

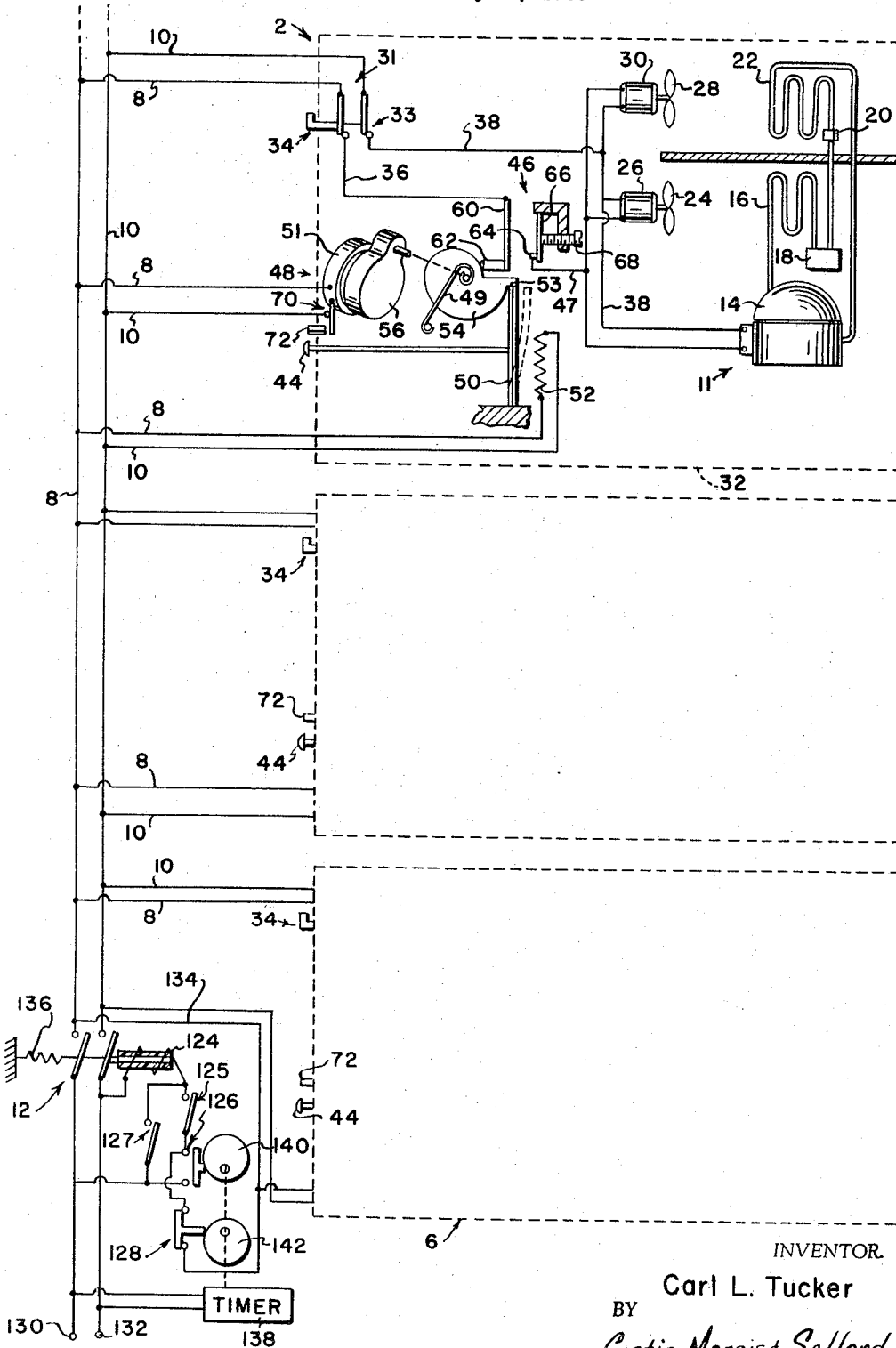
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AIR CONDITIONING

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1

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AIR CONDITIONING

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This invention relates to air conditioning, and more in particular to air conditioning systems for buildings or for rooms or other zones or spaces.

An object of this invention is to provide an air conditioning system for a multiple space or zoned building or a part thereof. A further object is to provide an air conditioning system which is versatile and which may be operated efficiently to condition the air in the various rooms or spaces individually, and without the operation in one room or space interfering with the operation elsewhere. A further object is to provide a cooling and ventilating system of the above character. A further object is to provide a system of the above character where there is central control by which all of the units of the system may be started and stopped, and yet where the individual units may be operated independently. Another object is to provide an air conditioning system having individual units within the various zones or spaces and a central control by which the units may be started in a controlled sequence and which insures against unnecessary operation of any of the various units. These and other objects will be in part obvious and in part pointed out below.

In large office buildings and in multiple unit living quarters, it is desirable to provide considerable leeway in the relative amounts of air conditioning which is provided in various spaces or zones. There may be extreme differences in the heating and cooling loads and the occupants may desire different temperature conditions. Furthermore, when one space or zone is unoccupied, it may be desirable to discontinue the operation of the air conditioning facility for that space or zone. The present invention provides for such control. Furthermore, the system permits any or all of the air conditioning facilities to be started and stopped in accordance with any desired program. Also, the system may be left in a condition so that air conditioning is provided only in the spaces or zones where the occupants desire it, but is immediately available in all of the spaces or zones.

In the drawing:

The single figure is an abbreviated and schematic representation of an air conditioning system comprising one embodiment of the invention.

Referring to the drawing, the system is illustratively formed by a large number of identical self-contained air conditioning units. However, for purposes of understanding the invention, it is necessary to illustrate only three of these units in the drawing and the showing has been limited in that manner to avoid unnecessary complications and repetition. The three air conditioning units 2, 4 and 6, which are shown with their casings represented in broken lines, are located in different rooms of a building, and each of them is positioned at a window so as to use outside air for cooling and for ventilation, and so as to cool the room where the unit is located. These units receive electrical current through a pair of power lines 8 and 10 which extend from a master control switch 12. The master control switch and the other com-

2

ponents of the system which are shown, are presented schematically in the drawing, and it is understood that other equivalent switches and additional or other components are used in the actual commercial construction.

The air conditioning units 2, 4 and 6 are identical and unit 2 will be described. Air conditioning unit 2 has a refrigeration system or unit 11 which comprises a motor-compressor 14, a condenser 16, a receiver 18, an expansion valve 20, an evaporator 22, and standard thermostatic and safety controls. A fan 24, driven by a motor 26, directs air over the condenser, and a fan 28, driven by a motor 30, directs air over the evaporator. This entire refrigeration system and the controls are enclosed within a casing indicated in broken lines at 32. As has been stated above, the unit is positioned at a window or an opening in the outside wall so that outside air is drawn in by the fans for ventilation of the room and for cooling the compressor and the condenser, and fan 28 circulates the air over the evaporator for cooling the room. The circulation of air by fan 28 involves recirculation of a substantial amount of the air in the room, but fresh air is drawn in as desired. An air filter is provided for the air passing through the evaporator, and other components and controls are provided as desired.

Air conditioning unit 2 includes internal power lines 36 and 38 to which power is supplied to operate the unit through a manual control switch 34, in a manner discussed below. The manual control switch 34 is formed by a pair of switch units 31 and 33 which are closed when the occupant of the room or zone desires air conditioning. Line 38 extends from switch unit 33 directly to the motor compressor 14 and the fan motors 26 and 30. Line 36 extends from switch unit 31 to a normally open, cam-operated switch 46 the other side of which is connected through a line 47 to the motor compressor 14 and the fan motors 26 and 30. Hence, when power is supplied to lines 8 and 10 and switches 34 and 46 are closed, the unit 11 is operated either continuously or under the control of automatic thermostat controls.

The normally open switch 46 is closed by the operation of a timer motor and cam unit 48 formed by an electric motor 52 and a cam 54 driven thereby through a gear reduction and clutch assembly 56. Cam 54 is shown in its "home" or rest position to which it is returned automatically by a spring 49 whenever motor 51 is de-energized. However, when power is supplied to motor 51 the motor operates through assembly 56 to drive cam 54 clockwise from the position shown through an arc of the order of 300° where it is stopped and held as long as motor 51 remains energized. Assembly 56 includes a release clutch which permits the cam to be held in either its rest position or the position at the end of its clockwise movement.

A bimetallic strip 50, having an electric heater 52 is mounted at its lower end with its upper end adjacent cam 54. Heater 52 controls the temperature of strip 50 and causes it to move between the position shown in full lines when it is heated and the position shown in broken lines when it is at room temperature. When in the heated position, the upper end of strip 50 is positioned to engage with a ledge 53 upon cam 54 and to thereby latch the cam from clockwise movement away from its "home" or rest position. However, when the bimetallic strip is at room temperature it is out of the path of movement of the cam so that the cam is rotated freely by the energization of motor 51. Heater 52 is

connected directly across lines 8 and 10 so that it heats strips 50 and moves it to the cam-latching position whenever the system is supplied with power. However, for purposes to be discussed below, a push-button plunger 44 is provided which projects from the cabinet and is pressed to move the bimetallic strip 50 from its full line position toward the broken line position and thereby release the latching engagement of the strip with the cam.

Normally open switch 46 is formed by a contact 64 and a flexible contact arm 60, which has a switch contact at its lower end and which carries a cam follower 62 riding upon cam 54. When cam 54 turns clockwise, arm 60 is swung to the right against contact 64, thus to close the switch. Contact 64 is mounted upon a flexible spring arm 66 which may be swung to the left from the position shown by an adjusting screw 68. Hence, the position of contact 64 may be changed by adjusting screw 68 so as to regulate the distance which arm 60 must be moved by cam 54 so as to close switch 46. The clockwise movement of cam 54 is at a constant rate so that the adjustment of the position of contact 64 determines the length of time which elapses between the start of the turning of the cam and the closing of switch 46. As will be discussed below this adjustment is used to regulate the timing for the starting of the various air conditioning units in the system so as to avoid simultaneous starting. Timer motor 51 is connected at one side directly to line 8 and at the other side through a normally closed switch 70 to line 10. Switch 70 has a push button 72 which projects from the cabinet and may be pressed to de-energize motor 51 and thereby cause cam 54 to return to its rest position, as will be discussed below.

When power is supplied to lines 8 and 10 by the closing of switch 12 the timer motor 51 in each of the units 2, 4 and 6 is energized. Assuming that all of the switches 34 are closed and that the power has been disconnected for a sufficient period of time for the bimetallic strips 50 to be at room temperature and in the broken line position, each of the timer cams 54 is free to turn and starts to turn clockwise from its rest position. The adjustments of the various switch contacts 64 is such that the air conditioning units are started in accordance with a predetermined sequence, thus avoiding an excessive current surge. The air conditioning units then continue to operate in accordance with the temperature demands in their various rooms or zones and may be started and stopped by their automatic controls.

The invention contemplates that it is desirable at times to stop all of the air conditioning units, but to permit the occupants of the various rooms or zones to restart their units individually. For example, as discussed above, most of the occupants of an office building may leave the premises at the end of the working day, but it is desirable to permit the remaining occupants to start their air conditioning units if they wish. Accordingly, at the end of the day, or at such other time as it is desirable to do so, power is momentarily disconnected from lines 8 and 10 so as to de-energize each of the timer motors 51, and each of the cams is returned automatically to its rest position, as represented in the drawing. That opens the various switches 46 and stops all of the air conditioning units. However, in the meantime, each of the heater elements 52 has heated its bimetallic strip 50 so that the strip is in the full-line position. Therefore, when each of the cam 54 returns to its rest position, its bimetallic strip latches and holds the cam from turning. When power is restored to lines 8 and 10 after only the momentary discontinuance, strips 50 have not cooled off and each of the timer motors 51 is restarted, but the bimetallic strips hold each of the cams 54 in its rest or open-switch position. The characteristics of unit 48 are such that the slip clutch of assembly 56 permits the timer motor to run freely. Hence, the various switches 46 remain open and their air conditioning units 11 are not restarted as long as the cams are held from movement by strip 50. With

the system in this condition the system does not provide air conditioning. However, if any person within any of the rooms or zones desires air conditioning he may immediately press his push button plunger 44 so as to manually move the bimetallic strip to the broken-line position out of latching relationship with its cam. That will permit the cam to start its rotation, and it is turned in the normal manner so as to close its switch 46 and start the operation of the air conditioning unit. The operation normally continues until power is again disconnected from lines 8 and 10. However, the person in the room may open the manual switch 34 to stop the unit at any time. The opening of the switch 34 of an air conditioning unit renders that unit inoperative even though power is shut off from lines 8 and 10 for a sufficient time to permit the bimetallic strip 50 to return to room temperature. However, if the occupant or operator wishes to stop a unit which has been started by pressing the push-button plunger 44, he may press the push button 72 to momentarily open switch 70. That action disconnects the power to motor 51 so as to permit the cam 54 to return to its rest position in the same manner as when switch 12 is opened momentarily. Thus, the operator or the occupant is provided with manual control to start and stop the air conditioning unit as he wishes, and he may also restore the circuit to the "stand by" condition, after the unit has been started by pressing the push button plunger 44.

The illustrative embodiment of the present invention has an additional important feature, namely, the switches 46 are adjusted to give a predetermined sequence to the starting of the various air conditioning units after they have all been shut down for a period of time. The sequence starting of the units distributes the peak starting current loads over a sufficient time to prevent overloading of the electrical circuit, but these peak current loads are of very short duration, and the staggered starting does not make any perceptible change in the time of starting the various air conditioning units. Nevertheless, very substantial benefits are derived, as compared with a system where all of the starting switches would be closed at exactly the same instant.

The present invention contemplates the momentary disconnecting of the electrical power to the system so as to stop the various units of the system, and it has been indicated that this can be done manually at selected times. The invention also contemplates that this power disconnecting operation may be carried on automatically, for example, by a program switch unit. Accordingly, in the drawing, master control switch 12 is of the solenoid type, with a solenoid 124, and a manual switch 127 which is closed to energize the solenoid to close switch 12 manually. However, in order to provide automatic operation, solenoid 124 includes a normally opened push-button switch 126, and a normally closed push-button switch 128. The closing of switch 12 connects line 8 and 10 respectively to power lines 130 and 132. Solenoid 124 is connected at one side to line 132, and the closing of switch 126 connects the other side of the solenoid to line 130. An interlock circuit to solenoid 124 is also provided by a line 134 which extends from line 8 through the normally closed switch 128 to solenoid 124. Switch 12 is normally urged toward its open position by a spring 136. A normally closed switch 125 in series with switch 126 may be opened to disconnect the automatic program circuit.

The momentary closing of push-button switch 126 energizes solenoid 124, and closes the master control switch 12. The switch is then held closed by the interlock circuit formed by switch 128 and line 134. The opening of switch 128 breaks the interlock circuit and de-energizes solenoid 124, and switch 12 reopens automatically. Connected across lines 130 and 132 is an adjustable timer 138 which has a cam shaft upon which two cams 140 and 142 are mounted. When the cam shaft is rotated by timer

138, cam 142 first moves into engagement with switch 128 and opens this switch, and then after a short interval of time cam 140 moves against and closes switch 126. Hence, one complete revolution of the cam shaft opens the master control switch 12 and then recloses it after a predetermined period of time. This period of time is sufficient to permit the cam 54 of each of the various air conditioning units to return to its rest position so that its switch 46 is opened.

Timer 138 may be adjusted to turn its cam shaft a complete revolution at the end of any predetermined period of time, or at predetermined intervals in accordance with a program. Therefore, with the timer operating continuously, the cam shaft remains stationary except at the preselected times of the day when it is determined that the power circuit should be opened. For example, with the arrangements discussed above, the suggested manual opening and closing operations of the master control switches are performed in accordance with a predetermined setting of timer 138. This may include the opening of switch 12 at 8 p.m., and at every four hours thereafter as long as the building is occupied during the evening and over weekends.

It will be understood that the invention is applicable to systems other than the one represented in the drawing, and particularly to systems incorporating additional features and characteristics. In the illustrative embodiment, the refrigeration means at each zone or room is a self-contained unit, but it is understood that other air conditioning means, such as heat exchange coils and induction and fan-coil units, may be used while still attaining certain advantages of the invention. The power supply and control circuit provides remote control for the basic operation, and yet permits the occupants to exert control upon the individual air conditioning units. Also, thermostatic controls provide automatic operation, particularly where manual control is not fully satisfactory.

Under some circumstances the power for operating the air conditioning units 11 is supplied from power lines which also supply power to other equipment. In such cases, the power is supplied to the timer motors 51 and the heaters 52 through a separate control circuit. Also the air conditioning units may be supplied with power from a four-wire, three-phase circuit having a neutral line. In such cases the power for the timer motors 51 and the heaters 52 may be supplied through the neutral line and one of the other lines.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an air conditioning system, the combination of: power supply means constituting a supply of electric power; an air conditioning unit which is adapted to change the temperature of air flowing through it and which includes electrical means which renders it operative when connected to said power supply means; and a switch assembly connected to receive power from said power supply means and adapted to be closed and thereby complete an electric circuit to said air conditioning unit, said switch assembly comprising, a normally open switch, and a cam which is adapted to be turned from a rest position to close said switch, a timer motor which is connected to said cam and is operative to turn said cam from said rest position to its switch-closing position, latch means having a latch portion which has a latching position wherein it engages said cam and holds said cam from moving from said rest position and an inoperative position wherein said cam is free to move, and latch-releasing means which is positioned relative to said latch means whereby it may be operated manually to move said latch

means to said inoperative position, said latch means including temperature responsive means which is operative to move said latch portion from said inoperative position to said latching position upon a predetermined rise in temperature, said switch means including means to heat said temperature responsive means when power is supplied thereto.

2. Apparatus as described in claim 1 wherein said latch means is a bimetallic strip rigidly mounted at one end and having its other end forming said latch portion and adapted to swing between said latching and inoperative positions, and wherein the means to heat said latch means is an electric heater positioned adjacent said bimetallic strip.

3. Apparatus as described in claim 2 wherein said latch-releasing means is a push button plunger positioned to engage said bimetallic strip.

4. Apparatus as described in claim 3 wherein said timer motor operates at a predetermined speed, and wherein said switch is adjustable to control the time between the starting of the movement of said cam and the closing of the switch.

5. An air conditioning system comprising a plurality of units each of which comprises the combination as described in claim 1, and common power supply lines which are connected to operate all of said air conditioning units and all of said switch assemblies.

6. Apparatus as described in claim 5 which includes a timer switch assembly which is adapted to disconnect and connect power to said common power supply lines.

7. In an air conditioning system for maintaining various zones of a building at individually selected temperatures, the combination of: a plurality of separate air-conditioning units; power means constituting an electric power supply for said units; and a control system including a plurality of switch assemblies associated respectively with said units, each of which comprises a unit-control switch and is connected to said power means, timer motor-cam means including a cam and means to turn said cam from a rest position to close said unit-control switch, latch means which is moved during the operation of the unit to and from a position to latch said cam in said rest position, and latch control means to render said latch means ineffective after said timer motor-cam means has been inoperative for a substantial period of time and to render said latch means effective after said timer motor-cam means has operated for a period of time, and manual means to release said latch means.

8. In an air conditioning system for maintaining the desired temperatures throughout a building, the combination of, a plurality of separate units each of which is operable to change the air temperature flowing through it, and a power supply and control system comprising means constituting a supply of power for said units and to connect and disconnect said supply, said power supply and control system including a plurality of control assemblies associated respectively with said units and each including unit-control switch means which is opened and closed to stop and start its unit when power is supplied thereto and a timer operating unit which is operable upon the initial supplying of power to the unit to close its unit-control switch means, each of said control assemblies being constructed and arranged to open its unit-control switch upon each discontinuance of the supplying of power thereto and latch means which includes a latch portion and latch operating means to move said latch portion, said latch-operating means being operative in accordance with a timed cycle to move and said latch portion from an inoperative rest position to an operative latching position a predetermined time after power has been supplied to the control assembly and to return said latch portion to said inoperative rest position only after power has been discontinued for a predetermined period of time whereby

7

said latch means is operable to prevent the reclosing of its unit-control switch except when the power supply has been discontinued for more than a predetermined period of time, each of said control assemblies also including latch-releasing means which is operable manually to release said latch means.

9. A system as described in claim 8, wherein said latch-operating means comprises a bimetallic latch and heating means therefor, said latch being mounted to move to its latching position when heated and to move from its latching position when at ambient temperature.

8

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