Sept. 1, 1936. H. L. GALSON 2,052,561

MEANS FOR INTERCHANGING COMPRESSOR AND CONDENSER FUNCTIONS OF A REFRIGERATING SYSTEM AND CONTROLLING A COMPRESSOR THEREFOR

Filed May 31, 1933 2 Sheets-Sheet 1

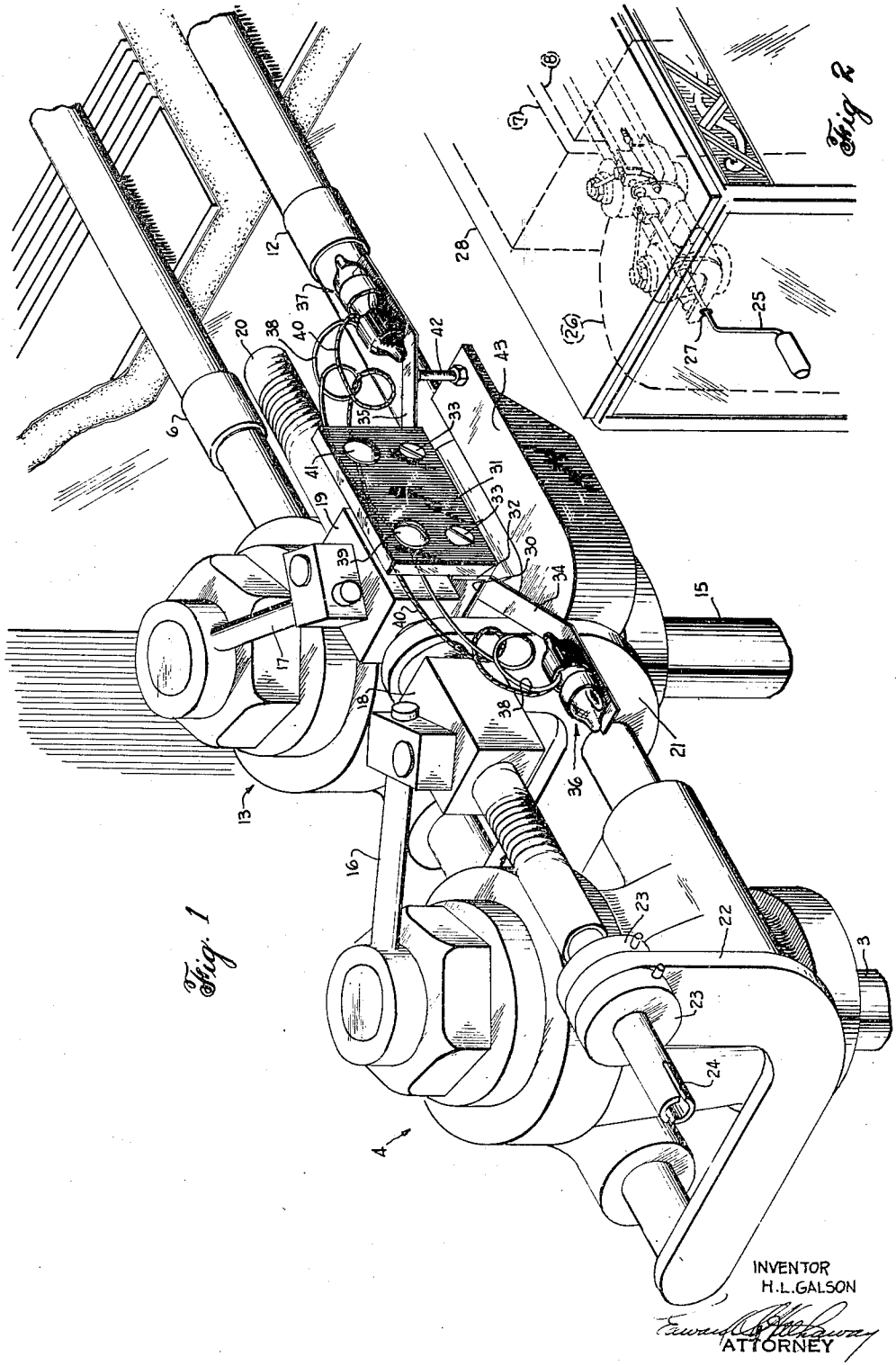


Fig. 1

Fig. 2

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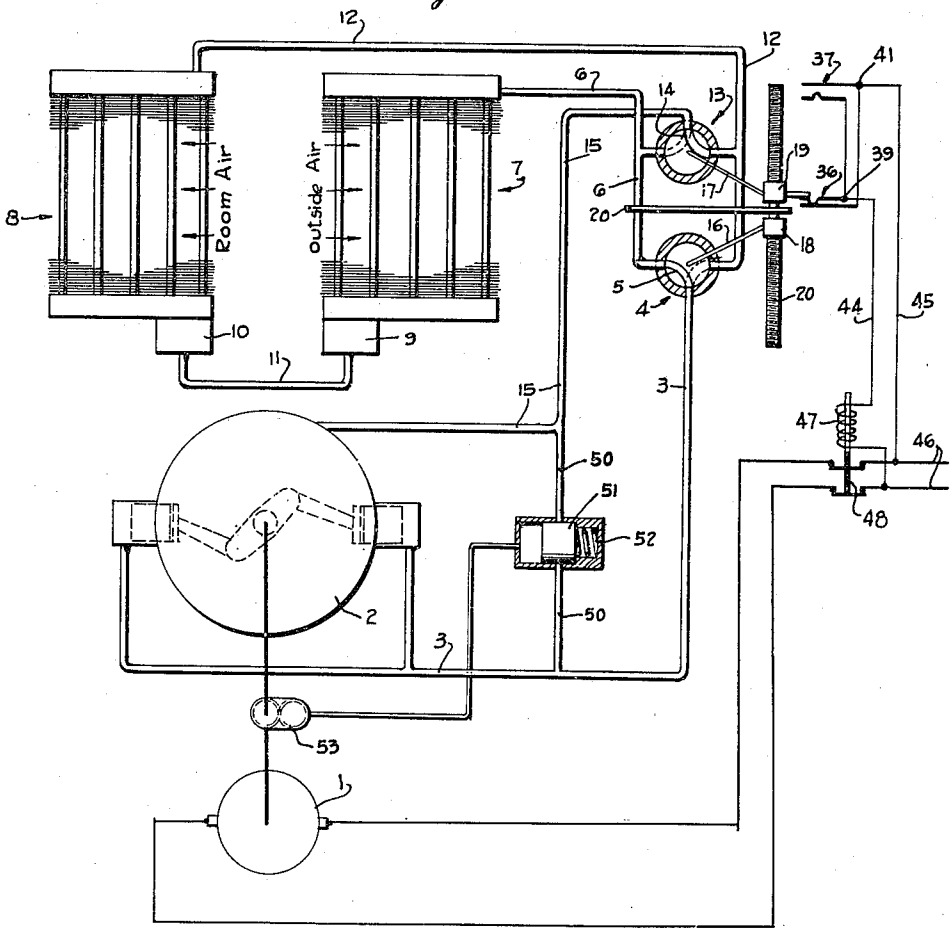
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Fig. 3



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MEANS FOR INTERCHANGING COMPRESSOR AND CONDENSER FUNCTIONS OF A REFRIGERATING SYSTEM AND CONTROLLING A COMPRESSOR THEREFOR

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Application May 31, 1933, Serial No. 673,742

14 Claims. (Cl. 62—115)

This invention relates generally to air conditioning apparatus of the type employing a compressor-condenser-evaporator refrigerating circuit and more particularly to improved control means for permitting such a circuit to be effectively used for either heating or cooling the air of homes, offices or rooms used for various purposes.

It is well-known that a refrigerating system can be employed for either heating or cooling purposes depending upon whether the room air is passed over the condenser or over the evaporator. In a unit wherein outside air is circulated over one of the heat exchange elements and room air is circulated over the other of said elements, then by interchanging the functions of these two elements the room air may be either cooled or heated. Such a system is particularly adapted for self-contained air conditioning apparatus for homes or offices.

However, it is desirable that apparatus used in the environment of homes or offices should be easily, positively and safely operated by any man, woman or child and irrespective of their age, experience or discretion. Compliance with such requirements not only installs confidence in the apparatus by the user but insures maximum operating efficiency and flexibility of use together with complete elimination of possible injury to person, property or the refrigerating mechanism during the interchanging operation.

It is one object of my invention to accomplish the foregoing advantages by providing improved means for controlling the compressor operation automatically in accordance with the interchanging operation.

A further object is to provide improved means whereby substantially upon initiation of the interchanging function, the pumping of refrigerant through the heat exchange elements is interrupted and whereby substantially upon completion of the interchanging function, the normal refrigerant flow is automatically reestablished. Another object is to provide improved means for effecting equalization of pressure between the heat exchange elements automatically in accordance with the interchanging operation.

In one specific aspect of the invention the foregoing objects are accomplished by providing improved switch mechanism for stopping and starting operation of the compressor motor automatically in accordance with initiation and completion of the interchanging operation, while the pressure equalization is effected preferably by a compressor unloader suitably interconnected with the refrigerant system although any suitable pressure equalizing ports may be used in and controlled by the interchanging valves.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a perspective of the mechanism for interchanging the functions of the complementary heat exchange elements such as the condenser and evaporator together with the compressor control associated with the interchanging mechanism;

Fig. 2 is a fragmentary perspective view of a room unit with my improved control mechanism employed therein;

Fig. 3 is a diagrammatic view of the refrigerating circuit, interchanging mechanism and compressor control.

In the illustrated embodiment of my invention which is shown herein merely for the purpose of disclosing one specific form among possible others that it might take, in practice I employ valve mechanisms and actuating means therefor of the type preferably shown in an application of J. Vogler, filed May 31, 1933, Serial No. 673,733, although it will of course be understood that various types of valves and valve arrangements and actuating means therefor may be used in my improved combination.

Hence it will suffice to describe only briefly the refrigerating system and the valve mechanism and actuating means therefor whereby the functions of the condenser and evaporator are interchanged to permit an air conditioning unit to be used for either heating or cooling room air. As shown in Fig. 3, an electric motor 1 drives a suitable compressor 2 preferably of the positive displacement type whose discharge pipes 3 are connected to a reversing valve generally indicated at 4. A passage 5 in said valve connects with a pipe 6 leading to a heat exchange element 7 over which outside air is circulated. This element is connected with a complementary heat exchange element 8 through traps or expansion valves 9 and 10 interconnected by a pipe 11. Heat exchange element 3 is connected by pipe 12 to a second interchanging valve generally indicated at 13 provided with a passage 14 registering with the compressor suction pipe 15. Room air is preferably circulated over the heat exchange element 8 so that with passages 5 and 14 of the interchanging valves in the full line position as shown, the heat exchange element 7 will function as a condenser cooled by outside air, the

condensed refrigerant then flowing freely downwardly through valve 9 which is inoperative while the apparatus is functioning as a room cooler. The liquid refrigerant then flows upwardly through valve or trap 10 which is operative to permit substantially only flow of liquid into the heat exchange element 8 now functioning as a flooded type evaporator. As the evaporator absorbs heat from room air circulated thereover, the gaseous refrigerant is discharged through pipe 12 and valve 13 to the compressor suction pipe 15.

To interchange the functions of the heat exchange elements 7 and 8 so that elements 7 will function as an evaporator to extract heat from the outside air and transfer the heat to the element 8 which is now functioning as a condenser and thereby heat the room air circulated thereover, the valves 4 and 13 are rotated so that passages 5 and 14 assume the dotted line position shown in Fig. 3. In this case the compressor discharge pipe 3 is connected through passage 5 to pipe 12, thus causing heat exchange element 8 to function as the condenser. Condensed refrigerant then flows downwardly through trap or valve mechanism 10 which is now inoperative and thence across pipe 11 to trap or valve 9 which is rendered operative to permit substantially only refrigerant liquid to flow into heat exchange element 7 now functioning as a flooded type evaporator. As heat is extracted from the outside air, the refrigerant gas is conducted through pipe 6 and valve passage 14 to the compressor suction pipe 15 to repeat the refrigerating cycle.

To operate interchanging valves 4 and 13, the valves as shown more particularly in Fig. 1 are provided with actuating arms 16 and 17 pivotally and slidably connected to nuts 18 and 19 having respectively right and left hand threaded engagement with a common actuating screw shaft 20. This shaft is journalled at its center in a suitable bracket 21 and at its end in a bracket 22. Collars 23 prevent axial displacement of the screw although due to the right and left hand threads, the valve operating forces are substantially equal and opposed, and hence all forces are self-contained so as to eliminate any great strain being placed upon the brackets 21 and 22. The outer end of the screw shaft is provided with a slot 24 to receive a suitable crank 25, Fig. 2. The valve mechanism as above described is placed preferably above the motor-compressor or unit generally indicated at 26 and has communication with the heat exchange elements 7 and 8 which extend longitudinally away from unit 26, thereby permitting crank 25 to be readily connected to slot 24 merely by insertion through a suitable opening 27 in one end of a cabinet 28 which preferably entirely houses the refrigerating system and air circulating means.

From the foregoing disclosure it is seen that by rotating the crank 25 in one direction, the valves 4 and 13 will have their operating arms brought toward each other as shown in Fig. 1 while upon reverse rotation said arms will be moved away from each other to effect rotation of the valves for interchanging the condenser and evaporator functions of the heat exchange elements.

To insure complete cooperation between the interchanging functions and the operation of the compressor so that the pumping of fluid to the elements will be temporarily interrupted during the interchanging operation, I have provided an improved switch control actuated by the interchanging valve mechanism. Specifically this includes a bracket 30 secured to the under side of one of the nuts such as 19 while a block of insulation 31 is secured to a vertical leg 32 of plate 30 as by screws 33. To permit swinging or pivotal movement of the mercury switches, yieldable switch carrying arms 34 and 35 are secured to the under side of bracket 30 and these arms carry respectively switches 36 and 37 preferably of the mercury contact bulb type. One contact of each switch 36, 37 is commonly connected by a flexible wire 38 secured to a binding post 39 in the insulation block 31 while the other set of contacts of switches 36 and 37 are commonly connected by wire 40 which is connected to a binding post 41.

To actuate one or the other of the switch arms 34 and 35 automatically in accordance with the position of the interchanging valve mechanism there is provided an arm engaging pin 42 secured to a suitable bracket 43 which is rigidly secured to the center bracket 21.

As shown in Fig. 3, the binding posts 39 and 41 are connected by wires 44 and 45 across the main compressor motor supply line 46 to control a relay 47 whose switch 48 connects or disconnects the compressor motor circuit without disconnecting the relay circuit. Thus these switches are operated automatically in accordance with the initiation or completion of the interchanging operation.

To effect equalization of pressure in the heat exchange elements automatically during the interchanging operation, I provide a by-pass 50 connected across suction pipe 15 and discharge pipe 3 but this by-pass is closed during compressor operation by a piston valve 51. During compressor operation this valve is moved against a spring 52 by fluid pressure from a suitable pump 53, preferably of the gear type driven directly from the motor-compressor. When the compressor stops, the fluid pressure drops and spring 52 moves piston 51 to uncover the ends of pipe 50 thereby to allow communication between pipes 3 and 15 and accordingly allow condenser and evaporator pressure to equalize through pipe 6, valve passage 5, pipes 3, 50 and 15, to valve passage 14 and pipe 12.

Operation.—The control apparatus in the position shown in Figs. 1 and 3 has its arm 35 held in raised position by engagement with pin 42 thereby causing mercury within switch 37 to make contact between wires 38 and 40 and permit wires 44 and 45 to maintain a closed circuit for relay 47 with consequent closure of switch 48 and the motor circuit 46. However, if it is desired to change over the functioning of the air conditioning unit from heating to cooling or vice versa, a person merely inserts crank 25 through opening 27 in the end of the cabinet 28 so as to engage the slotted end 24 of reversing screw 20 and upon rotation of said crank, nuts 18 and 19 will move away from each other due to right and left hand threads on said screw and at the same time nut 19 will carry and move therewith bracket 30, insulation block 31 and the switch arms 34 and 35. The result is that before the valves have rotated any appreciable amount, switch 37 moves downwardly due to the inclination or cam action of arm 35 in moving over stationary pin 42 in a right hand direction. After a certain small amount of movement of arm 35, switch 37 is disconnected thereby breaking the circuit for relay 47 and thus opening the motor circuit 48 to stop operation of the motor and compressor. When the compressor stops, the pressure from pump 53 drops to allow spring 52 to move piston 51 thereby to

open by-pass 50 between valves 4 and 13 and equalize the condenser and evaporator pressures. This arrangement also functions as a compressor unloader in that when the compressor stops, the suction and discharge pipes are in free communication thus allowing the motor to start up without load. However, when normal motor speed is obtained, then fluid pressure is built up to reclose by-pass pipes 50 and permit normal compressor operation. Reverting again to the switch control, due to the appreciable distance between the inclined portions of arms 34 and 35, it is seen that the nuts 18 and 19 may move away a very substantial distance along screw shaft 20 before the inclined portion of arm 34 begins to engage stationary pin 42. However, before this engagement is effected, the valves will have been sufficiently rotated so as to establish their new connections for interchanging the functions of the compressor and condenser. Hence it is seen that upon engagement of arm 34 with pin 42 and upon continued rotation of shaft 20, switch 36 will be raised thereby connecting wires 38 and 40 to reestablish the circuit through wires 44 and 45 and close relay switch 43 whereupon the compressor motor immediately starts.

From the foregoing disclosure it is seen that I have provided a relatively simple and yet positive means for stopping the compressor motor automatically in accordance with initiation of the interchanging operation and that during or before said operation the condenser and evaporator pressures are equalized and the compressor unloaded, while upon completion of the interchanging operation the motor is automatically re-started after which the compressor is re-loaded and the pressure equalization discontinued. It is thus seen that from this improved mode of operation, no damage will result to the compressor or system which might otherwise happen in case the compressor were continuously operating during such interchanging operation as might be caused for instance by liquid refrigerant being drawn into the compressor. Hence my improved apparatus will permit any person at any time to operate the unit with ease, confidence and safety together with efficient operation and comfort.

It will of course be understood by those skilled in the art that various changes may be made in the details of construction and arrangement of parts without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including switch mechanism carried by and bodily movable with said interchanging means.

2. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including a plurality of switches adapted to be simultaneously moved by said interchanging means to open one of said switches and to close the other during one position of the interchanging means and vice versa for the other position thereof.

3. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including a pair of mercury switch elements and means for simultaneously moving the same and changing their inclination to cause the mercury contact of one or the other to be made or broken with an interim period in which both contacts are broken.

4. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including a switch, means for carrying the same by said interchanging mechanism so as to be bodily movable therewith, and stationary means cooperating with said carrying means for causing a predetermined movement of the switch during operation of the interchanging means.

5. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including a switch and arm adapted to be bodily moved together to close or open the switch contact, and stationary means cooperating with said arm for effecting the opening or closure of said switch upon movement of said interchanging means.

6. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements connected to said compressor, and means for controlling said compressor motor automatically in accordance with a predetermined operation of said interchanging means including a switch and cam means for controlling the operation thereof in accordance with predetermined positions of the interchanging means, said switch and at least a portion or the cam means being a bodily movable with said interchanging means.

7. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, valve mechanism, screw and nut operating means therefor for interchanging the functions of said heat exchange elements, switches supported by said nut, stationary means for causing said switches to be opened or closed automatically in accordance with predetermined positions

of the interchanging means, and means for controlling the operation of the compressor motor in accordance with the closure or opening of said switches.

8. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, valve mechanism, screw and nut operating means therefor for interchanging the functions of said heat exchange elements, switch means carried by said nut and movable longitudinally therewith as said nut moves along said screw, said switch means including a flexible member, stationary means for engaging said member and effecting flexure of said arm upon longitudinal movement thereof with said nut.

9. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, valve mechanism, screw and nut operating means therefor for interchanging the functions of said heat exchange elements, switch means carried by said nut and movable longitudinally therewith as said nut moves along said screw, said switch means including an inclined arm carrying a gravity operated mercury contact tube, a stationary pin adapted to engage the inclined portion of said arm whereby upon longitudinal movement thereof said stationary pin will engage and raise said arm or allow it to lower to permit the mercury of said switch to make or break its contact.

10. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements, and means for equalizing the pressures in said heat exchange elements.

11. Air conditioning apparatus comprising, in combination, a motor-driven compressor, complementary heat exchange elements connected to said compressor to form a refrigerating system, means for interchanging the functions of said heat exchange elements, and compressor unloading means controlled automatically in accordance with the operation of said interchanging operation.

12. Apparatus for controlling a refrigerating system having complementary heat exchange elements and a compressor comprising, in combination, valve means for interchanging the functions of said heat exchange elements, and means for controlling said compressor automatically in accordance with a predetermined operation of said interchanging mechanism including a plurality of rotatable mercury controlled switches angularly disposed with respect to each other so that in certain rotatable positions both contacts are broken and in other positions one or the other of said contacts is closed.

13. Apparatus for controlling a refrigerating system having complementary heat exchange elements and a compressor comprising, in combination, valve means for interchanging the functions of said heat exchange elements, actuating means for said interchanging valve means, a mercury controlled switch for said compressor, and means for rotating said switch including movable and stationary cooperating members one of which is carried by and movable with said actuating means and the other of which is associated with a suitable stationary element.

14. Apparatus for controlling a refrigerating system having complementary heat exchange elements and a compressor comprising, in combination, valve means for interchanging functions of said heat exchange elements, nut and screw means for actuating said interchanging valve means, a rotatable mercury switch carried by and movable with said nut, and stationary means for resisting movement of said switch, thereby causing the switch to rotate as said nut travels along the screw to effect said interchanging operation.

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