(54) Title: ENGINE DRIVEN COMPRESSOR

(57) Abstract: A compressor assembly (110) comprises a compressor (114) including a fluid inlet (122) having an inlet valve (126) and an engine (118) that drives the compressor (114). A tank (130) receives pressurized fluid from the compressor (114), and includes an outlet (134) for discharging pressurized fluid. A control system (142) is in fluid communication with the tank (130), and a regulator (138) provides fluid flow from the tank (130) to the control system (142) when the pressure within the tank (130) exceeds a set point pressure. A pneumatic controller (146) controls the inlet valve (126) in response to the fluid pressure within the control system (142). An electronic controller (166) controls the speed of the engine (118) in response to fluid pressure within the control system (142) and provides a control pressure signal (174) to the electronic controller (166).
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Engine Driven Compressor

FIELD OF THE INVENTION

The present invention relates to a compressor assembly, and more particularly to a compressor assembly including an engine driven compressor, an electronic controller that controls the engine speed and a pneumatic controller that controls an inlet valve of the compressor.

BACKGROUND OF THE INVENTION

In air compressors, control of the discharge air pressure from the compressor is achieved by control of the engine speed and the compressor inlet opening. Generally, increasing the engine speed or opening the inlet valve increases the discharge pressure. Reducing the engine speed or closing the inlet valve decreases the discharge pressure.

A compressor assembly commonly includes a separator tank, an air end for compressing the air and driven by an engine, and a control system. In operation, air enters the air end through an inlet valve, the air end compresses the air to pressures above normal atmospheric pressures, and delivers the air to a separator tank. The air is discharged through an outlet valve.

Fig. 1 illustrates a schematic diagram of a prior art compressor assembly including a mechanically controlled engine having a pneumatic control system. The engine drives an air end that compresses the air. A mixture of compressed air and oil flows from the air end to a separator tank, where the oil is separated from the air. The tank discharges compressed air through an outlet valve to a customer. The customer determines compressor demand for compressed air from the tank.

When the pressure within the tank exceeds a preset level, a regulator permits air to flow into a control pipe. As pressure within the tank increases, pressure within the control pipe also increases. In Fig. 1, the pneumatic control system includes a cylinder assembly, an inlet valve, and an engine throttle lever, all of which are connected to a pivot lever. As the control pipe is pressurized, the cylinder assembly retracts and pivots the pivot lever to close the inlet valve and move the engine throttle lever to decrease the engine speed. As demand is increased, pressure within the tank and the control pipe decreases, and the cylinder assembly extends. Extension of the cylinder assembly pivots the pivot lever to open the inlet valve and actuates the engine throttle to increase the engine speed.
The pneumatic control system 18 adjusts the inlet valve 46 and actuates the engine throttle 50 simultaneously. In the compressor assembly 10 illustrated in Fig. 1, under part-load conditions, the engine speed is at a point somewhere between low idle and full speed, and the compressor inlet valve 46 is partly closed. Since the compressor inlet flow is partially closed, the inlet losses are high and the compressor efficiency drops.

SUMMARY OF THE INVENTION

The invention relates to a compressor assembly comprising a compressor including a fluid inlet having an inlet valve, an engine that drives the compressor, a tank that receives pressurized fluid from the compressor. A control system is in fluid communication with the tank, and a pressure regulator permits fluid flow from the tank to the control system when the pressure within the tank exceeds a setpoint pressure. An electronic controller controls the speed of the engine in response to fluid pressure within the control system. A pneumatic controller controls the inlet valve in response to fluid pressure within the control system. The electronic controller is separate from the pneumatic controller.

A control pressure sensor senses fluid pressure within the control system and provides a control pressure signal to the electronic controller. The electronic controller may include software control logic that receives the control pressure signal and determines the new desired speed of the engine. The electronic controller may provide an output signal to the engine that adjusts the speed of the engine to the new desired speed in response to the control pressure signal. A tank pressure sensor senses fluid pressure within the tank and provides a tank pressure signal to the electronic controller. The electronic controller may determine the setpoint pressure in response to the control pressure signal and the tank pressure signal.

The engine speed and the inlet valve may be separately controlled to increase efficiency of the compressor assembly. The inlet valve remains substantially open, while the electronic controller adjusts engine speed between the maximum and minimum speed for the engine. Once the engine reaches the minimum speed, the pneumatic controller may adjust the inlet valve between an open condition and a closed condition. For maximum part-load efficiency, the inlet valve should remain fully open during part-load operation while engine speed is modulated to match flow demand.
BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of a prior art compressor assembly.

Fig. 2 is a schematic diagram of a compressor assembly embodying the present invention.

Fig. 3 is a graph illustrating the control of the compressor assembly of Fig. 2.

Fig. 4 is a diagram illustrating the control logic of the compressor assembly of Fig. 2.

Before any embodiments of the invention are explained, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

DETAILED DESCRIPTION

Fig. 2 illustrates a compressor assembly 110 that electronically controls engine speed, and pneumatically controls an inlet opening. The compressor assembly 110 compresses fluids, such as air or other similar fluids, to pressures above normal atmospheric pressure. The compressor may be a screw compressor, a piston compressor, a scroll compressor or a centrifugal compressor, and may be an oil flooded compressor or an oil free compressor. The engine may be any conventional internal combustion engine, such as a diesel engine.

The compressor assembly 110 includes an air end 114, or compressor, that compresses the air, and an engine 118 that drives the air end 114. Air enters the air end 114 through an inlet opening 122. The compressor includes a capacity control device that controls air flow into the inlet opening 122. In the illustrated embodiment, the capacity control device includes an inlet valve 126, such as a butterfly valve. The capacity control device may also include an unloader valve. The air end 114 compresses the air and delivers the air to a separator tank 130. If the compressor assembly 110 includes an oil-
filled compressor, the oil is separated from the compressed air in the separator tank 130. If the compressor assembly 110 includes an oil-free compressor, the air may collect in the tank 130, or the air end 114 may discharge compressed air directly to a discharge air pipe.

The tank 130 includes an outlet valve 134 that controls discharge air flow from the tank 130 to a user. The user may include air powered machinery, or other similar devices connected to an air system. The customer generally determines compressor demand based on the need for compressed air within the air system. As demand increases, more compressed air is discharged from the tank 130, and the tank pressure generally decreases. As demand decreases, less air is discharged from the tank 130, and tank pressure generally increases.

When the pressure within the tank 130 exceeds a setpoint pressure, a pressure regulator 138 permits air to flow from the tank 130 into a control system 142. In the illustrated embodiment, the control system 142 is a closed pneumatic system, such as a conduit, piping or tubing, and helps relieve pressure above the setpoint within the tank 130. As pressure within the tank 130 increases above the setpoint, pressure within the control system 142 also increases proportionately.

The compressor assembly 110 includes a pneumatic controller 146 that controls the inlet valve 126. The inlet valve 126 influences compressor capacity, the compressor discharge pressure, and the pressure within the tank 130. In the illustrated embodiment, the pneumatic controller 146 includes a cylinder assembly 150 having a cylinder 154 in fluid communication with the control system 142, and a piston rod 158 at least partially disposed within the cylinder 154 and movable with respect to the cylinder 154 between an extended condition and a retracted condition. A pivot lever 162 is coupled to the piston rod 158 and the inlet valve 126, and the inlet valve 126 is pivotally coupled adjacent the inlet opening 122.

In the illustrated embodiment, as pressure within the control system 142 increases and the cylinder 154 is pressurized, the piston rod 158 retracts and moves the inlet valve 126 toward the closed condition, or unloaded position. A biasing member 164, such as a spring, may bias the inlet valve 126 toward the open condition, or loaded position. As pressure within the control system 142 decreases, the piston rod 158 extends and the inlet valve 125 moves toward the open condition. Opening the inlet valve 126 generally increases the tank pressure or discharge pressure, and closing the inlet valve 126 generally decreases the tank pressure or discharge pressure. The compressor assembly 110 may
include a partial-load compressor, and the inlet valve 126 may be positionable between the open condition and the closed condition. Fig. 2 illustrates the inlet valve 126 in a partially loaded position.

The compressor assembly 110 includes an electronic controller 166 that controls the speed of the engine 118. The electronic controller 166 may include an electronic control module (ECM), a computer, or other similar electronic processors. The engine 118 is an electronically controlled engine. Engine speed influences the compressor discharge pressure, and the pressure within the tank 130. Increasing engine speed generally increases the tank pressure or discharge pressure, and decreasing engine speed generally decreases the tank pressure or discharge pressure. A control pressure sensor 170 senses fluid pressure within the control system 142 and provides a control pressure signal 174 to the electronic controller 166 identifying the pressure within the control system 142. In Fig. 2, the control pressure signal 174 is represented by line 174. The compressor assembly 110 may also include a tank pressure sensor 178 that senses fluid pressure within the tank 130 and provides a tank pressure signal 182 to the electronic controller 166. In Fig. 2, the tank pressure signal 182 is represented by line 182.

The electronic controller 166 controls engine speed in response to the pressure within the control system 142. The electronic controller 166 receives the control pressure signal 174 from the control pressure sensor 170, determines the appropriate engine speed, and provides an output signal 186 to the engine 118 to control the engine speed. In Fig. 2, the output signal 186 is represented by line 186. If the control system pressure is above a desired level, the electronic controller 166 decreases engine speed. If the control system pressure is below a desired level, the electronic controller 166 increases engine speed. The engine 118 is generally adjustable between a maximum speed and a minimum speed, or idle speed. Increasing engine speed generally increases the tank pressure and control system pressure, and the decreasing engine speed generally decreases the tank pressure and control system pressure.

Fig. 3 represents a control strategy for the compressor assembly 110. Fig. 3 illustrates a graph including control system pressure, tank pressure, and engine speed in relation to time as compressor demand changes over a period of time. Together, Figs. 2 and 3 illustrate how the compressor assembly 110 responds to changes in compressor discharge pressure or customer demand. Points (A)-(H) represent various changes in demand for the compressor assembly 110. In the illustrated embodiment, the engine 118
has a minimum or idle speed of 1200 RPM and a maximum or full speed of 1800 RPM. The setpoint pressure for the pressure regulator 138 and pressure within the tank 130 is approximately 150 psig, and the desired level for pressure within the control system 142 is approximately 4 psig.

During initial compressor pressure loading at point A, demand is relatively high. Tank pressure is below the setpoint and control system pressure is zero. Since control system pressure is zero and below the desired level, the electronic controller 166 increases engine speed to full speed and the pneumatic controller 146 allows the compressor inlet valve 126 to open fully. From point A to point B, demand remains high and the engine speed increases from idle to full speed.

From point B to point C, engine speed is at full speed and tank pressure is near the setpoint. At point C, demand decreases slightly, and the tank pressure increases above the setpoint. The control system pressure is zero until the setpoint pressure is reached in the separator tank 130. In the illustrated embodiment, the setpoint pressure is approximately 150 psig. Once the separator tank pressure rises beyond the setpoint, the pressure regulator 138 begins to bleed air into the control system 142. Air flow in the control system 142 is balanced by a bleed orifice 190 to provide a steady regulation air pressure proportional to the separator tank pressure rise beyond the setpoint.

From point C to point D, demand continues to decrease, and tank pressure and control system pressure continues to increase. Once the control system pressure rises enough to become detectable by the control pressure sensor 170 and reaches the desired level, as shown at point D, the electronic controller 166 begins lowering engine speed in order to match the decreasing demand. In the illustrated embodiment, the desired level is approximately 4 psig. Software logic in the electronic controller 166 generally controls engine speed such that the control system pressure is near the desired level. Maintaining a small pressure within the control system 142 may help the compressor assembly 110 respond more quickly to changes in compressor demand and separator tank pressure. Of course, other digital logic (e.g., an ASIC, discrete circuitry, etc.) may be used in place of the software logic.

From point D to point E, demand continues to decrease, and the electronic controller 166 continues to decrease engine speed to maintain the control system pressure near the desired level. While the electronic controller 166 is lowering the speed of the engine, the inlet valve 126 remains open. This allows flow demand to be matched at part
load conditions, and provides maximum part-load compressor efficiency. Controlling the engine speed and the inlet valve 126 separately is generally more efficient than controlling the engine speed and inlet valve 126 together. Once the demand has dropped to the point that engine speed has been lowered to low idle, as shown at point E, any additional reduction in demand causes the tank pressure to continue to increase above the setpoint. At point E, the engine 118 reaches the minimum idle speed, and the electronic controller 166 can no longer decrease engine speed to match decreasing demand.

From point E to point F, demand continues to decrease, and tank pressure increases because engine speed remains at the minimum idle speed. The control system pressure passing through the regulator 138 continues to rise proportional to the separator tank pressure. The pneumatic controller 146 controls the inlet valve 126 in response to the control system pressure. Increasing the control system pressure strokes the cylinder assembly 150 to close the inlet valve 126. As the control system pressure continues to increase from point E to point F, the pneumatic controller 146 continues to close the inlet valve 126 until the inlet valve 126 is fully closed. When the inlet valve 126 is fully closed, the compressor flow is effectively zero and the separator tank pressure can no longer increase. This condition is known in the art as “fully unloaded”, and is shown at point F.

The process described above operates in reverse for an increase in demand from zero to full compressor capacity. From point F to point G, demand increases which causes tank pressure and control system pressure to decrease as compressed air is discharged from the tank 130. The pneumatic controller 146 moves the inlet valve 126 toward the open condition as the control system pressure decreases toward the desired level. At point G, the inlet valve 126 is at the open condition, and the electronic controller 166 begins increasing engine speed as demand continues to increase. From point G to point H, the electronic controller 166 continues to increase engine speed to maintain the control system pressure near the desired level. At point H, the engine 118 reaches full speed. The compressor assembly 110 is at maximum flow, or full capacity, when the engine 118 is at full speed and the inlet valve 126 is fully open. As shown on Fig. 3 beyond point H, any increase in demand when the compressor assembly 110 is at maximum flow will decrease the tank pressure and control system pressure. When the tank pressure decreases below the setpoint, the control system pressure will be zero.

The compressor assembly 110 can maintain a steady-state position at any operating point if the compressed air demand remains steady. As demand begins to increase from
zero ("unloaded") to a small percentage of full compressor capacity, the pressure in the separator tank 130 begins to drop. This lowers the control system pressure, and allows the inlet valve 126 to open slightly while the engine remains at low idle. As the demand continues to increase to the point where the tank pressure is only slightly above the setpoint, the electronic controller 166 begins increasing engine speed as needed to match demand, and attempts to maintain the control system pressure at the desired level (e.g., 4 psi). The compressor assembly 110 may operate in this state to provide part-load flow demands up to the point of maximum engine speed. At maximum engine speed, the compressor assembly 110 reaches full capacity, or maximum flow. Any flow demand increase above this point will simply cause the tank pressure to fall below the setpoint.

As stated earlier, the electronic controller 166 includes software that controls the engine speed based on the signal 174 provided by the control pressure sensor 170. Fig. 4 schematically illustrates a control algorithm that controls engine speed for the compressor assembly 110 of Fig. 2. The control algorithm includes a PID control where the control system pressure is the measured as a variable input. Additionally, a comparison value is applied to the algorithm. In the illustrated embodiment, the comparison valve is the desired level, shown as approximately 4 psig. The difference between the desired level and the actual control system pressure is computed (could be positive or negative). This error is then acted upon by the PID algorithm to compute an adjustment or new speed for the engine. The electronic controller 166 then provides the output signal 186 including this new speed to the engine 118.

The tank pressure or discharge air pressure is also monitored during the above process. If the rate of change (rise or fall) of this discharge pressure exceeds given limits, the integral term in the PID algorithm will be reset to a specific value. For example, if the rate of change is negative, the reset value will be 1800 RPM (revolutions per minute). If the rate of change is positive, the reset value will be 1200 RPM. These reset values will cause the electronic controller 166 to make an immediate speed change (increase or decrease) in order to affect the corresponding air pressure change. Moreover, resetting the integral term allows the compressor assembly 110 to be more responsive to changes in load or demand.

The electronic controller 166 uses the tank pressure signal 182 provided by the tank pressure sensor 178 for determining the setpoint pressure, or regulated pressure. That is, an operator does not need to input a new setpoint pressure directly into the electronic
controller 166. The pressure regulator 138 may be adjusted manually. Once the pressure regulator 138 is adjusted to a new setpoint pressure, for example from 150 psig to 125 psig, the regulator 138 begins bleeding air into the control system 142 once the tank pressure rises slightly above the new setpoint pressure. When this occurs, the electronic controller 166 measures the separator tank pressure from tank pressure sensor 178 and may readjust the software control logic based on the new setpoint pressure. Therefore, automatic compensation is made and no direct user adjustment is required for the electronic controller 166. This simplifies and reduces the cost of the electronic controller 166 and/or control panel since no pressure select adjustment switches or output display features are needed for user adjustment.

In another embodiment, the electronic controller 166 is compatible with multiple compressors, and each compressor or compressor model includes a unique electronic identification (ID). The electronic controller 166 reads this ID and, based upon the ID, executes a control algorithm for that machine or model. Using the ID allows for a single software package for a family of machines where only the control algorithm varies. In the illustrated embodiment, a connection 194 between the compressor assembly 110 and the electronic controller 166 may include the ID that identifies the air end 114 or compressor model to the electronic controller 166 and software.

In yet another embodiment, the electronic controller 166 prevents undesired adjusting of the pressure regulator 138 above a maximum value allowable for the compressor assembly 110. This protects the compressor assembly 110 beyond operation range or design limitations such as engine horsepower and tank pressure. The design limitations of the compressor assembly 110, such as maximum discharge pressure or tank pressure, are known to the electronic controller 166 by the electronic ID of the controller. For example, a model identification plug in the electrical wiring harness may connect to the electronic controller 166, and is used as the identifier. Each compressor, or family of similar compressors, is installed with the plug, which has a particular resistor value in it. This value is interpreted by the electronic controller 166 as a voltage level, and is compared to a table programmed into the software. The software uses the table to determine the compressor model identity and operation range parameters. This allows for a common software package to be used across multiple compressor models, precluding the need for the software to be model-specific. Using the operation range and the registered tank pressure, the electronic controller 166 determines whether the regulator 138 is set too
high. If the regulator 138 is set too high, the electronic controller may actuate an alarm or stop the compressor assembly 110.

In another embodiment, the electronic controller 166 automatically detects whether a failed diaphragm is present in the pressure regulator 138. In some prior art pneumatically controlled compressors, a common failure of a pressure regulator is that a hole develops in an elastomer diaphragm. This results in the control system remaining at zero pressure even when the separator tank pressure rises beyond the setpoint pressure. The ultimate result is that the compressor continues to build pressure until a relief valve setting in the tank 130 or air system is reached. In oil flooded compressors, venting of the separator tank pressure through the safety relief valve often results in releasing compressor oil into the compressor package, and/or onto the ground. This results in a messy condition that requires expensive cleanup.

For this embodiment of the invention shown in Fig. 2, the electronic controller 166 knows the rated package discharge pressure from the electrical harness identification plug outlined above. Once the pressure in the separator tank 130 rises above a set amount beyond the maximum rated value for the compressor assembly 110 and the control pressure sensor 170 does not detect any pressure in the control system 142, the electronic controller 166 infers that the diaphragm of the pressure regulator 138 has failed. The electronic controller 166 then shuts down the compressor assembly 110 before the separator tank pressure rises to the point of relief valve venting, and may indicate an alarm condition through an alarm light.

The compressor assembly 110 may include a starting system 204 to assist in starting the compressor assembly 110. In Fig. 2, the starting system 204 is interconnected to the control system 142 and includes a second compressor 208, first solenoid 212, second solenoid 216, and a checkvalve 220. During unloaded starting, it may be desirable to close the inlet valve 126 during starting of the compressor assembly 110. The starting system 204 increases fluid pressure within the control system 142 during starting such that the pneumatic controller 146 closes the inlet valve 126. During starting, the solenoids 212, 216 may actuate to permit or restrict fluid flow through the control system 142. The second compressor 208 may then increase the pressure within the control system 142 to actuate the inlet valve 126.

In the illustrated embodiment, the first solenoid 212 is normally closed and may be energized to open during starting, and then de-energized to close during normal operation.
of the compressor assembly 110. The second solenoid 216 is normally open and may be energized to close during starting to permit the second compressor 208 to actuate the pneumatic controller 146 and close the inlet valve 126. The second solenoid 216 may then be de-energized to open during normal operation of the compressor assembly 110. The checkvalve 220 may permit one-way fluid flow such that the second compressor 208 may actuate the pneumatic controller 146, but the control system pressure does not flow toward the second compressor 208. In the illustrated embodiment, the second compressor 208 includes a 24 VDC Air Compressor.

As can be seen from the above, the invention provides, among other things, an engine driven compressor assembly 110 including a electronic controller 166 that electronically controls the engine speed and a pneumatic controller 146 that pneumatically controls the inlet valve 126 and the capacity of the compressor. It is envisioned that one or more embodiments described above may be combined into a single embodiment.
CLAIMS:

1. A compressor assembly comprising:
   a compressor including a fluid inlet having an inlet valve;
   an engine that drives the compressor;
   a tank that receives pressurized fluid from the compressor, and the tank having an
      outlet for discharging pressurized fluid;
   a control system in fluid communication with the tank, the control system
      including a regulator providing for fluid flow from the tank when the pressure within the
      tank exceeds a setpoint pressure;
   an electronic controller that controls the speed of the engine in response to fluid
      pressure within the control system; and
   a pneumatic controller that controls the inlet valve in response to fluid pressure
      within the control system.

2. The compressor assembly of claim 1, wherein the electronic controller is
   separate from the pneumatic controller.

3. The compressor assembly of claim 1, wherein the setpoint pressure is
   adjustable, and the electronic controller determines the setpoint pressure in response to
   fluid pressure within the control system and fluid pressure within the tank.

4. The compressor assembly of claim 1, further comprising a control pressure
   sensor that senses fluid pressure within the control system and provides a control pressure
   signal to the electronic controller, and the electronic controller adjusts the engine speed in
   response to the control pressure signal.

5. The compressor assembly of claim 4, wherein the control pressure sensor
   includes a pressure transducer.

6. The compressor assembly of claim 4, further comprising a tank pressure
   sensor that senses fluid pressure within the tank and provides a tank pressure signal to the
   electronic controller, wherein the setpoint pressure is adjustable and the electronic
controller determines the setpoint pressure in response to the control pressure signal and the tank pressure signal.

7. The compressor assembly of claim 6, wherein the tank pressure sensor includes a pressure transducer.

8. The compressor assembly of claim 1, wherein the electronic controller increases the engine speed when control system fluid pressure is below a desired level.

9. The compressor assembly of claim 1, wherein the electronic controller decreases the engine speed when fluid pressure within the control system is above a desired level.

10. The compressor assembly of claim 1, wherein the pneumatic controller adjusts the inlet valve toward a closed condition when the fluid pressure within the control system increases beyond a desired level and the engine speed is at a minimum speed.

11. The compressor assembly of claim 1, wherein the pneumatic controller adjusts the inlet valve toward an open condition when the fluid pressure within the control system decreases toward a desired level.

12. The compressor assembly of claim 1, wherein the engine speed is adjustable between a minimum speed and a maximum speed, and the inlet valve is adjustable between an open condition and a closed condition, and the electronic controller adjusts engine speed while the inlet valve is substantially in the open condition, and the pneumatic controller adjusts the inlet valve while the engine is substantially at the minimum speed.

13. The compressor assembly of claim 1, wherein the pneumatic controller includes a cylinder assembly having a cylinder, and a piston rod movable with respect to the cylinder between an extended condition and a retracted condition, and wherein the inlet valve includes a pivotally coupled butterfly valve, and a pivot lever interconnecting the butterfly valve to the piston rod.
14. The compressor assembly of claim 1, wherein the electronic controller includes a processor that calculates the change in fluid pressure and the rate of change in fluid pressure within the tank and the control system, and adjusts the engine speed in response to the change in fluid pressure and the rate of change in fluid pressure within the tank and the control system.

15. The compressor assembly of claim 1, wherein the compressor is a partial load compressor, and the inlet valve is infinitely movable between an open condition and a closed condition.

16. The compressor assembly of claim 1, wherein the electronic controller is compatible with multiple compressor models, and the compressor includes an identifier that identifies to the electronic controller which compressor model is connected to the electronic compressor.

17. The compressor assembly of claim 16, wherein the identifier includes an identification plug at the interconnection between the compressor and the electronic controller.

18. The compressor assembly of claim 16, wherein the identifier includes a code that is entered into the electronic controller.

19. The compressor assembly of claim 16, wherein the electronic controller includes a separate logic and control algorithm, and design limitations corresponding to each of said multiple compressor models.

20. The compressor assembly of claim 1, further comprising a second compressor in fluid communication with the control system to actuate the pneumatic controller and close the inlet valve during starting of the compressor assembly.
21. A compressor assembly comprising:
   a compressor including a fluid inlet having an inlet valve;
   an engine that drives the compressor;
   an electronic controller that controls the engine speed;
   a tank that receives pressurized fluid from the compressor, and the tank having an
   outlet for discharging pressurized fluid;
   a control system in fluid communication with the tank, the control system
   including a regulator providing fluid flow from the tank when the pressure within the tank
   exceeds a setpoint pressure;
   a control pressure sensor that senses fluid pressure within the control system and
   provides a control pressure signal to the electronic controller;
   a pneumatic controller in fluid communication with the control system that controls
   the inlet valve in response to fluid pressure within the control system; and
   wherein the electronic controller controls engine speed in response to the control
   pressure signal.

22. The compressor assembly of claim 21, wherein the engine speed is
   adjustable between a minimum speed and a maximum speed, and the inlet valve is
   adjustable between an open condition and a closed condition, and the electronic controller
   adjusts engine speed while the inlet valve is substantially in the open condition, and the
   pneumatic controller adjusts the inlet valve while the engine is substantially at the
   minimum speed.

23. The compressor assembly of claim 21, wherein the engine speed is
   adjustable between a minimum speed and a maximum speed, and the electronic controller
   adjusts the engine speed to maintain the control pressure signal at approximately a desired
   level.

24. The compressor assembly of claim 21, wherein the electronic controller
   increases the engine speed when the control pressure signal is below a desired level.

25. The compressor assembly of claim 21, wherein the electronic controller
   decreases the engine speed when the control pressure signal is above a desired level.
26. The compressor assembly of claim 21, wherein the pneumatic controller adjusts the inlet valve toward a closed condition when the control system fluid pressure increases beyond a desired level and the engine speed is at the minimum speed.

27. The compressor assembly of claim 21, wherein the pneumatic controller adjusts the inlet valve toward an open condition when the control system fluid pressure decreases toward a desired level.

28. The compressor assembly of claim 21, wherein the pneumatic controller includes a cylinder assembly having a cylinder in fluid communication with the control system, and a piston rod movable with respect to the cylinder between an extended position and a retracted position, and the pneumatic controller adjusts the inlet valve when fluid pressure within the control system actuates the piston rod with respect to the cylinder.

29. The compressor assembly of claim 28, wherein the inlet valve includes a pivotally coupled butterfly valve, and a pivot lever interconnecting the butterfly valve to the piston rod, and movement of the piston rod actuates the butterfly valve to adjust the inlet valve.

30. The compressor assembly of claim 21, wherein the control system sensor includes a pressure transducer.

31. The compressor assembly of claim 21, further comprising a tank pressure sensor that senses fluid pressure within the tank and provides a tank pressure signal to the electronic controller.

32. The compressor assembly of claim 31, wherein the setpoint pressure is adjustable and the electronic controller determines the setpoint pressure in response to the control pressure signal and the tank pressure signal.

33. The compressor assembly of claim 31, wherein the tank pressure sensor includes a pressure transducer.
34. A method of controlling a compressor assembly comprising a compressor having an inlet valve, an engine that drives the compressor, a tank that receives pressurized fluid from the compressor and includes an outlet for discharging pressurized fluid, a control system in fluid communication with the tank, a regulator that permits fluid flow from the tank to the control system when the pressure within the tank exceeds a setpoint pressure, an electronic controller that controls the engine speed, a pneumatic controller that controls the inlet valve, and a control pressure sensor, the method comprising:
   sensing the fluid pressure within the control system with the control pressure sensor and generating a control pressure signal;
   providing the control pressure signal from the control pressure sensor to the electronic controller;
   adjusting the engine speed with the electronic controller in response to the control pressure signal received from the control pressure sensor; and
   adjusting the inlet valve with the pneumatic controller in response to the fluid pressure within the control system.

35. The method of claim 34, further comprising adjusting the engine speed with the electronic controller while the inlet valve is substantially in an open condition.

36. The method of claim 34, further comprising adjusting the inlet valve with the pneumatic controller while the engine is substantially at a minimum speed.

37. The method of claim 34, further comprising adjusting the engine speed with the electronic controller to maintain the control pressure signal at approximately a desired level, the electronic controller adjusting the engine speed between a maximum speed and a minimum speed, including increasing engine speed to generally decrease the control pressure signal, and decreasing engine speed to generally increase the control pressure signal.

38. The method of claim 34, further comprising increasing the engine speed when the control pressure signal is below a desired level.
39. The method of claim 34, further comprising decreasing the engine speed when the control pressure signal is above a desired level.

40. The method of claim 34, further comprising adjusting the inlet valve toward a closed condition when the control system fluid pressure increases beyond a desired level and the engine speed is at a minimum speed.

41. The method of claim 34, further comprising adjusting the inlet valve toward an open condition when the control system fluid pressure decreases toward a desired level.

42. The method of claim 34, wherein the pneumatic controller includes a cylinder assembly having a cylinder in fluid communication with the control system, and a piston rod movable with respect to the cylinder between an extended position and a retracted position, and the pneumatic controller adjusts the inlet valve when fluid pressure within the control system actuates the piston rod with respect to the cylinder.

43. The method of claim 34, wherein adjusting the engine speed includes: receiving the control pressure signal with the electronic controller; determining a new engine speed with the electronic controller in response to the control pressure signal; and generating an output signal, and providing the output signal to the engine representing the new engine speed.

44. The method of claim 34, further comprising: sensing the fluid pressure within the tank with a first pressure sensor and generating a tank pressure signal from the tank pressure sensor; providing the tank pressure signal to the electronic controller; and determining the setpoint pressure in response to the control pressure signal and the tank pressure signal.

45. The method of claim 34, wherein the control pressure sensor is a pressure transducer.
Fig. 4

Setpoint

Proportional
K*Err

Integral
K1*∫Err

Derivative
K2*d/dt Err

Regulation
System Air
Pressure

To Engine ECM
Speed Setpoint

If d/dt exceeds limits values,
Reset integral term to Min or
Max, depending direction of
Slope value

4 PSI

Discharge Air
Pressure

174
170
118
182

166
A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : F04B 49/00
US CL : 417/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 417/26, 1, 36, 298

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category *</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 5,888,051 A (McLOUGHLIN et al.) 30 March 1999 (30.03.1999), column 2 lines 28-41 and column 3 lines 45-63.</td>
<td>1-3, 8-13, 15 and 20</td>
</tr>
<tr>
<td>A</td>
<td>US 4,232,997 A (GRIMMER et al.) 11 November 1980 (11.11.1980), see abstract.</td>
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<td>A</td>
<td>US 6,041,765 A (O'NEILL et al.) 28 March 2000 (28.03.2000), see particularly Figure 1.</td>
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