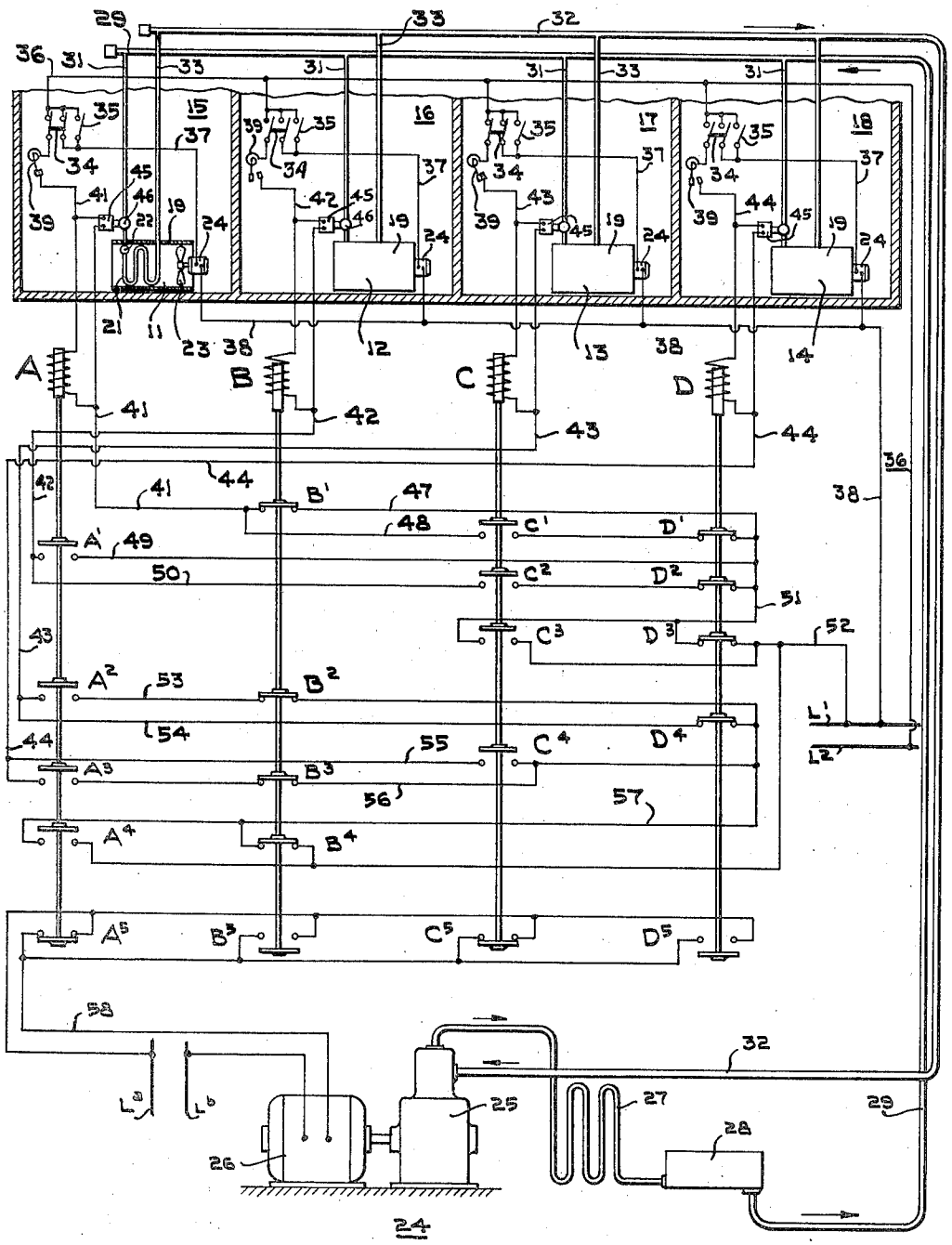
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CONTROL SYSTEM FOR AIR CONDITIONING APPARATUS

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WITNESSES:

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CONTROL SYSTEM FOR AIR CONDITIONING APPARATUS

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My invention relates to a control system more particularly to a control system for air conditioning apparatus comprising a plurality of air coolers having a common limited supply of cooling fluid, and it has for an object to provide an improved control system.

A more particular object is to provide a control system which effects a maximum limit on the number of air coolers in operation at any one time, that is, the number supplied with cooling fluid, and which permits any one air cooler, or any combination of air coolers not exceeding said maximum limit, to be operated at one time.

In accordance with my invention, I provide mechanism responsive to the number of air coolers in operation and effective to render the remainder inoperative when the maximum number thereof are in operation. Preferably, the mechanism includes a circuit for each cooler and a set of contacts in said circuit for each combination of the maximum number of the other air coolers. The contacts of each set are in parallel with each other and the several sets of contacts are in series. Thus, a circuit is maintained open when all the parallel contacts of any one set are open, which occurs when the maximum number of air coolers is in operation. Means for effecting operation of the cooling fluid supply means when any air cooler or coolers are in operation may also be provided.

The subject-matter of the present application is broadly covered by the claims in the patent of Raymond J. Ridge, No. 2,048,711, issued July 28, 1936, and assigned to the Westinghouse Electric & Manufacturing Company.

These and other objects are effected by my invention, as will be apparent from the following description and claims, taken in connection with the accompanying drawing, forming a part of this application, in which:

The single figure is a diagrammatic view of my novel control mechanism.

Referring to the drawing in detail, I show air cooling devices 11, 12, 13 and 14, which may be disposed, for example, in rooms or enclosures 15 to 18, respectively. Each air cooling device may include, as shown, a cabinet 19, a cooling coil or evaporator 21 disposed therein, an expansion valve 22, a fan 23 for circulating air into the cabinet, over the cooling coil and into the room. The expansion valve is of any suitable type known in the art, such as a thermostatic expansion valve operating in response to the pressure and the temperature of the refrigerant leaving the evaporator to maintain the superheat thereof substantially constant. A motor 24 is provided for driving the fan 23.

The several evaporators are supplied with liquid refrigerant by a refrigerating mechanism 24, commonly termed a refrigerating or condensing unit, including a compressor 25 driven by a motor 26, a condenser 27 and a liquid receiver 28. The liquid receiver 28 is connected to the inlet ends of the several evaporators through a conduit 29 and branch conduits 31, while the inlet of the compressor is connected by a suction conduit 32 and branch conduits 33 to the outlet ends of the several evaporators. The refrigerating mechanism operates in the conventional manner, the vaporous refrigerant being compressed in the compressor 25, condensed in the condenser 27, collected in the receiver 28 and delivered through the conduits 29 and 31 to the evaporators in which it is vaporized in extracting heat from the air passing thereover. The vaporized refrigerant is withdrawn from the several evaporators by the compressor through the conduits 33 and 32, and again compressed.

Air cooling apparatus of the type so far described may sometimes be used in cases where only a limited amount of cooling at one time is required but where such cooling may be required in different rooms. In such cases, it is expedient to provide a refrigerating unit 24 of less capacity than the total capacity of the air coolers. For the purpose of disclosing my invention, I have assumed that it will be desired normally to cool but two rooms and that the refrigerating unit 24 has a capacity to supply liquid refrigerant for satisfactory operation of two air coolers. Each air cooler may have a capacity, for example, to extract 12,000 B. t. u.'s per hour and the refrigerating unit 24 may have a capacity to supply liquid refrigerant for extraction of 24,000 B. t. u.'s per hour.

The present control system provides for the control of the air cooling apparatus such that the air coolers may be individually controlled and any one or any combination of room coolers whose capacity does not exceed the capacity of the refrigerating unit 24, may be operated at one time. The control mechanism includes a hand-operated double-pole switch 34 for each air cooler, the first pole controlling the supply of liquid refrigerant and the second pole providing operation of the fan 24. A second switch 35 is also provided for each air cooler for effecting operation of the fan 24 without providing for cooling. One terminal of each switch pole is connected through a conductor 36 to a line conductor L^2.

The other terminals of the switch poles for controlling the fan are connected to a conductor 37 which is connected to one terminal of the motor 24, the other terminal being connected through a conductor 38 to the line conductor L^1. The other terminals of the first pole of the several switches 34 are connected through thermostats 39 to circuits 41 to 44, respectively. Solenoids A to D are connected in the circuits 41 to 44, respectively. A solenoid 45 is connected in shunt with each of said solenoids and operates a valve 46 in the branch supply conduit 31, for the purpose of controlling the supply of liquid refrigerant to the individual air cooler. The solenoid opens the valve when energized and closes the valve when deenergized.

For the purpose of preventing operation of more than two air coolers at one time, the circuits 41 to 44 are provided with contacts operated by the solenoids A to D, as will now be described. The reference characters of the contacts contain the letter designating the solenoid by which they are operated. There is provided in each of said circuits, a set or pair of contacts arranged in parallel with each other for each combination among the remaining coolers of the maximum number to be operated at one time, in this case two. As the contacts of each set are in parallel with each other, when a combination of air coolers corresponding to the maximum number is in operation, the circuit is opened by the parallel contacts of one set. The several sets of contacts are in series with each other, so that any one of the several possible combinations is effective to open the circuit. As shown on the drawing, and as will be described, some of these contacts are preferably common to a plurality of sets of contacts.

The circuit 41 has one branch 47 extending through contacts B^1 and a second branch 48 containing contacts C^1 and D^1 in series. The circuit 42 has one branch 49 containing contacts A^1 and a second branch 50 having contacts C^2 and D^2. Beyond the contacts first mentioned, the several branches 47 to 50 join a conductor 51, through which the circuits 41 and 42 extend in common to the line conductor L^1. The conductor 51 contains contacts C^3 and D^3 arranged in parallel. The circuit 43 has a branch 53 containing contacts A^2 and B^2 and a second branch 54 containing contacts D^4. The circuit 44 has a branch 55 containing contacts C^4 and a second branch 56 containing contacts A^3 and B^3. Beyond the contacts just mentioned, the branches 53 to 56 are connected to a conductor 57 through which the circuits 43 and 44 extend in common. The conductor 57 contains contacts A^4 and B^4 arranged in parallel, and joins the conductor 52 to connect with the line conductor L^1.

It will be noted that each circuit contains a set of parallel contacts for each combination of two of the other air coolers, so that it is opened whenever two other coolers are in operation. Referring to the circuit 41, for example, the contacts B^1 and C^1 are in parallel, as are the contacts B^1 and D^1, so that if either the cooling devices 12 and 13 or the cooling devices 12 and 14 are in operation, both of the branches 47 and 48 will be opened to prevent closing of the circuit 41. Operation of the third possible combination, comprising coolers 13 and 14, opens contacts C^3 and D^3 so that energization of the circuit 41 is prevented. Similarly, the circuit 42 contains contacts A^1 and C^2 in parallel, and the contacts A^1 and D^2 in parallel. The contacts C^3 and D^3 are common to the circuits 41 and 42, so that both air coolers 11 and 12 are rendered inoperable when air coolers 13 and 14 are in operation. Likewise, the circuits 43 and 44 each contain a pair of parallel contacts for each possible combination of two other air coolers, as will be readily seen from the drawing.

The solenoids A to D also have contacts A^5 to D^5 respectively, which contacts are in parallel with each other and are arranged to be closed when the associated solenoid is energized. These contacts close a circuit 58 which connects the motor 26 to line conductors L^a and L^b. The line conductors L^a and L^b may be in common with the line conductors L^1 and L^2.

The operation of the above described apparatus is as follows: Air cooling of any one of the rooms may be obtained by closing the switch 34. For example, assume that it is desired to obtain cooling in room 15, the switch 34 of that room is closed and if the temperature is above the desired temperature, the thermostat 39 closes its contacts to complete the circuit 41. Assume also that no other cooler is in operation. All of the contacts B^1, C^1, D^1, C^3 and D^3 are closed so that the circuit 41 is completed. The closing of the circuit 41 energizes the solenoid 45 of the air cooler 11 to open its valve 46, and also energizes the solenoid A to close the contacts A^5. The latter contacts energize the motor 26 to effect operation of the refrigerating unit 24 for supplying the liquid refrigerant. Operation of the air cooler 11 is thus provided.

When the temperature in the room 15 is reduced to the desired value, the thermostat 39 opens the circuit 41, effecting closing of the valve 46 and shutting down of the refrigerator unit 24. Intermittent operation of the cooling device 11 is effected to maintain the desired temperature. The fan 24 operates continuously for ventilation, but cooling is not provided except when refrigerant is admitted to the evaporator 21.

Assume now that air coolers 11 and 13 are to be operated. Their switches 34 are closed, and assuming the temperatures to be above the value to be maintained, the circuits 41 and 43 are completed and the solenoids A and C energized. The control mechanism is now in the condition shown on the drawing, in which the circuits 41 and 43 are completed and in which the circuit 42 is opened at the contacts A^1 and C^2 and the circuit 44 is opened at the contacts A^3 and C^4, so that operation of the air coolers 12 and 14 is prevented. The refrigerating unit 24 and the air coolers 11 and 13 operate as described, each air cooler being under control of its thermostat 39 and the refrigerating unit 24 operating as long as either thermostat calls for cooling.

When operation of either of the air cooling devices 11 and 13 ceases, due either to opening of the switch 34 or the thermostat 39, either of the remaining air coolers 12 and 14 may be operated. For example, if the switch 34 and thermostat 39 of the air cooler 12 are closed when the thermostat of the air cooler 11 opens the circuit 41, the deenergization of the solenoid A permits the contacts A^1 to close. The circuit 42 is thereby closed to effect operation of the air cooler 12. The air cooler 11 then cannot be again operated as long as both air coolers 12 and 13 are in operation.

While some of the contacts are common to more than one set of contacts, it will be noted that, in the circuit of each air cooler, there is

a set of contacts arranged in parallel for each combination of two of the other air coolers. The several sets of contacts are, in effect, arranged in series, since any one set is adapted to open the circuit.

It will be apparent that the control system may be extended to control a greater number of air coolers and to provide for operation at one time of a maximum number of air coolers greater than two.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desired, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a control system for cooling apparatus including at least three evaporator elements and common means for supplying liquid refrigerant thereto, the combination of means for selectively admitting liquid refrigerant to said evaporator elements, and means responsive to operation of a predetermined plural number of evaporator elements of various combinations for rendering the remaining evaporator element or elements inoperable.

2. In a control system for cooling apparatus including at least three evaporator elements and common means for supplying liquid refrigerant thereto, the combination of a switch associated with each evaporator element for controlling the supply of refrigerant thereto and for effecting operation of the refrigerating unit, and means responsive to operation of a predetermined plural number of evaporator elements of various combinations for rendering the remaining evaporator element or elements inoperable.

3. In a control system for cooling apparatus including at least three evaporator elements and common means for supplying liquid refrigerant thereto, the combination of a switch associated with each evaporator element for controlling the supply of refrigerant thereto and for effecting operation of the refrigerating unit, and means responsive to operation of a predetermined plural number of evaporator elements of various combinations for rendering the remaining evaporator element or elements inoperable, said control system permitting simultaneous operation of any combination of evaporator elements not exceeding said predetermined number.

4. In a control system for cooling apparatus including at least three evaporator elements, common means for supplying liquid thereto, and at least three valves for controlling the flow of liquid refrigerant from said supply means to said evaporator elements, the combination of an electrical circuit for each valve, means for energizing each circuit at will, a relay for each circuit including a solenoid connected in the circuit and contacts in the other circuits, each circuit having therein a set of parallel contacts for each combination of a predetermined maximum number of other circuits, the several sets of each circuit being in series, whereby when the predetermined number of circuits is energized the remainder are rendered incapable of being energized.

5. In comfort cooling apparatus, the combination of at least three air cooling elements, means for selectively supplying cooling medium to said elements, and means responsive to the operation of any air cooling elements of a predetermined plural number less than the total number of elements for rendering the remaining element or elements inactive.

6. In comfort cooling apparatus, the combination of at least three evaporators for cooling air, a fan associated with each evaporator for translating air in heat exchanging relation therewith, means for selectively supplying refrigerant to said evaporators, and means responsive to the operation of any evaporators of a predetermined plural number less than the total number of evaporators for rendering the remainder inactive.

7. In a control system for cooling apparatus including at least three evaporator elements, the combination of an electrical circuit associated with each evaporator element and adapted to be energized concurrently with operation of the evaporator element, means associated with each evaporator element for initiating and terminating operation thereof, the action of the last-mentioned means in initiating operation being dependent upon energization of the associated electrical circuit, a relay for each circuit including a solenoid connected in the circuit and contacts in the other circuits, each circuit having therein a set of parallel contacts for each combination of a predetermined maximum number of other circuits, the several sets of each circuit being in series, whereby when the predetermined number of circuits is energized the remaining circuit or circuits are rendered incapable of being energized.

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