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(54) DEVICE FOR REVERSAL OF FLOW IN NATURAL GAS DISTRIBUTION NETWORKS

(57) Described is a device for reversal of flow in natural gas distribution networks, wherein between a medium/high pressure supply line (LD) of gas and a local gas distribution line (LL) of said gas, in which the gas is supplied with a pressure suitable for the user device (100) less than said medium/high supply pressure, there are means for reducing the gas pressure (12) from the values present in said medium/high pressure supply line (LD) to the values present for said local distribution line (LL), said device (10) being **characterised in that** it is interposed between said medium/high pressure gas supply line (LD) and said local distribution line (LL), and it comprises gas compression means (14) designed to change the pressure of said gas to the values present in said medium/high pressure supply line (LD), said compression means (14) being activated at the same time as an increase in the pressure of the gas in the local distribution line (LL).

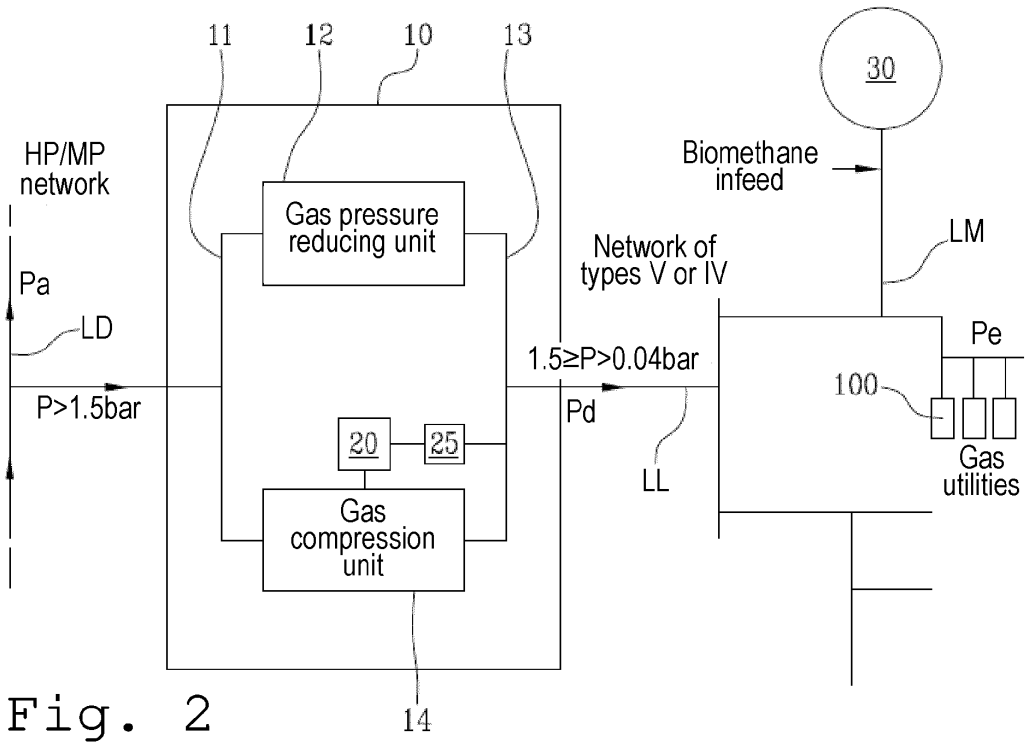

Fig. 2

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Description

[0001] This invention relates to the measures planned to implement a transformation called decarbonisation, in particular of the gas sector, and aims to introduce an innovative concept specifically with regard to the conveying of fuel in gas distribution networks, with the aim of increasing the flexibility of the distribution networks and reducing the demand for natural gas of fossil origin by promoting and facilitating introductions of renewable gas into networks.

[0002] In this invention, the term "gas" is used to mean, in general, a fuel gas, that is to say, a gas of any type (preferably natural gas, biomethane or other) provided it is designed to allow a combustion reaction.

[0003] The invention proposed here aims to promote a new approach to the management of gas networks by making them more prepared and feasible for potential introductions of renewable gas. Specifically, but without limiting the scope of the invention, reference will be made below to the introductions of biomethane into the distribution network, but without limiting the scope of application of the invention to this type of fuel. The operating principle of the device according to this invention may in fact be applied and used for the introduction of any type of renewable gas into gas distribution networks, including hydrogen and other types of green gas (such gases are examples of combustible gases).

[0004] Currently, a biomethane manufacturer may apply for the introduction into the network to the national transport network operator or the operator of a local distribution network. In the event of introduction into the national transport network, there is the drawback which is not widespread throughout the territory.

[0005] If, on the other hand, the introduction is carried out in a local distribution network, it occurs that the reception of biomethane, due both to the functional and management arrangement of the network and the consumption of the users fed by the network in question, in particular during the summer season, cannot always be guaranteed. This latter type of network is widespread throughout the territory and usually represents the first available point for introducing biomethane.

[0006] The various types of network are classified on the basis of the current regulations according to the operating pressure. In particular, there are the following types of networks:

- **Type I:** pipelines with maximum operating pressure greater than 24 bar.
- **Type II:** pipelines with a maximum operating pressure greater than 12 bar and less than or equal to 24 bar.
- **Type III:** pipelines with a maximum operating pressure greater than 5 bar and less than or equal to 12 bar.
- **Type IV:** pipelines with a maximum operating pressure greater than 1.5 bar and less than or equal to 5 bar.
- **Type V:** pipelines with a maximum operating pressure greater than 0.5 bar and less than or equal to 1.5 bar.
- **Type VI:** pipelines with a maximum operating pressure greater than 0.04 bar and less than or equal to 0.5 bar.
- **Type VII:** pipelines with a maximum operating pressure less than or equal to 0.04 bar.

[0007] The networks classified as types IV, V and VI are referred to as medium pressure networks, while type VII is referred to as a low pressure network.

[0008] Networks with higher pressures, that is to say, of types less than type IV, are referred to as "high pressure" networks.

[0009] This invention only relates to distribution networks.

[0010] For the passage of the gas, usually one-way, from networks with higher pressure to networks with lower pressure, use is made of suitable pressure reducers, located in suitable reduction cabins, and the fuel gas with reduced pressure is then transferred to a subsequent delivery line, which conveys the fuel gas to the final distribution network and, therefore, to the users.

[0011] An example diagram of this network configuration may be that shown in Figure 1, in which the distribution line LD of type IV, with medium pressure, extends on the left side and is connected to the distribution line LL of type V, shown on the right, by means of a system 1 for reducing the gas pressure. Other reduction systems, not illustrated because they are not of particular interest for the description of the invention, then further lower the pressure of the gas before supplying it to the users.

[0012] In the experience of the Applicant of this utility model application, there is frequently the situation in which the gas network closest to the biomethane production plant consists of pipelines with a diameter and pressure such as to be able to receive the expected flow rate, however, the users fed by the network are not able to consume the quantity of biomethane expected to be fed, in particular during the summer or with lower consumptions.

[0013] This situation occurs in particular for the introduction in gas networks of type V or VI, which are very widespread in the territory, which are able to receive introduction of biomethane at the management pressures, but which feed users with summer consumption less than the capacity corresponding to the introductions of biomethane. In these cases, the biomethane producer must be connected to the closest network of lower type, that is to say, at least type IV, which usually feeds a larger perimeter of user devices, so is able to receive and consume, even during the summer period, the required infeed flow rates.

[0014] In these cases, given the lesser diffusion in the territory of networks of type IV, or with high pressure, it is necessary to carry out significant connection works, in

relation to the distance between these networks and the plant for producing biomethane (for example, the introduction of biomethane may be carried out by means of a connecting line 18, Figure 1).

[0015] The aim of this invention is to provide a device for a fuel gas distribution network which allows the introduction of biomethane in the networks of types V or VI, so as to make them available for the introduction even in the presence of limited consumption, for example during summer periods.

[0016] The aim of the invention is completed with the proposal for a device which allows a greater dynamism of the network, allowing the natural gas to flow in a "two-way" manner, that is to say, to pass from a network at s lower pressure to one at a higher pressure and vice versa on the basis of the consumption of the users supplied by the lower pressure network.

[0017] In practice, the aim of this invention is to make the flow of gas possible even in the opposite direction, that is to say, to switch from a type V or VI network to a type IV network, or lower type, so that the capacity offered by the local distribution network and the widespread diffusion on the territory of the latter can be fully exploited without any restrictions on the introductions due to the surplus of natural gas produced compared with actual consumption.

[0018] A further aim of the innovation is also to resolve in a simple and inexpensive and above all reliable manner the problem described above and, preferably, to allow the modification of the reduction systems already installed without having to resort to a massive replacement of components, with costs and downtimes which have negative impacts on the service to the users.

[0019] The above-mentioned aims are achieved by providing a device which is capable of reversing the flow of gas in the natural gas distribution networks, as described in the independent claim.

[0020] Possible variants and additional features are shown in the subordinate claims.

[0021] The features of the invention which do not emerge from the above are made clear in the following description, which should be considered with reference to the accompanying drawings, in which:

Figure 1 shows an example functional diagram comprising networks type IV and V, in the current state (that is to say, prior art);

Figure 2 illustrates a functional example and reference diagram in which the system according to the invention is included;

Figures 3 and 4 illustrate the functional diagram of Figure 2 in two characteristic operating moments, relating to different conditions of supply and introduction of natural gas.

[0022] With reference to the above-mentioned drawings, in which different versions of an example diagram are illustrated, in which a supply line LD of medium/high pressure gas and a local distribution line LL of the gas are positioned in series and each carry gas (fuel) at a relative pressure, established, in accordance with sector regulations, according to the respective features and functions.

[0023] In more detail, the line LD for supplying gas at medium/high pressure receives gas from a national transport network (not illustrated in the drawings as not of interest in this invention) using suitable reduction systems (also not illustrated in the drawings as not of interest in this invention), which lower the gas pressure to the values typically provided for the main transport networks.

[0024] The gas (fuel) is then fed into a local distribution network LL, which, for the purposes of this invention, may be of the V or VI types; therefore, with distribution pressure values Pd of between 1.5 and 0.04 bar, and there are further pressure reducers (not illustrated in the accompanying drawings) to bring the pressure to the operating values Pe, suitable for the supply to the users, relating to the VII type lines, with operating pressure values Pe not exceeding 0.04 bar.

[0025] Between the medium/high pressure supply line LD and the local distribution line LL there are means 12 for reducing the pressure of the gas from the values present in the supply line LD, at medium/high pressure Pa, to the values provided for the local distribution line LL Pd (Figure 1).

[0026] According to known methods, the gas pressure reducing means 12 may consist, for example, of suitable pressure reducers.

[0027] The pressure reducers are operated with preset methods and dynamic adjustment of the respective flows of gas according to specific control pressures, corresponding to the pressure values provided for the local distribution line LL.

[0028] In accordance with the aims of this invention, there is also an line LM for introducing biomethane, for example connected to the local distribution line LL for introducing additional biomethane gas into the latter.

[0029] The line LM for introducing biomethane, connected to the local distribution line LL comes from one or more biomethane production plants 30, schematically illustrated in the accompanying drawings and not described as not related to the object of invention.

[0030] The device 10 according to the invention, which is designed to allow a reversal of the flow in the natural gas distribution networks, such as to determine the introduction of the biomethane gas supplied by the infeed line LM in excess of the volume of gas consumed by the users 100, is interposed between the medium/high pressure gas supply line LD and the local distribution line LL.

[0031] The presence of excess gas in the local distribution network is detected by a flow rate and pressure measuring system of known type and not described in detail, consisting of measurement apparatuses already present along the line or specially prepared.

[0032] The device 10 replaces or integrates the system comprising only the gas pressure reducing means 12,

accompanying with them means for compressing the gas 14, designed to bring the gas to the values present in the medium/high pressure supply line LD.

[0033] According to the preferred embodiment illustrated, the gas compression means 14 are positioned in parallel with the gas pressure reducing means 12 (Figures 2, 3 and 4) and can be activated as an alternative to the gas pressure reducing means 12 at the same time as an increase in the gas pressure of the local distribution line LL (which, according to a non-limiting example, may coincide with the introduction of additional biomethane gas from the infeed line LM).

[0034] According to the preferred embodiment illustrated, the compression means 14 consist of a compressor unit designed to change the excess gas pressure in the local distribution line LL to a pressure equal to or greater than the pressure Pa of the gas present in the medium/high pressure distribution line LD.

[0035] The compression unit 14 is controlled by a system for adjusting and controlling the operation of the plant, consisting of apparatuses of known type and therefore not described in detail.

[0036] By way of an example, the compressor unit is driven by an electronic control unit 20 designed to record the pressure values of the distribution line LL by means of sensors 25 designed to detect the pressure Pd present in it.

[0037] The operation of the device 10 for reversal of the flow in the natural gas distribution networks is described below, with particular reference to Figures 3 and 4.

[0038] Under normal operating conditions, the gas supplied by the medium/high pressure gas distribution line LD enters the device 10 and travels along the branch 11 directed towards the gas pressure reducing means 12 (Figure 3). The reduced pressure gas Pd then travels along the branch 13 directed towards the distribution line LL and is then conveyed to the user devices 100 with further reduced pressure Pe.

[0039] The infeed line LM provides biomethane gas and the operation of the device 10 remains unchanged until the additional supply causes an excess of the gas present in the local line LL compared with the actual consumption of the users 100, as occurs, for example, during the summer periods.

[0040] The device 10 then switches the path of the gas, picking up the excess height from the local line LL and sending it by the branch 15 to the compression unit 14, which compresses the gas bringing it at least to the pressure Pa of the distribution line LD.

[0041] It should be noted that in order to introduce the excess compressed gas into the distribution line LD, the pressure must necessarily be greater, even if only slightly, than the pressure Pa present in the line LD. For this purpose, the dispensing pressure of the compression unit may be at most equal to the maximum pressure of types of the distribution line LD.

[0042] The control unit 20 therefore acts according to preset pressure values, as a function of the actual pressure Pd present in the distribution line LL, detected by the suitable sensors 25 already mentioned above.

[0043] The operation in the two modes is therefore alternated, actuating one after the other, according to the volumetric and/or pressure conditions of the gas present in the lines in question. Or it remains stably in one of the two modes for longer periods, again according to the conditions of the network, generically determined by the seasonal situations.

[0044] During the winter period, the pressure reduction section comprising the branches 11 and 13 and the pressure reduction unit 12 will operate mainly, or exclusively, whilst during the summer period, that is to say, when the consumption is smaller, the compression section will mainly be made operational, with the branches 15 and 17 and the compression unit 14, with possible intervals of deactivation (and simultaneous activation of the pressure reduction section) when the introduction of biomethane is not able to provide a sufficient quantity of gas.

[0045] As mentioned in the introduction, the device according to the invention aims to promote a new approach for the management of gas networks, making the gas distribution network more set up and usable for potential introductions of renewable gas, in particular of biomethane.

[0046] The device proposed allows a type of plant to be made characterised by a greater dynamism of the network, allowing natural gas to flow in a "two-way" fashion, that is to say, to pass from a network with a lower pressure to one with a higher pressure and vice versa, on the basis of the consumption of the users supplied by the network at a the lower pressure, unlike what usually occurs with a one-way flow of gas, in which the pressure is lowered.

[0047] By way of a non-limiting example, this allows the gas to also flow in the opposite direction, that is to say, to pass from a type V or VI network to a high or medium pressure network, making full use of the capacity offered by the distribution network and the diffusion on the territory of the latter.

[0048] To allow this two-way passage of the natural gas fluid the proposed device compresses the excess gas present in the network to a lower pressure and pushes it towards that with an upper pressure, thus alternating a normal reduction operation with compression operation.

[0049] The availability of the device according to the invention may allow the introduction of biomethane, for example in the distribution networks of types V and VI, avoiding in these cases the need to carry out significant works for connection to the distribution or transport network, which are able to receive the required infeed flow rate, normally located at a considerable distance from the biomethane production.

[0050] Similarly, a device according to the invention may allow the introduction of biomethane in the distribution networks of types V and VI and the use of the latter

in cases in which the distribution or transport network, which is able to receive the required flow rate, is at a distance such as not to make it sustainable for the applicant from the economic point of view for the implementation of the necessary connecting works (18 in Figure 1).

[0051] With reference to the preset aims, the device according to the invention offers reliability, with the creation of plant consisting of a reduction unit, a compression unit, a system for measuring flow rates and pressures, and a system for adjusting and controlling the operation of the plant. All these devices are already available on the market, marketed by the companies in each specific sector and are therefore based on well-established and reliable technologies.

[0052] In addition to the reliability, the proposed device is highly level of scalable, with the possibility of rapid implementation on existing national distribution networks.

[0053] The compact system solution designed allows the works to be carried out on existing systems to be limited as much as possible, in such a way as to speed up the installation and the putting into operation, without the need for substantial modifications to the reduction and adjustment components. The proposed device may be adapted and applied for operation on distribution networks of different types. The operating principle of the device according to this invention may be applied and used for the introduction of any type of renewable gas into gas distribution networks, including hydrogen and other types of green gas.

[0054] The device according to the invention is designed for operation on distribution networks which currently have strong limitations on the possibility of introducing biomethane or renewable gas.

[0055] Since the reduction systems are extremely widespread in the national territory, the device in question is characterised by a significant replicability factor, as it can be installed throughout the entire national territory, irrespective of the characteristics of the pipelines, the type of user and the geographical reality of the territory.

Claims

1. A device for reversal of flow in natural gas distribution networks, wherein between a medium/high pressure supply line (LD) of gas and a local gas distribution line (LL) of said gas, in which the gas is supplied with a pressure suitable for the user device (100) less than said medium/high supply pressure, there are means for reducing the gas pressure (12) from the values present in said medium/high pressure supply line (LD) to the values present for said local distribution line (LL), said device (10) being **characterised in that** it is interposed between said medium/high pressure gas supply line (LD) and said local distribution line (LL), and it comprises gas compression means (14) designed to change the pressure of said gas to the values present in said medium/high pressure supply line (LD), said compression means (14) being activated at the same time as an increase in the pressure of the gas in the local distribution line (LL).

2. The device (10) according to claim 1, wherein said gas compression means (14) are located in parallel with said gas pressure reducing means (12) and can be activated alternatively to said gas pressure reducing means (12).

3. The device (10) according to claim 1 or 2, wherein said gas pressure reducing means (12) comprise suitable pressure reducers activated by respective flows of control gas according to respective control pressures corresponding to the pressure values provided for said local distribution line (LL).

4. The device (10) according to any one of claims 1 to 3, wherein said compression means (14) which can be activated alternatively to the gas pressure reducing means (12) consist of a compressor unit designed to change the pressure of the excess gas present in said local distribution line (LL) to a pressure equal to or greater than the pressure of the gas present in said supply line (LD) at medium pressure.

5. The device (10) according to claim 4, wherein said compressor unit is controlled by an electronic control unit (20) designed to determine the switching on or off of the compressor in relation to the pressure of the gas present in the local distribution line (LL).

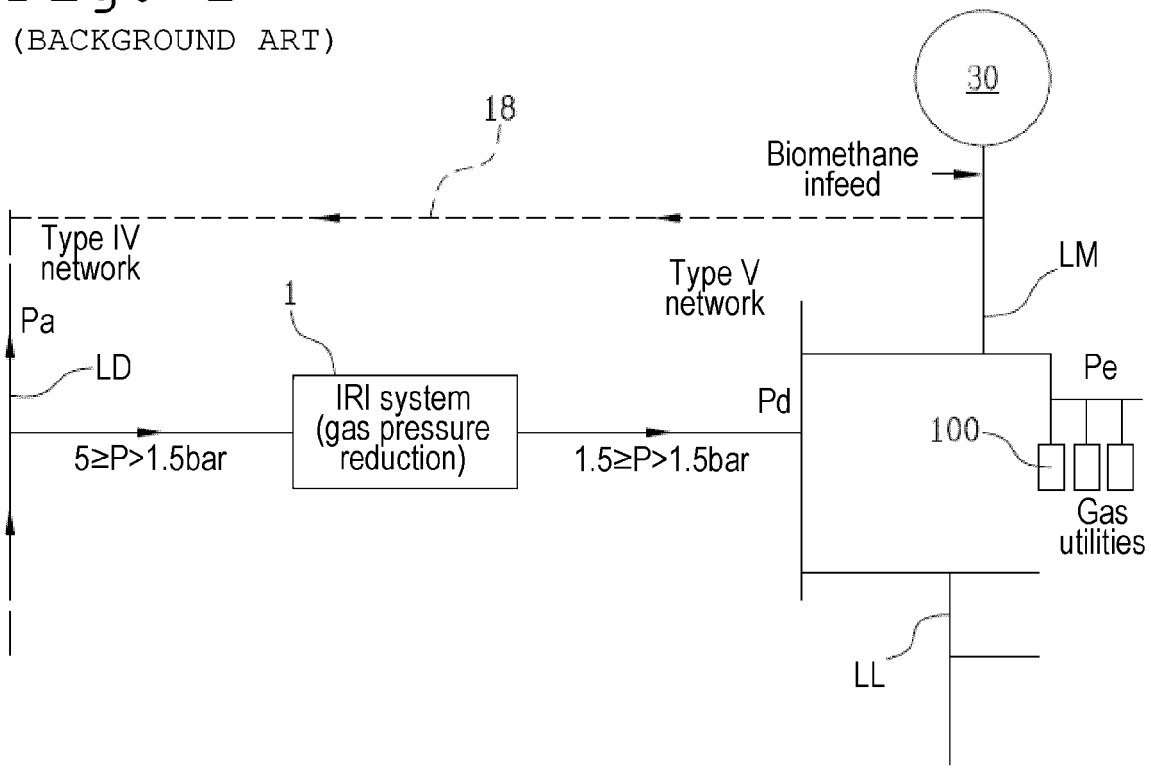
6. The device (10) according to claim 5, wherein said control unit (20) is connected to said local distribution line (LL) by sensors (25) designed to detect the pressure present in it, said compression means (14) being activated on the basis of the pressure signal of said sensors (25).

7. The device (10) according to any one of the preceding claims, associated with an infeed line (LM) of biomethane connected to said local distribution line (LL) for introducing additional biomethane gas into the latter, preferably coming from one or more biomethane production plants (30).

8. The device (10) according to one of the preceding claims, wherein said local distribution line (LL) is of type V or VI.

9. The device (10) according to one of the preceding claims, wherein said local distribution line (LL) is of type V or VI and there are further means for reducing the pressure designed to change the pressure of the gas to a value suitable for supplying to the user devices (100).

Fig. 1
(BACKGROUND ART)



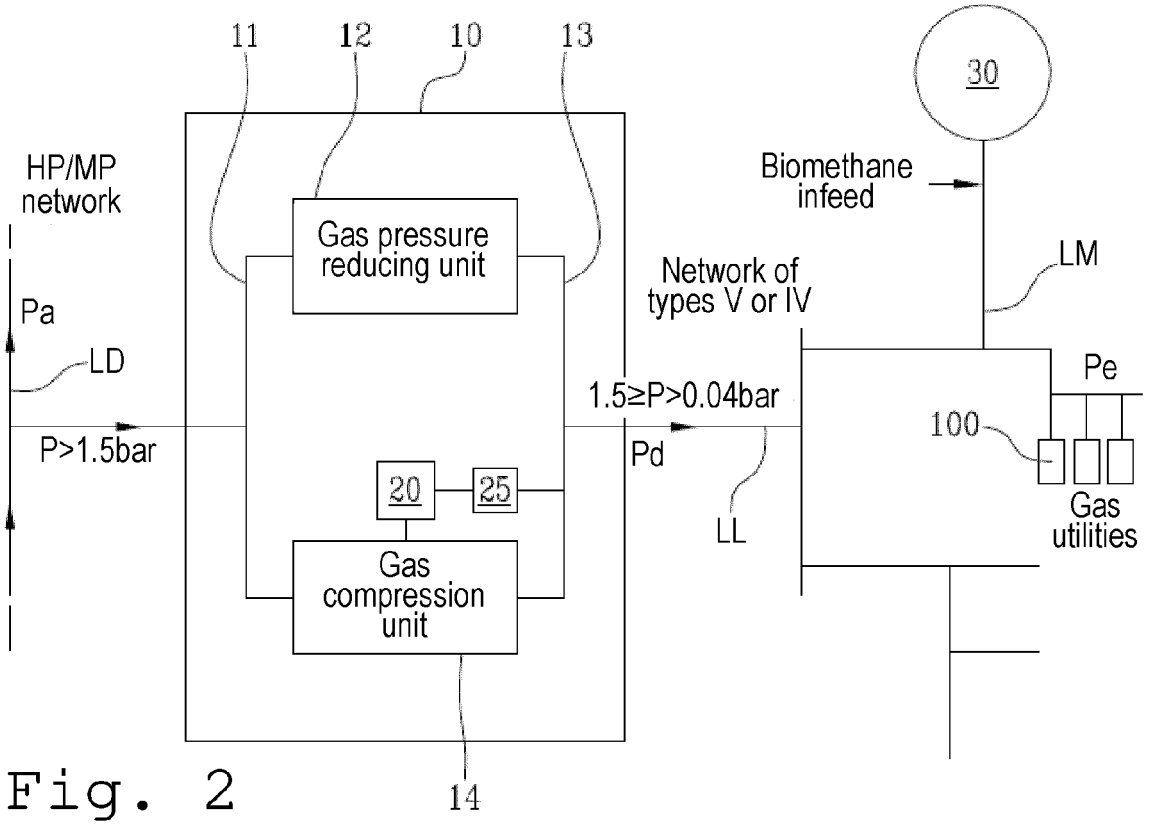
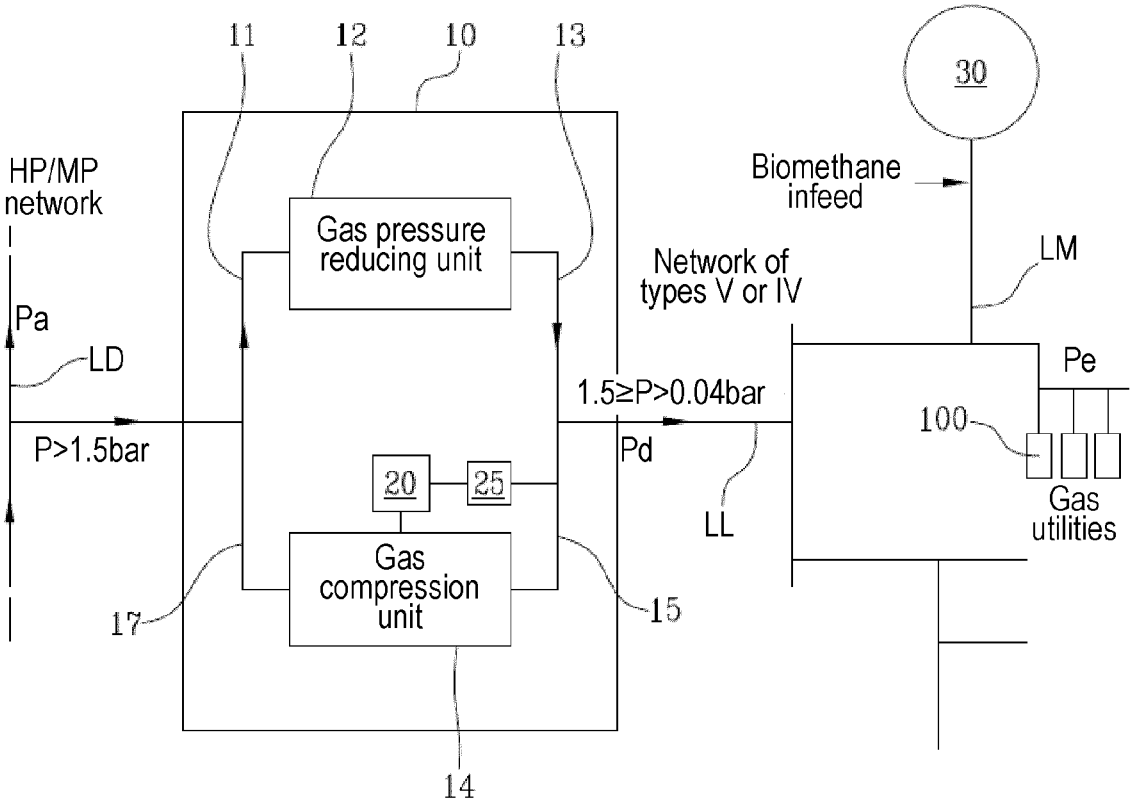
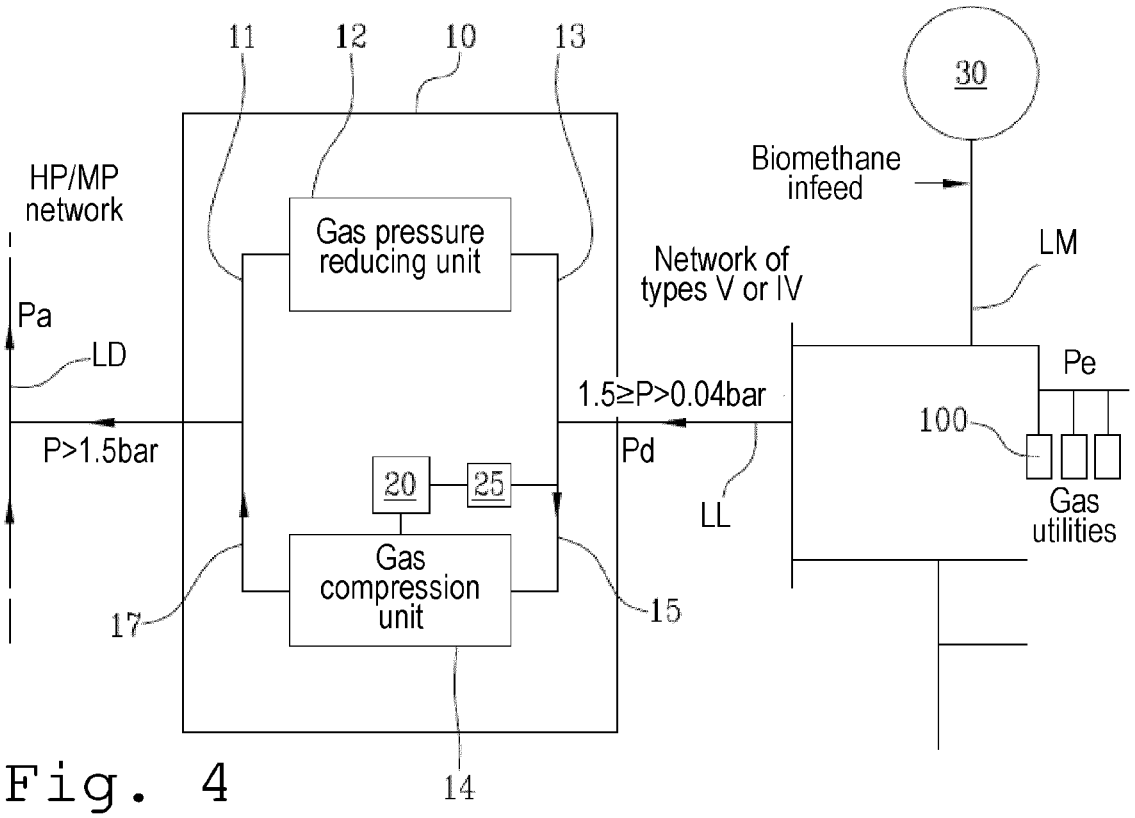


Fig. 2

Fig. 3


11
12
10
13
30
HP/MP network
Biomethane infeed
Gas pressure reducing unit
Network of types V or IV
LM
Pa
LD
1.5≥P>0.04bar
Pe
100
P>1.5bar
Pd
20
25
LL
Gas utilities
Gas compression unit
17
15
14


11
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30
HP/MP network
Biomethane infeed
Gas pressure reducing unit
Network of types V or IV
LM
Pa
LD
1.5≥P>0.04bar
Pe
100
P>1.5bar
Pd
20
25
LL
Gas utilities
Gas compression unit
17
15
14

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 0175

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	US 2021/285605 A1 (DUFOUR DANIEL [FR] ET AL) 16 September 2021 (2021-09-16) * paragraphs [0005], [0075], [0090], [0091], [0092], [0097], [0118], [0119]; figure 1 *	1-9	INV. F17D1/04
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TECHNICAL FIELDS SEARCHED (IPC)

F17D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 October 2024	Forsberg, Peter

CATEGORY OF CITED DOCUMENTS

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