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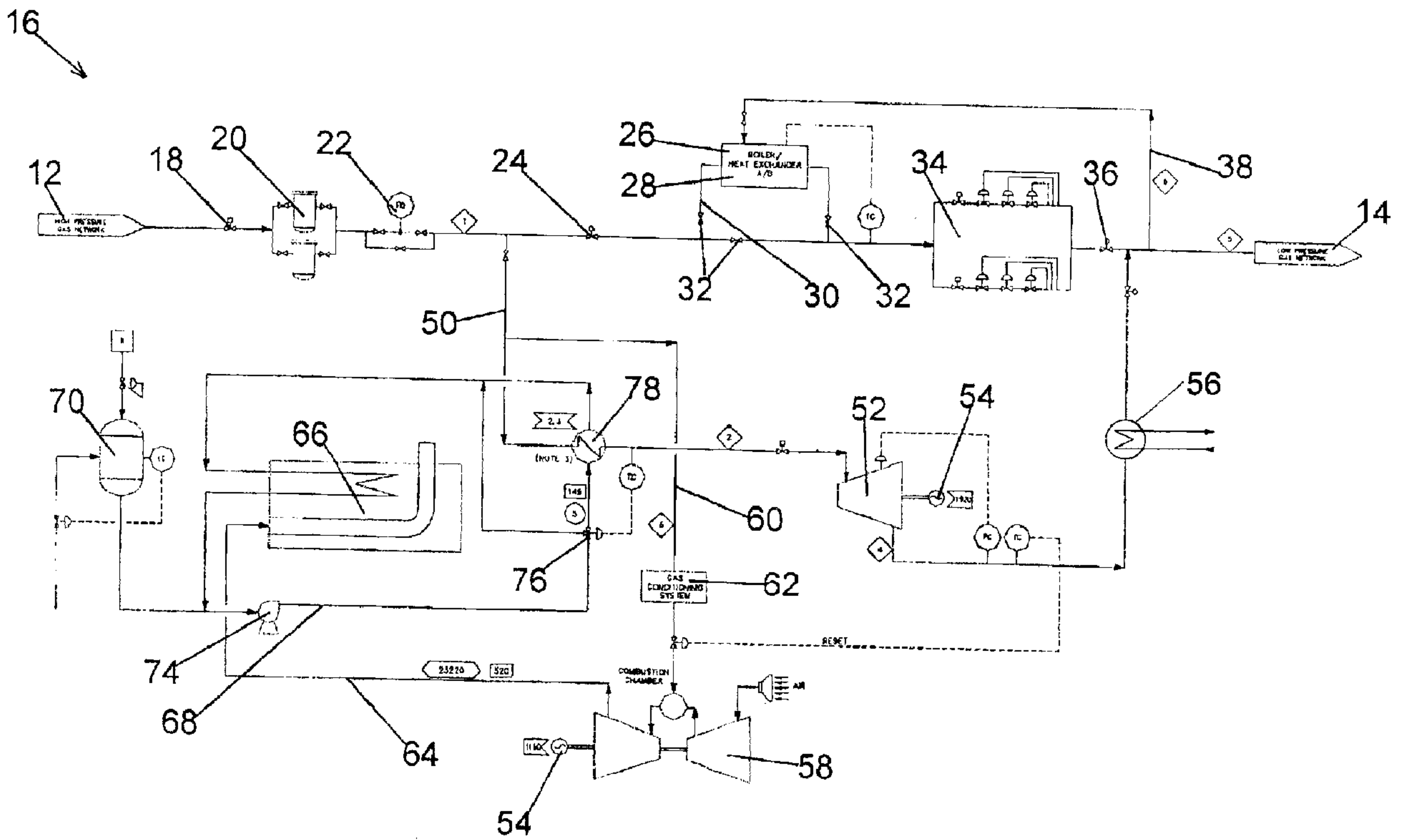
(54) Titre : METHODE DE PRODUCTION D'ENERGIE A PARTIR DE POSTES DE COMMANDE DE LA PRESSION D'UN SYSTEME DE DISTRIBUTION DE GAZ NATUREL

(54) Title: METHOD OF POWER GENERATION FROM PRESSURE CONTROL STATIONS OF A NATURAL GAS DISTRIBUTION SYSTEM



(57) **Abrégé/Abstract:**

A method is described of generating power from a pressure control station of a natural gas distribution system. A first step involves channelling natural gas entering the pressure control station into a turbine which is powered by expansion of the natural gas as the pressure of the natural gas is reduced. A second step involves capturing the output of the turbine for useful purposes.

ABSTRACT OF THE DISCLOSURE

A method is described of generating power from a pressure control station of a natural gas distribution system. A first step involves channelling natural gas entering the pressure control station into a turbine which is powered by expansion of the natural gas as the pressure of the natural gas is reduced. A second step involves capturing the output of the turbine for useful purposes.

TITLE OF THE INVENTION:

Method of power generation from pressure control stations of a natural gas distribution system

FIELD OF THE INVENTION

The present invention relates to method of generating power from pressure control stations of a natural gas distribution system.

BACKGROUND OF THE INVENTION

Natural gas distribution systems use three types of natural gas pipeline networks: high pressure (approximately 1,000 psig), medium pressure (approximately 100 psig) and low pressure (approximately 5 psig). Where the high pressure pipeline network feeds into the medium pressure pipeline network, the pressure must be reduced from 1000 psig to 100 psig. Where the medium pressure pipeline network feeds into the low pressure pipeline network, the pressure must be reduced from 100psig to 5psig. This is done through a series of pressure reducing control valves at facilities known as Pressure Control Stations.

As the pressure of natural gas is reduced, it expands. As the natural gas expands, the temperature of the natural gas decreases. This dramatic drop in temperature leads to the formation of hydrates, which damage the pressure reducing control valves. In order to avoid the formation of hydrates, the natural gas is pre-heated at the Pressure Control Stations before pressure is reduced, with a view to maintaining an outlet temperature of 5 degrees Celsius. The mode of preheating the natural gas upstream of the pressure control valves is by consuming some of the natural gas in a hot water or low pressure steam boiler, which supplies heat to a heat exchanger. The heat exchanger is then used to preheat the incoming natural gas.

In this typical mode of pipeline pressure control arrangement, the energy lost across the pressure reducing control valves in bringing the pressure down from 1000psig to 100psig is significant. Similarly, there is energy lost across the pressure reducing control valves in bringing the pressure down from 100psig to 5psig. If this energy could be captured, there potentially could be a net energy gain, as opposed to a net energy loss realized from the Pressure Control Stations.

SUMMARY OF THE INVENTION

What is required is a method of generating power from pressure control stations of a natural gas distribution system.

According to the present invention there is provided a method of generating power from a pressure control station of a natural gas distribution system. A first step involves channelling natural gas entering the pressure control station into a turbine which is powered by expansion of the natural gas as the pressure of the natural gas is reduced. A second step involves capturing the output of the turbine for application for useful purposes.

The method described above utilizes energy that is presently lost across the stem of the pressure control valves and utilizes it in a form of turbine which is powered by expanding gases, commonly known as a Turbo-expander.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to in any way limit the scope of the invention to the particular embodiment or embodiments shown, wherein:

FIGURE 1 labelled as **PRIOR ART** is a schematic diagram of a Pressure Control Station.

FIGURE 2 is a schematic diagram of a Pressure Control Station constructed in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred method of generating power from a pressure control station of a natural gas distribution system will now be described with reference to **FIGURES 1** and **2**.

In order to place the present method in context, the **PRIOR ART** system will first be described. Referring to **FIGURE 1**, a high pressure pipeline network is indicated by reference numeral 12 and a low pressure pipeline network is indicated by reference numeral 14. Interposed between high pressure pipeline network 12 and low pressure pipeline network 14 is a Pressure Control Station generally indicated by reference numeral 16. High pressure natural gas flowing from high pressure pipeline network 12 passes through a first line shut off valve 18, a course control valve assembly, generally indicated by reference numeral 20, a fine control valve assembly 22, before encountering a second line shut off valve 24. A boiler 26 with an associated heat exchanger 28 is positioned on a diversion loop 30. Three valves 32 are provided which control the feed of natural gas into and out of heat exchanger 28. Natural gas is pre-heated in heat exchanger 28. The pre-heated natural gas is then directed through a series of pressure reducing control valves 34. A third line shut off valve 36 enables Pressure Control Station 16 to be isolated from low pressure pipeline network 14. A fuel gas supply conduit 38 diverts some of the processed low pressure natural gas for use in fuelling boiler 26. The principle of operation is to preheat the natural gas in heat exchanger 28 to avoid the production of hydrates when the natural gas passes through the series of pressure reducing control valves 34. The energy generated as the pressure of the natural gas is produced is lost at pressure reducing control valves 34. In addition, energy input is needed in the form of gas consumption to power boiler 26. There is, therefore, a net energy loss.

Referring to **FIGURE 2**, a configuration in accordance with the present method is illustrated as being super-imposed upon the **PRIOR ART** Pressure Control Station of **FIGURE 1**. It is envisaged that the existing infrastructure will be kept in place to maintain redundant systems for reasons of public safety.

In accordance with the teachings of the present method, natural gas is diverted by passing heat exchanger 28 and series of pressure reducing control valves 34. A key aspect of the present method is channelling natural gas entering Pressure Control Station along line 50 and into a turbine 52 which is powered by expansion of the natural gas as the pressure of the natural gas is reduced. The output of turbine 52 is then captured for application for useful purposes. It is preferred that the turbine be used to power an electrical generator 54. The use of turbine 52 can be done either with or without the natural gas being pre-heated, as will hereinafter be further described.

Turbine 52 is preferably a turbine known as a "turbo-expander". It is a radial inflow turbine with variable inlet guide vanes for flow control, which are used to extract energy from a gas stream. The method uses the turbo-expander (turbine 52) to generate power in Pressure Control Stations 16 in a natural gas distribution system. The expansion across the inlet guide vanes and expander wheel produces torque and therefore shaft power that can be used to turn power generator 54.

Where the natural gas specifications of the working stream permit, turbine 52 can be used without preheating the natural gas. The natural gas is channelled into turbine 52, with a view to intentionally generating cold temperatures. A heat exchanger 56 is provided to capture the cold temperatures generated for use in either refrigeration or air conditioning. A fluid circulation can then be provided through heat exchanger 56 which can be used for air conditioning of nearby facilities or refrigeration of nearby cold storage warehouses. The refrigeration achieved by expansion of the gas is usually much more than achieved by Joule-Thompson (J-T) expansion across a valve.

Where preheating of the natural gas is required, boiler 26 replaced by a gas fuelled turbine power generator 58, sometimes referred to as a "micro-turbine". A portion of the high pressure natural gas is diverted along conduit 60 and passed through a gas conditioning system 62 to condition the natural gas so that the natural gas is suitable to power gas fuelled turbine power generator 58. Exhaust gases from gas fuelled turbine power generator flow along conduit 64 and are passed through a first heat exchanger 66. A hot water circulation circuit is provided which includes expansion tank circulation conduit 68, expansion tank 70, a pump 74 and valves 76. Expansion tank 70 provides make up water for circulation conduit 68, as required. Pump 74 is used to circulate hot water through circulation conduit 68. Water is circulated through conduit 68, which passes heat exchanger 66, so that a heat transfer takes place with the hot exhaust gases from gas fuelled turbine power generator 58 and heating the water. The exhaust gases are then released to atmosphere. A secondary heat exchange then takes place in a second heat exchanger 78 between the hot water and the natural gas. The natural gas, which has been preheated in second heat exchanger 78 is then channelled through line 50 to turbine 52. The output of gas fuelled turbine power generator 58 is also captured for useful purposes of power generation through generator portion 54. The intent of the method is to capture and use energy that is currently being wasted. Depending upon the circumstances, it may be desirable to position a dehydrator upstream of second heat exchanger 78, to dry the natural gas. Suitable dehydrators which use absorbent medium are well known in the art. Normally two are used. One is always in service, while the absorbent medium in the other is being regenerated. Of course, where the objective is to generate low temperatures for the purpose of air conditioning or refrigeration, the hot water circulation circuit will not be used.

In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiment without departing from the spirit and scope of the invention as hereinafter defined in the Claims.

I CLAIM:

1. A method of generating power from a pressure control station of a natural gas distribution system, comprising the steps of:

determining a pressure and temperature required for the natural gas distribution system;

channelling natural gas entering the pressure control system into an expansion turbine which is powered by expansion of the natural gas as the pressure of the natural gas is reduced, thereby effecting a pressure reduction for the natural gas;

capturing the output of the expansion turbine via a first power generator for application for useful purposes;

heating the natural gas downstream of the expansion turbine by passing the natural gas through a downstream heat exchanger to effect a heat exchange with a coolant to capture cold temperatures generated for one of refrigeration or air conditioning, thereby effecting a temperature reduction of the natural gas;

where the required pressure and temperature for the natural gas distribution system has not been attained, taking further steps of:

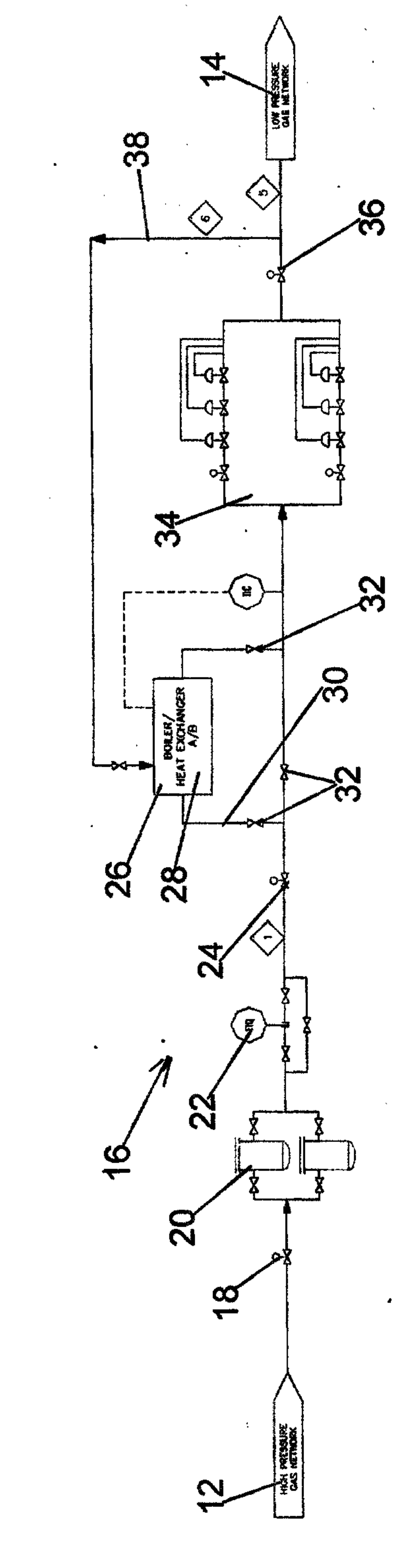
using a portion of the natural gas to power a gas fuelled turbine;

passing exhaust gases from the gas fuelled turbine through an exhaust gas heat exchanger through which is circulated a fluid heat transfer medium;

passing the fluid heat transfer medium which has been heated in the exhaust gas heat exchanger through an upstream heat exchanger positioned upstream of the expansion turbine to preheat the natural gas being channelled into the expansion turbine, wherein a pump is used to effect a circulation of the fluid heat transfer medium along a circulation path between the exhaust gas heat exchanger and the upstream heat exchanger; and

capturing the output of the gas fuelled turbine via a second power generator for application for useful purposes.

2. The method as defined in Claim 1, at least one of the first power generator or the second power generator being an electrical power generator.


14
LOW PRESSURE GAS NETWORK
38
6
5
36
34
32
30
BOILER/ HEAT EXCHANGER A/B
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24
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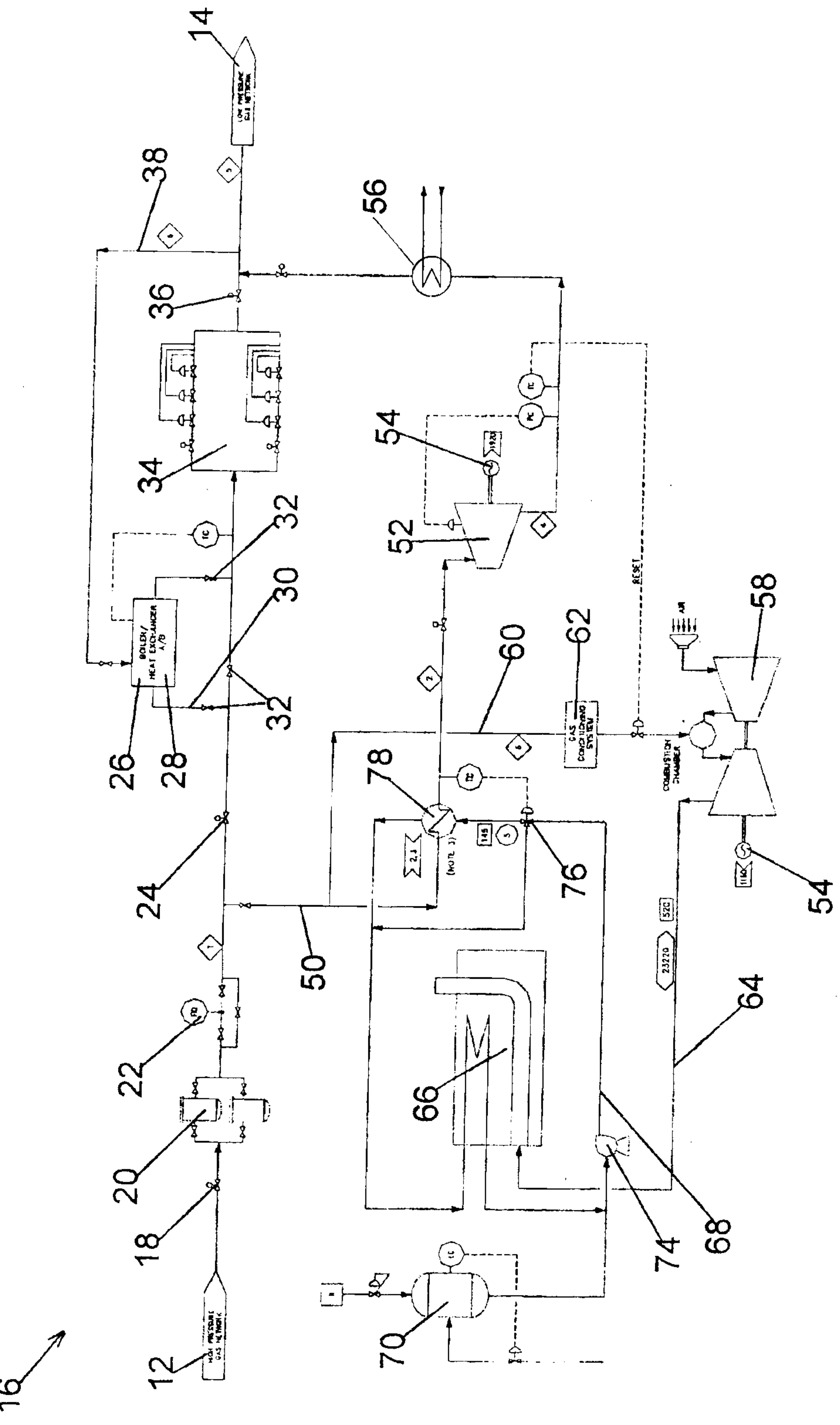
18
12
HIGH PRESSURE GAS NETWORK

FIG. 1

FIG. 2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HIGH PRESSURE GAS NETWORK
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BOILER/ HEAT EXCHANGER A/B
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LOW PRESSURE GAS NETWORK
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GAS CONDITIONING SYSTEM
RESET
AIR
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COMBUSTION CHAMBER
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BOILER/
HEAT EXCHANGER
A/B
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GAS
CONDITIONING
SYSTEM
RESET
COMBUSTION
CHAMBER
AIR
PC
TC
(NOTE 3)