METHOD AND MEANS FOR OBTAINING DRY GAS OR AIR

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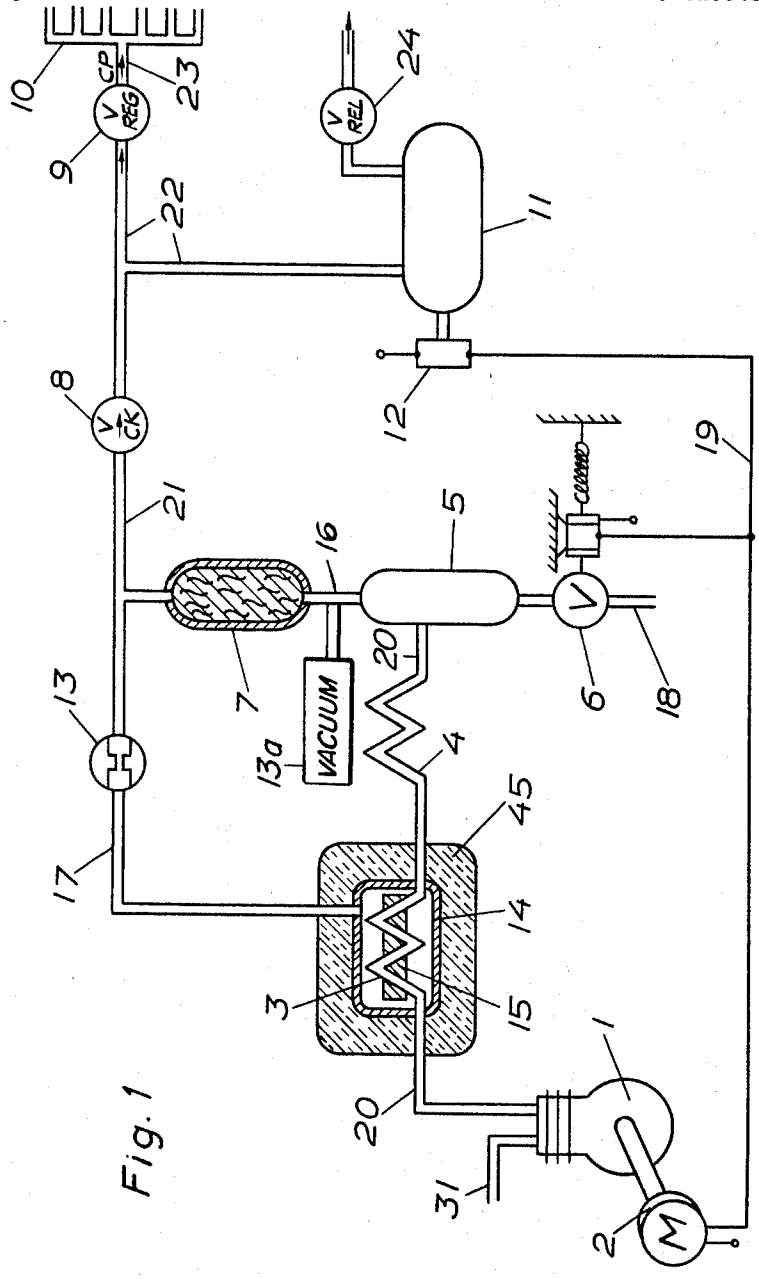

Fig. 1

METHOD AND MEANS FOR OBTAINING DRY GAS OR AIR

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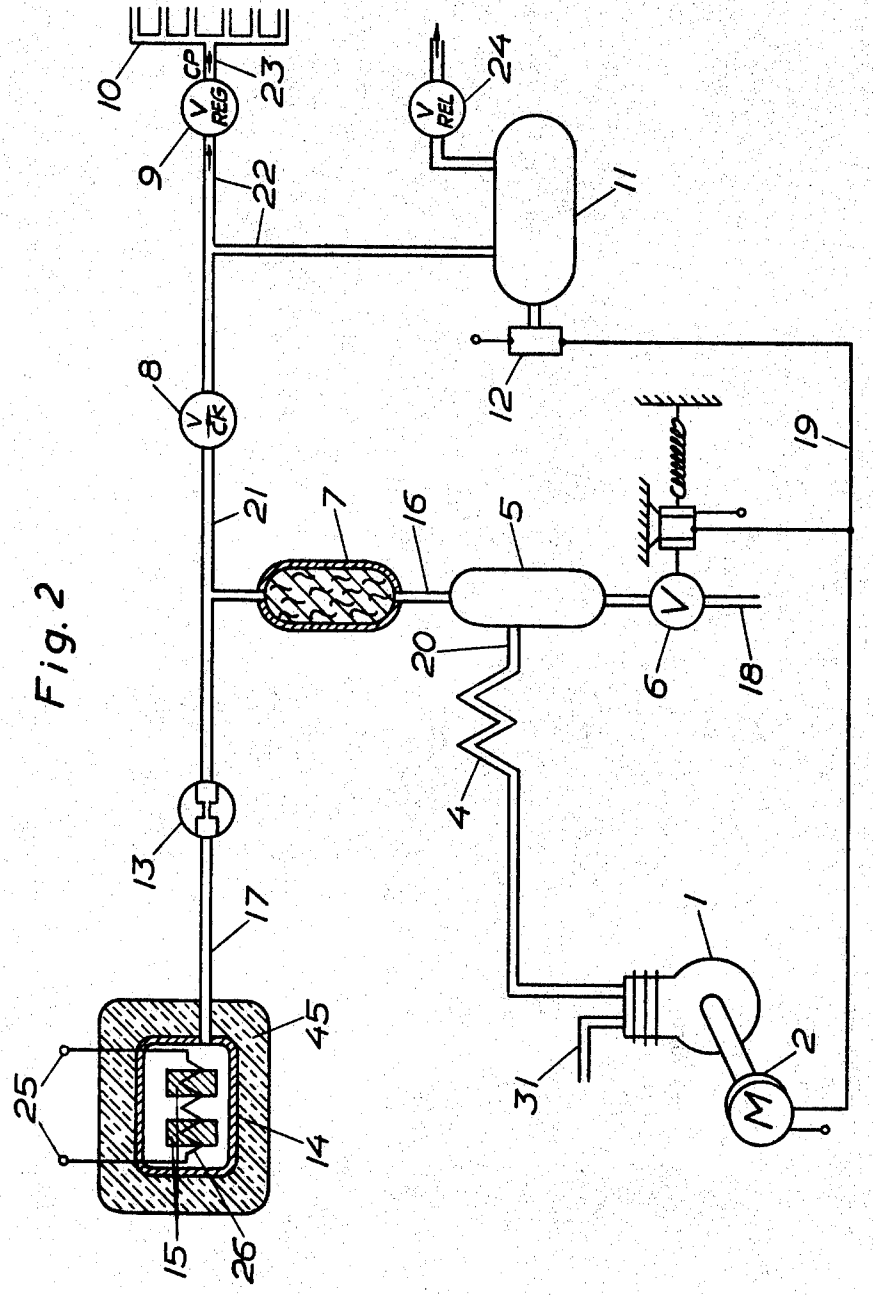

Fig. 2

INVENTOR.
IWAN ERNST ROLAND AKERMAN

BY
ERIC Y. MUNSON

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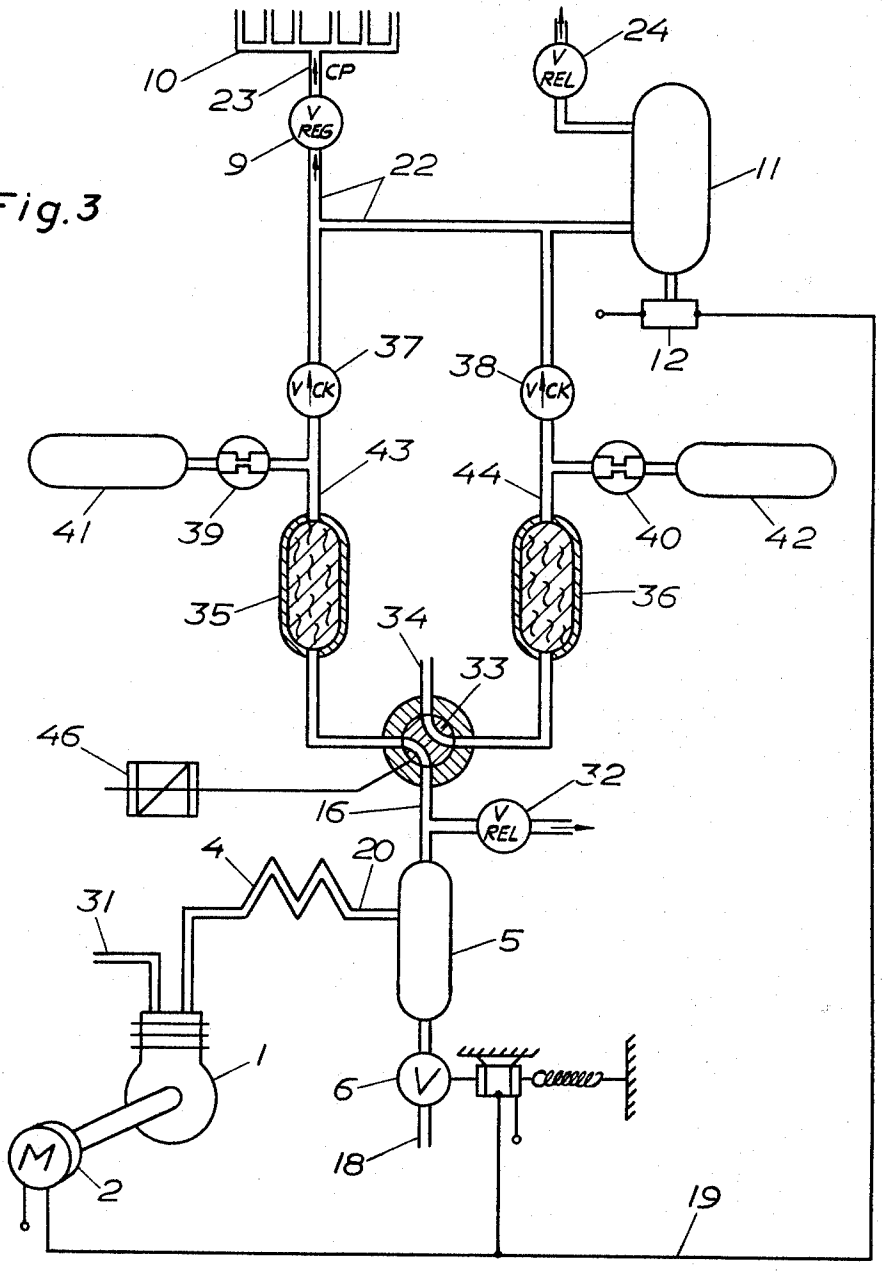
Fig. 3



INVENTOR.
IWAN ERNST ROLAND ÅKERMAN
BY ERIC Y. MUNSON

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METHOD AND MEANS FOR OBTAINING DRY GAS OR AIR

Iwan Ernst Roland Åkerman, Stockholm, Sweden, assignor to Atlas Copco Aktiebolag, Nacka, Sweden, a corporation of Sweden

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This invention relates to a method and means for obtaining dry gas, such as dry air or the like. It is well known in connection with the production of dry gas such as dry air to compress moist gas or air, to cool the compressed gas or air and to submit the gas or air to a first mechanical moisture separation, and afterwards to conduct the relatively dry gas or air through a moisture adsorber in which a second moisture separation is perfomed under pressure while the gas is flowing in direction towards a place of consumption or a receptacle, and alternately with the above procedure to regenerate the moisture adsorber by means of previously dried gas or air which is conducted through the moisture adsorber at a pressure so much lower that it is capable of carrying away a substantially larger quantity of moisture per kilogramme gas or air than the quantity carried by the compressed gas or air entering the moisture adsorber from the compressor. Means or apparatus applying the above method may be used for drying gas, especially air, which may be used for supplying electrical cables with dry air under pressure or for other purposes. Such cables may, for instance, be telephone cables or other electrical cables into which compressed dry air is introduced in order to prevent moisture from entering the cables, which might cause malfunction in their operation. The invention may also be used for producing dry air for compressed air networks in workshops, for paint spraying, for supplying dry air to pneumatic instruments, and for many chemical and other processes and for other purposes where it is desirable to have available dry air or gas having such a low moisture content that no condensation will occur even at the lowest temperatures at which the network or the apparatus involved or in the process may operate.

Compressed air systems for supplying dry air to cable networks must operate continuously so that the cable network is continuously supplied with a fresh amount of dry air which corresponds to the amount of leakage from the network. In systems of the type above described a portion of the compressed gas or air is used for regenerating the adsorber by conducting dry gas or air with reduced pressure through the adsorber at suitable intervals. Said reduced gas or air is conducted through the adsorber preferably in opposite direction to the gas or air intended for the place of consumption in order to remove from the adsorber moisture collected therein. The quantity of dry air or gas which is necessary for regenerating the adsorber naturally involves an expense which affects the economy of such a system as well as the capital investment for compressors and other components of the system. It is consequently an object of the present invention to reduce the quantity of regenerating gas as much as possible. This may be achieved in different ways. One method according to the invention which has several advantages comprises storing a part of the extremely dry compressed gas or air produced in the system in a receptacle and reducing a predetermined amount of such stored gas or air to such a low pressure that said gas or air is capable of removing several times the amount of moisture which could be removed by the compressed gas or air entering the moisture adsorber from the compressor, said pressure reduced gas or air being conducted through the moisture adsorber

to regenerate its moisture adsorbing ability. The predetermined amount of low pressure gas is so calculated that it is just sufficient for regenerating the moisture adsorber thus avoiding excess dry gas or air from being conducted through the moisture adsorber for regenerating purposes and wasted. According to the invention it is also important and advantageous to heat the quantity of gas or air which is used for regeneration before it is introduced into the moisture adsorber for regenerating purposes. Such heating may be carried out by utilizing the compression heat from the compressor forming a part of the system. Separate electrical heating means or other means of heating the regenerating gas or air may also be used. For many practical purposes the pressure of the regenerating gas or air is reduced to about atmospheric pressure. However, in cases where pressure below atmospheric or vacuum is available the pressure of the regenerating gas or air may be reduced to subatmospheric pressure or vacuum which greatly increases the moisture carrying ability of the regenerating gas or air and thereby reduces the amount necessary for regeneration. The means for carrying out the method according to the invention may take several forms. The predetermined amount of low pressure gas or air may, for instance, be stored in a separate receptacle or it may be released from a main receptacle for a predetermined length of time and through a flow restriction device so as to insure that the predetermined amount of gas or air is used only for regenerating purposes. The invention may also be employed in connection with apparatus working on a continuous principle.

In the accompanying drawings a number of embodiments of means according to the invention are illustrated by way of example. FIG. 1 is a diagrammatical view of a plant for producing dry air for supplying a cable network in which plant extremely dry air for regenerating purposes is collected in a separate receptacle which serves also as a regenerative heat exchanger in which the air for regenerating the adsorber is collected. FIG. 2 is a diagrammatical view of a plant which is a modification of the plant in FIG. 1 in which the extremely dry air in the auxiliary receptacle is electrically heated. FIG. 3 is a diagrammatic view of a plant in which two moisture adsorbers are arranged in parallel and in which each moisture adsorber is provided with an auxiliary receptacle for storing the gas or air of predetermined volume which is to be used for regenerating purposes.

The plant illustrated in FIG. 1 consists of a compressor **1** which is driven by a motor **2** which may be an electric motor. The compressor draws air through an inlet conduit **31** and delivers compressed air to a network **20** which comprises a regenerative heat exchanger **3** and a cooler **4** for aftercooling the air compressed in the compressor **1** as well as a water separator **5** of the mechanical type which may be emptied by opening an electromagnetically operated valve **6** connected to the atmosphere through a drain pipe **18**. In the separator **5** a first moisture separation of the main part of the water in the compressed air takes place. The relatively dry air flowing from tthe water separator **5** through a conduit **16** passes through a second separator which is a moisture adsorber **7** which may comprise a vessel filled with silica gel or other suitable moisture adsorbing material or which may be carried out as a molecular filter capable of retaining water and other undesirable constituents in the compressed air. From the adsorber **7** a conduit **21** leads to a check valve **8** and a network **22** which is connected to a pressure reducing valve **9** and a main receptacle **11** and through valve **9** to a compressed air network **23** and a place of consumption **10** which may be a telephone cable network or other consumer. The compressor **1** may preferably be so dimen-

sioned that it delivers considerably more compressed air than the amount used by the consumer **10**. The valve **9** functions in such a way that it keeps the pressure constant in the compressed air network **23**. The main receptacle **11** is provided with a pressure responsive switch **12** which, when a certain pressure in the main receptacle **11** is attained interrupts the current supply to the motor **2** and simultaneously actuates the electromagnetic valve **6** so that said valve opens the drain conduit **18** from the mechanical moisture separator **5**. Reference numeral **19** indicates the electrical connection between the switch **12** and valve **6** and motor **2**. Reference numeral **24** indicates a relief valve.

Between the moisture adsorber **7** and the check valve **8**, a conduit **17** is branched off through a flow restriction orifice **13** to an auxiliary receptacle **14**. The orifice **13** permits the receptacle **14** to be loaded with dry air during the loading period for the main receptacle **11**. Said auxiliary receptacle serves as a regenerative heat exchanger and comprises suitable tube lobes **3** which together with a lobe **4** form the aftercooler of the compressor. Heat, which is delivered through the lobes **3** is stored by the compressed air and heat storing bodies **15** in the auxiliary receptacle **14** and in the walls of the receptacle itself, which is provided with heat insulation **45**. The receptacle **14**, therefore, operates as a heat accumulator for gas or air of substantially the same pressure as that prevailing in the main receptacle **11**. When the compressor has stopped and the first moisture separator **5** is vented to the atmosphere through the valve **6**, then the pressure in the adsorber **7** is reduced by way of a pressure reducing means **13***a* which, in this instance, is a vacuum producing means. Subsequently, dry, warm, compressed air which has been stored in the auxiliary receptacle **14** flows through the pipe **17**, the restriction **13** in which the pressure is reduced to a low value, for instance in the vicinity of atmospheric pressure, and through the adsorber **7** where the dry and still rather hot air due to its low pressure and elevated temperature is capable of taking up the moisture which has been collected in the adsorber and to carry away said moisture through the valve **6** and through the vent passage **18** to the atmosphere. During this regeneration of the adsorber **7**, the check valve **8** is closed and the cable network is fed from the man dry air receptacle **11**. When the pressure in said main receptacle has dropped to a predetermined value, the pressure switch **12** is again closed which results in the closing of the circuit to the electric motor **2** and the starting of the compressor. Simultaneously the electromagnetic valve **6** is moved to closed position so that venting of the moisture separator **5** is interrupted. Then a new supply of dry compressed air is conducted to the consumer **10** and the main receptacle **11** through the moisture adsorber and the check valve **8** until the pressure switch again interrupts the circuit to the motor **2**.

In the modification illustrated in FIG. 2 the same reference numerals as in FIG. 1 have been used to indicate equivalent parts. Said parts are therefore not described again. The plant according to FIG. 2 differs from the plant illustrated in FIG. 1 in that the heat accumulating auxiliary receptacle **14** is replaced by an auxiliary receptacle **14** in which the air is heated electrically. The plant is in other respects arranged in the same manner as the plant in FIG. 1 with the exception that the heat supply to the auxiliary air receptacle **14** is obtained from a source of current **25** which delivers current to a heating element **26** within the auxiliary air receptacle **14** for heating the air in said receptacle. Preferably said source of current **25** may be arranged to be connected as soon as the auxiliary receptacle **14** starts to deliver dry air for regenerating the moisture adsorber **7**. When the pressure switch **12** stops the motor **2** and opens the valve **6**, then dry hot air flows from the auxiliary receptacle **14** through the restriction **13** and through the moisture adsorber **7** and carries moisture from said adsorber to the atmosphere.

The plant according to FIG. 3 is intended for use where continuous delivery from a continuously running compressor is desired. This may be the cause in connection with industrial plants, workshops, paint spraying plants or other places where a continuous demand of extremely dry air is present. The plant in FIG. 3 is provided with two moisture adsorbers **35**, **36** arranged in parallel and each moisture adsorber is connected to a conduit **43**, **44**, which through a flow restriction device **39**, **40** is branched to an auxiliary receptacle **41**, **42** and which otherwise through check valves **37**, **38** communicates with a conduit network **22** leading to the consumer **10** and the main receptacle **11**. The auxiliary receptacles **41**, **42** may be unheated or they may be provided with means for direct or regenerative heating as indicated in connection with the devices **14** in FIGS. 1–2 described hereinabove. A shift valve **33** is provided in the conduit **16** leading from the first moisture separator **5** to the adsorbers **35**, **36** and said shift valve serves to alternately connect the compressor to one of the moisture adsorbers **35** or **36**, respectively, at a time while the other moisture adsorber is connected to a vent conduit **34**. The shift valve is moved periodically between the illustrated position and a position in which adsorber **35** is vented and **36** is connected to the compressor delivery by a relay **46**. Two check valves **37**, **38** prevent air escape from the main receptacle **11** through the moisture adsorber which is under regeneration, **32** is a relief valve for protection of the compressor against excess pressure. Otherwise the plant or apparatus according to FIG. 3 is similar to the apparatus in FIG. 1. It is obvious that during the time when one adsorber **35**, **36** is operative to collect moisture the other adsorber is regenerated by dry air from the pertaining auxiliary receptacle **41**, **42**, respectively, the arrangement being such that the necessary time for regeneration is always shorter than the time of moisture adsorption.

The embodiments of the invention above described and illustrated on the drawings should only be considered as examples and the invention may be modified in several different ways within the scope of the following claims. It is for instance possible to provide more than two moisture adsorbers **35**, **36** in parallel. Drain pipe **18** may be connected to a condenser or vacuum source.

What I claim is:

1. A method for obtaining extremely dry gas comprising; compressing moist gas in a compressor wherein heat is produced, cooling the compressed air, separating moisture mechanically from said compressed gas to produce relatively dry gas, conducting said relatively dry gas under pressure through a moisture adsorber in which moisture is separated from said relatively dry compressed gas to produce extremely dry gas for use by a consumer, conducting said extremely dry gas through a main line to a main receptacle, storing a part of said extremely dry compressed gas in said main receptacle, storing a predetermined amount of said compressed dry gas in an auxiliary receptacle branched off from the main line in continuous flow communication with said moisture adsorber through a flow restricting device, reducing the pressure of said predetermined amount of such stored extremely dry compressed gas to such a low pressure that said gas is capable of carrying several times the amount of moisture which would be carried by the compressed gas entering the moisture adsorber from the compressor, supplying said heat produced during compression of the gas in the compressor to said predetermined amount of dry gas by indirect heat exchange in said auxiliary receptacle, and conducting said predetermined amount of extremely dry low pressure and heated gas through said moisture adsorber to regenerate its moisture adsorbing ability.

2. Apparatus for obtaining extremely dry gas comprising a compressor provided with an inlet conduit and a delivery conduit, cooling means in said delivery conduit, a mechanical moisture separator in said delivery conduit,

a moisture adsorption means in said delivery conduit after said cooling means and mechanical moisture separator, a check valve, means for conveying extremely dry gas from said adsorption means through said check valve to a main receptacle and a consumer device communicating with said receptacle, an auxiliary receptacle for storing a predetermined amount of said compressed dry gas, means providing heat insulation to said auxiliary receptacle, a conduit means for delivering a portion of said extremely dry gas to said auxiliary receptacle branched off from said conveying means before said check valve, means carrying said delivery conduit through said receptacle to deliver compression heat to said receptacle and the gas therein, means for interrupting delivery from said compressor to the adsorption means, means for lowering the pressure in the adsorption means, and means for conveying said predetermined amount of extremely dry gas from said auxiliary receptacle through a pressure reduction device to and through the adsorption means in order to regenerate the adsorption means.

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SAMIH N. ZAHARNA, *Primary Examiner.*

J. ADEE, *Assistant Examiner.*