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[54] METHOD AND APPARATUS FOR SUPPLYING DEHYDRATED AIR TO AIR-OPERATED MECHANISMS

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[51] **Int. Cl.** **B01d 53/04**

[58] **Field of Search** ..... 55/33, 62, 74, 75, 179, 387, 55/275, 18; 23/253 A

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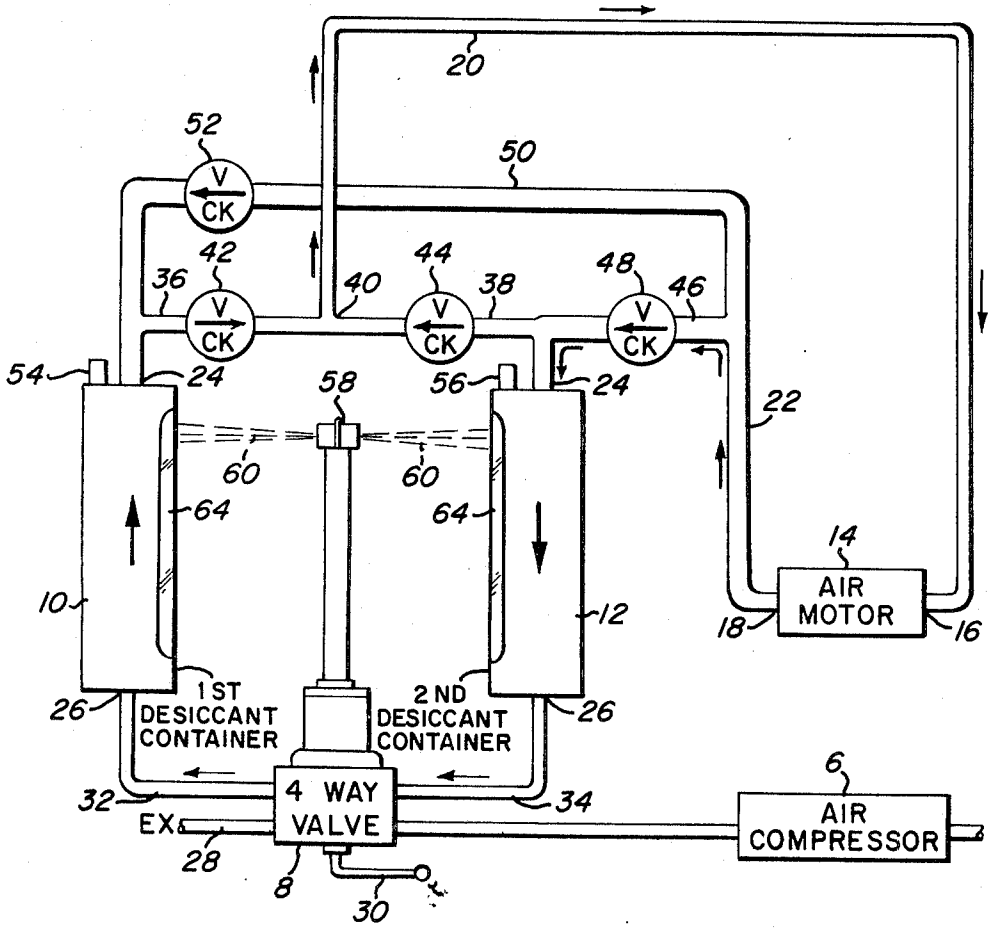
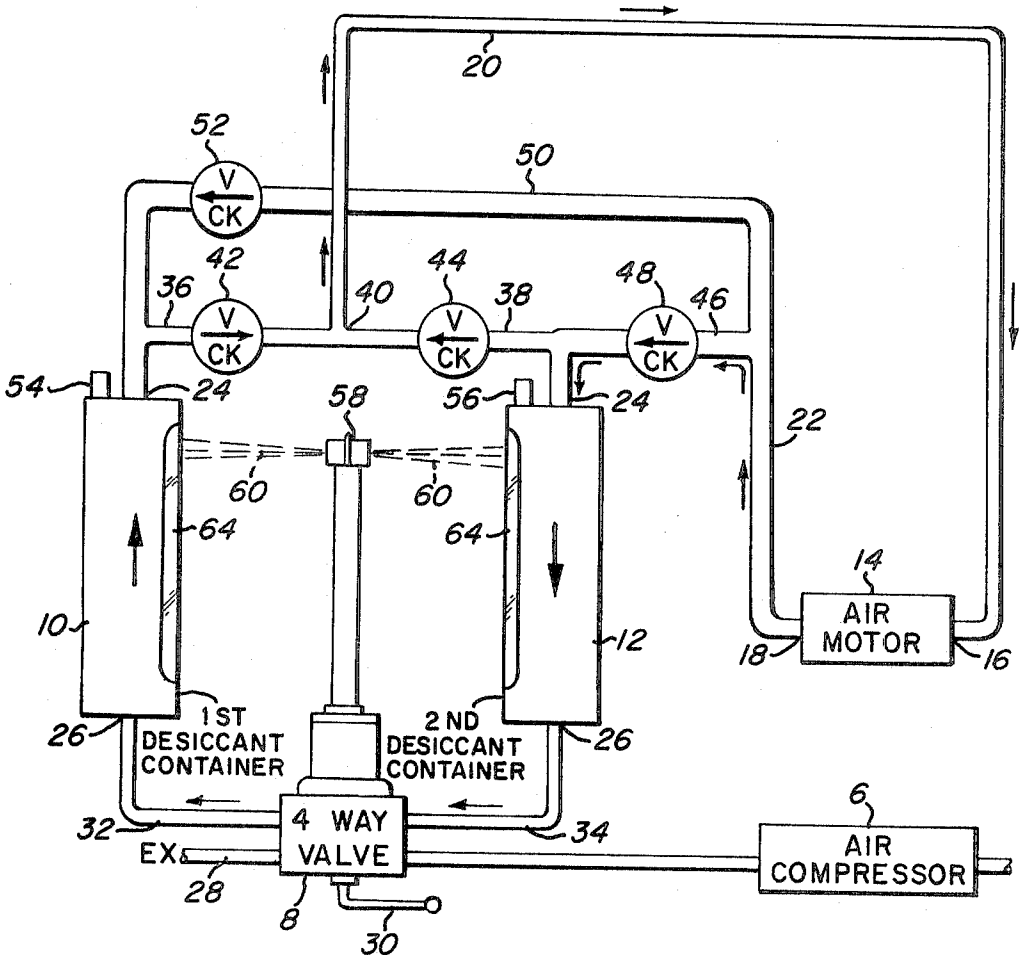
[57] **ABSTRACT**

The apparatus supplies thoroughly dehydrated super-clean air to an air-operated mechanism in a closed dehydration, pressure differential reactivation system. In the operation of the apparatus, dehydrated air, under pressure supplied to an air-operated mechanism, is exhausted from said mechanism as spent dry air at a lowered pressure, but without substantial reduction in volume, and is then without loss of any volume utilized to reactivate one or the other of a pair of dehydrators incorporated in the system. The entire exhaust from the air-operated mechanism is utilized to reactivate one dehydrator, while the other dehydrator gathers moisture from the air supplied to the air-operated mechanism. The arrangement eliminates the need for heat in effecting reactivation of the dehydrators.

9 Claims, 1 Drawing Figure





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METHOD AND APPARATUS FOR SUPPLYING DEHYDRATED AIR TO AIR-OPERATED MECHANISMS

This invention relates to a method and apparatus for supplying dehydrated air to air-operated mechanisms. The air-operated mechanisms referred to may be machines, apparatus, or equipment widely varied as to class or category, but having in common an air intake port, and a port for exhaust of the air taken in at the intake port. Air motors, air-operated clutches, air braking systems and the like, are common examples of air-operated mechanisms the performance of which may be benefitted by the method and apparatus of the present invention.

The presence of moisture in air, under various circumstances and conditions, has been recognized heretofore as a major source of difficulty, and oftentimes failure, in the operation of air-operated mechanisms of various kinds. At freezing temperatures, for example, moisture in the air supply lines of braking mechanisms or control systems can result in icing, with disastrous consequences. The resultant loss of control is particularly hazardous in the operation of aircraft, road vehicles, and even certain classes of stationary machinery the failure of which might endanger lives or property. Even in the absence of freezing temperatures, moisture present in various operating or control systems encourages corrosion, which may eventually disable the system or seriously affect its operating efficiency or dependability.

An object of the present invention is to provide an improved highly efficient method and apparatus for supplying dehydrated air to air-operated mechanisms.

Another object of the invention is to achieve high operating efficiency in connection with the aforesaid method and apparatus, with substantial savings of power, maintenance expense, and equipment costs.

A further object of the invention is to provide operating air for various types of mechanisms, which is characterized by a high degree of cleanliness, and a total absence of foreign particles, in addition to extreme dryness.

The foregoing and other objects are attained by the means described herein and illustrated upon the accompanying drawing, in which:

The drawing is a schematic drawing of apparatus for supplying dehydrated air to an air-operated device or mechanism, in accordance with the teaching of the present invention.

The apparatus herein disclosed may comprise an air compressor **6** to deliver air under pressure to a valve **8**, which valve may be manipulated for directing the pressured air alternately to a first dehydrator **10**, and a second dehydrator **12**, either of which dehydrators may supply dry air to a machine, device, or mechanism **14** to be air-operated. The air-operated mechanism **14**, whatever its nature, is to have an air intake port **16** and an air exhaust port **18**. The volume of air discharged from mechanism **14** through exhaust port **18**, may approximate the volume of air admitted to said mechanism through intake port **16**. At exhaust port **18** however, the pressure of air leaving the mechanism **14** will be substantially less than the pressure of air entering said mechanism at intake port **16**, as is usual where pressured air performs work in driving, actuating or energizing an air-operated mechanism.

Air under pressure may be delivered to mechanism **14** through a feedline or pipe **20**, and may be exhausted therefrom through an exhaust line or pipe **22**. Movement of air through the mechanism **14** may be controlled manually or by automatic means, and may be either continuous or intermittent depending upon the nature of said mechanism.

Each of the dehydrators **10** and **12** may have a first port **24** and a second port **26** communicating with the interiors of the dehydrators. Each dehydrator is packed with a suitable desiccant or drying agent for removing moisture from air delivered thereto by compressor **6** through valve **8**. As was previously explained, valve **8** may be manipulated for directing pressurized air to one dehydrator, while exhausting air from the other dehydrator, in alternation. Dehydrator exhaust may be effected through the valve exhaust port **28**. Valve **8** may be actuated either automatically, or manually by means of a suitable hand lever **30**, to control the direction of airflow through the dehydrators.

The ports **26**, **26** may communicate with valve **8** through pipes **32** and **34**, the arrangement being such that in one position of the valve, pressurized air from compressor **6** is delivered to dehydrator **10** while the other dehydrator is exhausting air through pipes **34** and **28**. Conversely, by changing the position of the valve, pressurized air from compressor **6** may be delivered to the second dehydrator **12** while the other dehydrator **10** is exhausting through pipes **32** and **28**.

The ports **24**, **24** of dehydrators **10** and **12** may be rendered communicable with the air operated mechanism **14** as follows. Both of the ports **24** may have connection with feedline **20** through branch pipes **36** and **38** which intersect the feedline at **40**. Between the intersection **40** and each of the ports **24**, **24** the branch pipes are provided with one-way check valves **42** and **44** which act to preclude back-flow of air from feedline **20** to the dehydrator ports **24**, **24**.

One of the branch pipes, such as **38**, may be connected to exhaust line **22** by way of an exhaust shunt pipe **46** which communicates also with port **24** of the second dehydrator **12**; and into the shunt pipe **46** is incorporated a one-way check valve **48** precluding flow of pressurized air into exhaust line **22** from the port **24** of dehydrator **12** when said dehydrator **12** is pressurized.

A second exhaust shunt pipe **50** connects exhaust line **22** with the port **24** of the first dehydrator **10**, said shunt pipe **50** incorporating therein a one-way check valve **52** precluding back-flow of air into exhaust line **22**. Shunt pipe **50** communicates also with branch pipe **36**, between check valve **42** and the port **24** of first dehydrator **10**, as shown.

In the light of the foregoing explanation, it will be understood that valve **8** in one position will direct pressurized air from compressor **6**, into pipe **32** and dehydrator **10**. The air having been dried by the action of desiccant within dehydrator **10**, then passes upwardly through branch pipe **36**, valve **42**, and feedline **20** which supplies the dried air to the air-operated mechanism **14**. From the mechanism **14**, the used but still dry exhaust air travels under reduced pressure through exhaust pipe **22**, shunt pipe **46**, and check valve **48**, to and through the port **24** of dehydrator **12**.

Since the exhaust air in pipe **22** has lost much of its pressure in performing work at mechanism **14**, said exhaust air will not unseat the valves **44** and **52**, which valves **44** and **52** are firmly seated by pressure of air emanating from dehydrator **10**. Therefore, said exhaust air passes through valve **48** and port **24** of dehydrator **12**, to enter said dehydrator **12** and pass onward to pipe **34**, valve **8**, and exhaust pipe **28** which releases the spent air to atmosphere.

The air so passed through dehydrator **12** ordinarily will be very dry air, and will therefore have the ability to absorb any moisture that may be present in the desiccant of dehydrator **12**, and to carry said absorbed moisture to atmosphere through exhaust pipe **28**. By removing the moisture from dehydrator **12**, the spent dry air exhausted from mechanism **14** performs the highly desirable function of reactivating said dehydrator **12**, or preparing it for use as an efficient air dryer. While dehydrator **12** is thusly undergoing reactivation, the other dehydrator **10** is gradually accumulating moisture from the air supplied by compressor **6**, until finally, the desiccant of dehydrator **10** reaches or approaches the saturation point.

Before the dehydrator **10** reaches a state of saturation, valve **8** should be manipulated either manually or automatically, to reverse the direction of compressed air flow through the apparatus, so that said air may pass upwardly through the reactivated dehydrator **12**, which will thereupon dry the air and release the dried air through branch pipe **38**, check valve **44**, and feed line **20** supplying dry air to mechanism **14**. The air spend in mechanism **14** leaves through port **18** under reduced pressure, and enters exhaust line **22** whence it is conveyed via shunt pipe **50** and check valve **52**, to the port **24** of the previously saturated dehydrator **10**. Said exhaust air so entering

port 24 is usually very dry, and will therefore eagerly absorb moisture from the desiccant of dehydrator 10, and reactivate the latter. The moisture-laden air from dehydrator 10 leaves the apparatus through pipe 32, valve 8 and exhaust pipe 28, at pressure approximating atmospheric.

During the period that dehydrator 10 undergoes reactivation as above explained, the other dehydrator 12 is collecting moisture from the compressed air fed thereto. At a proper time, preferably before complete saturation of the desiccant of dehydrator 12, the valve 8 is to be manipulated either automatically or by means of hand lever 30, to once more reverse the flow of air through the dehydrators.

It should readily be understood that with every reversal of airflow through the dehydrators, one dehydrator acts to dry the air while the other dehydrator undergoes reactivation with the use of dry air exhausted from the air-operated mechanism 14. By the method disclosed, pressurized dehydrated air is continuously available for operating the mechanism 14, without a noticeable pressure drop occurring during operation of the apparatus.

It is important to note that all of the spent dry air exhausted from the air-operated mechanism 14, is utilized for reactivating one or the other dehydrator when ever reactivation becomes necessary. By this method, the desiccants of the dehydrators are demoisturized rapidly and thoroughly during each cycle of apparatus reversal, without the aid of heat or other supplemental power, all of which results in simplification of the apparatus and a highly desirable reduction in size and weight thereof.

In the foregoing description, reference was made to actuation of valve 8 manually, as by means of handle 30, whenever a dehydrator required reactivation. If the apparatus is to be operated manually, each dehydrator may desirably be provided with a dew point indicator or the like, illustrated conventionally at 54 and 56, affording the operator of the apparatus a visual indication of the condition of the dehydrator desiccant with respect to its moisture content. When the indicator displays an indication that the desiccant is approaching saturation, the operator may manipulate the valve manually to reverse the airflow and thereby place in service the reactivated dehydrator.

If the changeover of dehydrators is to be effected automatically, various means may be devised for the purpose. The drawing suggests by way of example a photoelectric device or scanner head 58, whose beams 60 may be sensitive to changes in color or density of the desiccant material within the dehydrator. Thus, when the photoelectric apparatus senses a change in the desiccant which indicates approaching saturation, the photoelectric apparatus may initiate operation of a drive mechanism within the casing 62, for actuating the control valve 8, it being understood that the photoelectric device or scanning head may be sensitive not only to changes in moisture content of the desiccant but also to changes in color resulting from moisture changes.

The reference characters 64 indicate translucent windows in the side walls of the dehydrators, through which changes in the character of the desiccant may be rendered changeable in color in correspondency with changes in moisture content, by dispersing therein a quantity of blue jel or equivalent moisture-indicating material.

The apparatus of the invention operates satisfactorily with a relatively small air compressor, for example, one which may deliver 100 c.f.m. of air with capacity to compress at 100 p.s.i., or about seven atmospheres. Higher or lower air pressures may be employed, however, depending upon the demand of the air-operated mechanism 14. Especially to be noted is the absence of the use of heat in operating the apparatus of the present invention, whereby operating and maintenance costs are greatly minimized.

By utilizing the full charge of air exhausted from the air-operated mechanism 14 in reactivating the dehydrators, without the use of heat, very substantial economies are effected. Moreover, the efficiency of the apparatus is so enhanced as to make possible a substantial reduction in size and weight of the apparatus, with no loss of capacity.

Since all of the dry air supplied to and exhausted from the air-operated mechanism is reused for for dehydrator reactivation, the present apparatus may properly be considered a closed dehydration, pressure differential reactivation system.

It is to be understood that various modifications and changes may be made in structural details of the apparatus, within the scope of the appended claims, without departing from the spirit of the invention. The specific kind of desiccant employed in the dehydrators, and the nature of the indicator utilized for revealing the wetness of the desiccant during operation of the apparatus, as well as the particular character of the means employed for automatically actuating the control valve 8 as the dehydrators approach saturation, are matters of immateriality to the present invention.

What is claimed is:

1. A closed dehydration, pressure differential reactivation system comprising, a compressor, two dehydrators and an air-operated mechanism, a first conduit connecting the compressor and the two dehydrators, a valve in the first conduit directing the flow of moisture-laden air under pressure from the compressor to a selected dehydrator, a second conduit connecting the dehydrators and the air-operated mechanism, valve means in the second conduit allowing flow of dry air under pressure from the selected dehydrator to the air-operated mechanism but preventing flow in the opposite direction, a third conduit connecting the exhaust opening of the air-operated mechanism and the dehydrators, valve means in the third conduit allowing flow of dry air exhaust under reduced pressure from the air-operated mechanism to the dehydrators but preventing flow in the opposite direction, dehydrating means in the dehydrators to remove and hold moisture from the pressurized moisture laden air, the second conduit passing the pressurized dry air to the air-operated mechanism and the third conduit passing the exhaust dry air from the air-operated mechanism to the nonselected dehydrator, the exhaust dry air removing the moisture held by the nonselected dehydrator to reactivate the dehydrating means therein, the moisture laden air then passing to atmosphere.

2. The system as set forth in claim 1 wherein the valve in the first conduit is operated in response to changes in the moisture content of one of the dehydrators.

3. The system as set forth in claim 1 wherein the valve in the first conduit is manually operable.

4. The system as set forth in claim 1 wherein the valve means in the second and third conduits are one-way check valves.

5. The system as set forth in claim 1 wherein the dehydrating means is subject to change under varying moisture conditions and means responsive to such change operating the valve in the first conduit to change the selected dehydrator.

6. The method of dehydrating moisture laden air in a closed dehydration, pressure differential reactivation system, comprising, compressing moisture laden air, causing the compressed air to flow through a controlled conduit to a selected dehydrator, dehydrating means in the dehydrator, removing the moisture from the pressurized air, causing the dehydrated pressurized air to flow in one direction through a second conduit to an air-operated mechanism, causing the exhausted depressurized dry air from the air-operated mechanism to flow in one direction through a third conduit to a nonselected moisture laden dehydrator, causing the depressurized dry air to flow through the moisture laden dehydrator to remove the moisture therefrom and reactivate the dehydrating means therein, the then moisture laden air flowing to atmosphere.

7. The method as set forth in claim 6 wherein the pressurized air is caused to flow through the dehydrator in one direction and the depressurized air is caused to flow in a reverse direction.

8. The method as set forth in claim 6 wherein the controlled conduit is controlled in response to changes in the moisture content of one of the dehydrators.

9. The method as set forth in claim 6 wherein the moisture content of the selected dehydrator causes the control of the flow of the compressed air to shift to the reactivated dehydrator.

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