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[54] **SUCTION PRESSURE RELIEVING SYSTEM FOR A ROTARY VANE COMPRESSOR**
9 Claims, 1 Drawing Fig.

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[50] **Field of Search** 417/295, 439, 542, 298, 299, 306, 323, 557, 540

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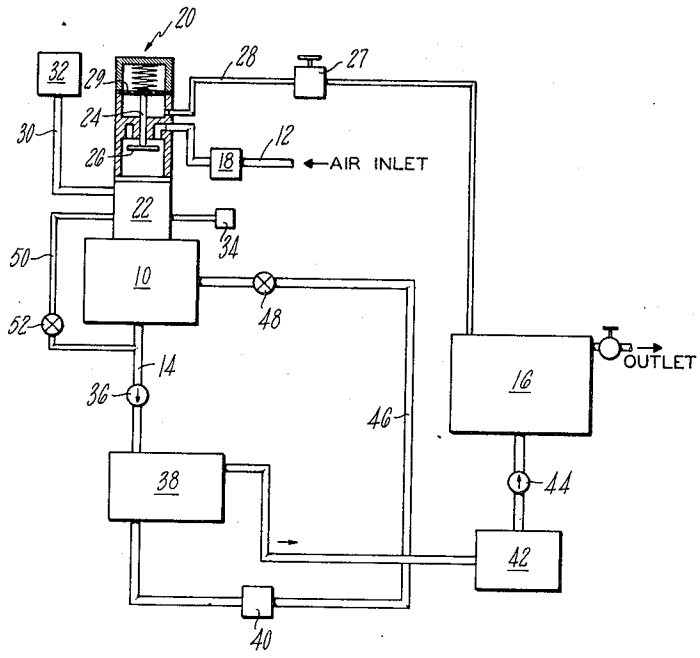
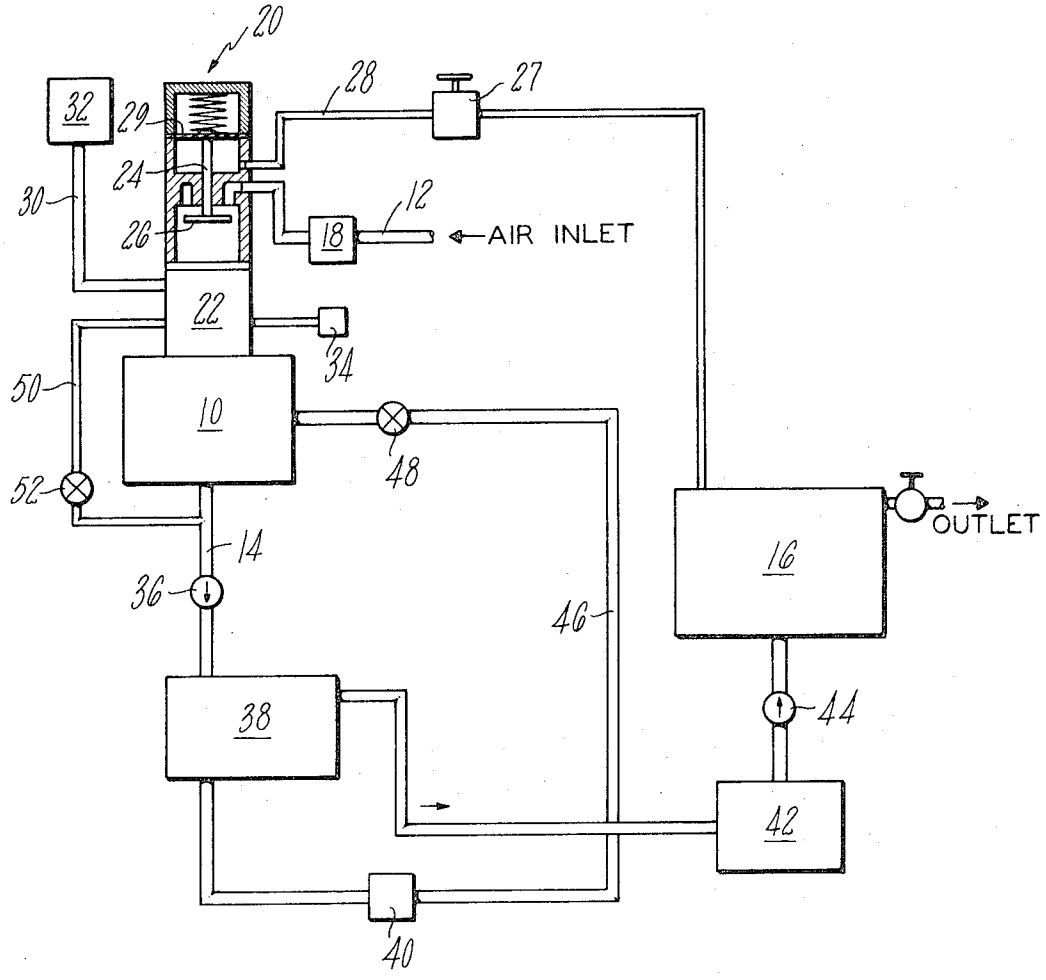
ABSTRACT: A suction pressure relieving system for a rotary vane gas compressor which automatically establishes a safe startup pressure at the compressor inlet ports whenever the compressor is shut down.





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SUCTION PRESSURE RELIEVING SYSTEM FOR A ROTARY VANE COMPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of rotary vane gas compressors which have throttling valves in the compressor inlet conduits for controlling the suction pressure at the compressor inlet ports. Accordingly, the general objects of the present invention are to provide novel and improved apparatus of such character.

2. Background of the Invention

In rotary vane compressors where a throttling valve is used to control the compressor output as a function of the output pressure or load, it is frequently desirable to stop the compressor to reduce wear and power consumption whenever the demand or load on the compressor is zero for extended periods of time. In such situations, high-pressure air in the compressor discharge system will leak back past the motionless vanes of the compressor into a confined portion of the inlet conduit. It is most probable that the suction pressure control valve in the compressor inlet will have been closed prior to compressor shutdown since it is the no load condition which causes the shutdown. In addition, the throttling valves used in such compressors often perform both the throttling function and a reverse flow checking function to prevent filters in the inlet line from being backwashed and to prevent large quantities of oil laden air from being expelled through the air inlet. As a consequence, when the compressor is shutdown, the compressed air which leaks back past the vanes will be captured within the throttled suction chamber and the compressor inlet.

Rotary vane compressors are designed with a specific compression ratio. It is quite possible that the compressor could be severely damaged if an attempt is made to start the compressor and further compress an abnormally high-pressure gas existing at the compressor inlet ports. This high-pressure condition can arise shortly after shutdown in compressors which have the suction pressure throttling valves due to the leakage past the motionless vanes. The pressure of this high-pressure gas at the inlet ports would preclude restarting the compressor if a load demand occurs shortly after shutdown. It is therefore important that the pressure at the compressor inlet ports be relieved or bled down at least to a preselected maximum pressure which can be accommodated by the compressor. This maximum pressure will vary from one rotary compressor to another and will be defined as the maximum compressor-starting inlet pressure.

It is also desirable that the static shutdown pressure which exists at both the inlet and discharge sides of the compressor after the high-pressure gas has bled down to an equilibrium condition be as small as possible to minimize the initial driving torque required to start the compressor after shutdown.

It is important that the bleeding down of the high-pressure gas through the compressor not occur too rapidly; otherwise, air dissolved in the oil on the high-pressure side of the compressor will create excessive foam and flood the tanks and filters in the compressor discharge.

In order to reestablish the maximum discharge pressure as soon as possible after the compressor has been started up, it is desirable to minimize the volume of the discharge system which does bleed through the compressor into the inlet. This minimization also aids in minimizing the static shutdown pressure which will exist across the compressor in the equilibrium condition.

SUMMARY OF THE INVENTION

The rotary vane gas compressor of this invention has an improved inlet system which provides a pressure at the inlet ports after the compressor has been shutdown which is no greater than the preselected maximum compressor-starting inlet pressure tolerated by the particular compressor in question.

The compressor is controlled in its output by means of a conventional suction control valve which is located in the compressor inlet conduit to restrict the amount of gas which reaches the compressor while it is running. This control valve is operated in response to the compressor load or discharge pressure in the receiver for the high-pressure gas. Since the conventional suction control valve is both a throttling valve and a check valve, this valve will in all circumstances be closed when the high-pressure gases leak back into the inlet suction chamber after shutdown.

In order to prevent the static shutdown pressure across the compressor from exceeding the preselected maximum, an auxiliary tank is connected into the suction chamber between the suction control valve and the actual compressor inlet ports.

In order to minimize the volume of high-pressure gas which must be diffused into the suction chamber and auxiliary tank, a check valve is interposed in the compressor discharge manifold at a position close to the discharge port from the compressor itself. This check valve not only serves to minimize the volume of gas to be expanded but in addition maintains the oil tanks and demister tanks downstream of the compressor discharge manifold under the high-pressure after shutdown. Maintaining these tanks at high-pressure prevents oil foaming due to entrapped air and reduces the time necessary to reestablish maximum rated pressure output at the discharge ports after a new load demand occurs.

The compressor discharge system includes an oil tank from which lubricating fluid is fed back to the rotary compressor for lubrication. In order to prevent the oil from being forced under the high-pressure in the discharge system into the rotary compressor, a flow control valve is provided in the filtered oil feed line to regulate the oil flow and prevent compressor flooding during shutdown.

Since the rate at which the high-pressure gas will bleed back into the suction chamber is dependent upon other compressor design factors and therefore not readily controllable, a regulated pressure bleeding conduit which bypasses the compressor itself interconnects the high-pressure discharge manifold with the inlet manifold. A valve interposed in this bleed conduit can be shut off during compressor operation and regulated during compressor shutdown for the most desirable bleed down rate in view of the oil-foaming problem within the compressor and discharge manifold itself.

If desired, a pressure switch interlocking with the compressor startup system may be employed to prevent inadvertent starting when for any reason the pressure at the inlet ports is not below the maximum compressor-starting inlet pressure.

BRIEF DESCRIPTION OF THE DRAWING

The drawing shows my suction pressure relieving system which provides a safe compressor starting inlet pressure for a rotary vane compressor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference to the drawing shows the inlet pressure control system including my improved inlet for relieving the compressor starting inlet pressure.

The rotary vane compressor is generally designated by the numeral **10**. The compressor **10** has an inlet **12** and a discharge manifold **14** which leads to a discharge receiver **16**. The receiver performs the function of storing the high-pressure air until it is needed for operating an air hammer or other pneumatic device.

Inlet air which is to be processed by the compressor enters the air inlet **12** and first passes through a filter **18**. After the air has been filtered it passes to a suction control system which includes a suction control valve **20** and a suction chamber **22** connected to the rotary compressor adjacent the inlet ports.

The control valve **20** is a conventional suction control valve which includes a spring-biased, diaphragm-operated valve stem **24** and a valve plate **26** slidably mounted on the stem **24**.

Such valves are well known in the art. The function of such a valve is to regulate the quantity of air which passes to the compressor as a function of the load or discharge pressure from the receiver **16**. In order to provide the appropriate pressure control signal for operating the valve **20**, a control pressure conduit **28** is connected from the discharge receiver **16** to the valve **20** below diaphragm **29** to control the position of the spring-biased valve stem **24**. A pressure regular **27** is included in the conduit **28** to adjust the pressure which operates the valve **20**.

Connected to the suction chamber **22** by means of conduit **30** is an auxiliary tank **32** which performs one of the principal functions of my invention. The tank **32** connects directly into the suction chamber **22** and is carefully matched with the volume of the chamber **22** and the compressor system to operate as described below.

A pressure sensing switch **34** is also connected to the suction chamber **22**. The pressure switch may be interconnected with a compressor-starting system such as a motor starter which starts the driving motor for the compressor. The pressure switch **34** is sensitive to the inlet or suction chamber pressure and prevents starting of the compressor unless the inlet pressure is below the maximum permitted compressor-starting inlet pressure. The pressure switch therefore is a safety device supplementing my improved inlet pressure relieving system.

High-pressure air leaving the compressor **10** through discharge manifold **14** first passes through a check valve **36** which prevents reverse flow of the compressed air in a large portion of the discharge system. The compressed air then passes into an oil tank **38** where the bulk of the lubricating oil carried by the high-pressure air is deposited. From the oil tank the high-pressure air is transmitted to a demister tank **42** where the remaining oil is separated from the air. From the demister tank **42** the oil-free air is transmitted through a second check valve **44** to the discharge receiver **16** for use as needed. Check valve **44** maintains pressure in receiver **16** during compressor shutdown.

The lubricating system for the compressor **10** includes the oil tank **38**, the oil filter **40**, the oil feed line **46**, and the oil flow valve **48**. The compressed air in the oil tank **38** will force oil through the filter **40** into conduit **46** and the compressor **10**. Valve **48** is adjusted to control the rate of oil flow to the compressor **10** as needed for its efficient operation and cuts off flow at shutdown to prevent the oil from flooding the compressor.

In one embodiment of my invention I include a gas pressure bleed line **50** connected to the discharge manifold **14** and the suction chamber **22**. A bleed valve **52** incorporated in the line **50** is used to adjust the rate at which high-pressure gas is permitted to flow back into the suction chamber **22** after the compressor **10** has been shutdown. Since the rate at which high-pressure air bleeds through the compressor depends on clearances established for efficient gas compression and, therefore, cannot be independently designed into the compressor, the bleed line **50** offers a convenient alternative. During normal compressor operation the valve **52** would be closed so that no flow in line **50** will interfere with the regulation of suction chamber pressure by control valve **20**.

It is an important feature of my invention that the inlet control system relieve the suction chamber pressure when the compressor is shutdown at the no-load condition. The inlet system is designed to reduce the inlet pressure to a prescribed value and at a rage which prevents foaming of the oil entrained in the high-pressure air.

When the rotation of the compressor vanes is stopped, high-pressure air will exist in the compressor itself as well as in the portion of the discharge manifold **14** between the compressor **10** and check valve **36**. Since there is a pressure differential across the compressor **10** immediately after shutdown, the high-pressure air will tend to leak around the vanes and rotor of the compressor into the suction chamber **22**. A controlled leakage rate may be established through bleed line **50** with valve **52**. The leakage will be prevented from backflowing through the filter **18** and air inlet **12** by means of the suction control valve **20**. Valve **20** will most likely have been closed due to the no-load condition immediately prior to compressor shutdown and even if the valve has not been closed by the load condition, the flow-checking function of valve **20** will prevent undesired backwashing of filter **18** and expulsion of the oil laden air at the inlet **12**.

Without the improved inlet system, the equilibrium pressure or static shutdown pressure generated by the bleed back of high-pressure gas could prevent compressor startup until leakage through the compressor seals and the suction valve eventually drops the inlet pressure to an acceptable level. This delay in restarting the compressor may severely hamper its utility particularly where a new demand from the receiver **16** arises shortly after the compressor is shut down.

To prevent an undesirably long delay in restarting the compressor, the auxiliary tank **32** is calibrated with the suction chamber **22**, compressor **10** and manifold **14** to increase the total confined gas volume to a value which will expand the high-pressure air in the discharge manifold **14** down to the tolerable maximum compressor-starting inlet pressure, for example, 10 p.s.i.g. The tolerable pressure will vary from one compressor to another depending on its capacity to withstand high discharge pressures.

In order to further reduce the task of expansion performed by the auxiliary tank **32**, the check valve **36** is located in the discharge manifold **14** at a position which will minimize the initial volume of high-pressure gas which must be expanded into the suction chamber **22** and an auxiliary tank **32**. The check valve **36** additionally maintains the oil tank **38** and the remainder of the discharge system under the high pressure. Two advantages are readily apparent. First, lubricating oil in tank **38**, line **46** and the remainder of the discharge system will not foam due to entrained air as the discharge manifold **14** is bled down. Second, the total volume of the discharge system which must be pumped up to discharge pressure when the compressor is restarted is minimized and consequently the time necessary for the compressor **10** to reestablish its rated discharge pressure is minimized.

The rate at which the small volume of air in discharge manifold **14** is brought to equilibrium across the compressor **10** can be readily controlled by the adjustment of bypass line **52**. The controlled rate is desirable to prevent sudden equalization of the pressures across the compressor and the resulting foaming of oil-laden air in discharge manifold **14**.

It will be understood that the precise system disclosed can have many forms without departing from the scope of the invention. For example, as pointed out above, the control bleed line **50** is not essential to the system. In addition, more than one auxiliary tank **32** may be connected to the line **30** so that the total volume of the suction chamber **22** and the tanks **32** will establish the desired static shutdown pressure. In this respect, however, it should be noted that the added, calibrated volumes of the auxiliary tank **32** will reduce the suction pressure response at the inlet ports of the compressor **10** to the regulation of suction control valve **20**. It is therefore preferred that the total volume of the auxiliary tanks **32** be calibrated in conjunction with the suction chamber **22** to perform the inlet pressure relieving function without significantly interfering with the throttling function of the suction control valve **20**.

What is claimed is:

1. In a rotary vane gas compressor system including an inlet suction control valve, a rotary vane compressor having inlet and discharge manifolds, and a compressed gas receiver, the improvements comprising:

valve means interposed between the compressed gas receiver and the compressor discharge manifold for preventing flow of compressed gas in the receiver back into the rotary compressor; and

auxiliary chamber means connected to the rotary compressor inlet manifold and having a preselected minimum volume for reducing the static shutdown pressure across the rotary compressor to a value not greater than a maximum startup inlet pressure limit.

2. The improvements of claim 1 further including:
a oil demister tank connected to the compressed gas receiver upstream in the direction of normal gas flow from the receiver and downstream with respect to the valve means.

3. The improvements of claim 1 further including:
an oil reservoir interposed between the valve means and the compressed gas receiver;
an oil feed conduit connecting the oil reservoir with the rotary compressor; and
an oil flow regulating valve interposed in the oil feed conduit for regulating the flow of oil from the reservoir to the rotary compressor.

4. The improvements of claim 3 still further including:
an oil filter located in the oil feed conduit between the reservoir and the oil flow regulating valve.

5. An automatic inlet pressure relieving apparatus for a rotary pneumatic compressor, said compressor having an inlet, a discharge manifold and a high-pressure gas discharge conduit connecting said discharge manifold to a high-pressure gas receiver, said pressure-relieving apparatus comprising:
suction control throttle valve means connected upstream of the gas inlet of the rotary compressor;
check valve means connected in the high-pressure gas discharge conduit between the high-pressure gas receiver and the compressor discharge manifold for checking flow from the receiver back to the compressor; and
an auxiliary suction pressure tank connected to the gas inlet downstream of the throttle valve means in the direction of gas flow through the throttle valve, the tank having an internal gas volume contiguous with the internal volumes of the throttle valve means, the gas inlet, the rotary compressor and the gas discharge path between the compressor and check valve means, said tank providing a static shutdown pressure at the gas inlet no greater than a preselected maximum pressure.

6. The pressure-relieving apparatus of claim 5 further including:
a pressure-bleeding conduit connected at one end to the high-pressure gas discharge between the rotary compressor and the check valve means and at the opposite end to the gas inlet of the compressor; and
a shutoff valve positioned in the pressure-bleeding conduit between the ends of the conduit whereby the bleeding of the higher pressure discharge gas through the conduit to the compressor inlet can be shutoff.

7. A suction control inlet for a rotary air compressor having an inlet and discharge manifold means including a valve for inhibiting reversed flow of the compressed air comprising:
an inlet conduit defining a passage for admitting a flow of ambient air;
inlet check valve means located in the inlet conduit and oriented to transmit the airflow toward the rotary compressor and prevent reverse flow through the inlet conduit;
suction control means connected with the check valve means and responsive to the load on the compressor for regulating the inlet air pressure at the rotary compressor;
auxiliary chamber means operatively connected between the suction control means and the rotary compressor, the chamber means having a chamber volume commensurate with the remaining air volume between the inlet check valve means and the flow inhibiting valve in the discharge manifold means whereby the volume of compressed air in the compressor and discharge manifold at shutdown will be expanded into the auxiliary chamber means volume and remaining volume at a pressure no greater then a prescribed maximum compressor-starting inlet pressure.

8. The apparatus of claim 7 further including:
an air filter positioned in the inlet conduit at a location upstream in the direction of inlet airflow from the inlet check valve means whereby the check valve means prevents back washing of the air filter.

9. The apparatus of claim 7 wherein:
the auxiliary chamber means includes at least one tank connected to the compressor inlet downstream of the suction control means and having an internal volume calibrated for expansion of the volume of compressed air below the maximum compressor-starting inlet pressure.

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