



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**05.12.2012 Bulletin 2012/49**

(51) Int Cl.:  
**F04D 27/02 (2006.01)**

(21) Application number: **11168122.7**

(22) Date of filing: **30.05.2011**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**  
**80333 München (DE)**

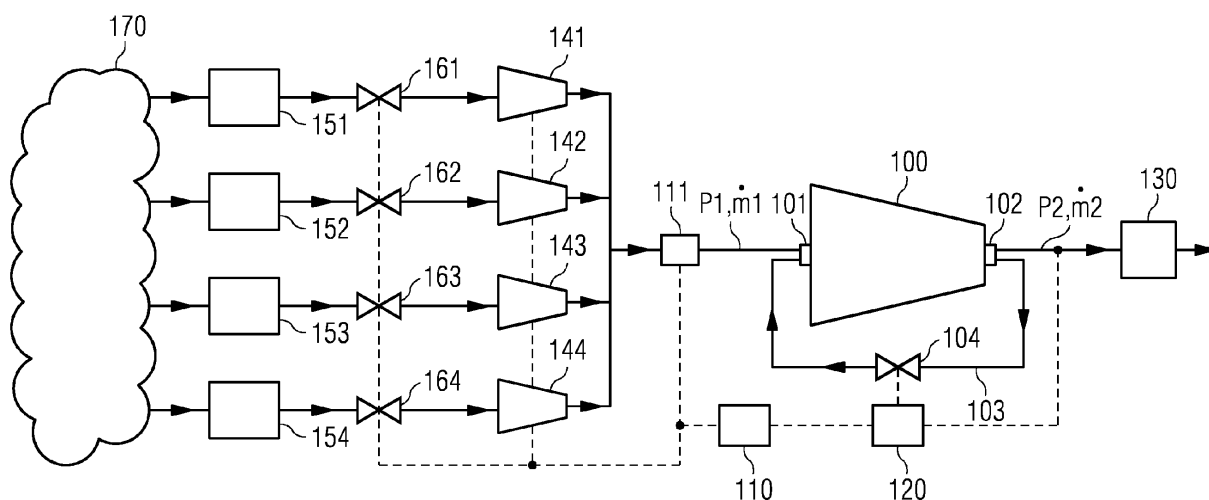
(72) Inventor: **The designation of the inventor has not yet been filed**

(54) **System for gathering gas from a gas field comprising a high pressure compressor**

(57) System for gathering a gas from a gas field (170). The system comprises a high pressure compressor (100) which comprises a gas input (101) and a gas output (102). The gas input (101) is coupleable to the gas field (170) for receiving the gas gathered from the gas field (170) with a first gas pressure and the gas output (102) is coupleable to a gas export system (130) for providing the gas with a second gas pressure to the gas

export system (130).

The system further comprises a measuring unit (110,111) coupled to the gas input (101), wherein the measuring unit (110,111) measures an input mass flow value which is indicative of an input mass flow at the gas input (101). The system further comprises a mass flow control unit (120), wherein the mass flow control unit (120) is coupled to the measuring unit (110,111) for receiving the measured input mass flow value.



## Description

### Field of invention

**[0001]** The present invention relates to a system for gathering gas from a gas field and to a method for controlling a gas mass flow of a system for gathering gas from a gas field.

### Art Background

**[0002]** In the technical field of gas gathering, gas is gathered from conventional gas field types and unconventional gas field types exist.

**[0003]** In conventional gas fields the stored gas comprises an initially high pressure such that further compression by external compressors is not needed in the beginning. After years of so-called free-flow production a high pressure central compressor, for example of a centrifugal type compressor, is installed for another couple of years. In the end of the gas field lifetime, low pressure wellhead compressors are implemented and connected to the respective wellheads of the gas field. The high pressure central compressor and the low pressure wellhead compressor are adapted for sucking the gas out of the gas field and generating a high pressure gas flow for subsequent gas export systems, such as pipelines or gas generators.

**[0004]** In unconventional gas fields, such as tight gas, shell gas or coal bed methane gas fields, the gas pressure inside the gas field decreases in a short time interval, such that central high pressure compressors and low pressure wellhead compressors are needed from the beginning of the gathering of the gas from the gas field.

**[0005]** Up to now, the low pressure wellhead compressors and the high pressure central compressor are designed as separate and independent subsystems. The low pressure wellhead compressors and the high pressure wellhead compressor often form independent and separated units. The high pressure central compressor is optimised for a small range of inlet pressures and inlet mass flow values. The low pressure wellhead compressors are optimised for individual ranges of respective inlet pressures and mass flows. Hence, each low pressure wellhead compressor produces an output pressure and an output mass flow of gas without considering the small range of inlet pressures and mass flow of gas at which the high pressure central compressor works efficiently. A variation of the gas pressure in the gas field does not affect the efficiency of the low pressure wellhead compressors dramatically, whereas the efficiency of the subsequent high pressure central compressor is affected dramatically during pressure changes. Hence, the gathering of the gas is inefficient, if the inlet gas pressures and inlet mass flow of the high pressure central compressor, the high pressure central compressor is not working under its efficient working point for which the high pressure central compressor is designed for.

## Summary of the Invention

**[0006]** It may be an objective of the present invention to provide an efficient gas gathering system for gathering gas from a gas field.

**[0007]** This objective is solved by a system for gathering a gas from a gas field and by a method for controlling a gas mass flow of a system for gathering gas from a gas field according to the independent claims.

**[0008]** According to a first aspect of the present invention, a system for gathering a gas from a gas field is presented. The system comprises a high pressure compressor which comprises a gas input and a gas output. The gas input is coupleable to the gas field for receiving the gas gathered from the gas field with a first gas pressure. The gas output is coupleable to a gas export system for providing the gas with a second pressure to the second gas export system. The second gas pressure is higher than the first gas pressure. Furthermore, the system comprises a measuring unit which is coupled to the gas input, wherein the measuring unit measures an input mass flow value which is indicative of an input mass flow at the gas input. Furthermore, the system comprises a mass flow control unit, wherein the mass flow control unit is coupled to the measuring for receiving the measured input mass flow value. The mass flow control unit is coupled to the gas input for controlling the input mass flow such that the measured input mass flow value corresponds to a set point input mass flow value.

**[0009]** According to a further aspect of the present invention, a method for controlling a gas mass flow of a system for gathering gas from a gas field is presented. According to the method an input mass flow at a gas input of a high pressure compressor is measured. The gas input receives the gas gathered from the gas field with a first gas pressure, wherein the high pressure compressor comprises a gas output for providing gas with a second pressure to a gas export system. The second gas pressure is higher than the first gas pressure. An input mass flow value which is indicative of an input mass flow at the gas input is measured by a measuring unit which is coupled to the gas input. The measured input mass flow value is received by a mass flow control unit. The input mass flow is controlled by the mass flow control unit which is coupled to the gas input. The mass flow control unit controls the input mass flow such that the input mass flow value at the gas input corresponds to a set point input mass flow value.

**[0010]** By the above-described system and by the above-described method for controlling a gas mass flow, (natural) gas may be gathered from a conventional gas field or from an unconventional gas field, in which tight gas, shell gas or coal bed methane gas is gathered.

**[0011]** The high pressure compressor is installed between the gas field and the gas export system. The high pressure compressor is adapted for receiving the gas from the gas field with a first pressure, e.g. approximately 10 to 14 bars, and adapted to compress the gas up to a

second gas pressure of approximately 60 to 90 bars which are needed by the gas export system.

**[0012]** The high pressure central compressor may be e.g. of a centrifugal type compressor and is most suitable for the gas gathering in order to generate the high gas pressure for the subsequent gas export system. The high pressure compressor comprises a small efficient range regarding the inputted mass flow and input pressure in which the high pressure compressor works efficient. Hence, changes in inlet conditions, such as in the mass flow and in the inlet gas pressure, a high impact on the operation efficiency is caused.

**[0013]** The gas export system comprises for example a pipeline system for transporting the gas to a desired destination. Moreover, the export gas system may comprise a gas power plant for generating electricity or further gas treatment systems.

**[0014]** The measuring unit is coupled to the gas input of the high pressure compressor and is adapted for measuring a variety of parameters which are indicative of the input mass flow of the gas at the gas input of the high pressure compressor. In particular, the measuring unit measures the input mass flow value ([kg/s]). Additionally, the measuring unit may measure the first gas pressure of the gas at the gas input and the second gas pressure at the gas output. Moreover, the measuring unit is also adapted for measuring the output mass flow at the gas output of the high pressure compressor. Additionally, the measuring unit may measure the composition of the gas as well as the temperature of the gas at the gas input and the gas output of the high pressure compressor.

**[0015]** The measured values, in particular the measured input mass flow value, are provided to the mass flow control unit. The mass flow control unit compares the measured values, i.e. the input mass flow value, with a given set point input mass flow value. If there is a difference between the input mass flow value and the set point input mass flow value, the mass flow control unit controls the input mass flow value such that the input mass flow value corresponds to the set point input mass flow value.

**[0016]** The set point input mass flow value defines the mass flow at the gas input of the high pressure compressor, by which the high pressure compressor is working at its working point and thus is working with the highest efficiency. The working point is dependent on the pressure relation between the first gas pressure at the gas input and the second gas pressure at the gas output, the mass flow of the gas through the high pressure compressor (i.e. the mass flow at the gas input) and the rotational speed of the high pressure compressor.

**[0017]** Hence, under given first pressures and second pressures, a set point input mass flow value is given for running the high pressure compressor at its working point and hence at its best efficiency. It has been shown, that a deviation of the input mass flow value causes a severe effect on the efficiency of the high pressure compressor. In particular, if the measured input mass flow value differs dramatically to the set point input mass flow value, in

particular at given first and second gas pressures, compressor surge may occur.

**[0018]** The mass flow control unit is adapted for reducing the deviation of the measured input mass flow value from the given set point input mass flow value. The mass flow control unit may control various subsystems for influencing the input mass flow of the gas at the gas input. For example, the mass flow control unit may control upstream installed low pressure compressors, delivery valves or a mass flow in a return flow tubing and/or a mass flow of a bypass tubing which will be explained in more detail below.

**[0019]** Hence, by the present invention, even when the gathered mass flow of gas from a gas field varies dramatically, a predetermined and desired input mass flow at the gas input of the high pressure compressor is adjustable by the mass flow control unit such that the high pressure compressor is working approximately at its working point. Hence, the efficiency of the high pressure compressor and hence the gathering of gas from a gas field is more efficient.

**[0020]** According to a further exemplary embodiment, the system comprises a first low pressure compressor which is connectable to a first wellhead arrangement of the gas field for receiving the gas from the first wellhead arrangement. The first low pressure compressor is connected to the gas input for providing the gas to the gas input with a first mass flow. Moreover, the system comprises a second low pressure compressor which is connectable to a second wellhead arrangement of the gas field for receiving the gas from the second wellhead arrangement. The second low pressure compressor is connected to the gas input for providing the gas to the gas input with the second mass flow.

**[0021]** The mass flow control unit is connected to a) the first low pressure compressor for controlling the first low pressure compressor and b) the second low pressure compressor for controlling the second low pressure compressor such that the first mass flow and the second mass flow are controllable for controlling the input mass flow at the gas input.

**[0022]** Each wellhead arrangement is connected to a borehole through which gas of the gas field is gathered. A gas field may comprise a plurality of boreholes, wherein to each borehole a respective wellhead arrangement is attached for gathering gas. Each wellhead arrangement is connected to a respective low pressure compressor. For example, if a wellhead arrangement delivers gas with approximately 1 to 4 bars to the low pressure compressor, the low pressure compressor increases the pressure up to approximately 5 to 20 bars. By increasing the pressure, a sucking effect is achieved, such that the gas is sucked out of the respective borehole, so that also the respective mass flow through the low pressure compressor is increased.

**[0023]** For the low pressure wellhead compressors, screw-type or reciprocating compressors may be used. These kind of compressors are relative insensitive to

changes in inlet conditions. They have a large operating range and can easily handle a wide range of inlet pressure variations and inlet mass flows variations under which an effective operation is still possible.

**[0024]** For example, the measuring unit is adapted for measuring each mass flow and pressure at a respective gas input of a respective low pressure compressor and at a gas output of a respective low pressure compressor. These measured data are sent to the mass flow control unit. The mass flow control unit receives also the information of the input mass flow at the gas input of the high pressure compressor. If more or less mass flow is needed at the gas input of the high pressure compressor, the mass flow control unit controls the respective low pressure compressors, i.e. the first low pressure compressor and the second low pressure compressor.

**[0025]** In particular, the mass flow control unit receives the information of the working points of the respective low pressure compressors. Hence, for adjusting the desired input mass flow of the high pressure compressor, each low pressure compressor is controlled under consideration of its respective working points such that each low pressure compressors is operated more efficiently. Hence, the overall efficiency of the system is increased.

**[0026]** Additionally or alternatively, according to a further exemplary embodiment, the system comprises a first delivery valve which is connectable to a first wellhead arrangement of the gas field for receiving the gas from the first wellhead arrangement, wherein the first delivery valve is connected to the gas input for providing the gas to the gas input with a further first mass flow. The system further comprises a second delivery valve which is connectable to a second wellhead arrangement of the gas field for receiving the gas from the second wellhead arrangement, wherein the second delivery valve is connected to the gas input for providing the gas to the gas input with a further second mass flow.

**[0027]** The mass flow control unit is connected to a) the first delivery valve for controlling the first delivery valve and b) the second delivery valve for controlling the second delivery valve such that the further first mass flow and the further second mass flow are controllable for controlling the input mass flow at the gas input.

**[0028]** The first and second delivery valves may be installed between the respective first and second wellhead arrangement and the respective first and second low pressure compressors. Alternatively, the first and second delivery valves may be installed behind, i.e. downstream, of the respectively first and second low pressure compressors.

**[0029]** By controlling the respective delivery valves, the further first mass flow and the further second mass flow of the gas gathered from a respective borehole is adjustable and controllable individually, such that a desired input mass flow of the gas at the gas input of the high pressure compressor is adjustable.

**[0030]** In gas gathering systems, in particular in conventional gas gathering systems, gas may be gathered

without using low pressure compressors. In this case only the delivery valves are installed downstream of the wellhead arrangement in order to control mass flow from the respective wellhead arrangement to the gas input of the high pressure compressor.

**[0031]** According to a further exemplary embodiment, the system comprises a return flow tubing which is connected to the gas output for bleeding off a part of the gas from the gas output and which is connected to the gas input for injecting the part of the gas in the gas input. The mass flow control unit is coupled to the return flow tubing for controlling the bleeding off of the part of the gas from the gas output and for controlling the injecting of the part of the gas in the gas input such that the input mass flow at the gas input is controllable.

**[0032]** For example, if the measured input mass flow value is below the set point input mass flow value, a part of the gas may be bled off from the gas output and injected at the gas input, so that the input mass flow is increased at the gas input. In the return flow tubing a control valve may be installed which is controllable by the mass flow control unit.

**[0033]** By using the return flow tubing, an anti-surge system is established. The mass flow control unit may act as a supervisory system and controls the anti-surge system. By controlling the input gas parameters, in particular the input mass flow of the gas, and by influencing the upstream located systems, such as the low pressure (wellhead) compressors, the anti-surge system for the high pressure compressor is safer and more efficient.

**[0034]** According to a further exemplary embodiment, the system further comprises a bypass tubing which is connected to the gas input for bleeding off a further part of the gas from the gas input. The mass flow control unit is coupled to the bypass tubing for controlling the bleeding off of the further part of the gas from the gas input such that the input mass flow at the gas input is controllable.

**[0035]** For example, if the input mass flow is higher than the set point input mass flow value, the bypass tubing may bleed off the gas from the gas input e.g. to the environment or to a further use, for example into a gas generator. Hence, by bleeding off the gas from the gas input, the input mass flow is reduced till the desired set point input mass flow value is adjusted.

**[0036]** By the present invention, the high pressure compressor of a gas gathering system is controlled and operated more efficiently. In particular, predetermined set point input values, in particular set point input mass flow values, of the gas at the gas input of the high pressure compressor are determined, so that already at the design phase the high pressure compressor may be optimised for predetermined operating ranges in order to run more efficiently at the given set point input mass flow values. For example, the high pressure compressor may be designed with a certain number of stator rings, cooling systems, etc., so that already at the design phase of the high pressure compressor an optimised high pressure

compressor is constructable.

**[0037]** By the present invention, optimised inlet conditions for the high pressure compressor are generated in particular by adapting and controlling the low pressure compressors. By controlling the low pressure compressors dependent on the desired input values of the high pressure compressor, an interconnected efficient and effective gathering system is achieved.

**[0038]** It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this application.

#### Brief Description of the Drawing

**[0039]** The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.

**[0040]** The Figure shows schematically a gas gathering system according to an exemplary embodiment of the present invention.

#### Detailed Description

**[0041]** The illustration in the drawing is schematical. It is noted that in the figure, similar or identical elements are provided with the same reference signs.

**[0042]** The **Figure** shows a system for gathering a gas from a gas field 170. The system comprises a high pressure compressor 100 which comprises a gas input 101 and a gas output 102.

**[0043]** The gas input 101 is coupleable to the gas field 170 for receiving the gas gathered from the gas field 170 with a first gas pressure  $p_1$ . The gas output 102 is coupleable to a gas export system 130 for providing the gas with the second gas pressure  $p_2$  to the gas export system 130. The second gas pressure  $p_2$  is higher than the first gas pressure  $p_1$ .

**[0044]** A measuring unit 110 is coupled to the gas input 101, wherein the measuring unit 110 measures, for example by sensor elements 111, an input mass flow value (e.g. in [kg/s]) which is indicative of an input mass flow  $m_1$  at the gas input 101.

**[0045]** Furthermore, the system comprises a mass

flow control unit 120, wherein the mass flow control unit 120 is coupled to the measuring unit 110 for receiving the measured input mass flow value and the gas input 101 for controlling the input mass flow  $m_1$  such that the measured input mass flow value corresponds to a set point input mass flow value.

**[0046]** The measuring unit 110 may measure additionally further mass flow affecting parameters, such as the first pressure  $p_1$  and the temperature at the gas input 101 and/or the second pressure  $p_2$ , the output mass flow  $m_2$  and/or the temperature at the gas output 102.

**[0047]** All measured data are provided to the mass flow control unit 120. The mass flow control unit 120 may calculate on the basis of the inputted data values, such as the input mass flow  $m_1$ , the first pressure  $p_1$ , the second pressure  $p_2$ , the output mass flow  $m_2$ , the respective gas temperature at the gas input 101 and the gas output 102, a set point input mass flow value (e.g. [kg/s]) at which the high pressure compressor 100 is operated approximately at its working point. Moreover, the mass flow control unit 120 may be connected to the high pressure compressor 100 for controlling for example the speed of rotation of the high pressure compressor 100.

**[0048]** In the figure the tubing which transports the gas between the system devices are shown by the solid lines, whereas the data lines, for transmitting measuring data and control data are shown with the dotted lines.

**[0049]** Besides the high pressure compressor 100, in the figure further components of the system for gathering gas are shown. Generally, from the gas field 170 gas is gathered through a plurality of boreholes. At each borehole, a respective wellhead arrangement 151-154 is attached. Downstream of each wellhead arrangement 151-154, a respective delivery valve 161-164 is coupled. Hence, by controlling the delivery valves 161-164, a respective mass flow from a respective wellhead arrangement 151-154 to the gas input 101 is controllable.

**[0050]** In order to increase the amount of gathered gas from the gas field, in all or in some tubes between the gas input 101 and a respective first wellhead arrangement 151-154, a respective low pressure compressor 141-144 is installed. Each low pressure compressor 141-144 may increase the pressure from approximately 1 to 4 bars to approximately 5 to 20 bars.

**[0051]** By controlling the low pressure compressor 141-144 the mass flow of gas which is delivered by a respective wellhead arrangement 151 to the gas input 101 is adjustable. The mass flow control unit 120 is adapted for controlling the respective low pressure compressors 141-144 individually, so that each low pressure compressor 141-144 may deliver a predetermined input mass flow  $m_1$  of gas to the gas input 101. The mass flow control unit 120 is adapted for example for controlling the rotational speed of each low pressure compressor 141-144, for example.

**[0052]** In the exemplary embodiment shown in the figure four low pressure compressors 141-144, four wellhead arrangements 151-154 and four delivery valves

161-164 are shown. In other exemplary embodiments, more or less of low pressure compressors 141-144, wellhead arrangements 151-154 and delivery valves 161-164 may be installed.

**[0053]** A gathering group may be formed by one low pressure compressor 141-144, one wellhead arrangement 151-154 and one delivery valve 161-164. Each gathering group is coupled to a respective borehole. All gathering groups deliver gas to a common collecting manifold to which the high pressure compressor 100 is coupled. In particular, a gas field may comprise a plurality of boreholes, wherein to each borehole a respective gathering group is coupled.

**[0054]** Furthermore, the system may comprise a further high pressure compressor 100, wherein first gathering groups are connected to the one high pressure compressor 100 and second gathering groups are connected to the further high pressure compressor.

**[0055]** The high pressure compressor 100 is adapted for increasing the received gas at the gas input 101 from approximately 10 to 14 bars to approximately 60 to 90 bars at the gas outlet 102. Hence, for the gas export system 130, a high gas pressure is provided which is needed e.g. for the further processing of the gas.

**[0056]** Moreover, as shown in the figure, the system comprises a return flow tubing 103 to which a bleeder valve 104 is connected. The bleeder valve 104 is controlled by the mass flow control unit 120. If the measured input mass flow  $m_1$  is lower than the set point input mass flow, the mass flow control unit 120 controls the bleeder valve 104 such that a part of the gas is bled off from the gas outlet 102 and injected into the gas input 101, such that the input mass flow value is increased until it corresponds to the set point input mass flow value.

**[0057]** It should be noted that the term "comprising" does not exclude other elements or steps and "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

## Claims

1. System for gathering a gas from a gas field (170), the system comprising
  - a high pressure compressor (100) which comprises a gas input (101) and a gas output (102),
  - wherein the gas input (101) is coupleable to the gas field (170) for receiving the gas gathered from the gas field (170) with a first gas pressure, wherein the gas output (102) is coupleable to a gas export system (130) for providing the gas with a second gas pressure to the gas export system (130), and wherein the second gas pressure is higher than the first gas pressure,
  - a measuring unit (110, 111) coupled to the gas input

(101), wherein the measuring unit (110, 111) measures an input mass flow value which is indicative of an input mass flow at the gas input (101), and a mass flow control unit (120),

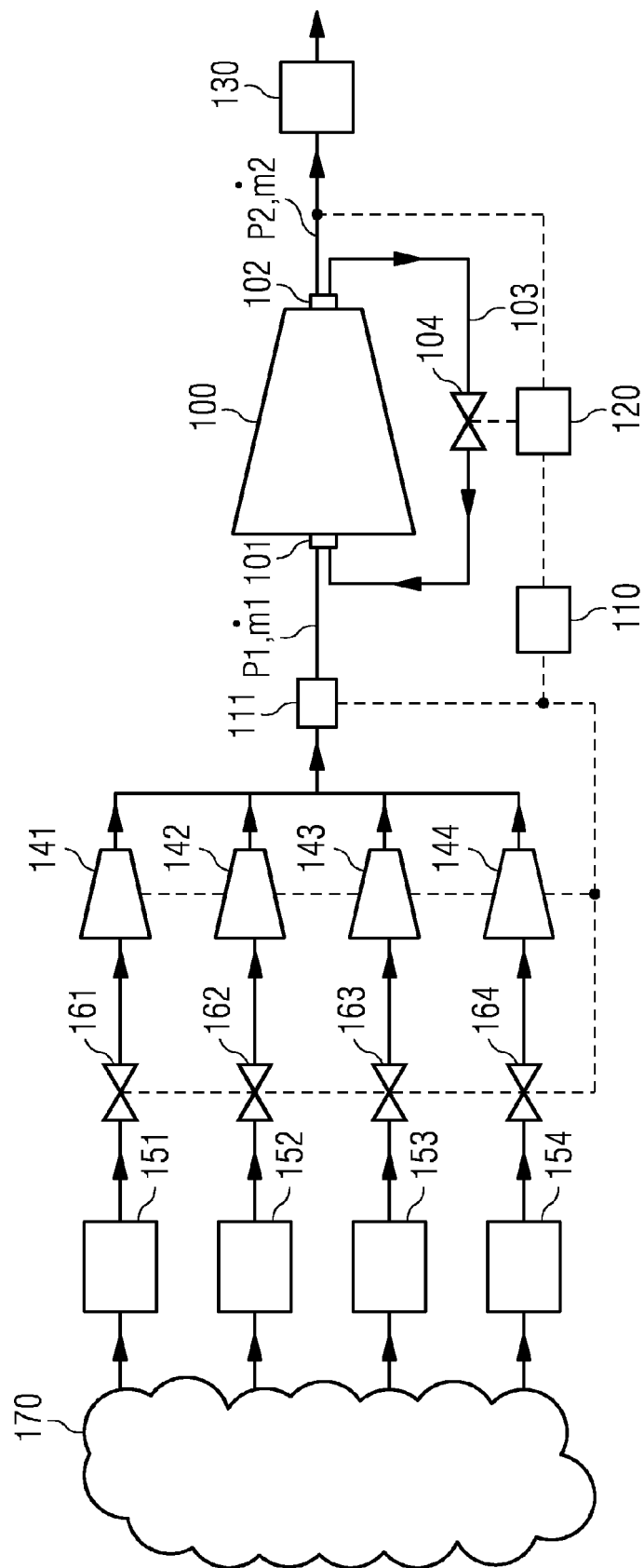
wherein the mass flow control unit (120) is coupled to the measuring unit (110, 111) for receiving the measured input mass flow value and the gas input (101) for controlling the input mass flow such that the measured input mass flow value corresponds to a set point input mass flow value.

2. System according to claim 1, further comprising a first low pressure compressor (141) which is connectable to a first wellhead arrangement (151) of the gas field (170) for receiving the gas from the first wellhead arrangement (151),
  - wherein the first low pressure compressor (141) is connected to the gas input (101) for providing the gas to the gas input (101) with a first mass flow, and
  - a second low pressure compressor (142) which is connectable to a second wellhead arrangement (152) of the gas field (170) for receiving the gas from the second wellhead arrangement (152),
  - wherein the second low pressure compressor (142) is connected to the gas input (101) for providing the gas to the gas input (101) with a second mass flow, wherein the mass flow control unit (120) is connected to
    - a) the first low pressure compressor (141) for controlling the first low pressure compressor (141) and
    - b) the second low pressure compressor (142) for controlling the second low pressure compressor (142) such that the first mass flow and the second mass flow are controllable for controlling the input mass flow at the gas input (101).
3. System according to claim 1 or 2, further comprising a first delivery valve (161) which is connectable to a first wellhead arrangement (151) of the gas field (170) for receiving the gas from the first wellhead arrangement (151), wherein the first delivery valve (161) is connected to the gas input (101) for providing the gas to the gas input (101) with a further first mass flow, and
  - a second delivery valve (162) which is connectable to a second wellhead arrangement (152) of the gas field (170) for receiving the gas from the second wellhead arrangement (152), wherein the second delivery valve (162) is connected to the gas input (101) for providing the gas to the gas input (101) with a further second mass flow,
  - wherein the mass flow control unit (120) is connected to
    - a) the first delivery valve (161) for controlling the first delivery valve (161) and

b) the second delivery valve (162) for controlling the further second mass flow

such that the further first mass flow and the further second mass flow are controllable for controlling the input mass flow at the gas input (101). 5

4. System according to one of the claims 1 to 3, further comprising  
a return flow tubing (103) which is connected to the gas output (102) for bleeding off a part of the gas from the gas output (102) and which is connected to the gas input (101) for injecting the part of the gas in the gas input (101),  
wherein the mass flow control unit (120) is coupled to the return flow tubing (103) for controlling the bleeding off of the part of the gas from the gas output (102) and for controlling the injecting of the part of the gas in the gas input (101) such that the input mass flow at the gas input (101) is controllable. 10 15 20
5. System according to one of the claims 1 to 4, further comprising  
a bypass tubing which is connected to the gas input (101) for bleeding off a further part of the gas from the gas input (101),  
wherein the mass flow control unit (120) is coupled to the bypass tubing for controlling the bleeding off of the further part of the gas from the gas input (101) such that the input mass flow at the gas input (101) is controllable. 25 30
6. Method for controlling a gas mass flow of a system for gathering gas from a gas field (170), the method comprising  
measuring an input mass flow at a gas input (101) of a high pressure compressor (100), wherein the gas input (101) receives the gas gathered from the gas field (170) with a first gas pressure, wherein the high pressure compressor (100) comprises a gas output (102) for providing gas with a second gas pressure to a gas export system (130), wherein the second gas pressure is higher than the first gas pressure,  
measuring an input mass flow value which is indicative of an input mass flow at the gas input (101), by a measuring unit (110, 111) which is coupled to the gas input (101),  
receiving the measured input mass flow value by a mass flow control unit (120), and  
controlling the input mass flow by the mass flow control unit (120) which is coupled to the gas input (101), wherein the mass flow control unit (120) controls the input mass flow such that the input mass flow value at the gas input (101) corresponds to a set point input mass flow value. 35 40 45 50 55





## EUROPEAN SEARCH REPORT

Application Number  
EP 11 16 8122

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                  |                                                     |                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Citation of document with indication, where appropriate, of relevant passages                                                                                    | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | EP 1 016 787 A2 (MAN TURBOMASCHINEN AG GHH BORS [DE] MAN TURBOMASCHINEN AG [DE])<br>5 July 2000 (2000-07-05)<br>* paragraphs [0010], [0013]; figure 1 *<br>----- | 1-6                                                 | INV.<br>F04D27/02                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                  |                                                     | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                  |                                                     | F04D                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                  |                                                     |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                  | Date of completion of the search<br>10 October 2011 | Examiner<br>de Martino, Marcello        |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>.....<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                  |                                                     |                                         |

1  
EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 16 8122

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-10-2011

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)      | Publication<br>date      |
|-------------------------------------------|---------------------|---------------------------------|--------------------------|
| EP 1016787 A2                             | 05-07-2000          | DE 19860639 A1<br>US 6293766 B1 | 06-07-2000<br>25-09-2001 |
| -----                                     |                     |                                 |                          |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82