

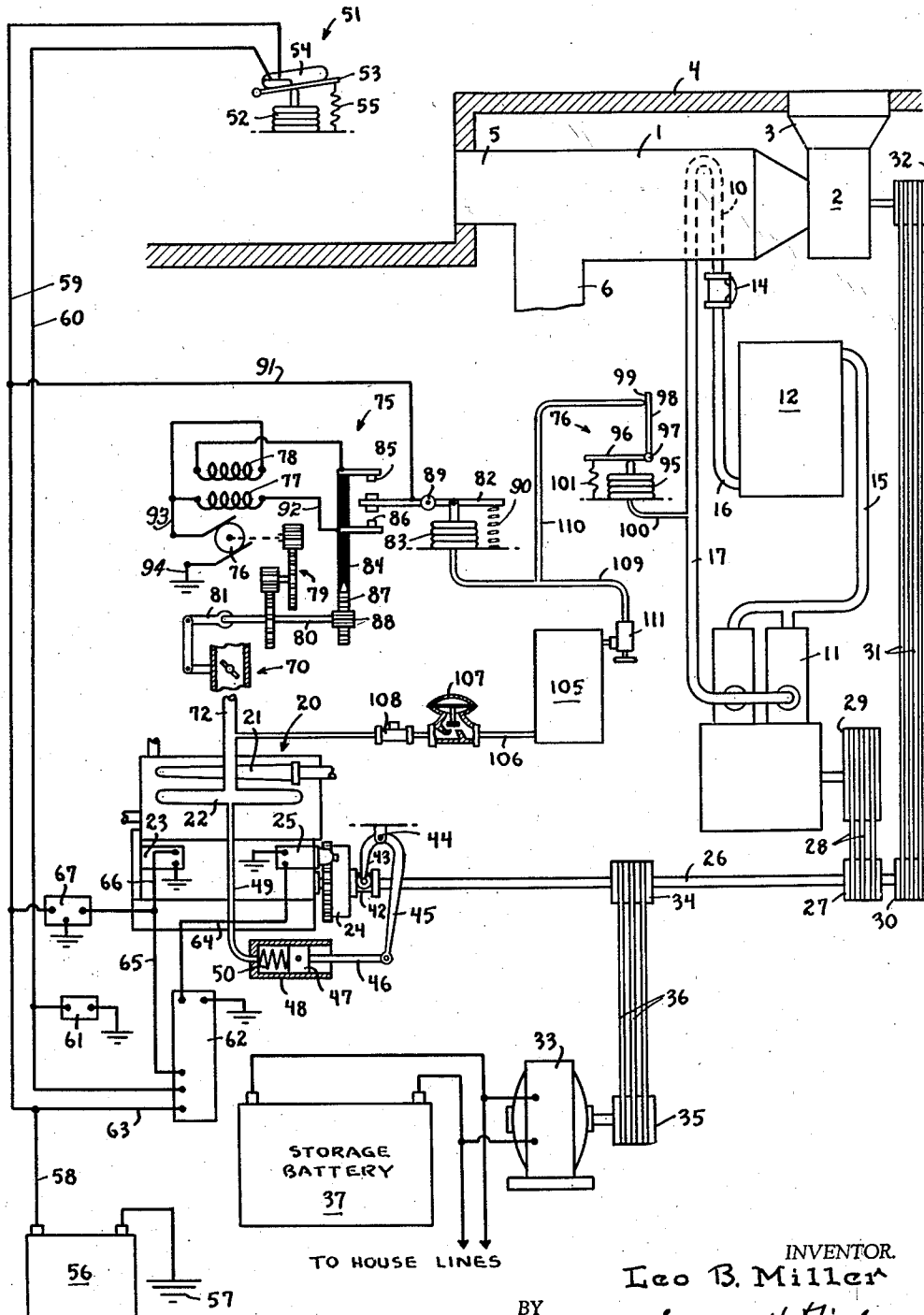
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L. B. MILLER

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AIR CONDITIONING SYSTEM

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AIR CONDITIONING SYSTEM

Leo B. Miller, Milwaukee, Wis., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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This invention relates to pneumatic control systems and its object is to provide a means whereby in a system including an internal combustion engine the engine provides the source of pneumatic force or pressure utilized by the pneumatic control system.

Thus in pneumatically controlled air conditioning systems or the like wherein an internal combustion engine is utilized, my invention provides an arrangement whereby the pneumatic system is connected to the intake manifold of the internal combustion engine so that the engine will produce a vacuum in the pneumatic system, the vacuum in the pneumatic system providing for operation of the various pressure responsive devices in response to atmospheric pressure.

Another object of my invention is to provide an automatic control system of the pneumatic type wherein the pneumatic system is connected to the intake manifold of an internal combustion engine forming part of the system.

This application is a division of my previously filed application, Serial No. 154,023, filed July 16, 1937, now Patent No. 2,284,914, issued June 2, 1942.

Referring to the drawing, reference character 1 indicates a conditioning chamber, this chamber discharging into the inlet of a fan 2 which is connected by a discharge duct 3 to the conditioned space 4. At its other end the conditioning chamber 1 is connected to the space 4 by a return duct 5. The conditioning chamber 1 is also provided with a suitable fresh air inlet 6, this duct having the usual damper means (not shown) for controlling the flow of fresh air into the conditioning chamber. In the conditioning chamber 1 is a cooling coil 10 for cooling the air before it is passed to the conditioned space. With the arrangement described, it will be apparent that a mixture of fresh and return air is passed over the cooling coil 10 where it is cooled and then passed to the space 4.

The cooling coil 10 is herein shown as forming part of a compression refrigeration system, this system including also a compressor 11, a condenser 12, and an expansion valve 14, the discharge of the compressor 11 being connected to the refrigerant inlet of the condenser 12 by a pipe 15, and the refrigerant outlet of the condenser 12 being connected to the expansion valve 14 by a pipe 16. The outlet of the cooling coil 10 is connected by a suction line 17 to the compressor 11. The operation of compression refrigeration systems of this type is well known in the art, and therefore no detailed description is given here.

However, it may be stated that operation of the compressor causes chilling of the cooling coil 10 and the temperature of the cooling coil 10 will vary with the speed of the compressor and also with the temperature of the air being passed in contact with said coil.

Reference character 20 indicates generally an internal combustion engine, this engine having the usual exhaust manifold 21, intake manifold 22, generator 23, fly-wheel 24 and starting motor 25. The fly-wheel 24 is connected to a drive shaft 26, this drive shaft having mounted thereon a pulley 27 cooperating with belts 28 which run over a pulley 29 attached to the compressor crank shaft. Attached also to the drive shaft 26 is a pulley 30, this pulley cooperating with belts 31 which run over a pulley 32 attached to the fan shaft. In this manner the engine 20 drives the compressor 11 and also drives the fan 2. The drive shaft 26 also drives a generator 33 by means of pulleys 34 and 35 which cooperate with belts 36. The generator 33 is adapted to supply electricity for domestic use and for this purpose is preferably of the third brush type having a storage battery 37 floating across the generator terminals. It will be understood that a suitable cut-out may be provided for preventing discharge of the storage battery through the generator when said generator is not running.

In accordance with my invention, the engine is automatically started and stopped in accordance with the air conditioning load. When the engine is started, it is necessary to disconnect it from its load and for this purpose an automatic clutching device is provided. The fly-wheel 24 contains a suitable clutching mechanism, this mechanism being actuated by means of a clutch collar 42. The clutch collar 42 is actuated by a bell crank lever 43 which is pivoted at 44, and which has an actuating arm 45 connected to the piston rod 46, which in turn is connected to piston 47 located within cylinder 48. The interior of the cylinder 48 is connected to the intake manifold by means of a conduit 49. A spring 50 is located within the cylinder 48 and is arranged to urge the piston 47 outwardly, this causing movement of the clutch collar 42 for disengaging the clutch. When the engine is running, however, a vacuum is developed within the intake manifold 22, this causing evacuation of the cylinder 48, which results in piston 47 moving to the left against the action of spring 50, thereby causing engagement of the clutch. The automatic clutching mechanism just described therefore acts to disengage the clutch when the engine has

stopped and to automatically engage the clutch after starting of the engine.

In accordance with the preferred form of my invention, I provide for automatically starting and stopping the engine in accordance with the temperature of the conditioned space. For this purpose a temperature controller generally indicated as 51 is provided. This temperature controller is shown herein as comprising a bellows 52 which is fixedly supported at its lower end and which cooperates with a pivoted switch carrier 53 which carries a mercury switch 54. A tension spring 55 is connected to the free end of the switch carrier 53 and urges such carrier against the bellows 52. The bellows 52 contains a suitable volatile fluid wherefore the vapor pressure therein varies with the temperature surrounding the bellows 52. Thus, upon an increase in temperature, the vapor pressure within the bellows will increase, this causing expansion of the bellows against the action of the spring 55 and tilting the mercury switch towards closed position. Upon a decrease in temperature, however, the vapor pressure within the bellows will decrease, this causing contraction of the bellows under the action of the spring 55, thereby tilting the mercury switch 54 towards open position.

Reference character 56 indicates a storage battery. One terminal of this battery is grounded as at 57, and the other terminal of said battery is connected to one terminal of mercury switch 54 by means of wires 58 and 59. The other terminal of mercury switch 54 is connected to a wire 60, and this wire 60 is connected to an ignition coil 61 and also to the control terminal of starting relay 62. The starting relay 62 may be of the type shown and described in the Loehr et al. Patent 1,773,913, dated August 26, 1930. This type of starting relay is adapted to automatically energize the starting motor whenever the control circuit of said relay is energized, and for this purpose is connected to the battery 56 and to the starting motor 25 by means of wires 63 and 64 respectively. This starting relay is also arranged to prevent energization of the starting motor so long as the engine is in operation, as evidenced by operation of the generator, and for this purpose is connected to the generator 23 by means of wires 65 and 66. Reference character 67 indicates a suitable generator cut-out for preventing discharge of the battery 56 through the generator when said generator is not in operation.

From the description thus far, it should be apparent that whenever the space temperature is below a predetermined value, the mercury switch 54 will be open, thereby deenergizing the starting relay 62 and the ignition coil 61, this causing the engine to be stopped at which time the automatic clutching mechanism will cause disengagement of the clutch. When, however, the space temperature rises above the value for which the controller 51 is set, the mercury switch 54 will close, thus energizing the ignition circuit for the engine and also energizing the control circuit of the starting relay, this causing operation of the starting motor for starting the engine. After the engine is started, the starting motor is automatically placed out of operation by said starting relay, and also the resulting vacuum in the intake manifold causes operation of the automatic clutching mechanism for engaging the clutch, thereby causing the engine to drive the compressor, the fan, the generator, and any other apparatus that may be connected to shaft 26.

My invention also contemplates the modulating of the engine speed in accordance with the conditioning load, that is, to increase the engine speed when the conditioning load increases and to decrease the engine speed upon decrease in such conditioning load. For this purpose, a suitable throttle valve 70 is provided in the fuel line 72 to the intake manifold. This throttle valve is shown herein as being positioned by a pneumatically controlled reversible motor generally indicated as 75, this motor being controlled by means of a pneumatic type of suction pressure controller 76.

Referring now to the motor 75, this comprises an armature 76 and a pair of oppositely wound field coils 77 and 78. It will be understood that when field coil 77 is energized, the armature 76 will be rotated in one direction, and that when the field coil 78 is energized, the armature will be rotated in the opposite direction. The armature 76 is arranged to drive through a gear train 79, an operating shaft 80, said operating shaft having attached thereto a lever arm 81 which is connected by suitable linkage to the throttle valve 70. Thus, rotation of the armature 76 will cause movement of throttle valve 70.

For controlling the energization of field coils 77 and 78, a suitable form of primary control and follow-up mechanism is provided, this comprising a switch arm 82 which is actuated by a bellows 83, and a movable contact carrier 84 formed of insulating material, this contact carrier carrying contacts 85 and 86. The contact carrier 84 is arranged to follow up movements of the operating shaft 80 and is herein shown as being secured to a rack 87 cooperating with a pinion 88 which is mounted upon the operating shaft 80. By this arrangement, when the operating shaft 80 is rotated counter-clockwise for closing the throttle valve, the contact carrier 84 will be caused to move upwardly, and when the operating shaft is rotated in the opposite direction the carrier 84 will move downwardly. The carrier 84 will therefore assume positions corresponding to the degree of opening of the throttle valve 70.

The switch arm 82 is arranged to cooperate with contacts 85 and 86 and for this purpose is pivoted at 89. Thus, upon expansion of the bellows 83, the switch arm 82 will be tilted counter-clockwise to bring its contact into engagement with the contact 86. This will cause energization of the field coil 77 by a circuit as follows: storage battery 56, wire 58, wire 59, wire 91, switch arm 82, contact 86, wire 92, field coil 77, wire 93, armature 76 and wire 94 to ground. This will cause rotation of the operating shaft 80 in a direction to open the throttle valve, this causing downward movement of the carrier 84, thereby disengaging the contact 86 from the switch arm 82, thus deenergizing the motor. Conversely, upon contraction of the bellows 83, the switch arm 82 will be tilted clockwise, thereby bringing it into engagement with the contact 85, this causing energization of the field coil 78 for driving the operating shaft 80 in a direction to close the throttle valve, this simultaneously causing upward movement of the contact carrier 84 which disengages the contact 85 from the switch arm 82. From the foregoing, it will be apparent that the electric motor driving mechanism will cause the throttle valve to assume positions corresponding to the degree of expansion of the bellows 83. In other words, as the bellows 83 expands, the throttle valve 70 will be moved towards open

position, and as the bellows 83 contracts, the throttle valve will be moved towards closed position.

For controlling the degree of expansion of the bellows 83 and hence the position of the throttle valve 70, the suction pressure controller 76 is provided. Controller 76 comprises a bellows 95, this bellows being fixedly secured at its lower end and cooperating with the actuating arm 96 of a bell crank lever which is pivoted at 97. The bell crank lever also includes a control arm 98 which forms a valve member cooperating with a port 99 for forming a control valve. The bellows 95 is connected by means of a conduit 100 to the suction line 17 of the refrigeration system. Upon an increase in pressure within the system, the bellows 95 will expand, this causing clockwise rotation of the actuating arm 96 against the action of a spring 101, this moving the valve member 98 away from the port 99. Upon a decrease in suction pressure the bellows will contract under the action of the spring, thereby causing movement of the valve member 98 towards the port 99.

For actuating the bellows 83 of motor 75 in accordance with changes in suction pressure affecting controller 76, I utilize the vacuum developed in the intake manifold of the engine 20. For this purpose I provide a receiver 105, this receiver being connected to the intake manifold of the engine by means of a conduit 106, this conduit having interposed therein a pressure regulating valve 107 and a check valve 108 which is arranged to open towards the intake manifold. The pressure regulating valve 107 is of known form and is arranged to close when the pressure in receiver 105 is reduced to a predetermined value. By this arrangement, a constant subatmospheric pressure is maintained within the receiver 105 even though the subatmospheric pressure within the intake manifold may vary. Also connected to the receiver 105 is a conduit 109 which leads to the bellows 83. This conduit is also connected to the port 99 of the pressure controller 76 by means of conduit 110. Interposed in the conduit 109 is a restrictor 111. This restrictor is shown as taking the form of a needle valve and this valve is adjusted to have a capacity less than the capacity of the port 99.

When the suction pressure of the refrigeration system falls to a predetermined value, the valve member 98 will be caused to engage the port 99. This will prevent admittance of air into conduit 110 through port 99 thereby causing the pressure within conduits 109 and 110, and within the bellows 83 to decrease to a value equal to the subatmospheric pressure maintained within the receiver 105. This will cause the bellows 83 to contract to a maximum extent, thereby rotating the switch arm 82 around its pivot 89 in a clockwise direction, thus compressing spring 90 and causing engagement of switch arm 82 with contact 85. This, in the manner previously described, will cause the motor to rotate until the contact carrier 84 is at its uppermost limit, at which time the throttle valve 70 will be moved to the minimum fuel feeding position. As the suction pressure begins to rise, the bellows 95 will expand causing movement of the valve member 98 away from port 99. This will admit air into the conduits 110 and 109 and into the bellows 83, thereby causing a rise in pressure therein, this rise in pressure permitting expansion of the bellows 83 under the action of the compression spring 90, thereby tilting switch arm 82 in a counter-clock-

wise direction to bring it into engagement with the contact 86, which will cause operation of the motor in a direction to open the valve, the valve thereby being opened to such an extent that contact carrier 84 is moved downwardly a sufficient distance to disengage switch arm 82 from contact 86. Upon a further increase in suction pressure, the valve member 98 of controller 76 will be shifted farther from port 99, thereby admitting more air into the conduits 109, 110 and the bellows 83, thus causing expansion of the bellows 83 farther, which in turn results in the throttle valve 70 being moved further towards open position. When the suction pressure rises to a predetermined maximum the valve member 98 will be moved to a position wherein it leaves port 99 unobstructed, this causing a maximum flow of air through such port, thus causing bellows 83 to be expanded to a maximum, which will in turn result in the throttle valve 70 being moved to a wide open position. From the foregoing, it will be apparent that with the control arrangement just described, the throttle valve will be gradually controlled in accordance with the suction pressure of the refrigeration system, the throttle valve being opened to increase the engine speed when the suction pressure increases, and being closed for decreasing the engine speed when the suction pressure decreases.

From the foregoing, the operation of the system in its entirety is readily apparent. Summarizing the operation, whenever the engine 20 is started in response to the controller 51, the refrigeration system will of course be put in operation so as to reduce the pressure in the evaporator coil 10. When the engine is started, the air accumulated in the receiver 105 will of course be pumped out inasmuch as the receiver is connected to the intake manifold 22 of the engine and the receiver will be pumped down to a vacuum depending upon the setting of the pressure regulating valve 107. Also when the refrigerating system is started, due to the suction pressure being reduced, bellows 95 will collapse, as described above, bringing control arm 98 closer to port 99 so as to obstruct the admission of air into pipe 110. Thus as described above, the controller 76 will control the pressure in the pipe 110 and in the bellows 83 depending upon the suction pressure, and the throttle valve 70 will be positioned accordingly, that is, in accordance with the suction pressure. In other words, the engine 20 will be controlled in response to the suction pressure so that the power developed by the engine will be proportionate to the load on the coil 10.

By connecting the receiver of the pneumatic system to the intake manifold of the engine, the pneumatic system is operated under vacuum so that atmospheric air bleeds into the system. This, as distinguished from more conventional systems wherein there is a source of compressed air which is supplied to the pneumatic system, and air pressure is bled off from the pneumatic system. With the arrangement I have provided, the necessity of a source of compressed air for the pneumatic system is entirely obviated, it being only necessary to connect the receiver of the pneumatic system to the intake manifold of the engine through the pressure regulating valve 107.

The form of my invention which I have disclosed is representative and many variations and modifications will occur to those skilled in the art. The scope of my invention is therefore to be determined only in accordance with the claims appended hereto.

I claim as my invention:

1. In an air conditioning system, in combination, a heat exchange device, means for passing air into heat exchange relationship with said device for a conditioning action, means for causing a flow of heat exchange medium through said device comprising a compressor, an internal combustion engine for driving said compressor, said engine having an intake manifold, a variable speed controller for said internal combustion engine, a fluid actuated device for causing movement of said variable speed controller, means for supplying actuating fluid to said fluid actuated device, said last mentioned means including a fluid flow controlling device responsive to a load condition on the system for controlling the supply of actuating fluid to said fluid actuating device, and a connection to the intake manifold of the engine for inducing flow of said actuating fluid.

2. In an air conditioning system, a conditioning chamber from which air to be conditioned is passed, an evaporator coil in heat transfer relationship with said chamber, a compressor for supplying refrigerant to said coil, an internal combustion engine for driving said compressor, a speed controller for varying the speed of said engine, a pneumatic control system for said speed controller including a control valve responsive to a condition indicative of the demand for compressor operation, and means whereby said internal combustion engine maintains a pressure within said pneumatic system other than atmospheric pressure.

3. In an air conditioning system, a conditioning chamber through which air to be conditioned is passed, an evaporator coil in heat transfer relationship with said chamber, a compressor for supplying refrigerant to said coil, an internal

combustion engine for driving said compressor, a speed controller for varying the speed of said engine, a pneumatic control system for said speed controller including a control valve responsive to a condition indicative of the demand for compressor operation, and a connection between the conduit of said pneumatic control system and the intake manifold of said engine tending to maintain a vacuum within said conduit.

4. A system of the character described comprising in combination, an internal combustion engine, a throttle valve in the fuel supply thereto for varying the speed of said engine, a pneumatic system, means operated by said engine for developing a pressure other than atmospheric within said pneumatic system, valve means connecting said pneumatic system to the atmosphere, means operating said valve means to maintain a pressure within said pneumatic system which is dependent upon the demand for engine operation, and means positioning said throttle valve in accordance with said pressure.

5. A refrigeration system comprising in combination, an internal combustion engine, a refrigerant compressor driven thereby, a throttle valve in the fuel supply to said engine for varying the speed thereof, a pneumatic system, means operated by said engine for developing a pressure other than atmospheric in said pneumatic system, valve means connecting said pneumatic system to the atmosphere, means operating said valve means in response to the pressure on the suction side of said compressor for varying the pressure in said pneumatic system in accordance with said suction pressure, and means operating said throttle valve and hence varying the speed of the engine in accordance with the pressure in said pneumatic system.

LEO B. MILLER.