

[54] SWITCHING MECHANISM

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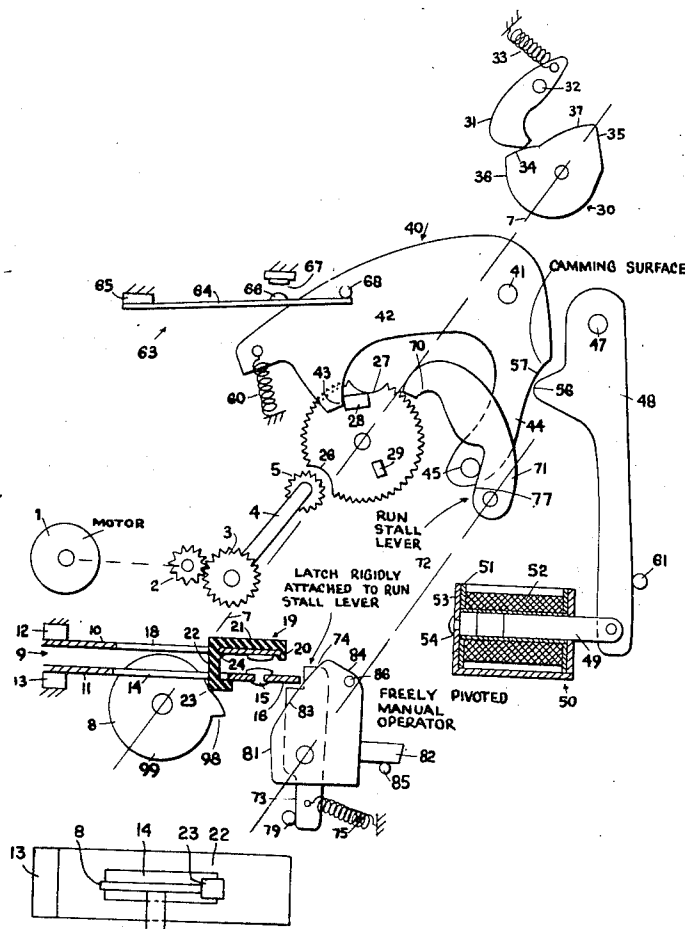
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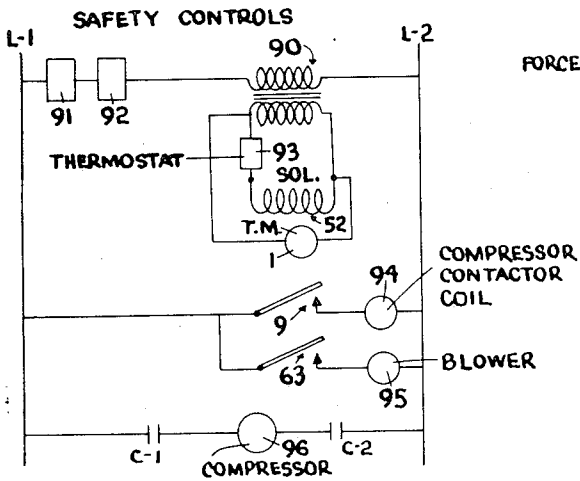
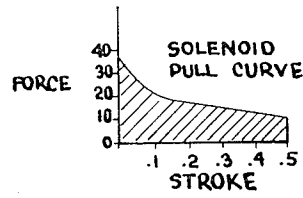
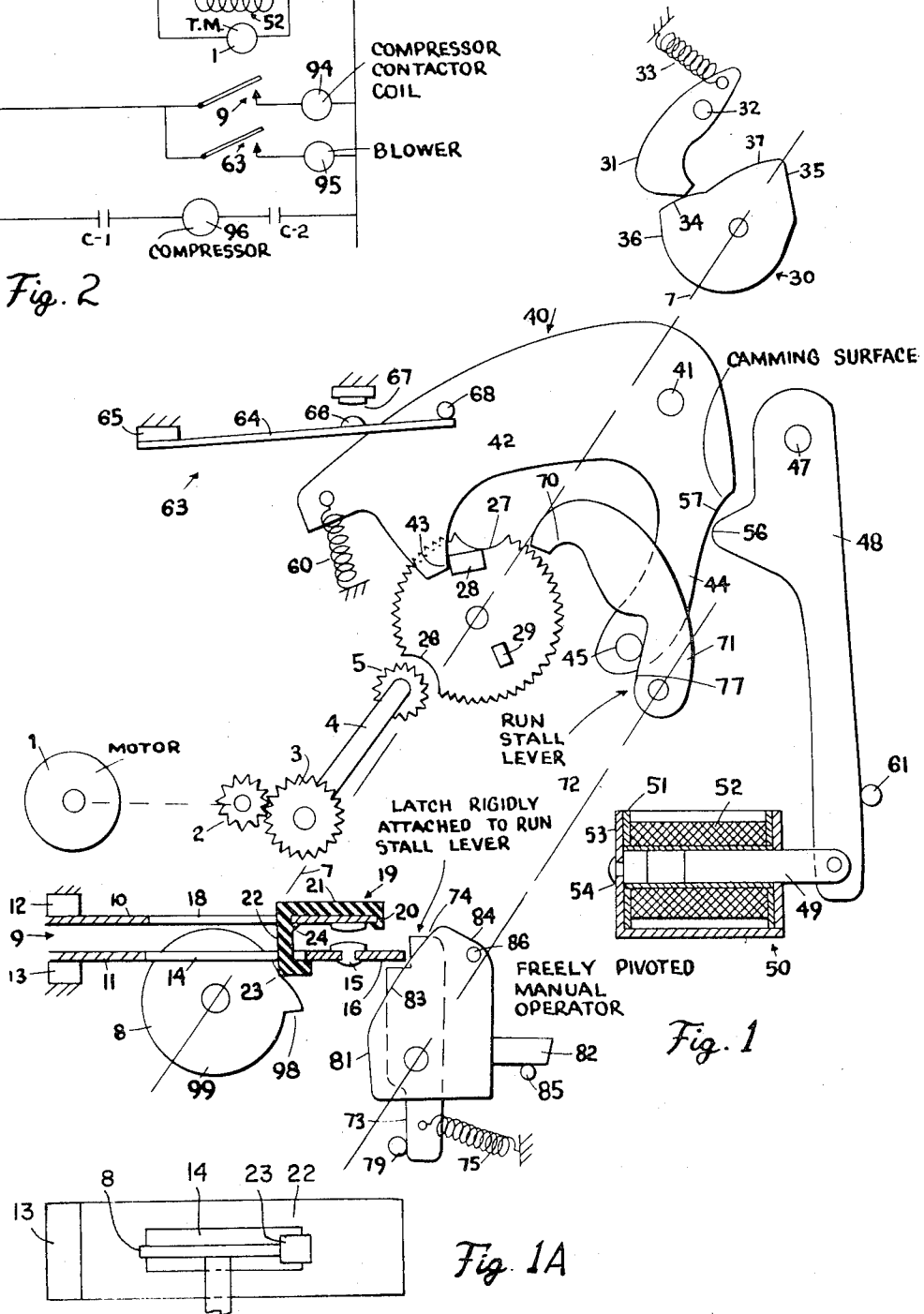
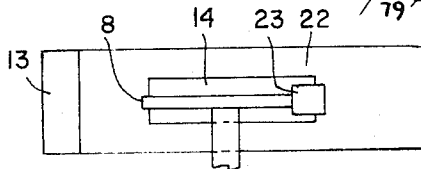
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ABSTRACT

Protection against refrigeration compressor burnout by short cycling is provided by a time delay switching mechanism having a motor and a solenoid controlled by a room thermostat. The motor runs continuously and the solenoid stops and starts the timer by stalling or releasing the timer gear. The timer gear has teeth omitted at the stalling points to allow the motor to run free. A starter cam follower bearing on a starter cam serves to start the timer gear when released by the solenoid. The solenoid operates the stalling and switch control mechanism through a compound leverage and camming system compensating for the non-linear pull curve of the solenoid. The device also includes a combination cam and latch operated switch in which one switch blade carries a follower lifting another blade which is then held by the latch when the follower drops to close the switch. A manual operator is provided for closing the switch independently of the timing mechanism. This manual operator is released automatically by the solenoid dropping out when the thermostat becomes satisfied. The timer also includes an arrangement for locking the compressor switch closed for a period of time when it first closes to allow the system to settle down and thus avoid short cycling.

10 Claims, 4 Drawing Figures





SWITCHING MECHANISM

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of application, Ser. No. 133,077, filed Apr. 12, 1971, now U.S. Pat. No. 3,716,720.

BACKGROUND OF INVENTION

This invention relates to automatic controls and more particularly to time delay devices and control systems for protecting electric motors such as refrigeration system compressors.

In the air conditioning and refrigeration industry it has become common to install a time delay system between the compressor contactor and the thermostat and protective controls. The purpose is to prevent damage to the compressor by short cycling due to the safety controls responding to excessive high or low pressures caused by a malfunctioning system. Such time delays also protect against frequent stops and starts by thermostat jiggling, and insure a delay between stopping and restarting long enough to allow the pressures in the system to equalize so the compressor starts in an unloaded condition. Timers have also been used in compressor control systems for shunting out the high and low pressure controls for a short period of time when the compressor first starts. This is done to give time for surges in the system to settle down. This avoids false stops of the compressor and thus reduces the number of starts required.

Prior to applicant's invention, the delay mechanism required a timer and at least one relay. Also a separate timer was required to give the surge settling period, and the system required a considerable amount of electrical connections between the various components.

One problem encountered with prior art systems is testing of the system. The usual time cycle is on the order of five minutes. In the factory or on service calls, this requires waste of considerable time. A manual override is needed and this must be one that can't be left in an unsafe condition.

Another problem is the wide variation of voltages encountered. Some areas have 208 volt service while others have 240 volt service. These voltages can vary 10 percent either way. It is desirable from an inventory standpoint to have a single unit usable on both voltages. This requires satisfactory performance over a range from 187 to 264 volts. Where a control includes a solenoid, this voltage range gets into a problem of underpower at the low voltage and overheating at the high voltage, requiring an oversize solenoid for the low voltage and special insulation for the high voltage.

BRIEF SUMMARY OF INVENTION

The present invention provides a single component that may be wired between the thermostat and compressor contactor. This component includes a switch for the contactor which is actuated in part by an electric timing mechanism and a solenoid controlled by the room thermostat. When the thermostat calls for cooling it energizes the solenoid. This actuates a spring biased lever carrying a standby stop which releases a stalling lug on the timer gear. This allows a starter cam follower to advance the gear into engagement with a pinion which is rotated constantly by the timer motor.

The timer runs for 15 seconds and closes the contactor switch which is now held closed by a latch.

The switch consists of two blades lifted by a single cam follower with contacts disengaged. The blades are then released by the timer cam and the latch holds one blade up to maintain the contacts engaged.

The timer continues to run for another 15 seconds during which time the stalling lug on the gear blocks out the solenoid lever, keeping this lever from being actuated by dropping out of the solenoid. This provides a minimum run period allowing surges to settle down. After approximately ninety seconds the timer gear disengages from its drive pinion and the timer gear is stalled by a run stop.

When the thermostat is satisfied, it drops out the solenoid which: (1) Releases the switch latch opening the switch to stop the compressor; (2) Releases the run stop allowing the timer gear to advance into engagement with the drive pinion; and (3) Returns the standby stop into stalling position. The timer then runs approximately five minutes and returns to the standby position where the standby stop stalls it with the gears disengaged.

The solenoid operates the stops and latch through a compound lever mechanism providing a long stroke for the solenoid. This compound leverage also includes a camming action compensating for the non-linear force-stroke characteristic of the solenoid.

A manually operated lever is mounted on the latch pivot and has a camming surface lifting the inner switch blade to close the switch contacts and lift the switch beyond the reach of the cam. When the solenoid drops out to release the latch is also releases the manual lever.

One object of the invention is to provide a simple compact time delay mechanism in which the controlling functions are achieved mechanically with a minimum amount of components and electrical connections.

A further object is to provide a small compact unit operable over a wide range of line voltages.

Another object of the invention is to provide a manual override of the time delay mechanism which is simple in construction and which is self-releasing so that no danger is involved in forgetting to release the override.

A further object is to provide an improved switching mechanism in which a cam closes the switch contacts under the control of a latch.

Another object is to increase the usable capacity of an electro-magnet thus making it possible to use a smaller and less expensive unit for a given function.

Other objects will appear from the following detailed description and appended claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic illustration of a combination timer and solenoid operated control mechanism embodying the invention.

FIG. 2 is a schematic wiring diagram of a typical air-conditioning system embodying the invention.

FIG. 3 is a typical solenoid stroke-force curve.

FIG. 1a is a fragmentary view showing the cam follower extending freely through the lower blade slot.

DETAILED DESCRIPTION OF INVENTION

Referring to FIG. 1, reference character 1 indicates

an electric timing motor which drives a pinion 2 in turn driving gear 3 carried by shaft 4 which also carries a pinion 5. The pinion 5 drives the main timing gear 6 carried by the main shaft 7 which also carries a cam 8. The cam 8 operates a switch generally indicated as 9 consisting of switch blades 10 and 11 which are anchored at their left hand ends as at 12 and 13. The switch blade 11 is provided with a slot 14 and straddles the cam 8. The switch blade 11 carries a contact 15 and is provided with an extension 16. The switch blade 10 is formed with a slot 18 and carries a molded plastic cam follower 19. This follower includes a downwardly extending hook portion 20 which extends around the right end of blade 18 and bears on the bottom of this blade. The cam follower 19 also includes a horizontal portion 21 extending parallel with the blade along the top thereof and merging with a downwardly extending portion 22. The downward extension 22 passes through the slot 14 in switch blade 11 and then extends to the right along the bottom of blade 11 for lifting the same. As shown in FIGS. 1 and 1a, the extension 22 passes freely through the slot 14 in the blade and includes the corner 23 which serves as a cam follower surface riding the periphery of the cam 8. The cam follower 19 also includes an inclined supporting surface 24 extending under the lower edge of blade 10 adjacent the right hand edge of the slot 18. The cam follower 19 is molded of a suitable flexible material allowing it to be snapped into place on the switch blade 10 without any other fastening means.

The gear 6 is of the mutilated type having two portions 26 and 27 in which the gear teeth are omitted. The gear 6 also includes a standby stop lug 28 and a run stop lug 29 which extend from the front face of the gear as seen in the drawing. The cam shaft 7 also carries a starter cam 30 which cooperates with a starter cam follower 31 which is pivoted at 32 and is biased against the cam by a spring 33. This starter cam is formed with two sloping drop-off portions 34 and 35. The cam is also formed with two rise portions 36 and 37.

A solenoid operated lever 40 is pivoted at 41 and has a leg 42 which extends to the left of pivot 41 and downwardly into the path of the stalling lug 28.

The lever also has a downwardly extending leg 44 carrying an abutment 45 which extends forwardly as seen in the drawing.

Mounted on a pivot 47 which is spaced from pivot 41 is a second lever 48. This lever extends downwardly and is attached to the plunger 49 of a solenoid or electro-magnet generally indicated as 50. This solenoid includes a bobbin 51 supporting a coil 52 and fitting inside a "C" frame 53. The plunger 49 is of magnetic material and extends into the center core of the bobbin. A suitable backstop 54 is attached to the frame 53. The backstop, frame and plunger provide a magnetic path serving to pull the plunger 49 to the left when the coil 52 is energized. This energization of the solenoid coil 52 serves to cause rotation of the lever 48 in a clockwise direction about its pivot 47.

The lever 48 is formed with a driving surface 56 which bears against a driven surface 57 formed on the edge of lever 40. It will be apparent that upon energization of the coil 52 and rotation of the lever 48 clockwise, the engagement of surfaces 56 and 57 will cause clockwise rotation of the lever 40 about its pivot 41.

The lever 40 is provided with a biasing spring 60 tending to rotate this lever counterclockwise about

pivot 41. This maintains the driven surface 57 of lever 40 in engagement with the driving surface 56 of lever 48. Thus, when the solenoid coil 52 is deenergized, spring 60 is free to rotate lever 40 counterclockwise which in turn rotates lever 48 counterclockwise toward engagement with a stop 61.

The lever 48 also actuates a switch generally indicated as 63. This switch includes a switch blade 64 which is anchored at its left hand end as at 65 and carries a contact 66 cooperating with a stationary contact 67. The switch blade 64 extends alongside the lever 40 and is actuated by a pin 68 carried on this lever. The switch blade 64 is biased upwardly tending to cause contact 66 to engage contact 67. However, when the solenoid 50 is deenergized and the lever 40 is rotated to its clockwise limit of rotation by the biasing spring 60, the pin 68 on the lever pulls the switch blade 64 down for disengaging contact 66. When the solenoid is energized, it rotates lever 40 clockwise, thus raising the pin 68 and allowing contact 66 to engage contact 67.

A run stop surface 70 is carried on a run stop lever 71 which is pivoted on a shaft diagrammatically illustrated as 72. The shaft 72 also carries a latch 73 having a latching surface 74. The latch 73 is provided with a spring 75 tending to rotate this latch into latching engagement with the extension 16 of switch blade 11. The run stall lever 71 and the latch 73 are shown as two separate parts for illustrative purposes only. Preferably, these parts are molded in one piece. The run stall lever 70 is formed with a driven surface 77 adjacent the pin 45 carried on lever 40. When the solenoid 50 is deenergized and lever 40 is in the position shown, the pin 45 has engaged the driven surface of lever 70 causing it to assume the position shown in which the stalling surface 70 is out of the path of the abutment 29 on the gear 6. This motion of lever 71 has also moved the latch 73 to releasing position in which the contacts of switch 9 are open. This same motion of the lever 71 has also caused the lower leg of the latch 73 to engage a stop 79. The pin 45 engaging driven surface of lever 71 and the engagement of the latch 73 with the stop 79 serves as a stop for limiting the counterclockwise rotation of lever 40. It should be noted that the standby abutment 28 on the gear 6 is at a greater distance from center than the run abutment 29. It is important that the counterclockwise limit of rotation of lever 40 be limited so that is never gets in the path of the run abutment 29 on the gear.

Mounted loosely on the shaft 72 supporting the run stall lever 71 and the latch 73 is a manually operated lever 81. This lever includes a handle portion 82 which should extend outside of the enclosure (not shown) in which the mechanism is located. The manual lever 81 is mounted beside the latch 73 and under the extension 16 of switch blade 11. This latch includes a camming surface 83 and a holding surface 84. This holding surface 84 is preferably defined by a radius centered on the center of shaft 72. A stop 85 limits rotation of the lever 81 in the clockwise direction.

FIG. 2 shows schematically the wiring diagram for a typical air-conditioning system embodying the invention. The primary of a transformer 90 is connected across line wires L1 and L2 in series with the safety controls 91 and 92. These safety controls may include a high pressure cut-out, a low pressure cut-out, and overload cut-out, etc. The secondary of the trans-

former 90 supplies current to the coil 52 of the timer solenoid in series with a room thermostat 93. The timer motor 1 is wired across the transformer secondary so as to run continuously as long as power is supplied to the transformer 90. While it is preferable to employ a low voltage thermostat, if desired, a line voltage thermostat may be used. In such event, the transformer 90 may be omitted and line voltage power from the safety controls applied directly to the timer motor and solenoid. This, of course, would require different winding for the timer motor and solenoid.

Switches 9 and 63 are connected in parallel to the line wire L1. Switch 9 controls the power to the compressor contactor coil 94 while switch 63 controls power to the blower motor 95. The compressor contactor coil controls contacts C1 and C2 controlling power to the compressor motor 96.

OPERATION

With the parts in the position shown, the control is in the standby position awaiting a call for cooling by the thermostat 93. Switch 9 is open thus deenergizing the compressor contactor coil causing switches C1 and C2 to be open and the compressor therefore deenergized. Switch 63 is also open so that the blower 95 is deenergized. Assuming the safety controls 91 and 92 are closed power is supplied to the transformer 90 and the timer motor 1 is running. However, the gear 6 is now positioned with the toothless portion 26 adjacent the pinion 5, thus the motor 1 in an unloaded condition. At this time the starter cam follower 31 is pressing against the downward sloping portion 34 of the starter cam 30. This is applying a torque to the cam shaft or timing means tending to rotate it in a counterclockwise direction. This motion, however is restrained by the standby stalling surface 43 being in the path of the stalling lug 28 on gear 6. The lever 40 is in the stalling position due to the solenoid 50 now being deenergized.

When the thermostat or external condition responsive means 93 calls for cooling, it energizes the solenoid coil 52 pulling the plunger 49 to the right, thus causing lever 48 to rotate lever 40 clockwise through the camming surface 57 of this lever. This movement releases the stalling means or surface 43 from abutment 28 of the driven gear 6. The starter cam follower 31 acting on surface 34 is now free to advance the timing means 6-8 in a counterclockwise direction bringing the teeth of gear 6 into mesh with the pinion 5. The gear 6 and cam 8 are now driven by the motor 1 in a counterclockwise direction. The cam follower 19 carried by switch blade 10 is now raised by the cam 8 thus lifting switch blades 10 and 11 with the contacts separated. As the cam follower approaches the top of its stroke the extension 16 on switch blade 11 clears the latching surface 74 of latch 73. At this time the abutment 45 carried by lever 40 is to the left and clear of surface 77 of the run stall lever 71. The run stall lever 71 and latch 73 are therefore free to be moved in a counterclockwise direction by spring 75. The latching surface 74 of latch 73 therefore becomes positioned beneath the extension 16 of the switch blade 11. Also the stalling surface 70 moves into the path of the run stall lug 29 on gear 6. When the cam follower 19 is dropped by the lobe 98 of cam 8, both switch blades 10 and 11 are free to drop. The extension 16 of blade 11 now is supported by the latching surface 74 of latch 73. The contacts now engage before the cam follower 19 drops to the lower sur-

face 99 of the cam 8. Preferably the cam speed and configuration is designed so that an interval of approximately 15 seconds elapses between the time the solenoid is first energized and the switch 9 closes. As the blower switch 63 closed immediately when the solenoid was energized, this gives a period of time for the blower to remove hot air from the condenser before the compressor is started.

After switch 9 closes for starting the compressor, the gear 6 continues to be driven by the pinion 5 and the starter cam follower 31 rides up the sloping surface 37 on the cam 30 thus storing power in the spring 33. Approximately 90 seconds after switch 9 closes, the cam follower 31 starts down the sloping portion 35 of cam 30. At approximately the same time the toothless section 27 of gear 6 approaches the pinion 5 thus releasing the gear from pinion 5. The cam shaft assembly is now driven forward by the cam follower 31, bringing the run abutment 29 on gear 6 into engagement with the run stop 70 on lever 71. The cam shaft assembly is now stopped with the toothless section of the gear 6 in registry with the pinion 5, thus allowing the timing mechanism to be stalled while the motor 1 continues to run unloaded. At this time, the cam follower 31 is still on the sloping portion 35 of cam 30 and is urging rotation of the camshaft assembly or timing means, such rotation being prevented by the run abutment 29 engaging the stalling surface 70.

The compressor will normally remain in operation until the thermostat 93 is satisfied. When this occurs, the solenoid 50 is deenergized which permits the biasing spring 60 of lever 40 to rotate this lever counterclockwise, this in turn causing counterclockwise rotation of the lever 48 and outward movement of the solenoid plunger 49. This same motion of lever 40 also caused the abutment 45 to move to the right against the driven surface 77 of the run stall lever 71. This released the stalling surface 70 from abutment 29 on gear 6 and simultaneously released the latch 73 allowing downward movement of switch blade 11 for opening the contacts of switch 9. This deenergized the compressor contactor coil 94 which in turn deenergized the compressor 96. Due to the stalling surface 70 being released, the starter cam follower 31 acting on sloping portion 35 caused rotation of the cam shaft assembly for bringing gear 6 back into engagement with the pinion 5. The timing mechanism will now run back to the standby position where the parts are stalled by the standby stalling surface 43 being engaged by the standby abutment 27 on gear 6. At this time the latch 83 is locked in unlatched position by engagement of the blade extension 16 with the drop-off portion of the latch. This holds the run stall lever in the outer position as shown where it cannot interfere with the passage of the standby abutment 28 on gear 6. Thus if the solenoid 50 should become energized during the four minute 45 second resetting cycle of the timer, the run stall 70 will nevertheless be held clear of the standby abutment 28.

It should be noted that when the thermostat first calls for cooling, it energizes the solenoid 50 which rotates the lever 40 clockwise for releasing the standby 43 from the standby abutment 28. This allows instant rotation of the timing means or cam shaft assembly and brings the outer edge of the run abutment 28 under the lower surface of lever 40. This temporarily locks the safety controls 91 and 92 and the thermostat 93 out of

control relationship over the compressor. Even if these controls opened their circuits and deenergized the solenoid 50, the lever 40 is maintained in its raised position so that the abutment 45 is spaced from driven surface 77 of run stall lever 71 so as to allow the latch 73 to move into place and cause closure of switch 9. The standby abutment 28 and the lower edge of lever 40 are arranged so as to require approximately 30 seconds for the abutment 28 to clear the lever 40 and place it back under the control of the condition responsive devices. 15 seconds of this 30 second interval is taken up in closing the switch 9 to start the compressor. This means that the compressor must now run at least 15 seconds irrespective of the safety controls 91 and 92. This minimum on period prevents false stopping of the compressor due to surges occurring when the compressor first starts. The condition responsive devices are locked out mechanically by the timing mechanism for sufficient time to allow the surges to settle down. These controls are then placed back into full control so that the compressor can be stopped instantly if an unfavorable condition occurs.

The purpose of the compound leverage system including levers 48 and 40 is to obtain more useful work from the solenoid and to make it operable over a wide voltage range. FIG. 3 shows a typical force-to-stroke curve for a solenoid of the type illustrated. This curve indicates the solenoid will pull approximately 10 ounces when the plunger is 0.5 inches from its seated position. As the plunger comes in, the force increases to approximately 15 ounces at 0.2 inches stroke. As the plunger continues its inward motion the force available rapidly increases having approximately 35 ounces pull when the plunger is seated.

The use of the compound lever system makes it possible to utilize a long stroke on the solenoid without excessive movement of the lever 40. Also with the camming surface 57 on lever 40 the ratio of motion of lever 40 relative to plunger travel is arranged to take advantage of the non-linear force characteristic of the solenoid. With the camming surface illustrated, initial movement of the solenoid plunger from its retracted position results in relatively small movement of the lever 40 against the action of its biasing spring 60. Thus the outward pull on the solenoid is at a minimum corresponding with the force available from the solenoid at that position. As the solenoid plunger moves in, the slope of the camming surface contacted by the portion 50 of lever 48 increases thus increasing the movement of lever 40, taking advantage of the increasing pull available as the solenoid pulls in.

It should be noted that any time after abutment 28 clears the lever 40, the latch 73 can be released by deenergizing of the solenoid for opening the switch 9. Once the latch has been released and the switch opened the switch will remain open until the timer returns to the starting position where latch 73 comes back into place and the cam follower 23 rides off lobe 98 of cam 8. This insures that the compressor cannot be started too often, and that its operation will always be delayed until the pressures in the system equalize so that the compressor can start in an unloaded condition. This is very desirable except when the system is being tested either on initial installation or during a service call. Hence the manual override is provided. When it is desired to start this system manually the thermostat 93 is turned up so as to energize the solenoid 50 thus

rocking lever 40 and moving the abutment 45 away from the run stall lever 71. The handle 82 on the manual lever 81 is now raised, bringing the camming surface 74 into engagement with the end of switch blade 11 thus raising this blade. This engages the contacts closing switch 9 and starting the compressor. On continued movement of the lever 82, the switch blade 11 is raised high enough to lift the cam follower 19 sufficiently to be clear of the cam at its highest portion. Continued rotation of the manual lever brings the circular portion 84 beneath the extension 16 of switch blade 11. Now there is no returning force on the manual lever and it will stay in the on position indefinitely. When the manual lever 81 is rotated counterclockwise and after the blade extension 16 has been lifted clear of the latching surface on latch 74, the latch will move into latching position under extension 16 due to the biasing spring 75. At this time due to the solenoid being energized, the abutment 45 is clear of the run stall lever which allows this movement of the latch into latching position.

The compressor will now remain in operation until the thermostat 93 is reset or until the room temperature is reduced to the setting of the thermostat. Opening of the thermostat circuit drops out the solenoid 50 allowing counterclockwise rotation of lever 40 under the action of biasing spring 60. The abutment 45 on lever 40 moving to the right rocks the run stall lever 70 clockwise which also causes clockwise rotation of the latch 73. In its releasing motion latch 73 engages the pin 86 on the manual override lever 81 thus causing clockwise rotation of this lever into the released position shown.

The manual override lever can also be operated without first energizing solenoid 50. In this case rotation of the lever first lifts the lower blade 11 until the extension 16 is raised above the latching surface 74 on latch 73. After this occurs the pin 86 on the override lever engages the back of the latch and rotates it into latching position against the yielding action of the abutment 45 on the run stall lever 71. In other words manual operation of the manual override lever overcomes the spring 60. However now when the manual override lever is released, the spring 60 will move latch 73 to released position which in turn moves the manual override lever to released position.

From the foregoing it will be seen that the manual override lever may be used in two different ways. In one case by turning the thermostat down to energize the solenoid, the manual lever can be released after the compressor is started and the compressor will run until the solenoid is deenergized. In the other method the manual lever can be operated without closing the thermostat circuit. However in this case the manual lever must be held in actuated position as long as operation of the compressor is required. In no even, is it possible to manually lock out the control system causing a dangerous situation if forgotten.

As numerous modifications may be made without departure from the spirit and scope of the invention it is desired to be limited only by the scope of the appended claims.

I claim:

1. In a timing device, the combination of, a cam, a first switch blade having one end anchored and the other end free, a second switch blade having one end anchored and the other end free, said first blade being

located between the cam and said second blade and both blades being biased toward the cam, cooperating electrical contact surfaces carried by said blades, a cam follower carried by and attached to said second blade, said cam follower extending past the first blade and riding the cam, said cam follower being constructed and arranged to lift both blades against their bias with the contact surfaces disengaged, said cam having a lobe arranged to lift the cam follower and then lower it whereby both blades are raised and the second blade is lowered, a latch constructed and arranged to hold the first blade in lifted position whereby the contact surfaces engage when the second blade is lowered by the cam, and means for releasing said latch from the first blade to separate said contact surfaces.

2. In a timing device, the combination of, a cam, a first switch blade having one end anchored and the other end free, a second switch blade having one end anchored and the other end free, said first blade being located between the cam and said second blade and both blades being biased toward the cam, cooperating electrical contact surfaces carried by said blades, cam follower means for lifting the blades, said cam and cam follower means being constructed and arranged to first lift the blades against their bias with the contact surfaces separated and then lower the blades, latch means constructed and arranged to hold the first blade in lifted position for engaging the contact surfaces when the second blade is lowered by the cam, means for releasing the latch means from the first blade to separate the contact surfaces, manual operator means constructed and arranged to engage the contact surfaces independently of the cam, said manual operator means being arranged to lift the first blade sufficiently to engage said surfaces and to hold this blade in lifted position and means for releasing the manual operator means from holding position.

3. A device as recited in claim 2 including means actuated with the latch means in releasing the same for releasing the manual operator means.

4. A device as recited in claim 2 in which the manual operator means is arranged to lift the first blade sufficiently to maintain the contact surfaces engaged for all positions of the cam.

5. A device as recited in claim 2 in which the latch means is pivoted and the manual operator means consists of a camming member mounted on the same axis as the latch means pivot, the camming member engaging the first blade adjacent the latch means and having

a lifting surface and a holding surface.

6. In an automatic control device, a control switch having a first position and a second position, automatic means for operating said control switch from its first position to its second position at one time and for operating said switch from the second position back to the first position at another time, manual means separate from said automatic means for operating said switch to its second position independently of the automatic means, said manual means being arranged to hold said switch in the second position without manual effort, and means actuated by the automatic means in returning the switch back to the first position for releasing said manual means.

7. The combination recited in claim 1 in which the cam follower is attached only to the second blade and is arranged to engage the first blade when being lifted by the cam, said cam follower disengaging the first blade when it is lowered by the cam and the first blade is held by the latch.

8. The combination recited in claim 1 in which the cam follower is located adjacent the contact surfaces and determines the positions thereof independently of flexure of the blades.

9. In a timing device, the combination, a cam, a first switch blade having one end anchored and the other end free, a second switch blade having one end anchored and the other end free, said first blade being located between the cam and second blade and both blades being biased toward the cam, cooperating electrical contact surfaces carried by said blades, a cam follower carried by and attached to the second blade, said cam follower being formed of insulative material and riding the cam, said cam follower being constructed and arranged to lift both blades against their bias with the contact surfaces disengaged, said cam having a lobe arranged to lift the cam follower and then lower it whereby both blades are raised and the second blade is lowered, and holding means constructed and arranged to hold the first blade in lifted position whereby the contact surfaces engage when the second blade is lowered by the cam, said holding means being releasable to separate the contact surfaces.

10. The combination recited in claim 9 in which the first blade is formed with a slot and the cam follower extends freely through the slot and includes a portion extending under the first blade adjacent the slot for lifting said first blade.

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