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AUTOMATIC CONTROLLING MECHANISM FOR REFRIGERATING SYSTEMS.

APPLICATION FILED MAR. 15, 1907.

981,840.

Patented Jan. 17, 1911.

2 SHEETS—SHEET 1.

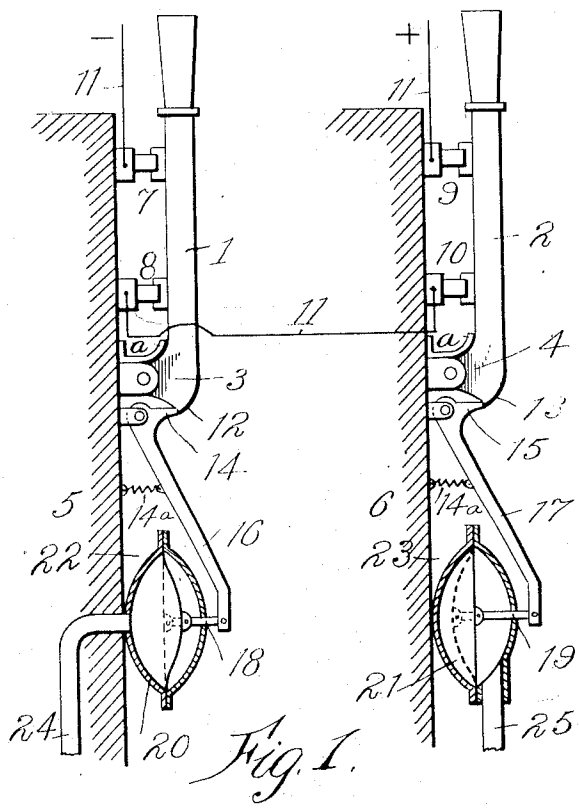

Fig. 1.

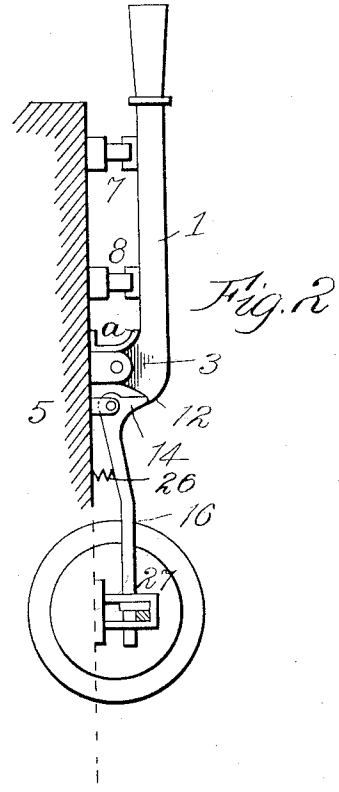

Fig. 2.

Fig. 3.

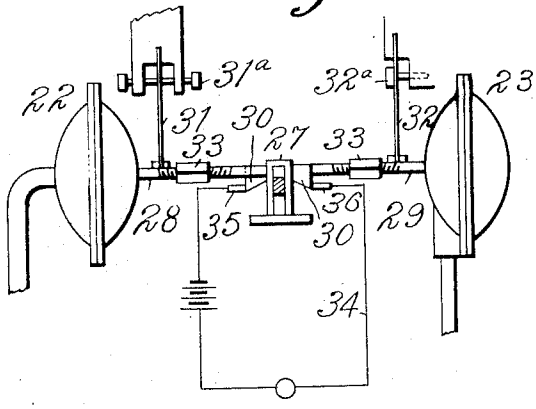

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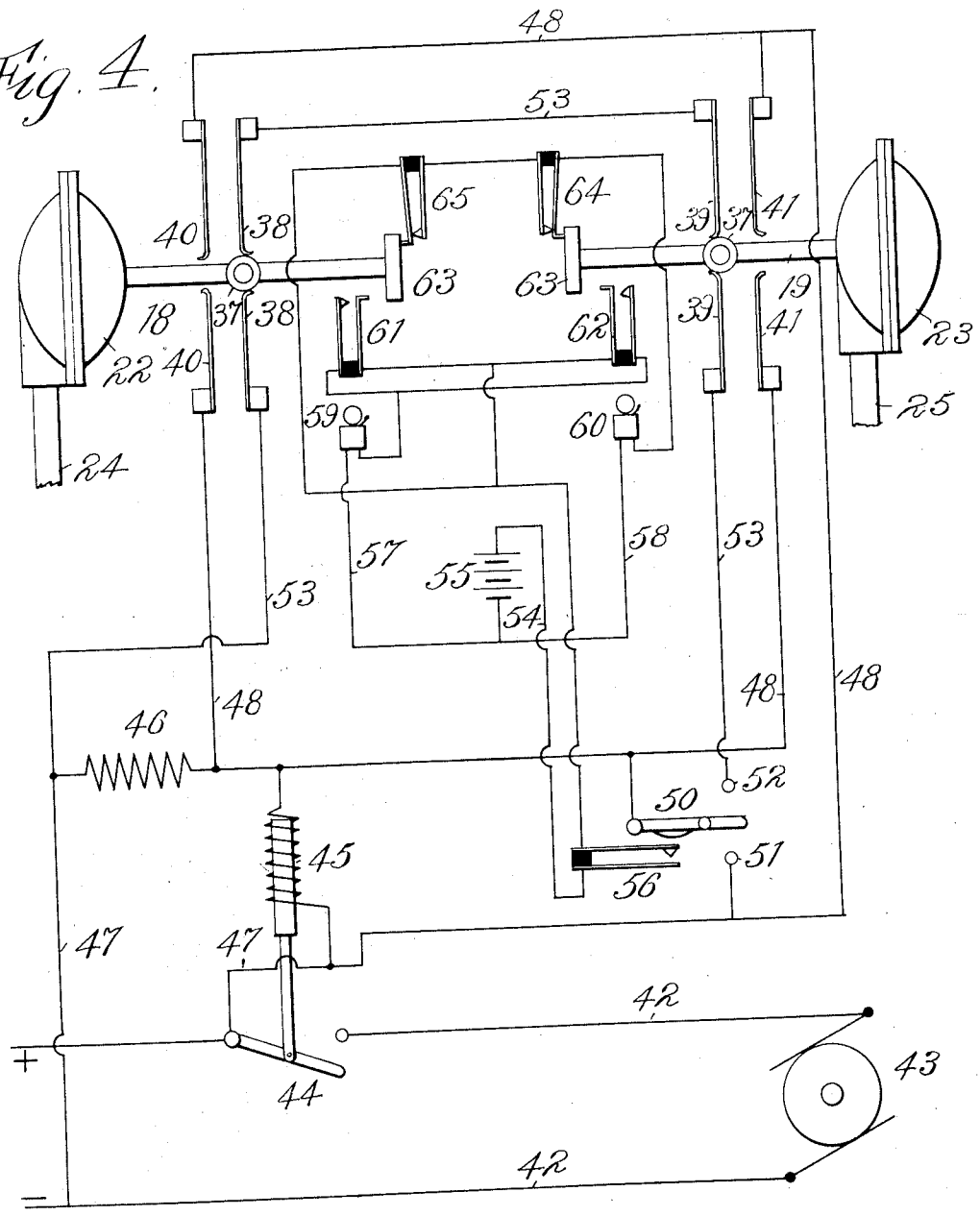
Fig. 4.



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AUTOMATIC CONTROLLING MECHANISM FOR REFRIGERATING SYSTEMS.

981,840. Specification of Letters Patent. Patented Jan. 17, 1911.

Application filed March 15, 1907. Serial No. 362,518.

To all whom it may concern:

Be it known that we, EUGENE CARPENTER and FRED M. KIMBALL, citizens of the United States, residing at Newton, county of Middlesex, State of Massachusetts, and Somerville, county of Suffolk, State of Massachusetts, respectively, have invented certain new and useful Improvements in Automatic Controlling Mechanism for Refrigerating Systems, of which the following is a specification.

Our invention relates especially to that type of refrigerating apparatus in which the maintenance of constant temperature in the refrigerated chamber or space, is, so far as possible, automatically controlled. Such apparatus involves a conduit for the refrigerant, whose low pressure side is located in the space to be refrigerated, whether the same be a cold storage chamber for example, or the cooling tank of a brine circulating system; a pump for compressing and circulating the refrigerant in said conduit, a motor (usually electric) for operating said pump, and a thermostat or other equivalent device in the refrigerating chamber or space to control the stopping and starting of the motor and therefore of the refrigerant circulating pump, in accordance with temperature conditions in said chamber or space. In such systems, situated as they are in a great variety of widely detached locations, the water supply depended upon for the condenser upon the high pressure side of the refrigerant circuit is not uniformly reliable or constant, and should its flow be diminished or cut off, or should for any reason a properly reduced temperature be unobtainable on the high pressure side of the refrigerant circuit, an abnormal pressure may develop in the latter, interrupting the proper normal operation of the apparatus, or even resulting in the accumulation of dangerous pressure.

The object of our invention is to prevent absolutely the operation of the pump, and to throw it out of operation if it is in operation, automatically, should abnormal pressures develop in the refrigerant circuit, or should the condenser water supply fall to an inadequate amount, and our invention particularly contemplates the coaction of both the refrigerant pressure and condenser fluid pressure (and any other fluid pressure whose abnormality might be prejudicial to the proper operation of the system) in controlling the motor—so that they have to be in substantially normal state in order that the motor shall start or continue in operation and the development of abnormal pressure in either (or any) conduit will automatically stop the motor.

In the forms of our invention here illustrated and more particularly described, the driving power for the pump is supposed to be an electric motor, but the invention is not to be understood as so limited, for the controlling devices here shown are applicable to other forms of motive power, and the member controlled thereby and itself controlling the motor, may be a switch as here shown, or the controlling lever or other device of a water, steam or gas motor.

In the accompanying drawing Figure 1 exhibits partly in diagram and partly in sectional elevation, so much of the apparatus only as is necessary to an understanding of our invention in a form employing two separate switches arranged in series in the motor circuit. Figs. 2 and 3 show respectively in side and plan views, a form of our invention wherein a plurality of controlling devices control one switch. The above figures show two forms of the invention, in which the circuit is closed manually and automatically controlled only as to the opening of the circuit. Fig. 4 shows in diagram a further and preferred development of the system in which both the opening and the closing of the circuit are controlled by the fluid pressure devices.

Referring to Fig. 1; 1, 2, are members controlling the stopping and starting of the refrigerant circulating pump. As here shown, they are hand knife-blade switches pivoted at 3, 4, either one alongside of the other on the same base plate, or on separate base plates 5, 6, as here shown. They are so hung and weighted or spring actuated by leaf spring *a* as to be held normally away from their contacts, but may be shifted by hand to engage a series of contacts 7, 8, 9, 10, arranged in series in circuit 11, which may include the pump motor or the controlling circuit thereof. Should either of said switches be open, the motor is cut out of circuit, and the pump absolutely prevented from operation. Only two switches are here shown, but it will be apparent, that

an additional one may be supplied for each part of the refrigerating system, an abnormal or changed condition in which may render necessary or desirable the stopping of the motor and the consequent stoppage of circulation of the refrigerant. One of said switches may for example be controlled by the pressure in the condenser water conduit, the other by the pressure in the high pressure side of the refrigerant conduit. A third might be controlled by the low pressure side of the latter. Various means may be adopted to this end, and those herein shown are intended to be illustrative merely, and may be modified to suit the requirements. As here shown, each switch arm 1, 2, is actuated by spring *a*, and has a shoulder 12, 13, engaged by the short arm or pawl 14, 15 of an angle lever pivoted to the base plate and connected at the end of its long arm 16, 17 to the pin 18, 19 of the diaphragm or piston 20, 21 in a pressure chamber 22, 23. The angle levers are so actuated by springs 14^a or other equivalent means, as to prevent the short arms thereof engaging with the shoulders of the switch levers except at such times as the diaphragms are in position due to normal operation of the system. The pressure chambers may be in various forms, for example, a cylinder and piston, a Bourdon tube, or equivalent construction may be used; but as the simplest form, we have shown and prefer the inclosed pressure chamber here illustrated, with flexible diaphragm directly controlling the pin 18, 19.

The pressure chamber 22 is, on the side of the diaphragm opposite from the controlling pin 18, connected, as by pipe 24, with the condenser water conduit, while the opposite side of the pressure chamber 23 is connected as by pipe 25 with the high pressure side of the refrigerant circulating conduit. Thus one of the diaphragms is controlled by the pressure of the water supply to the condenser, and the other by the refrigerant circulation, both of which have to be in proper condition in order that the system shall operate. Referring for example to the switch 1 and its controlling pressure chamber, it will be seen that normally the pressure in pipe 24 will hold the diaphragm 20 to the position shown in full lines holding the locking pawl 14 in position to engage the shoulder of switch arm 1, but if there is an inadequate pressure of water in the pipe 24, diaphragm 20 will be drawn in to the position shown in dotted lines, the pawl 14 will not engage its switch and if the latter is closed it cannot remain closed; also if, with the pump in operation, low pressure develops in the pipe 24, the diaphragm, moving into the position shown in dotted lines, will disengage the pawl 14 from the switch, and the electric circuit will be automatically opened. Referring to switch 2, it will be seen that if when said switch is manipulated to close it, the pressure in the pipe 25 is abnormally high, the diaphragm 21 will be in the position shown in dotted lines, and the switch cannot be held closed and that the pump will not be started, and if with the pump in operation such abnormal pressure develops in the refrigerant circuit, the switch will be automatically unlatched and will open the motor circuit and stop the pump. A duplicate of switch 1 and its controlling mechanism may, as already stated, be arranged in series therewith, but connected to the low pressure side of the refrigerant conduit so that abnormal drop of pressure therein would also open the circuit. The circuit would in that case be controlled by all three switches, all of the controlling pressures of which would have to be in normal condition in order that the motor might be started and kept in operation.

Either switch 1, 2, may be controlled by several pressure chambers. For example we have illustrated in Figs. 2 and 3 how switch 1 may be controlled by pressure in two or more pressure chambers in several fluid circulating conduits. With this form of the mechanism switch 2, arranged in series with switch 1 may still be employed, and be controlled by other fluid pressure devices—or it may be omitted and the motor circuit be controlled by the single switch 1 controlled by all the fluid pressure circuits whose liability to abnormal conditions might be prejudicial to the proper operation of the system. In Figs. 2, 3, a single controlling switch or lever 1 is employed having the pivoted locking pawl lever 14, 16 engaging the shoulder 12 thereof. The spring 26 holds and returns the pawl lever to engaging position, so that in the normal operation of the apparatus, the pawl 14 will engage and lock the switch whenever it is closed. The long arm 16 of the pawl lever enters a yoke 27 fixed to the base plate. Each diaphragm pin 28, 29 of the condenser water-pressure and refrigerant-pressure controlled chambers 22, 23, is prolonged to enter said yoke from opposite sides in rear of the arm 16 and they have inclines or cam faces 30 at their adjacent ends engaging the rear edge of arm 16. Thus abnormal pressure in either chamber 22, 23, causing an outward movement of the corresponding pin 28, 29 will cause movement of lever 16, 14 sufficient to free the switch and allow it to fall and open the circuit. It will be apparent that with this form also, both or all controlling pressure conditions must be normal to allow the switch to remain closed.

The pressure controlling devices above described may be made adjustable to suit the varying conditions, and may be provided with signaling apparatus to indicate return of pressure conditions to normal. We have

illustrated such mechanism on the form of the apparatus shown in Fig. 3.

Suitable devices, as for example, springs 31, 32, of any desired form and adjustable if desired in either or both directions by adjusting screws as shown, may be employed to adjust the pressure required for releasing or holding the switches.

The arrangement is evidently capable of extension, by simple addition of pressure chambers, &c., to the controlling of the switch by any number of members. In this way, a pressure chamber controlled by the low side of the refrigerant circuit may be added. However many such controlling devices are used, all must indicate a normal condition in their several conduits before the motor can be started and any departure from normal conditions, of a predetermined amount, in any conduit, will stop the motor.

The pins 28, 29 may be made with adjusting means such as turnbuckles 33, placed on pins 28, 29 so that their length may be adjusted as required for different conditions—different normal positions for example of the respective diaphragms.

A signal circuit as for example the light circuit 34, may be so arranged as to give a signal when both or all of the controlling pressure conditions are normal. As here shown the signal-circuit has terminals 35, 36, engaged by contacts on pins 28, 29 when the diaphragms are in normal position, so completing the circuit through the engaging metal parts 27, 28, 29.

In Fig. 4 we have illustrated a further development of the system whereby two or more pressure controlled devices coact in controlling both the starting and the stopping of the motor, as for example by closing and opening of the motor circuit, and we show associated with the motor controlling circuit, signal circuits for giving warning of the operative or inoperative condition of the main circuits;—in both main and signal circuits, the contacts being so arranged that the abnormal condition of any controlling mechanism will stop the motor and give the appropriate signal, while the restoring of all controlling mechanisms to normal will start the motor and give another and appropriate signal.

Two pressure controlled devices are shown by way of example at 22, 23, their diaphragm-operated pins 18, 19 bearing contact or bridge pieces 37, under normal conditions of pressure in chambers 22, 23, bridging the space between brushes 38, 38 and 39, 39 respectively but adapted, by the development of abnormal conditions in one or both of the pressure chambers to be shifted—one or both—to bridge the space between the brushes 40, 40 or 41 41—or both.

The invention is applicable to various forms of motor controlling systems. It is here shown applied to a system in which the motor circuit is opened and closed by a solenoid arranged in a controlling circuit. For simplicity of drawing, the rheostats of both the main and controlling switches are omitted. The main or motor circuit is shown at 42, the motor at 43, the controlling switch thereof at 44 and its controlling solenoid at 45 arranged in series with a resistance 46 in a branch circuit 47 from the motor circuit—the combined resistance of the solenoid and resistance coil being sufficient to prevent the raising of switch 44.

The contacts 40, 41, are in parallel in a circuit 48 around the solenoid, and in parallel with them across the circuit 48 is a switch 50 which may be hand operated or thermostatically controlled—as by a thermostat placed in a refrigerating chamber—and which when placed on contact 51 short-circuits solenoid 45 and opens or keeps open the motor circuit at 44. In the same manner, the development of abnormal conditions in either pressure chamber 22, 23 shifting the corresponding bridge 37 between contacts 40 or 41, will short-circuit the solenoid and open or keep open the motor circuit. The other contact 52 of switch 50 is in a branch circuit 53 around resistance 46 in which the contacts 38, 39 are arranged in series. When the condition in both pressure chambers is normal, and the branch circuit 53 is therefore closed by bridge pieces 37 at both 38 and 39, and the switch 50 is brought, by hand, thermostatically or otherwise, upon contact 52, the resistance 46 is short-circuited, the lifting power of solenoid 45 is augmented, the switch 44 closed and the motor 43 started. If now the circuit 53 be opened at any point, as by shifting of switch 50 away from contact 52 or by the moving of a bridge-piece 37 from contact with brushes 38 or 39 under a change of pressure in either chamber, the motor circuit may still be maintained at 44 by even the slight current passing through both solenoid and resistance, but if then the solenoid be short circuited by the switch 50 being brought in contact with contact 51 or by either bridge-piece 37 being brought in contact with brushes 40 or 41, the motor circuit will be immediately opened at 44 and the motor stopped.

It will be seen that by adopting a series arrangement for the contacts in branch circuit 53 all of the controlling devices have to be in normal condition in order to enable the motor to be started and that by adopting a parallel arrangement for the contacts in branch circuit 48, the development of abnormal—or sufficiently abnormal—condition in any controlling mechanism will positively open the motor circuit and stop the motor if it is in operation, or will prevent its being started if it is not.

It is also apparent that the system could be expanded to include any additional number of controlling devices and that with the arrangement of circuits indicated, both resistance and solenoid cannot be cut out at once—one or the other is always in circuit and thus dead short circuits are prevented. As each member 37 returns to normal position it not only opens the contacts at 40, 41 thus opening the solenoid short circuits 48 and preventing the thermostatic or other switch 50 from short circuiting the solenoid, but it completes at 38, 39 the short circuit to contact 52 around resistance 46, so that when the last member 37 returns to normal, it is only necessary for switch 50 to move to contact 52 in order to short circuit resistance 46, energize solenoid 45 and start the motor and resume the work of refrigeration.

The arrangement of circuits adapted for the motor controlling circuit—motor-circuit opening devices in parallel and motor-circuit closing devices in series—is followed also in the signaling circuits which will now be described. The circuit 54 of local battery 55 is controlled by a switch 56, closed automatically when the motor circuit is opened, as for example, by the shifting of switch 50 to point 51. Two branch circuits 57, 58 from the battery include two signaling devices 59, 60—preferably dissimilar in character, to render their signals readily distinguishable audibly or visually or both. In branch circuit 57, contacts 61, 62, (corresponding in number to the number of devices controlled by abnormal conditions in the system), are arranged in parallel and arranged to be closed automatically when any of such devices, moved by the occurring of such abnormal conditions, opens the motor controlling circuit. To this end the pressure controlled pins 18, 19, may have non-conducting lugs or heads 63, adapted, in abnormal position of their controlling members, to close the corresponding contacts 61 or 62, and thus give warning by the signal 59 of the abnormal condition. In the other branch circuit 58, contacts 64, 65 are arranged in series and adapted to be closed by the lugs or heads 63 when the latter are in normal position—thus indicating by signal 60 whether all of the controlling devices which indicate abnormal conditions—are at normal. The signal 60 may appropriately be a lamp and the signal 59 a bell. If the circuit 54 be closed at 56 when the motor is stopped by any means, as for example directly by the opening of the motor switch 44, or, as shown, by the switch 50 being brought against contact 51 the alarm signal circuit 57 can be completed by closing either of the contacts 61 or 62 while the signal device 60 will be actuated only by the closing of both contacts 64, 65. Thus when abnormal conditions occur and the motor circuit is open, closing contact 56, the same abnormal conditions which have stopped the motor will close contact 61 or 62 allowing the local battery current to pass through alarm signal 59. The alarm will continue to be operated until all abnormal conditions have passed and the parts 18, 19, 63 have returned to their normal position, allowing contacts 61 or 62 to be broken. When all the conditions have returned to normal, provided the motor has not been started, so that contact 56 is still closed, the signal circuit will be completed through 64 and 65 and the operating of signal 60—which may as stated be a light—will indicate that conditions are proper for the motor to be again started. The closing of the motor starting switch breaks the contact 56 making both signal circuits incomplete and both alarms and visual signal inoperative.

It is obvious that our system as herein described is capable of considerable variation within the scope of the following claims. For example the motor 43 is not necessarily an electric motor. It may be an engine of any desired kind. The switch 44 may represent the controlling lever of a steam or hydrocarbon engine or the switch of the sparking circuit of the latter.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In apparatus of the character described, the combination of a motor, a plurality of devices independently responsive to normal and abnormal conditions in the parts of the system, a motor controlling circuit having means in series controlled to close it to control the starting of the motor, by normal conditions in the several parts of the system and a motor controlling circuit having means in parallel to close it to stop the motor by abnormal conditions in any part of the system.

2. In apparatus of the character described, the combination of a motor, a starting circuit therefor, a stopping circuit therefor, contacts arranged in series in the starting circuit, contacts arranged in parallel in the stopping circuit, and means controlled by independent mechanisms responsive to conditions of different parts of the system, to close all the contacts in the starting circuit when all the conditions are normal and to close one of the contacts in the stopping circuit when the condition in any part of the system is abnormal.

3. In apparatus of the character described, the combination of means for stopping and starting a motor, a plurality of pressure controlled controlling devices for said stopping and starting means, a signal, and means for operating said signal by the conjoint action of said controlling devices.

4. In apparatus of the character described,

the combination of a plurality of devices actuated by changing conditions in different parts of the system, a signal circuit having a plurality of contacts in series each controlled by one of said devices and a signal circuit having a plurality of contacts in parallel each controlled by one of said devices.

5. In apparatus of the character described, the combination of a plurality of devices actuated by changing conditions in different parts of the system, a signal circuit having a plurality of contacts in series each controlled by one of said devices, a signal circuit having a plurality of contacts in parallel each controlled by one of said devices and a motor controlling switch controlling also both of said signal circuits.

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