will turn off the heating fluid sufficiently soon to anticipate this further gradual release of heat from the system during the remaining portion of the time interval when the steam is turned off and is subsequently turned on again.

Another factor which determines the shape of the cam is the gradient of outdoor temperature. When the outdoor temperature is low, the rate of heat dissipation from the room or from the building is greater than when the outdoor temperature is high. The trailing edge of the cam, therefore, is designed to take care, in cooperation with the temperature operated arm 21, of outdoor temperature variations. Briefly stated, therefore, the shape of the cam is determined first by the frequency of its operating cycle, the time required for the heating system to fill up to the radiators with heating fluid, the capacity of the system to deliver heat while the radiator is filling and remains full, and after the heating fluid is turned off and finally, by an outdoor temperature gradient. Based on an average dissipation from buildings and the number of equivalent sq. ft. of radiation in a building, the cams can be laid out to maintain the temperature within the building throughout the day within a fluctuation of a very few, normally only one, degree. By using the cams in combination with a thermostat or thermostats, the cams do not need to be individually designed for each particular building, but can be laid out in graduated sizes so that a heating contractor can use for a given installation a stock size of cam which most nearly meets his requirements. He would select a cam which would assure at all times sufficient heat for the building, and if it would otherwise produce overheating, the thermostat would function as a control to limit over-heating. Thus by coupling the cam mechanism and the thermostat mechanism, each affects a governing control over the other. In the ordinary practice of the invention the cam mechanism alone will maintain the temperature so closely within the desired range that the thermostat need not ordinarily function more than once or twice a day. By varying the steam pressure admitted to the heating system the cam may also be compensated for. If a stock size of cam gives too much heat, the steam pressure may be reduced, and vice versa.

While I have shown the device as being coupled in series with one or more thermostats, many heating installations function satisfactorily without resorting to the use of thermostats, and the use of the thermostats is only desired where a very close control of the heat consumed is wanted. Where the thermostat is used, however, it constitutes a means by which the frequency of the
operation of the valve can be modified while the
cams operate at a constant speed and it provides a
means whereby the time interval between the
periods at which steam is turned on may be varied,
whereas the cams would otherwise require the
same exact time interval from one turning on to
the next turning on operation.

In the arrangement previously described, the
closing of the circuits is effected through the tip-
ping of the mercury tube switches. The function
of the temperature responsive lever 21 is merely to
effect the tipping movement of the mercury tube
switches. The arm 21 and its associated parts can
move freely in accordance with temperature vari-
atations. The power available through slight tem-
perature changes for moving the arm 21 is very
slight and the fact that the arrangement permits
free, unrestricted movement of the arm when it is
off the cam, assures accurate movement of the
arm in response to temperature changes. In
order to assure that even in very cold weather the
terminus of lever 21 will be momentarily free to
adjust itself with each revolution of the cam, the
cam has the leading edge extended by means of a
step as shown to almost the center of the cam. By
decressing the screw 23, the relative position of
the lever 21 with respect to the arm 20 can be
changed for adjusting the device within very close
ranges. By changing the position of the arm 16a
the whole position of the temperature responsive
unit can be shifted with respect to the cams, secur-
ing a simple way of providing a rough adjustment
within a limited temperature range. Adjustment
of the arm 16a can be made by the building opera-
ator, while adjustment of the screw 23 would ordi-
narily be done by one skilled in the calibration of
the instrument.

In the arrangement shown in Figure 6, there is a
generally similar construction, but instead of the
mercury tubes being used, the temperature actua-

ated arm itself and the cam provide circuit closing
devices. In the arrangement shown in Figure 6,
10 40 designates a panel on which is a cam 41 formed
of conducting material and corresponding gen-
15 erally to the cam 5 of Figure 1. The cam 41 is
arranged to be rotated by a clock mechanism (not
shown). At 42 there is designated generally a
temperature responsive device comprising an ad-
justable base member 43 having an arm 43a cor-
responding to the arm 16a. The base 43 carries
the arm 44 on an engaging element 46 which is a lever 45.
The lever 45 is of conducting material and if prefer-
ably has an insulating member 47 thereon or in
which is carried a second arm 41. A lead wire 48
is connected to the arm 45 and a lead wire 45 is
connected to the arm 47. At 50 is a switch which
may be operated to connect with either the wire
48 or the wire 45. A cam 51 is provided for kick-
ing the switch over from one position to anoth-
er. At 52 there is a contact strip which is sup-
10 15 20 25 30 35 40 45 50 55 60 65 70
ported on the base 40 and a wire 52 is connected with it.
A wire 53 is connected to the arm 41. With this
arrangement, when the cam 41 moves around over
the member 52 it lifts the ends of the arms 46 and
47 off the strip 52, breaking the circuit from wire
44 through switch 50 and conductor 46 or 47 and
arm 45 or 47, as the case may be. A circuit is
simultaneously closed from either the arm 47 or
arm 45 through the cam to the wire 53. The
wire 53 is connected to control the opening of the
valve while the wire 52 is connected to effect the
closing of the valve. The circuit remains open as
long as the temperature responsive arms 45 and
47 are engaging the cam 41. When the cam 41
rides out from under the arms 45 and 47 they drop
back onto the contact 51. The circuit through
the cam is then opened and the circuit is com-
pleted through the wire 52 to close the steam
valve.

The two arms 45 and 47 are for day and night
operation respectively. During the day the tem-
perature range for the building is higher than

5 during the night. The arm 45 is always closer to
the center of the cam than the arm 47 and it
therefore always has a longer period of travel in
contact with the cam than does the arm 47. Dur-
5 10 15 20 25 30 35 40 45 50 55 60 65 70
ding the day the switch 50 closes the circuit to the
arm 45 and during the night the switch 50 closes
the circuit to the arm 47. In this arrangement I
have not shown any morning heating up cam corre-
sponding to the cam 4, but it is obvious that the
arrangement permits the use of such a cam. This
arrangement is somewhat more simple than the
one previously described. It, of course, can be
used with or without thermostats, as can the
arrangement shown in Figure 1. From a practi-
cal standpoint, some difficulty is encountered in
keeping the contact between the terminals of the
arms 45 and 47 and the disc 41 sufficiently clean
to assure of the proper actuation of the valve at low
voltage and also to assure the making of a good
contact when the arms 45 and 47 ride off the cam
onto the strip 52. The mercury tube switches are
more positive in their operation over a long period
of time, and for this reason the arrangement
shown in Figure 1 is preferred. Moreover, there
is some friction produced in maintaining the arms
45 and 47 in circuit closing contact with the con-
ductor 52, and this interferes to some extent with
the free movement of the arm 45 under varying
temperature conditions. The system, however,
can be cheaply manufactured and can be satis-
factorily used.

The modification shown in Figures 7 and 8 rep-

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
resents an embodiment of the invention wherein
a cam arrangement is provided for switching from
day to night temperatures and from night to day
temperatures. In this arrangement, the panel 50
has a clock 61 thereon which drives three cams 62,
63 and 64. Cam 62 revolves once every twenty-
four hours and corresponds to the cam 4 of Fig-
ure 1. Cam 63 revolves at relatively short inter-
cals and corresponds to the cam 5 of Figure 1.
Cam 64 revolves once every twenty-four hours.

Pivotedly supported on the panel 60 above the
50 55 60 65 70
clock is a base member 65, the pivot point for
which is located at 66. Its movement in a vertical
arc is limited by screws 57 passing through slots
68 in the base member. The pivot 66 also provides
a pivotal mounting for an arm 69 having its lower
50 55 60 65 70
end terminal portion 68a corresponding to the
terminal portion 21a of Figure 1. The tempera-
10 15 20 25 30 35 40 45 50 55 60 65 70
rature responsive mechanism is designated 70 and is
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
carried on the plate 65. It is arranged to operate
an arm 71 which arm is connected through a link
70 75 and a wire link 73 with an extension 69a on
the arm 69. Movement of the arm 71 transmits
motion to the arm 69 to move it back and forth with
respect to the cam 62 and 63. Arranged adjacent
the arms 62 and 63 is a tiltable frame 74 corre-
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
15 20 25 30 35 40 45 50 55 60 65 70
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csponding to the mercury tube contacts 75 and
76 corresponding to the mercury tube contacts
14 and 15 of Figure 1. The arm 69 functions in
cooperation with the arms 62 and 63 and in 70
cooperation with the tilting frame 74 the same as
the arm 21 of Figure 1 functions and for the
same purpose.

Extending down from the tiltable base mem-
15 20 25 30 35 40 45 50 55 60 65 70
ber 65 is an arm 77 having a roller 78 at its outer
75

end position to track on the periphery of the cam 64. The cam 64 has a relatively long, high part 64a which is concentric to the center about which the cam rotates and it has an irregularly shaped low part comprising the substantially radial stem 64b, dropping from the highest point on the cam to the lowest point, and from the base of the edge 64b the cam rises more or less regularly and gradually back to the portion 64a, this gradually rising edge being designated 64c. In operation, the high portion 64a of the cam bearing against the roller 18 serves to hold the base member 65 in the position shown in Figure 6. At this time the arm 69 is in the position for cooperation with the cam 64, 65 and 66 for day operation. When the roller 18 engages the drop in the cam, it allows the frame 65 to swing down, carrying with it the temperature responsive mechanism 70 and swinging the arm 65 to the left as viewed in Figure 7, so that it is further from the center of the cam 62 and 63.

Since the terminal 62a of the arm 68 is farther from the center of the cam 62 and 63 at this time, it either clears the cam 63 entirely or engages it only nearer the periphery of said cam. In this case, it does not change 25 of temperature during the period of day operation. The result of this is that the heat is turned on for a shorter period of time during the cycles of night operation than it is during the cycles of 30 day operation, even though the outdoor temperature should not change. The cam 64, cooperating with the roller 18, therefore, serves to change the relative operating range of the arm 68 with respect to the cam 63, thus allowing the building 35 to be kept cooler at night than during the day. This system can be used where day and night thermostats are not used. The contour of the cam 64 is determined according to how many hours of the day it is desired to maintain the building at normal temperature and how many hours it is desired to keep the building at a lower than normal temperature.

While I have specifically indicated in the foregoing description the turning on of a valve, particularly a steam valve for the supplying of heating fluid, it will be understood that the control panel is not limited to the control of a valve, but in place of a motor-driven valve the control panel may operate upon fuel burning mechanisms such as stokers, oil or gas burners, or other similarly function to maintain a heating system to be supplied with heat or to add to the heat already supplied periodically. Various modifications and changes in the detailed construction of the parts also may be made in the apparatus within the contemplation of my invention and under the scope of the following claims.

I claim:

1. A mechanism for use in a heat control system comprising a clock-driven flat cam mounted to rotate in a plane, and a member responsive to variations in temperature mounted for movement in a plane parallel to the plane of the cam, having a portion thereon which extends across the plane of travel of said cam, said cam serving to displace said member in a direction normal to the plane of the cam when the cam moves into engagement with said portion, and a switch mechanism operated by the movement of the member in a direction normal to the surface of the cam.

2. A mechanism for use in a heat control system comprising a clock-driven cam mounted to rotate in a plane, an arm for cooperation with the cam, a temperature responsive mechanism for actuating the arm in a plane parallel to the plane in which the cam revolves, said arm having a cam-engaging portion which extends across the plane of travel of said cam, said cam serving to displace the arm in a direction normal to the plane of the cam when the cam engages said portion of the arm, said arm being resilient whereby it springs back into normal position after being displaced by the cam.

3. A mechanism for use in a heat control system comprising a clock-driven cam mounted to rotate in a plane, an arm for cooperation with the cam, a temperature responsive mechanism for actuating the arm in a plane parallel to the plane in which the cam revolves, said arm having a cam-engaging portion which extends across the plane of travel of said cam, said cam serving to displace the arm in a direction normal to the plane of the cam when the cam engages said portion of the arm, said arm being resilient whereby it springs back into normal position after being displaced.
mechanism in a plane parallel to the plane in which the cam rotates, said arm having a portion thereon which projects across the path of travel of the cam whereby the cam may serve to displace the arm in a direction normal to the plane of the cam when the cam and said portion come into engagement, and an adjustable support on which said temperature responsive mechanism is mounted to permit of a relative adjustment between said mechanism and its arm and said cam.

8. Mechanism for use in a heat control system, comprising a clock-driven cam mounted to revolve in a plane, a mechanism actuated by changes in temperature, an arm member operated by said mechanism and movable by said mechanism in a plane parallel to the plane in which the cam rotates, said arm having a portion thereon which projects across the path of travel of the cam whereby the cam may serve to displace the arm in a direction normal to the plane of the cam when the cam and said portion come into engagement, an adjustable support on which said temperature responsive mechanism is mounted to permit of a relative adjustment between said mechanism and its arm and said cam, a second clock-driven cam, and means for transmitting motion from said second clock-driven cam to said adjustable support.

9. Mechanism for use in a heat control system, comprising a clock-driven member movable in a plane, a mechanism responsive to temperature and an arm actuated thereby, said arm being movable by operation of said temperature responsive mechanism in a plane parallel with said clock-driven member, said arm having a portion thereon which intersects the plane of travel of said clock-driven member whereby when said clock-driven member engages said portion said arm is displaced thereby, and a heat control circuit governed by such displacement of the arm.

10. Mechanism for use in a heat control system, comprising a clock-driven member movable in a plane, a mechanism responsive to temperature and an arm actuated thereby, said arm being movable by operation of said temperature responsive mechanism in a plane parallel with said clock-driven member, said arm having a portion thereon which intersects the plane of travel of said clock-driven member whereby said clock-driven member engages said portion of the arm to displace the arm in a direction normal to the plane of said member, said arm being free-floating when clear of said member, said member being so constructed as to assure disengagement of the arm at least once with every revolution of said member, and heat-controlled means governed by the movement of said arm in the direction normal to the plane of said member.

11. Mechanism for use in a heat control system, comprising a clock-driven member movable in a plane, a mechanism responsive to temperature and an arm actuated thereby, said arm being movable by operation of said temperature responsive mechanism in a plane parallel with said clock-driven member, said arm having a portion thereon which intersects the plane of travel of said clock-driven member whereby said clock-driven member engages said portion of the arm to displace the arm in a direction normal to the plane of said member, said arm being free-floating when clear of said member, said member being so constructed as to assure disengagement of the arm at least once with every revolution of said member, and heat-controlled means governed by the movement of said arm in the direction normal to the plane of said member, said last means comprising switch mechanism which is moved by movement of the arm when said portion of the arm is displaced by engagement with said member but which returns to its original position when said member is free of engagement with said arm when said arm is clear of said clock-driven member.

12. A heat control system comprising a temperature actuated device, a plurality of clock-driven cams operated at different speeds cooperating with the temperature actuated means, one of said cams having a leading edge which is regular and a trailing edge which is irregular to give different periods of time for cooperation with the temperature actuated device, the second cam having its leading edge irregular and its trailing edge regular whereby it will always disengage the temperature actuated device at the same time but may vary the period of initial engagement therewith, and a heat control circuit operated through the engagement and disengagement of said temperature actuated device and cams.

13. A temperature control system comprising a cooperating clock-driven cam and a temperature responsive contact arm, the cam being substantially flat and having an abrupt leading edge and a curve trailing edge, the temperature responsive arm being movable across the face of the cam from the center toward the periphery, the arm moving toward the center of the cam with reducing temperatures and toward the periphery with rising temperatures.

14. A temperature control system comprising a cooperating clock-driven cam and a temperature responsive arm adapted to contact therewith through engagement with the face of the cam and to be displaced by engagement with an edge of the cam, the cam being of a revolving disc type whereby the outer portion moves with a relatively greater velocity than the inner portion, the arm being movable with changes in temperature toward and away from the center of the cam, the arrangement being such that it moves toward the center with decreasing temperatures and away from the center with increasing temperatures.

15. A mechanism for use in a heat control system comprising a circuit-operating means, a temperature-actuated device, and a plurality of clock-driven cams operated at different speeds mechanically cooperating with said temperature-actuated device, said cams being supported for operation in parallel planes and being differently shaped, one being movable periodically across the face of the other, the circuit-operating means being operatively connected for actuation by the co-engagement of the temperature-actuated device with either of said cams.

16. A temperature control device comprising two flat cam-like members which lie in parallel planes and clock-driven means for rotating them in the planes in which they are mounted, a circuit controlling means for engagement with the faces of both of said members and movable in the same plane as said members in an arc toward and away from the centers of said members, temperature responsive means for moving the circuit controlling means in said plane, the faces of the flat cam-like members being of outwardly diminishing arcuate extent whereby the length of engagement between a cam and the circuit controlling means varies according to the position of said circuit controlling means in said plane.
17. A temperature control device comprising a flat plate-like cam member, means for rotating said member in the plane in which it is mounted, an arm adjacent said member mounted for movement in a plane parallel with the plane of rotation of the plate-like cam member and having a terminal portion adapted to ride over a face of the flat cam-like member when such member rotates into position to be engaged thereby, means governed by the engagement and disengagement of said terminal and cam-like member for turning a source of heat on and off, and temperature responsive means for moving the arm in a plane parallel to the plane of rotation of the cam-like member to move said terminal toward or away from the center of rotation of said cam-like member.

18. A mechanism for use in a heat control system comprising a pair of rotatable flat disk-like cams of outwardly decreasing arcuate extent, means for rotating both of the cams at relatively different speeds whereby one of them periodically eclipses the other, a temperature responsive means in the path of movement of both cams for engagement by either and movable, in response to temperature changes, in the plane of rotation of the cams whereby the duration of the engagement between the cam and said means is varied according to the position of said means in said plane, and an electric circuit governed by the engagement and disengagement of said means with the cams.

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