Sept. 5, 1950 A. B. NEWTON 2,521,247

CONTROL OF REFRIGERATION

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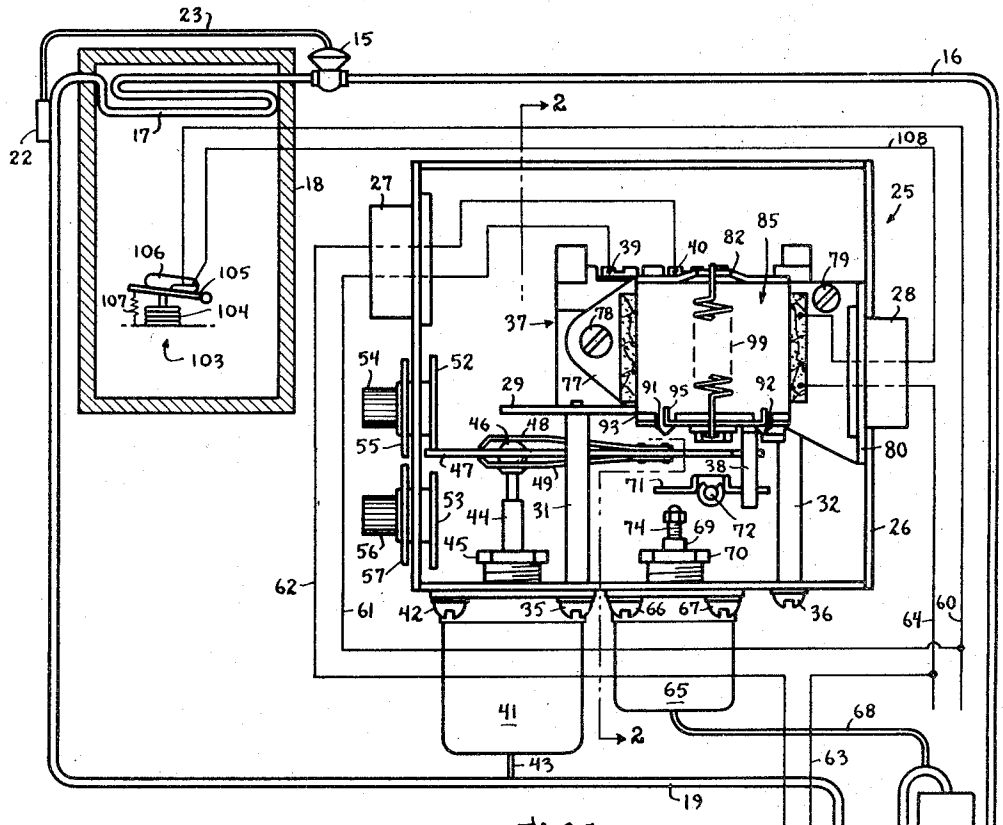


Fig. 1

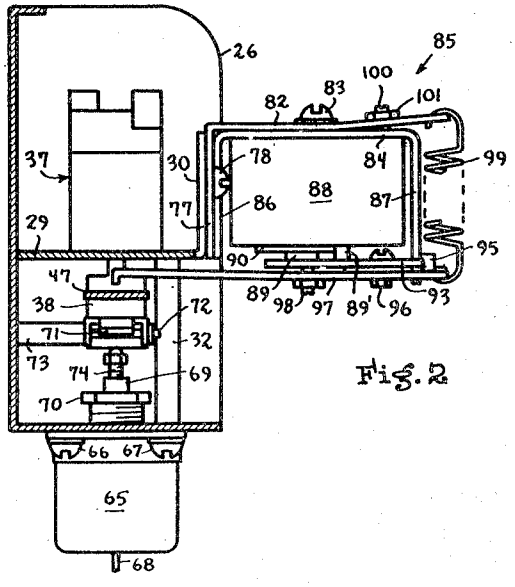


Fig. 2

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CONTROL OF REFRIGERATION

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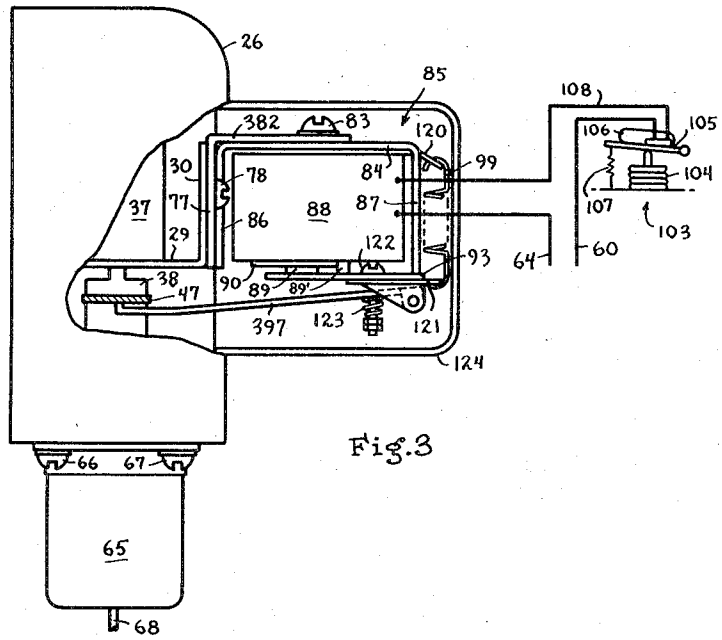
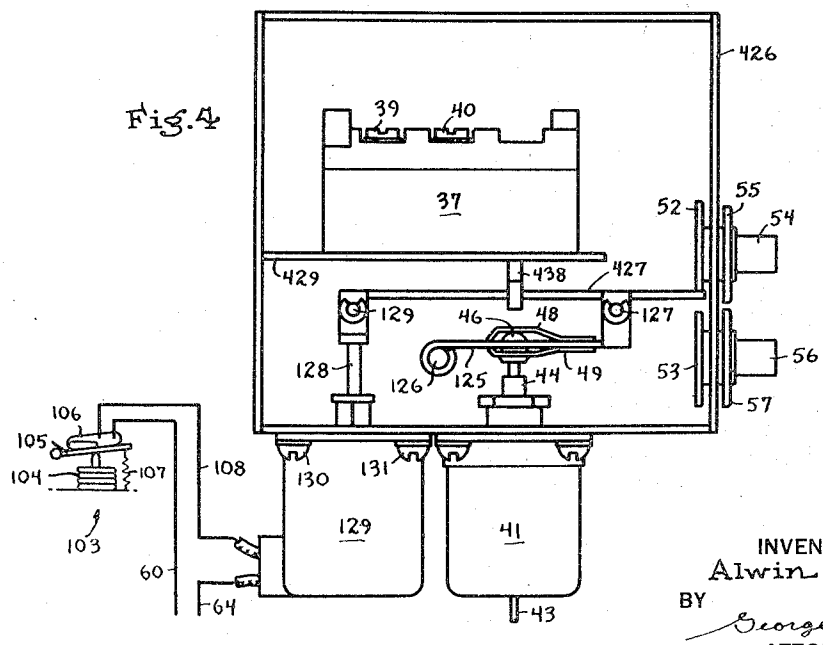


Fig.3

Fig.4



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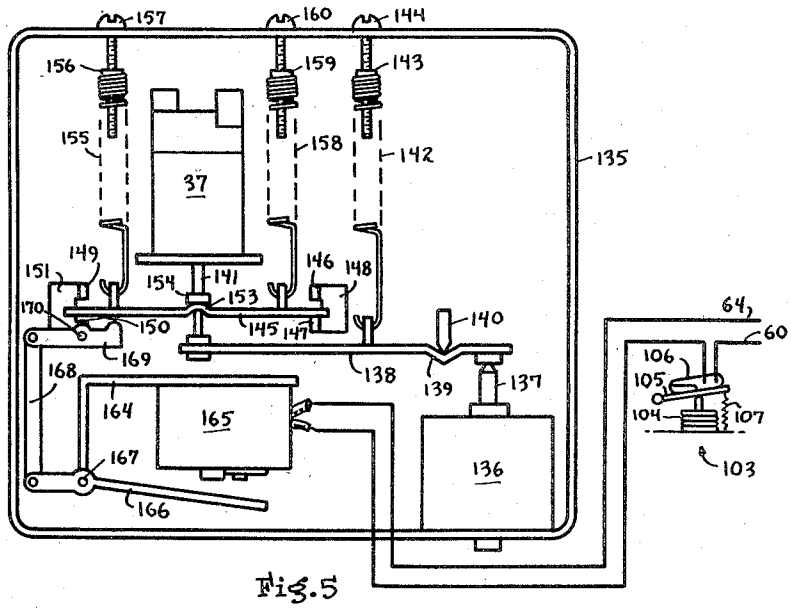


Fig. 5

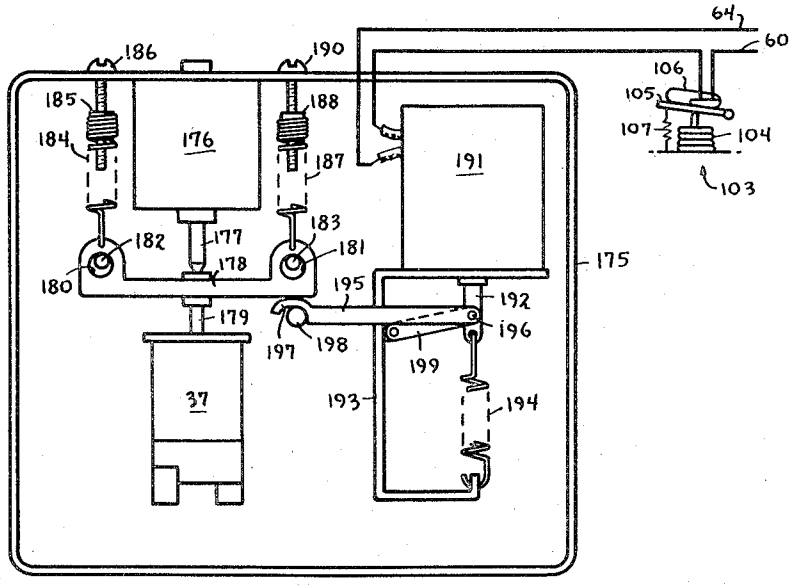


Fig. 6

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Fig.7

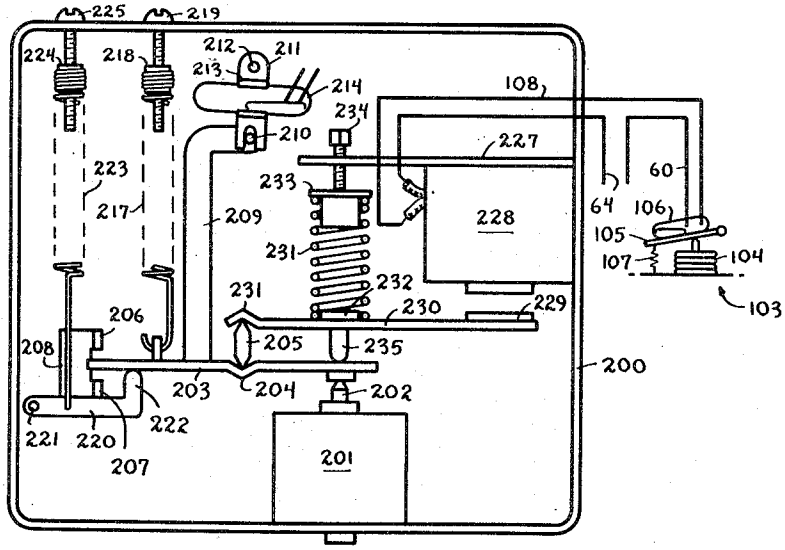


Fig.8

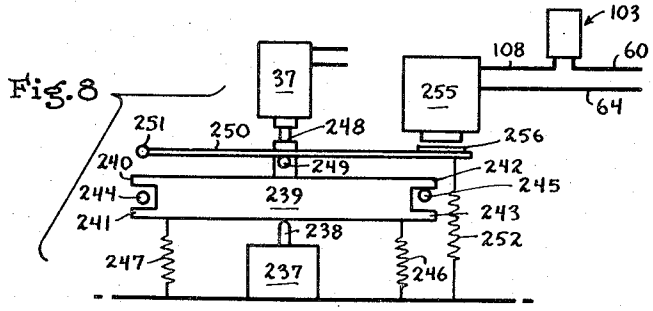


Fig.9

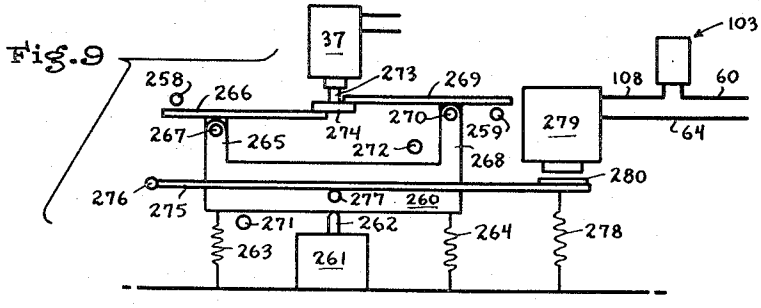
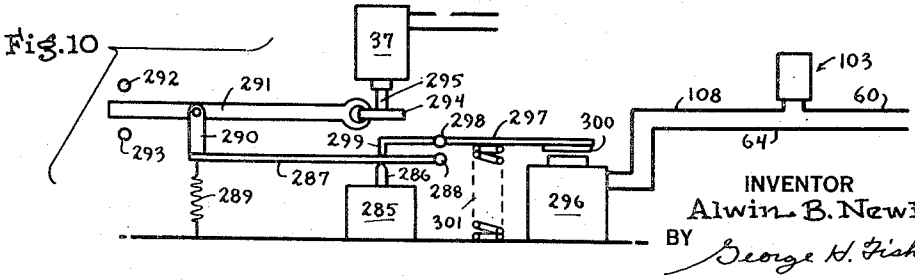


Fig.10



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UNITED STATES PATENT OFFICE

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CONTROL OF REFRIGERATION

Alwin B. Newton, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application January 13, 1941, Serial No. 374,179

18 Claims. (Cl. 62—4)

1

This invention relates to the control of refrigerating systems, particularly those of the compression type.

The object of my invention is to provide improvements in the manner and means of controlling the compressor, the control being in response to evaporator temperature or suction pressure, the temperature or other condition of the air in the refrigerated space, and head pressure. The invention may be applied where the source of refrigerant is other than a compressor.

Controllers have heretofore been proposed which provided for cycling the compressor from evaporator temperature or pressure, the compressor preferably being started at an evaporator temperature high enough to insure defrosting thereof. It is an object of my invention to provide improved means in conjunction with such a controller to prevent operation of the compressor whenever the temperature of the refrigerated space is at the desired value.

It is also an object of my invention to provide a modified arrangement whereby the compressor can be started when the refrigerated space requires cooling even though the evaporator temperature has not risen to a given value.

Another object of my invention is to provide an improvement for controllers of the type referred to in the foregoing object embodying a normally inactive device responsive to the temperature of the refrigerated space which acts to change the setting of the controller when the temperature of the refrigerated space is satisfactory so as to keep the compressor out of operation or to permit it to operate at higher than normal evaporator pressures.

More specifically, an object of my invention is to provide a compressor controller responsive to evaporator temperature or pressure embodying a switch, switch operating means and an attachment comprising a normally inactive device which in the preferred form of the invention is an electromagnetic device responsive to temperature of the refrigerated space for acting on the switch operating means either to keep the switch open in one form of the invention, or to independently close it in a modified form of the invention.

Another object of the invention is to provide a controller generally as described in the foregoing object having improved structural forms and arrangements whereby the switch can be controlled from evaporator temperature or suction pressure, the space temperature and discharge pressure of the compressor.

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Another object of my invention is to provide a compressor controller embodying a switch operating arm, a device responsive to suction pressure for moving the arm and an electromagnetic device responsive to the temperature of the refrigerated space operative directly on the arm for either keeping the arm in switch open position or for moving the arm to closed position of the switch.

Another object of my invention is to provide a compressor controller having a suction pressure responsive device for closing a switch and an attachment responsive to space temperature embodying a spring normally held in an inactive position and releasable to a position to resist the suction pressure device when the space temperature is at the required value, the additional resistance offered by the spring affecting the controller in a manner to normally keep the compressor out of operation or to permit it to operate at higher than normal evaporator pressures.

Another object of my invention is to provide an attachment responsive to temperature of the refrigerated space for compressor controllers of various types employing a whiffletree form of lever arrangement, the attachment embodying normally inactive means operative in response to the space temperature to act on the whiffletree, or more directly on the operating means of the switch of the controller to keep the compressor out of operation or to materially raise the evaporator pressures at which it is started and stopped.

The improved structural forms and arrangements of my invention, the details of which are described in the following specification constitute further objects of my invention.

In the annexed drawings:

Figure 1 represents a compression type refrigerating system showing the details of a controller with space temperature responsive attachment constituting one form of my invention.

Figure 2 is a view taken along line 2—2 of Figure 1.

Figure 3 is a view of modified form of controller having an attachment arranged to act in a manner reverse to that of Figure 1.

Figure 4 is a view of another modified form of controller.

Figure 5 is a view of another form of controller with direct acting space temperature responsive attachment as in Figure 1.

Figure 6 is a view of another form of controller with direct acting relay attachment.

Figure 7 represents a known form of com-

pressor controller with a space temperature responsive attachment for changing the setting of the controller.

Figure 8 is a diagrammatic view of a modified form of controller with space temperature responsive attachment for changing the control setting of the controller.

Figure 9 is similar to Figure 8 but representing a modified form of controller.

Figure 10 is similar to Figures 8 and 9 but representing a further modified form of controller.

Referring to Figure 1 of the drawings, a refrigeration system of the compression type is shown, the system having a compressor motor controlled by a controller constituting a preferred form of my invention. Numeral 10 designates the compressor, driven by an electric motor 11 by means of a belt 12. The compressor 10 discharges into a condenser 13 through a pipe 14 and the condenser 13 is connected to an expansion valve 15 by a pipe 16. The expansion valve 15 has its outlet connected to an evaporator 17 disposed within a compartment to be refrigerated, 18. The outlet of the evaporator 17 is connected to the suction side of the compressor by a pipe 19. The expansion valve 15 is of the usual superheat control type which is operated in response to the temperature of the refrigerant at the outlet of the evaporator as well as in response to evaporator pressure, the expansion valve including a thermal bulb 22 adjacent to the outlet of the evaporator connected to a pressure chamber within the expansion valve by a capillary tube 23.

The controller of my invention is indicated generally by the reference character 25, and it comprises a generally rectangular metal casing 26, as may be seen on Figures 1 and 2, the casing having flanged openings 27 and 28 in its opposite sides through which electrical leads pass to the interior of the casing.

Within the casing 26 is a horizontal shelf 29 having a vertical portion 30, the shelf 29 being supported by standards 31 and 32 upstanding from the bottom of the casing 26. Numerals 35 and 36 designate bolts which extend through the standards 31 and 32 and which engage the shelf 29 in screw-threaded relationship. Supported on the shelf 29 is a snap switch 37 which is of the same type disclosed in detail in Patent 2,318,734, issued May 11, 1943, to Albert E. Baak. The snap switch 37 is enclosed within a Bakelite housing and has "on" and "off" positions and is of the type which tends to remain in the position to which it is operated. The snap switch 37 has an operating stem 38 extending downwardly therefrom, the stem 38 having two spaced horizontal slots or openings therein. As may be seen in Figure 1, the snap switch 37 has two contact terminals formed by screws 39 and 40 for making electrical connections to the switch.

The operating mechanism for the snap switch 37 includes a pressure responsive bellows enclosed within a housing 41 at the lower portion of the casing 26. The housing 41 is flanged and the flange is secured to the lower side of the casing 26 by screws which include the screws 35 and 42. The bellows within housing 41 is expansible and contractible and is connected to the suction pipe of the compressor by a tube 43. The operating end of the bellows operates a bellows post 44 which extends through a nut 45 within the casing 26. At the upper end of the bellows post 44 is a ball 46 loosely disposed within an opening in an operating lever 47, the right end of which is engaged within one of the slots in the switch operating stem 38. Numeral 48 designates a leaf spring secured at one end to the lever 47 by rivets or the like with the other end engaging the ball 46. Numeral 49 designates a similar leaf spring secured to the opposite side of lever 47 and having an opening through which the upper end of the bellows post 44 extends with the leaf spring 49 engaging the lower side of the ball 46. The arrangement just described forms a strain release connection between the bellows post 44 and the operating lever 47. The left end of the operating lever 47 is disposed between two cams 52 and 53, each of which has a spiral contour. The cam 52 is mounted on a shaft which extends through a side wall of the casing 26 and which is rotatable by a manual knob 54 outside of the casing. Adjacent the knob 54 is a graduated dial 55 movable with respect to an index marker for indicating the position of the cam 52. The cam 53 is mounted on a shaft which extends through a side wall of the casing 26 and which is rotatable by a manual knob 56 outside of the casing, and there is a graduated dial 57 similar to dial 55 adjacent the manual knob 56.

From the foregoing it will be seen that the lever 47 is a floating lever and that its left end moves between the cams 52 and 53 which act as stops. The lever 47 is moved by the suction pressure effecting the bellows within housing 41. When the suction pressure rises, the bellows within housing 41 is expanded, and the bellows post 44 moves the lever 47 upwardly by reason of the engagement of ball 46 with the leaf spring 48. When the left end of lever 47 engages cam 52, the cam acts as a stop and the lever 47 is then constrained to pivot in a counter-clockwise direction about the cam which acts as a fulcrum. Counter-clockwise movement of the right end of lever 47 moves the operating stem 38 of switch 37 upwardly so as to move the switch to closed position. When the switch 37 moves to closed position, the circuit for the compressor motor is completed as follows; from a line conductor 60 through wire 61 to terminal 39 of the snap switch through the snap switch to terminal 40, wire 62 through the compressor motor 11 and through wire 63 back to a line conductor 64. In the event there should be a rise in suction pressure when the snap switch is closed, as described, and the compressor is operating, upward movement of the ball 46 with respect to lever 47 is permitted by virtue of the resiliency of the leaf spring 48. The point, that is the pressure at which lever 47 will begin to move in a counter-clockwise direction so as to close the snap switch, may be adjusted by rotatably adjusting cam 52, which as pointed out above has a spiral contour, so that the point of engagement between its edge and the end of lever 47 may be raised and lowered by rotating the cam. After the compressor has started in operation, the suction pressure will fall causing the bellows within housing 41 to contract, thereby moving the bellows post 44 downwardly until the left end of lever 47 engages cam 53. When this happens, the lever 47 will pivot in a clockwise direction about the cam 53 which acts as a fulcrum, the right end of lever 47 moving downwardly so as to move the operating stem 38 downwardly to open the snap switch 37. The pressure, at which lever 47 will thus move in a clockwise direction for opening the switch and stopping the compressor may be adjusted by adjusting the position of cam 53 which also has a

spiral contour as pointed out above, that is, the point at which the lever 47 engages the edge of the cam may be raised and lowered by rotatably adjusting the cam.

The snap switch 37 may also be operated by a device responsive to the discharge pressure of the compressor. This device includes an expansible and contractible bellows enclosed within a housing 65 which has a flange secured to the lower side of the casing 26 by screws 66 and 67. The bellows within housing 65 is connected to the discharge pipe 14 of the compressor by a tube 68. The bellows within housing 65 operates a bellows post 69 which extends through a nut 70 inside of the casing 26. Numeral 71 designates a small lever having ears pivotally engaging a pin 72 extending outwardly from the back of the casing 26. Numeral 73 designates a spacer member between one of the said ears and the back of the casing 26. The right end of the lever 71 is engaged in the other of the slots in the operating stem 38, and the left end of the lever 71 may be engaged by a screw-threaded member 74 carried by the end of the bellows post 69. That is, when the compressor discharge pressure increases to a predetermined relatively high value, the bellows within housing 65 expands moving member 74 into engagement with lever 71 causing lever 71 to rotate clockwise so as to move operating stem 38 downwardly for opening the snap switch 37. The snap switch may be thus opened even though the suction pressure is at a value at the time to have the switch closed. That is, the strain release connections between bellows post 44 and lever 47 will permit the operating stem 38 to be moved downwardly by the discharge pressure responsive device even though the lever 47 is engaging cam 52 at the time, the leaf springs 48 and 49 permitting relative movement of the lever 47 and the ball 46 as pointed out above.

The structure so far described has heretofore been used in the art for controlling a compressor in response to suction pressure and head pressure. My invention comprehends employing an additional device in conjunction with the controller whereby the compressor is controlled in response to the temperature within the refrigerated compartment as well.

Referring to Figures 1 and 2, numeral 77 designates a bracket secured to the vertical portion 30 of shelf 29 by screws 78 and 79. The bracket 77 has an angular portion 80 adjacent to the side wall of the casing 26 which has an opening to which is secured a flange on the flanged member 28 through which electrical leads are carried to the interior of the casing. Bracket 77 also has an angular portion 82 forming a projection extending outwardly and away from the casing 26 and the end of which is bent upward slightly, as may be seen on Figure 2. Secured to the portion 82 by a screw 83 is a frame 84 made of magnetic material and forming part of an electromagnetic device designated generally at 85. The frame 84 device designated generall at 85. The frame 84 has legs 86 and 87 disposed on opposite sides of a winding 88 within which is a core, the core and winding being held in place by the screw 83. The core is of the split pole type, a shaded portion being designated as 89 and the other portion being designated as 89'. Numeral 90 designates a shading coil engaged on the core portion 89. The leg 87 has two downwardly extending fingers 91 and 92 which engage in grooves or slots in a hinge member 93. The fingers 91 and 92 and the grooves in which they engage form a pivotal connection between the hinge member 93 and the leg 87. Numeral 95 designates a relatively thin brass plate member which has upwardly bent ears so disposed as to reduce the magnetic spacing between the fingers 91 and 92 and the adjacent portions of the slots in which they engage. The magnetic circuit of winding 88 is of course formed by the frame 84 including leg 87, the hinge member 93 and the core 89. Secured to the hinge member 93 by means of a bolt 96 is an arm 97 which is spaced from the hinge member 93 by the brass plate member 95. The portion of the arm 97 to the left of the plate member 95 is held in spaced relationship to the hinge member 93 by a screw 98 carrying a lock nut adjacent the arm 97. The left end of the arm 97 extends inwardly toward the interior of the casing 26 and normally is disposed in a position just above the right end of lever 47 adjacent the operating stem 38. That is, the winding 88 of the electromagnetic device 85 is normally energized with the hinge member 93 and arm 97 in the position shown in Figure 2, the hinge member 93 forming an armature which is held against the core 89. The right end of the arm 97 extends to the right beyond leg 87 of frame 84, as may be seen on Figure 2. A coil spring 99 is attached to this end of the arm, the other end of the coil spring 99 being attached to the right end of bracket portion 82 so as to normally urge the arm 97 and hinge member 93 in a counterclockwise direction, that is, toward deenergized position of the electromagnetic device. The right end of bracket portion 82 is spaced from the frame 84 by means of a screw 100 carrying an adjustable nut 101 whereby the spacing of the end of member 82 from frame 84 and consequently the tension of spring 99 may be adjusted.

The electromagnetic device 85 is controlled by a thermostat 103 disposed within the refrigerated compartment 18 so as to be responsive to the temperature of the air therein. The thermostat 103 comprises an expansible and contractible bellows 104 having an operating stem engaging a pivoted lever 105 carrying a mercury switch 106. The lever 105 is normally urged in a counterclockwise direction by a coil spring 107. The electrodes of the mercury switch are at its right end, and when the temperature within the compartment 18 is above a predetermined value, the bellows 104 is expanded so as to rotate the lever 105 to a position wherein the electrodes of the mercury switch are bridged, as shown in Figure 1. Whenever the mercury switch 106 is closed the winding 88 of the electromagnetic device 85 is energized through the following circuit: from line conductor 60 to mercury switch 106, through wire 108, winding 88, and back to the line conductor 64. Thus, whenever the temperature within the compartment 18 is above a predetermined value high enough to indicate that refrigeration is required, the electromagnetic device 85 is energized and the arm 97 is held in a normal and inactive position. Under these circumstances the compressor is controlled by the suction pressure responsive mechanism which operates to start the compressor at a predetermined relatively high suction pressure which is preferably above the melting point of water to insure that after each cycle of operation of the compressor the evaporator 17 will be defrosted before the compressor is again started. Thus the compressor is normally cycled in the manner just described. If, however, at any time the temperature within the refrigerated compartment 18 falls to a predetermined low value at which the

bellows 104 is contracted sufficiently to move the lever 105 in a counter-clockwise direction so as to open the mercury switch 106, the electromagnetic device 85 is deenergized. When the device 85 is deenergized, the coil spring 98 rotates the arm 97 in a counter-clockwise direction bringing its left end into engagement with the operating lever 47 moving the said lever downwardly, that is in a clockwise direction, so as to move the stem 38 downwardly to open the switch 37. If the switch 37 is already open at the time the electromagnetic device 85 is deenergized, the left end of arm 97 will engage lever 47 and hold the switch in an open position. When the electromagnetic device 85 is thus deenergized, even though the suction pressure rises to or above the value at which it normally closes the switch 37, the switch 37 will remain open. However, if the suction pressure should rise to a relatively high value which may be, for instance, ten pounds higher than the value at which suction pressure normally closes the switch 37, the lever 47 will be rotated in a counter-clockwise direction nevertheless, carrying the arm 97 upwardly with it so as to close the switch 37 irrespective of the electromagnetic device 85. The pressure at which the suction pressure responsive device will close the switch 37 when the electromagnetic device 85 is deenergized may be adjusted by adjusting the tension of spring 98, which determines the amount of loading which is placed on lever 47 when the electromagnetic device 85 is deenergized. The head pressure responsive device may of course open the switch 37 at any time that the head pressure or discharge pressure rises to an excessive value.

From the foregoing it will be understood that with the control arrangement of Figures 1 and 2, the compressor is controlled normally in response to suction pressure and that the arm 97 is normally held in an inactive position having no effect on the control of the compressor except when the thermostat 103 moves to a satisfied position. The arm 97 then moves downwardly engaging the lever 47 so as to open the switch 37 if it is closed or to hold it in an open position if it is already opened. The arrangement, therefore, provides for eliminating unnecessary operation of the compressor. That is, the compressor is controlled in a normal manner from suction pressure, but whenever refrigeration is not required the controller is prevented from functioning in its usual manner. The controller itself without the electromagnetic device is a unitary instrument which may be used without the electromagnetic device. The electromagnetic device forms an attachment which may be fastened to the controller and operated in conjunction therewith merely by means of securing the bracket 77 to the vertical portion 30 of the shelf 29 by means of screws as pointed out above, that is, the electromagnetic device forming the attachment may be very simply applied to controllers already in use on installations. When the electromagnetic device or attachment is fastened in position, the arm 97 assumes its proper position with respect to the lever 47. When the attachment is applied to controllers which have previously been installed, a special cover is used for the casing of the controller, which cover is so formed as to house the electromagnetic attachment as well.

Referring to Figure 3 of the drawings, this figure is a view of a slightly modified form of controller, this view being very similar to Figure 2. The electromagnetic attachment of the previous embodiment, I prefer to refer to as direct acting, while in the present embodiment of the invention I have provided an electromagnetic attachment which I refer to as being a reverse acting attachment. Most of the parts of Figure 3 are the same as parts shown in Figure 2 and are numbered the same. In Figure 3, however, the bracket 382 which is attached to the vertical portion 30 of the shelf 29 is slightly different in not having its end extended for attachment of the spring 98 thereto. The spring 98 is attached at its upper end to an ear 120 on the frame 84. The hinge member 93 has attached thereto a bracket member 121 having a pair of downwardly extending ears to which are pivoted corresponding ears on an arm 397 corresponding to the arm 97 of the previous embodiment. The lower end of spring 98 is attached to bracket 121. A bolt 122 extends through the hinge member 93 and through the arm 397, there being a coil spring 123 encircling the bolt between the arm 397 and a pair of nuts on the end of the bolt. The spring 123 exerts a pressure on the arm 397 urging it in a clockwise direction.

The thermostat 103 of the present embodiment is the same as in the previous embodiment and is connected to the winding of the electromagnetic device 85 in the same manner. In the present embodiment, the arm 397 has its left end disposed underneath the lever 47 adjacent the operating stem 38 of the snap switch 37. The electromagnetic device 85 in the present embodiment is energized whenever the thermostat 103 is in its hot position as shown. Under these circumstances the hinge member 93 and arm 397 are in the positions shown in Figure 3 with the left end of arm 397 holding the lever 47 in a raised position so that the snap switch 37 is closed. In other words, in the present embodiment whenever the thermostat is not satisfied, that is when there is a demand for refrigeration, the electromagnetic device moves the switch 37 to closed position for starting the compressor. Obviously the operation of the present electro-magnetic device is essentially opposite to that of the modification of Figures 1 and 2. In the present embodiment the snap switch 37 may be opened by the head pressure responsive device even though the switch has been closed by the electromagnetic device. That is, if the switch is closed, with the parts in the position shown in Figure 3, the head pressure responsive device may move the operating stem 38 of the snap switch downwardly, moving the arm 397 downwardly at the same time, the coil spring 123 forming a strain release mechanism permitting the arm 397 to be moved downwardly even though the electromagnetic device 85 is energized. In the present embodiment, when the thermostat is in an unsatisfied position, the switch 37 normally remains closed with the compressor in operation even though the suction pressure falls below the value at which the switch is normally opened in response to suction pressure. However, if desired the spring 123 may be adjusted so that the switch 37 will be opened at a lower than normal suction pressure when the electromagnetic device is energized. As shown, the electromagnetic device may be enclosed within a suitable housing 124 which may form part of the casing 26 or may form part of a cover for the casing 26.

Referring to Figure 4 of the drawings, I have shown a further modified form of my invention having a direct acting electromagnetic attachment as is the attachment of the embodiment

of Figures 1 and 2. Many of the parts of the embodiment of Figure 4 are the same as parts of the embodiment of Figures 1 and 2 and are numbered the same. In the present embodiment, the bellows within housing 41 actuates a lever 125 which is pivoted on a pin 126. The bellows post 44 is connected to the lever 125 by a strain release mechanism which is the same as that of the embodiment of Figures 1 and 2. The lever 125 has an ear at its right end which is pivoted to a corresponding ear on the lever 427 by a pin 127. In the present embodiment, the snap switch 37 has an operating stem 438 having a slot therein through which the lever 427 extends. The right end of the lever 427 is disposed between two cams 52 and 53 which are the same as the cams of Figures 1 and 2. The left end of the lever 427 has an ear which is pivoted to a corresponding ear on the end of an operating stem 128 by means of a pin 129. The operating stem 128 is connected to the armature of an electromagnetic device within a housing 129 which has a flange secured to the lower part of the casing 426 by screws 130 and 131. The electromagnetic device is controlled by a thermostat 103 which is the same as that of previous embodiments and which energizes the electromagnetic device when the thermostat is in a satisfied position. With the parts in the position shown, the thermostat is not satisfied and the electromagnetic device is deenergized. Under these circumstances the switch 37 is controlled by suction pressure. Upon a rise in suction pressure, the bellows within housing 41 expands moving bellows post 44 and lever 125 upwardly, the lever 125 moving in a counter-clockwise direction and also moving lever 427 in a counter-clockwise direction. Lever 427 moves relatively freely without moving the stem 438 until its right end engages the cam 52, the stem 128 being freely reciprocatable at this time as pointed out below. Upon this occurring, further upward movement imparted to lever 427 by lever 125 causes lever 427 to pivot in a clockwise direction about cam 52 which acts as a fulcrum, this action moving the stem 438 upwardly to close the snap switch 37. Upon a fall in suction pressure to a predetermined relatively low value, the bellows within housing 41 moves the post 44 downwardly moving lever 125 in a clockwise direction and moving the right end of lever 427 downwardly until said end engages the lower cam 53. Further downward force exerted on lever 427 causes it to pivot in a counter-clockwise direction about cam 53 which acts as a fulcrum, this action moving the stem 438 downwardly and opening the snap switch 37. During the above described opening and closing operations of the snap switch 37, the left end of lever 427 moves up and down relatively freely because the electromagnetic device within housing 129 is deenergized and very little effort is required to move the armature attached to the stem 128. In the event of the thermostat 103 becoming satisfied, however, and closing the mercury switch 106, the electromagnetic device becomes energized attracting its armature and moving the stem 128 downwardly. Upon this occurring, the left end of lever 427 is moved downwardly sufficiently to move the stem 438 downwardly so as to open the switch 37. If the switch 37 is closed at the time the electromagnetic device is energized, the switch is opened, and if it is already open, it is held in the open position as in the embodiments of Figures 1 and 2. If the switch 37 is closed when the electromagnetic device is energized, even if the right end of arm 427 is engaging cam 52, the downward movement of the left end of lever 427 is permitted by reason of the strain release connections between bellows post 44 and lever 125, the lever 427 pivoting in a counter-clockwise direction, under these circumstances, with the cam 52 acting as a fulcrum.

It will be understood of course that the controllers having modified forms as shown in Figures 3 and 4 are to be used in the same type of system as completely shown in Figure 1, and the thermostats of Figures 3 and 4 are to be disposed in refrigerated compartments as shown in Figure 1.

Referring to Figure 5 of the drawings, I have shown a form of controller of a somewhat different type with the electromagnetic attachment of previous embodiments applied thereto for holding the switch in its off position when there is no demand for refrigeration, the switch of course normally being controlled by suction pressure. The controller of Figure 5 comprises a casing 135 within which is a housing 136 containing a bellows to be connected to the suction pressure line of a refrigerating compressor. The bellows operates a bellows post 137 having a pointed end engaged in a suitable seat on the end of an operating lever 138. The lever has a crimped portion 139 which engages a knife-edge formed on a member 140 mounted within the casing so that the lever 138 may pivot about the member 140. The left end of the lever 138 is attached to the operating stem 141 of the snap switch 37 of the same type as that of the previous embodiments. Numeral 142 indicates a coil spring, the lower end of which is attached to an ear on the lever 138 and the upper end of which is attached to a member 143 engaged in screw-threaded relationship with a screw 144 adjustable from outside of the casing 135. The spring 142 urges the lever 138 in a clockwise direction, and its tension is adjustable by adjusting the screw 144. Numeral 145 indicates a lever of the whiffletree type, the right end of which is disposed between two projections 146 and 147 forming part of a bifurcated member 148 mounted within the casing 135, the projections 146 and 147 forming stops for the end of the lever 145. The other end of the lever 145 is disposed between two similar projections 149 and 150 forming stops, these projections forming part of a similar bifurcated member 151 mounted within the casing 135. The mid point of the lever 145 has a knob 153 which normally engages an abutment 154 on the operating stem 141 of the switch 37. Numeral 155 designates a coil spring, the lower end of which is attached to an ear on the lever 145 and the upper end of which is attached to a member 156 engaged in screw-threaded relationship with a screw 157 adjustable from outside of the casing 135. Numeral 158 designates a similar coil spring attached to an ear on the opposite side of the knob 153 of lever 145, its upper end being attached to a member 159 engaged in screw-threaded relationship with a screw 160 adjustable from outside of the casing 135. The spring 158 is somewhat stronger than the spring 155 for purposes which will now be described.

When the suction pressure is low, the bellows within housing 136 will be contracted, and under these circumstances the coil springs 142, 155 and 158 will hold the lever 138 in a clockwise rotated position and the whiffletree 145 in a posi-

tion with both its ends engaging the upper stops 149 and 146. With the parts so positioned, the operating stem 141 of the switch 37 will be in its upper position with the switch 37 opened, the switch 37 being open when the stem 141 is pushed upwardly in the present embodiment. As the suction pressure rises, the bellows within housing 136 will expand rotating the lever 138 in a counter-clockwise direction against the bias of spring 142. The left end of lever 138 will move downwardly pulling the stem 141 downwardly and also the whiffletree 145. As the left end of lever 138 moves downwardly, the left end of whiffletree 145 will first move downwardly from stop 149 to stop 150 inasmuch as spring 155 is the weaker of the two springs attached to the whiffletree. Such movement, however, is insufficient to close the switch 37 inasmuch as operation of the switch requires a relatively large movement necessitating that both ends of whiffletree 145 be in engagement with the lower stops before the switch is closed. As the suction pressure continues to rise, lever 138 will move the right end of whiffletree 145 downwardly from stop 146 to stop 147, and when this happens the stem 141 will be actuated to close the switch 37.

From the foregoing it will readily be seen that the suction pressure at which the switch closes is dependent upon the adjustment of spring 158 because the adjustment of this spring determines the suction pressure at which the right end of whiffletree 145 moves downwardly from stop 146 to stop 147. When the compressor is started by reason of closure of switch 37, the suction pressure will fall causing the bellows within housing 136 to contract permitting lever 138 to move in a clockwise direction. The right end of whiffletree 145 will now first move upwardly from stop 147 to stop 146, but such movement will not be enough to open snap switch 137. As the suction pressure further is reduced, the left end of whiffletree 145 will move upwardly from stop 150 to stop 149 causing the switch 37 to open. Obviously, therefore, the pressure at which the switch opens is dependent upon the adjustment of spring 155. It is to be seen therefore that separate adjustments of the cut-in and cut-out points of the switch are provided by the arrangement of the controller of the present embodiment. By adjusting the spring 142, both the cut-in and cut-out points of the switch may be varied.

In the present embodiment of the invention, I have shown a particular manner of applying the relay attachment of the previous embodiments so as to hold the switch in its off position when the thermostat is in its satisfied position. Numeral 164 designates a fixed member mounted within the casing 135 which supports the electromagnetic mechanism 165 comprising a winding and a core member, the winding being arranged to attract an armature formed on the end of a lever 166. The lever 166 is pivoted on a pivot 167, and its left end is attached to a link 168 which in turn is attached to another lever 169 pivoted on a pin 170 adjacent the member 151. The right end of the lever 169 bears against the left end of the whiffletree 145. When the thermostat 103 which is like that of previous embodiments is in its satisfied position, the electromagnetic devise 165 is energized and it attracts its armature rotating the lever 166 in a counter-clockwise direction. This action pulls the link 168 downwardly thereby rotating the lever 169 in a counter-clockwise direction so that its right end bears against the whiffletree 145 lifting it up to the stop 149 in which position the switch 37 is opened. The right end of whiffletree 145 will of course normally be in engagement with stop 146 because after switch 37 is closed to start the compressor the pressure will fall relatively quickly to permit spring 158 to raise the right end of the whiffletree against stop 146. Thus, whenever the thermostat is in its satisfied position, the switch is mechanically held in its open position so that the compressor cannot be cycled by the suction pressure responsive device. It follows that after the compressor has been stopped it cannot be restarted until there is a demand by the thermostat.

Referring to Figure 6 of the drawings, I have shown another form of my invention which is similar to the embodiment of Figure 5. The controller of Figure 6 comprises a casing 175 and within the casing is mounted a housing 176 within which is an expansible and contractible bellows which is to be connected to the suction line of a refrigerant compressor as in previous embodiments. The bellows actuates a bellows post 177 which has a pointed end engaging in a suitable seat at the mid point of a whiffletree type lever 178. At the mid point of the whiffletree at the opposite side is connected the operating stem of a snap switch 37 as in previous embodiments. In the present embodiment, the snap switch is closed when the operating stem 179 is pushed inwardly, that is, downwardly. The ends of the whiffletree 178 are slightly enlarged and the left end has an opening 180 while the right end has an opening 181, the opening 180 engaging a pin 182 mounted in the casing and the opening 181 engaging a pin 183 mounted in the casing, the pins being smaller in size than the openings. Numeral 184 designates a coil spring, the lower end of which is attached to the left end of the whiffletree 178 and the upper end which is attached to a member 185, the member engaging a screw 186 and the screw being adjustable from outside of the casing 175. Numeral 187 designates a similar spring attached to the right end of the whiffletree 178, the upper end of the spring engaging a member 188 which is engaged in screw-threaded relationship with a screw 190 adjustable from outside of the casing 175.

With the controller in the position shown, the whiffletree has both its ends in their lowermost positions with the pins 182 and 183 which act as stops engaging the upper sides of their respective openings. With the parts in this position, the switch 37 is closed so as to cause the compressor to operate and to reduce the suction pressure. Spring 184 is adjusted so as to be stronger than the spring 187, and as the suction pressure is reduced, the bellows within housing 176 begins to collapse or contract and the spring 184 moves the left end of whiffletree 178 upwardly so that the pin 182, which acts as a stop, engages the lower side of opening 180. This movement, however, is insufficient to open the switch which movement requires that the right end of the whiffletree 178 to be also moved upwardly before sufficient movement is imparted to operating stem 179 to open the switch. As the suction pressure continues to fall, (the bellows exerts less force), and at a predetermined low value of suction pressure the pin 187 will move the right end of whiffletree 187 upwardly until the pin 183 engages the bottom of opening 181. With the parts in this position, the switch 37 will have snapped to open position. When switch 37 is opened the

compressor is stopped and the suction pressure will rise. As it rises, the bellows within housing 176 expands urging whiffletree 178 downwardly. The right end of whiffletree will move downwardly first, spring 187 being the weaker, and at a predetermined relatively high pressure the left end of the whiffletree will be moved downwardly into the position shown in Figure 6 wherein switch 37 is again closed. The operation so far described is that which takes place without the electromagnetic attachment of my invention.

Numeral 191 designates an electromagnetic device similar to that shown in previous embodiments comprising a winding arranged to attract an armature which is attached to a stem 192. The electromagnetic device is mounted on a bracket 193 secured within the casing 175, and the stem 192 is normally biased in a downward direction by a coil spring 194 attached to a portion of the bracket 193. Numeral 195 designates a lever pivoted to the stem 192 by means of pivot 196. The left end of the lever 195 has a projecting portion 197 forming a cam surface and the lower side of which rests on a top or support 198. Numeral 199 designates a guiding link, one end of which is pivoted to the bracket 193 and the other of which is pivoted on the pivot 196 for guiding the stem 192 in its vertical reciprocatory movements. The electromagnetic device 191 is controlled by a thermostat 103, the same as in previous embodiments, the thermostat energizing the electromagnetic device in the present embodiment when the thermostat is unsatisfied (bellows expanded). With the parts in the position shown, the electromagnetic device is energized, the thermostat being in unsatisfied position, and with the parts in this position the armature of the electromagnetic device is attracted and raised with the stem 192 pulled to its uppermost position against the bias of spring 194. With the parts so positioned, the lever 195 is substantially horizontal and the cam portion 197 has no effect upon the whiffletree 178. Under these circumstances, the controller operates normally to cycle the compressor from suction pressure. Now if the thermostat should become satisfied (bellows retracted), the mercury switch deenergizes the electromagnetic device 191 so as to release the armature permitting spring 194 to pull stem 192 downwardly moving lever 195 in a clockwise direction. Upon such movement of lever 195, the cam portion 197 exerts a leverage upon the right end of whiffletree 178 moving said end upwardly until stop pin 183 engages the lower side of opening 181. It will be understood that after the switch 37 has been closed by suction pressure, practically as soon as the compressor starts, the stronger spring 184 will move the left end of whiffletree 178 upwardly as the suction pressure begins to fall. Thus when the right end of whiffletree 178 is moved upwardly by the lever 195, the switch 37 will be moved to open position and will be held in open position as long as the electromagnetic device is deenergized, that is, as long as the thermostat is satisfied. From the foregoing it will be understood that the present embodiment is similar to the previous embodiments but is different as to particular details.

Referring to Figure 7 of the drawings, I have shown a further form of my invention wherein I employ the electromagnetic attachment, but instead of utilizing it to cause the controller to start the compressor or to prevent the compressor from operating, it changes the control setting of the suction pressure responsive means. The controller of Figure 7 comprises a casing 200 having a housing 201 mounted therein with an expansible and contractible bellows within the housing connected to the suction pipe of a refrigerant compressor. The bellows operates a bellows post 202, the end of which is pointed and which engages in a suitable seat in the end of an operating lever 203. The operating lever 203 is crimped at 204 and the crimped portion pivotally engages a knife-edge formed on a member 205 mounted within the casing. The left end of lever 203 is disposed between projections 206 and 207 forming stops, the projections forming part of a bifurcated member 208 mounted within the casing 200. The lever 203 has an integral arm 209 carrying a pin 210 engaged in a slot in the end of a small switch carrying lever 211 pivoted on a pin 212, the lever 211 having a clip 213 in which is carried a mercury switch 214. When the lever 203 moves pivotally, the arm 209 is moved to the right or left, and the pin 210 rotates the lever 211 on its pivot so as to open and close the mercury switch 214.

Numeral 217 designates a coil spring, the lower end of which is attached to an ear on the lever 203 and the upper end of which is attached to a member 218 engaged in screw-threaded relationship with an adjusting screw 219 which extends throughout the side wall of the casing 200 and is adjustable from the outside thereof. The spring 217 normally urges the lever 203 in a clockwise direction about its pivot. Numeral 220 designates a small lever pivoted at 221 and having an upstanding finger 222 adapted to engage the left end of lever 203. A coil spring 223 is attached to the lever 220 at one end and the other end of the coil spring 223 is attached to a member 224 which is screw-threadedly engaged with a screw 225 which extends through a side wall of the casing 200 and is adjustable from the outside thereof. Stop 207 limits counter-clockwise movement of lever 220.

The electromagnetic device 228 of the present embodiment of the invention is supported on a bracket 227 and includes a winding and an armature 229 carried on the end of a lever 230. The electromagnetic device is controlled by the thermostat 103 as in previous embodiments, the device being energized when the thermostat is in an unsatisfied position. The left end of the lever 230 is crimped at 231 and the crimped portion pivotally engages a knife-edge on the upper side of member 205 previously referred to. Numeral 231 designates a coil spring, the lower end of which engages a boss 232 on the lever 230 and the upper end of which engages a spring retaining member 233, which is attached to an adjusting screw 234 extending from the support bracket 227. The lever 230 has a downwardly extending finger 235 which is coaxially aligned with bellows post 202 and which engages the lever 203 on the side opposite the bellows post. The spring 231 is a compression spring, the compression of which is adjustable by adjusting the screw 234. From the above description, it is to be seen that the force exerted by spring 231 directly opposes the bellows within the casing 201. The forces exerted by the spring and bellows are directly in line. Whenever the thermostat 103 is unsatisfied, the electromagnetic device is energized so as to attract the armature 229 moving the lever 230 in a clockwise direction so as to control the spring 231 and move the finger 235 out of engagement with the lever 203. Under these circumstances the spring 231 is inactive and ineffective to exert any control upon the controller at all.

With the electromagnetic device energized, the controller operates normally as follows. The switch 214 is closed causing the compressor to operate, the suction pressure is at an intermediate value and lever 220 is engaging stop 207 preventing its further upward movement. As the suction pressure decreases, the bellows within housing 201 contracts permitting the coil spring 217 to move the lever 203 in a clockwise direction about its pivot. As the lever 203 moves about its pivot in this manner, arm 209 moves to the right causing pin 210 to rotate lever 211 in a counter-clockwise direction about its pivot until the mercury switch 214 is opened and this occurs at a relatively low predetermined value of suction pressure. The stop 206 limits the upward movement of the left end of lever 203. When the compressor has been stopped, the suction pressure rises causing the bellows within housing 201 to expand, thereby rotating the lever 203 in a counter-clockwise direction against the force exerted by spring 217. During this operation the arm 209 moves to the left rotating lever 211 in a clockwise direction. As the left end of lever 203 moves downwardly, it engages the finger 222 requiring that the lever 220 be moved in a clockwise direction for further downward movement of lever 203. Thus, further expansion of the bellows is opposed by the force exerted by both springs 217 and 223. When the suction pressure has risen to a predetermined relatively high value, the lever 203 will be rotated to such a position that arm 209 rotates lever 211 to a position wherein mercury switch 214 is closed. The pressure at which mercury switch 214 is closed of course depends upon the tension of spring 223 which is adjustable by screw 225 inasmuch as this spring must be overcome in order to close the switch. Spring 223 is preferably adjusted so that the evaporator of the system will be defrosted before the switch closes. Screw 225 therefore provides an adjustment of the cut-in point of the switch. Only spring 217 is effective upon the lever 203 at the time that the switch is opened so that at this time only the force of this spring must be balanced against the force exerted by the bellows. The screw 219 therefore provides a separate adjustment of the cut-in point of the switch.

Whenever the thermostat 103 is satisfied, the electromagnetic device 228 is deenergized and the parts may be in the position shown in Figure 7. Under these circumstances the bellows within casing 201 is directly opposed by the spring 231, and both the cut-in and cut-out points of the switch are raised. That is, with the parts in the position shown with spring 231 resisting expansion of the bellows, the pressure must rise to a predetermined relatively higher value to close the switch, as now assumed, this value depending upon the adjustment of spring 231 and correspondingly the switch will open at a higher than normal pressure. The adjustment of spring 231 is in practice such that when the electromagnetic device is deenergized the controller will normally be held in the off position. That is the cut-in point of the switch will be raised to such a value of suction pressure that normally, when the thermostat is satisfied, the switch will stay in open position until the suction pressure rises, as at present assumed, a predetermined amount above the normal cut-in value. It is to be seen therefore that the present embodiment functions similarly to previous embodiments, in that the thermostat in the refrigerated compartment tends to maintain the controller in the off position, but in the present embodiment the electromagnetic device raises both the cut-in and cut-out points of the switch, without positively holding it open.

Referring to Figure 8 of the drawings, I have shown another modified form of my invention comprising a controller which embodies features of the embodiments of Figures 5 and 6 and of the embodiment of Figure 7. Numeral 237 designates a pressure actuatable device embodying a bellows responsive to suction pressure having a bellows post 238 engaging the mid point of a whiffletree 239. The ends of the whiffletree are bifurcated to form fingers 240 and 241 at one end and fingers 242 and 243 at the other end, the fingers forming stops between which are disposed stop pins 244 and 245, respectively. One end of the whiffletree 239 is normally urged downwardly by a coil spring 246 and the other end is normally urged downwardly by a coil spring 247. The spring 246 is the stronger of the two and of course both may be made adjustable. Numeral 37 designates the snap switch which has been described in previous embodiments, the snap switch having an operating stem 248 extending downwardly and being connected to the mid point of whiffletree 239. The operating stem 248 has a horizontally extending pin 249. Numeral 250 designates a lever pivoted at 251 and having its right end urged downwardly by a coil spring 252. An intermediate point of lever 250 rests on the pin 249 and inasmuch as the pin 249 is vertically aligned with the bellows post 238, the downward force exerted on lever 250 by spring 252 directly opposes the force exerted by the bellows responsive to suction pressure. Numeral 255 designates an electromagnetic device similar to that of previous embodiments controlled by a thermostat 103 also similar to that of previous embodiments. The lever 250 has an armature 256 at its right end cooperating with the electromagnetic device.

The electromagnetic device 255 is energized when the thermostat 103 is unsatisfied, and under these circumstances the armature 256 is attracted so as to move the lever 250 in a counter-clockwise direction against the force of spring 252 so as to disengage the lever 250 from the pin 249. Under these circumstances the electromagnetic device has no effect on the controller and it operates as follows: with the parts in the position shown, the switch 37 is closed and the compressor is operating to reduce the suction pressure. Inasmuch as spring 246 is stronger than spring 247, the right end of whiffletree 243 has been moved downwardly until stop pin 242 is in engagement with stop pin 245. When the suction pressure has been reduced to a predetermined value, the left end of whiffletree 239 is moved downwardly until finger 240 engages stop pin 244, and upon this occurring the operating stem 248 will be moved downwardly sufficiently to open the switch 37 and stop the compressor. Upon the suction pressure rising, the suction pressure responsive device moves the whiffletree upwardly, the left end moving upwardly first inasmuch as spring 247 is the weaker until the finger 241 engages stop pin 244. The right end of lever 239 then moves upwardly until finger 243 engages stop pin 245. When the latter occurs, the operating stem 248 will be moved upwardly sufficiently to close the snap switch 37 and restart the compressor.

When the thermostat 103 becomes satisfied, the electromagnetic device 255 is deenergized and

the parts assume the positions shown in Figure 8. Under these circumstances the lever 250 is bearing against pin 249, and the downward force exerted on the lever by spring 252 directly opposes expansion of the bellows responsive to suction pressure. Under these circumstances the control point of the controller is raised, both the cut-in and cut-out points of the switch 37 being raised by a predetermined amount inasmuch as the bellows now must overcome the spring 252 to close the switch 37 and the spring 252 assists the controller when it is operating in opening direction of the switch. The function of the electromagnetic device is substantially the same in the present embodiment as in the previous embodiment, and normally the additional resistance provided by the spring 252 is sufficient to maintain the controller in the off position unless the suction pressure rises to a somewhat higher value.

Referring to Figure 9 of the drawings, I have shown a further modified form of my invention wherein the electromagnetic attachment is applied to another form of controller. In Figure 9 the controller comprises a whiffletree type of lever 260 which is actuated by an expansible and contractible bellows within a bellows housing 261, the bellows having a bellows post 262 bearing against the lower side of the mid point of the whiffletree 260. The bellows is to be connected to the suction pipe of the refrigerant compressor as in previous embodiments. The left end of the whiffletree 260 is biased downwardly by a coil spring 263, and the right end of the whiffletree 260 is biased downwardly by a coil spring 264 which is weaker than the spring 263. The coil springs correspond to those of the previous embodiment and both may be made adjustable. The whiffletree 260 has an upstanding leg 265 at its left end, to which is pivoted a lever 266 by means of a pin 267. At the right end of the whiffletree 260 is an upstanding leg 268 having pivoted thereto a lever 269 by means of a pin 270. Counter-clockwise movement of the whiffletree 260 is limited by a stop 271 and a second stop 272. The snap switch 37 has an operating stem 273 with a button 274 on the end of the switch, the stem being in line with a bellows post 262 as shown. The right end of the lever 266 engages the lower side of the button 274 and the left end of lever 269 engages the upper side of the button 274.

Numeral 275 designates another lever pivoted at 276 and arranged to engage a pin 277 at an intermediate point of the lever, the pin 277 extending outwardly from the whiffletree 260 and the said point of lever 275 being in vertical alignment with the bellows post 262. The lever 275 is normally biased in a clockwise direction by a coil spring 278. Numeral 279 designates the electromagnetic attachment which is the same as in previous embodiments and which is controlled by a thermostat 103. The lever 275 carries an armature 280 at its right end which may be attracted by the windings of the electromagnetic device.

When there is a demand for refrigeration by thermostat 103, the electromagnetic device 279 is energized and armature 280 is attracted to disengage lever 275 from pin 277 and to thereby relieve the control of the effect of spring 278. With the electromagnetic device 279 energized, the operation of the controller of the present embodiment is as follows: with the parts in the position shown, the switch 37 is open and the pressure is rising in the suction line and hence

in the bellows within housing 261. The bellows post 262 bearing against the whiffletree 260 has caused its right end to move upwardly against the force of the weaker spring 264 to move the lever 269 upwardly moving its right end away from the stop 259. When the lever 269 engages the stop 272, the bellows will cause the left end of whiffletree 260 to move upwardly until the left end of lever 266 engages stop 258. Upon this occurring, lever 266 will be unable to freely rotate on its pivot, and further upward movement of the left end of whiffletree 260 causes the leg 265 to rotate the lever 266 about the stop 258 acting as a fulcrum and the right end of lever 266 will move the operating stem 273 of the switch 37 upwardly so as to close the switch and start the compressor. When the compressor starts and the suction pressure begins to fall, the left end of whiffletree 260 will first move downwardly by reason of spring 263 being stronger until stop 271 is engaged. This action will impart no movement to the operating stem 273 of the snap switch 37. As the suction pressure continues to fall, the right end of whiffletree 260 will move downwardly until the right end of lever 269 is brought into engagement with stop 259. When this occurs, lever 269 will not be able to rotate freely on its pivot, but it will be then rotated in a counter-clockwise direction about the stop 259 acting as a fulcrum. The left end of lever 269 engaging button 274 will then pull the operating stem 273 of the snap switch 37 downwardly so as to open the switch. When this occurs, the compressor will be stopped.

Whenever the thermostat 103 becomes satisfied indicating that there is no further need for refrigeration, the electromagnetic device 279 is deenergized and the parts assume the position shown in Figure 9. Under these circumstances, the spring 278 acting on lever 275 imposes a downward force on the whiffletree 260 which is directly in line with the force exerted upwardly through the bellows post 262 by the bellows within housing 261. This downward pressure raises both the cut-in and cut-out points of the switch as in the previous embodiment and is normally sufficient to keep the switch 37 in an off position so that when the thermostat is satisfied the compressor is normally maintained out of operation. If, however, the suction pressure should rise to a value determined by the tension of spring 278, the force exerted by the bellows may overcome the spring 278 and operate the whiffletree in the same manner as described above to close the snap switch 37 and restart the compressor. It is to be seen therefore that the present embodiment provides a form of controller for the compressor having separate adjustments of the cut-in and cut-out points of the controlling switch, the electromagnetic device providing an attachment for the controller whereby it is normally maintained in the off position when the thermostat is satisfied and the electromagnetic device being inactive to affect the controller when the thermostat is unsatisfied.

Referring to Figure 10 of the drawings, I have shown another form of my invention embodying a controller which is very similar to the controller of Figure 4 of the drawings. In Figure 10, numeral 285 designates a housing containing a bellows responsive to suction pressure and operative to move a bellows post 286 bearing against a lever 287 pivoted at 288. The lever 287 is normally biased in a counter-clockwise direction by a coil spring 289, and it has an upstanding por-

tion 288 pivoted to a floating lever 291, the left end of which is movable between stops 292 and 293. The right end of lever 291 has spaced fingers which engage on opposite sides of a button 294 at the end of the operating stem 295 of the snap switch 37, which switch is the same as in previous embodiments.

In the present embodiment the electromagnetic device is designated at 296. It is the same as that of previous embodiments and is similarly controlled by a thermostat 103. Numeral 297 designates a lever pivoted at 298 and having a downwardly extending finger 299 at its left end which bears against the lever 287 opposite the bellows post 286, the finger 299 and the bellows post 286 being in vertical alignment. The lever 297 carries an armature 300 at its right end. Numeral 301 designates a coiled compression spring which engages the lever 297 to the right of the pivot 298 and which normally urges the lever 297 in a counter-clockwise direction. The thermostat 103 energizes the electromagnetic device 296 when the thermostat is unsatisfied, that is, when there is a demand for refrigeration. Under these circumstances, the armature 300 is attracted so as to rotate the lever 297 in a clockwise direction against the force of spring 301 so as to disengage finger 299 from the lever 287. When the electromagnetic device is thus energized, the spring 301 is inactive to exert any effect upon the controller and the operation is then very similar to that of the embodiment of Figure 4. With the lever 291 in the position shown, the suction pressure is at an intermediate value and is rising. As the pressure rises, the lever 287 is rotated in a clockwise direction by bellows post 286 and thus moves the left end of lever 291 upwardly against the force of spring 289. When the left end of lever 291 engages the stop 292, the lever 291 pivots in a counter-clockwise direction about the stop 292 which acts as a fulcrum. The right end of lever 291 then moves the button 294 and operating stem 295 of switch 37 upwardly so as to close the switch and start the compressor. When the compressor starts, the suction pressure falls causing the bellows within housing 285 to contract moving lever 287 in a counter-clockwise direction and moving the left end of lever 291 downwardly. When the left end of lever 291 engages the stop 293, lever 291 pivots in a clockwise direction about the stop 293 which acts as a fulcrum. The right end of lever 291 now moves downwardly so as to pull downwardly on the button 294 and the operating stem 295 of the snap switch 37 so as to open the switch and stop the compressor.

Whenever the thermostat 103 becomes satisfied, the electromagnetic device 296 is deenergized and the parts assume the positions shown in Figure 10. Under these circumstances, the spring 301 exerts downward force through the lever 297 and finger 299 which directly opposes the force exerted by the bellows within housing 285 so as to tend to prevent the suction pressure from closing the snap switch 37. The force exerted by spring 301 raises both the cut-in and cut-out points of the switch as in previous embodiments and is normally sufficient to maintain the controller in the off position when the thermostat is satisfied. However, in the event of the suction pressure rising to a relatively high value determined by the force of spring 301, the bellows within housing 285 may expand sufficiently to close the switch 37 and start the compressor in the same manner as described above. From the foregoing, it will be seen that in the present embodiment, there is provided a controller with an electromagnetic attachment which does not effect the controller when the thermostat is unsatisfied but which raises the control setting of the controller to a high enough value when the thermostat is satisfied to normally maintain the controller in the off position.

In all of the embodiments of my invention which I have disclosed, the controller has switch operating mechanism which may be operated by a bellows responsive to suction pressure of the compressor. It is to be understood that my invention also comprehends the use of bellows responsive to temperature of the refrigerated compartment for actuating the controller switch and controlling the electromagnetic device by means of a switch responsive to suction pressure. A device which is mechanically actuated in response to the temperature of the refrigerated compartment or the suction pressure may be substituted for the electromagnetic device and arranged to operate in the same manner as I have disclosed.

The embodiments of my invention which I have disclosed are illustrative of the preferred manners of constructing it and of the preferred modes of operation. The disclosed embodiments of the invention are also illustrative of different forms of controllers to which the invention may be applied and of different manners of applying the invention to controllers having different structural and operating characteristics. There are many modifications and adaptations of the invention which may be made by those skilled in the art but which fall within the spirit and scope of my invention, and therefore my disclosure is not to be interpreted in a limiting sense but only in a representative one. The invention is to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a refrigerating system, in combination, means including an evaporator and a source of refrigerant supply for said evaporator, control means for said source of supply comprising a switch, actuating means for the switch including a device responsive to a condition which is a measure of evaporator temperature, said actuating means being arranged to close said switch at a predetermined value of the condition, means responsive to a condition of a medium affected by operation of the said system, and mechanism associated with said actuating means and controlled by said last condition responsive means, said mechanism being arranged to close said switch when the condition of the medium attains a predetermined value, said mechanism controlled by the means responsive to the condition of the medium comprising an electromagnetic device operable on the switch actuating means.

2. In a refrigerating system, in combination, means including an evaporator, and a source of refrigerant supply for said evaporator, control means for said source of supply comprising a switch, actuating means for the switch including a device responsive to a condition indicative of evaporator temperature, said actuating means being arranged to close said switch at a predetermined value of the condition, means responsive to a condition of a cooled medium indicative of a need for operation of the system, and mechanism associated with said actuating means and controlled by said last condition responsive means, said mechanism being arranged to close said switch when the condition of the medium attains a predetermined value, said mechanism

being arranged to permit movement of said actuating means independently thereof except when the condition of the medium attains said predetermined value.

3. In combination, an electric snap switch, a condition responsive device, mechanical connections between said device and switch by which said device normally opens and closes said switch solely upon changes in the condition to which it responds to spaced predetermined values, additional mechanical means including stress limiting means operable to a position to open said switch and prevent closing of said switch upon a change in said condition to a value at which said condition responsive device would normally close said switch, and electromagnetic means in control of said mechanical means.

4. In combination, an electric snap switch, a condition responsive device, mechanical connections between said device and switch by which said device normally opens and closes said switch solely upon changes in the condition to which it responds to spaced predetermined values, additional mechanical means including spring means operable to a position to bias said switch to one of its circuit controlling positions to thereby prevent operation of said switch to the other of its circuit controlling positions even though there is a change in said condition to the value at which said condition responsive device would normally operate said switch to said other of its circuit controlling positions, the extent of said bias being limited by said spring means, and electromagnetic means in control of said mechanical means.

5. In combination, an electric snap switch, means to open and close said switch including a lever which must be moved to a first position to open said switch and must be moved to a second position substantially spaced from said first position to close said switch, a condition responsive device for operating said lever to its first position at one value of the condition to which it responds and for operating said lever to its second position at a different value of said condition, additional means including a spring operable to urge with a predetermined force said lever towards one of its positions, and electromagnetic means in control of said last-named means.

6. In combination, an electric snap switch, means to open and close said switch including a lever which must be moved to a first position to open said switch and must be moved to a second position substantially spaced from said first position to close said switch, a condition responsive device for operating said lever to its first position at one value of the condition to which it responds and for operating said lever to its second position at a different value of said condition, spring means operable to urge said lever towards one of said positions, and electromagnetic means operable to render said spring means effective and ineffective.

7. In a refrigerant system controller, a switch in circuit with a refrigerant compressor motor, a pair of devices responsive respectively to air temperature in the space being refrigerated and to low side refrigerant pressure, said responsive devices each being operable independent of the other one to move said switch to cut-out position, both of said responsive devices being associated with said switch so that both must normally be in their cut-in positions to permit movement of the switch to its cut-in position, and a pressure responsive device responding to the high side pressure of said refrigerant system and operable

to move said switch to cut-out position independent of the other two responsive devices and to permit it to be moved to cut-in position if said other two devices are in their cut-in positions, and electrically operated means to move said switch to cut-out position in response to said air temperature responsive means.

8. In a refrigerant system controller, a switch in circuit with a refrigerant compressor motor, a first device responsive to pressure in the low side of the refrigerant system, a second device responsive to pressure in the high side of the refrigerant system, a third device responsive to the temperature of air in the space being refrigerated by said refrigerant system, said first, second and third devices being operatively connected with said switch to effect cut-out thereof upon movement of any of the three devices to its cut-out position and to effect cut-in of the switch only when all three devices are in their cut-in positions, said third device including an electromagnet for moving the switch to cut-out position, and a thermostat in circuit therewith and located in the space being refrigerated.

9. In control apparatus for a refrigerating system comprising, in combination, switch means, means including a condition responsive device for actuating said switch means, and a mechanism associated with the said actuating means, said mechanism including an electromagnetic device and means controllable thereby, the said controllable means being operable to bear against the said actuating means to oppose actuation of the said switch means by said condition responsive means, the said electromagnetic device being capable when energized of holding the said controllable means in an ineffective position.

10. In control apparatus for a refrigerating system comprising, in combination, switch means, means for actuating said switch means including a condition responsive device, said actuating means being arranged to operate said switch means to cut-in and cut-out positions at predetermined values of the condition to which the said device responds, and mechanism for exercising control over said switch means including an electromagnetic device operable on a portion of the switch actuating means, said electromagnetic device either being ineffective to control operation of the said switch means or operative to overpower the said pressure responsive device and assume primary control of said switch means.

11. In refrigerating control apparatus, in combination, switch means, actuating means for said switch means including a condition responsive device, said actuating means being operative to close the said switch means at a predetermined relatively high value of the condition to which said device responds and operative to open the said switch at a predetermined relatively low value of the said condition, and auxiliary mechanism associated with the said actuating means, said mechanism comprising an electromagnetic device arranged to obstruct closing of the said switch means upon a predetermined state of energization of the said electromagnetic device.

12. In refrigerating control apparatus, in combination, switch means, actuating means for said switch means including a condition responsive device, said actuating means being operative to close said switch means at one value of the condition to which said device responds and to open the said switch means at a different value of said condition, and mechanism operative in conjunction with said actuating means for operating

said switch means, said mechanism comprising a two-position device including an electromagnet and means controlled thereby, said means controlled thereby being operative in one position to obstruct operation of the said switch means by said actuating means and ineffective in its other position to affect the operation of said switch means, the state of energization of said electromagnet determining which of the two positions will be assumed by the said controlled means.

13. In control apparatus for use with a condition responsive control device including switching means and having an actuating bar, comprising, in combination, an electromagnet, support means for the said electromagnet, lever means pivotally mounted to said support means and including an armature portion for coacting with the said electromagnet, means also including an elongated portion adapted to bear against and to exert pressure on means such as the aforesaid actuating bar, and spring means between said support means and said lever means effective to rotate said lever means relative to said support means so that the said elongated portion may exert pressure on means such as the said actuating bar when the said electromagnet is deenergized but of such strength that the electromagnet can, when suitably energized, move the said armature portion into an attracted position against the force of said spring and prevent the said elongated portion from exerting the said pressure.

14. In a refrigerating control actuator, an auxiliary device comprising, in combination, an electromagnet, a support means for the said magnet, a lever means pivotally mounted on said support means, said lever means including an elongated actuator portion, an armature portion and an extended portion, said armature portion being adapted to be attracted by the said electromagnet, spring means connected between the said extended portion of the lever means and the said support means for urging said armature portion away from the said electromagnet, the said spring means also providing the operating force for the said elongated actuator portion, and means for adjusting the tension of the said spring means so the force of the said actuator portion can be varied.

15. In a refrigerating control device, in combination, a switch, condition responsive means for operating said switch to open and closed positions, and additional means for independently controlling said switch, said additional means including an electromagnet and a spring, the said spring being arranged to exert a controlling force on the said switch and said electromagnet serving to load the said spring.

16. In refrigerating control apparatus, in combination, a switch; means including a condition responsive device for actuating the said switch, said means being normally operative to close said switch at one value of said condition and to open the said switch at a different value of said condition; and auxiliary mechanism for changing the values at which the said condition responsive device operates the said switch, the said mechanism comprising a movable portion, spring means for moving said portion in one direction, and electromagnet means for moving the said portion in the opposite direction.

17. In refrigerating control apparatus, in combination, a switch; means including a condition responsive device for actuating the said switch, said means being normally operative to close said switch at one value of said condition and to open the said switch at a different value of said condition; and auxiliary mechanism operative on said actuating means for changing the values at which the said condition responsive device operates the said switch, said mechanism including a movable portion, spring means for moving said portion with a predetermined force, and electromagnet means for operating the said movable portion against said spring means, the amount of change of the said values being dependent on the force exerted by the said spring means.

18. In a refrigerating control apparatus, in combination, a switch; means including a condition responsive device for actuating the said switch, said means being normally operative to close said switch at one value of the said condition and to open the said switch at a different value of the said condition; and additional mechanism operative on said actuating means for opening said switch regardless of said condition responsive device and for opposing the closing of said switch by the said device, said mechanism including a movable member, a spring means, and an electromagnet, the said movable member being operative to switch opening position by said spring means and being retractable by said electromagnet.

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