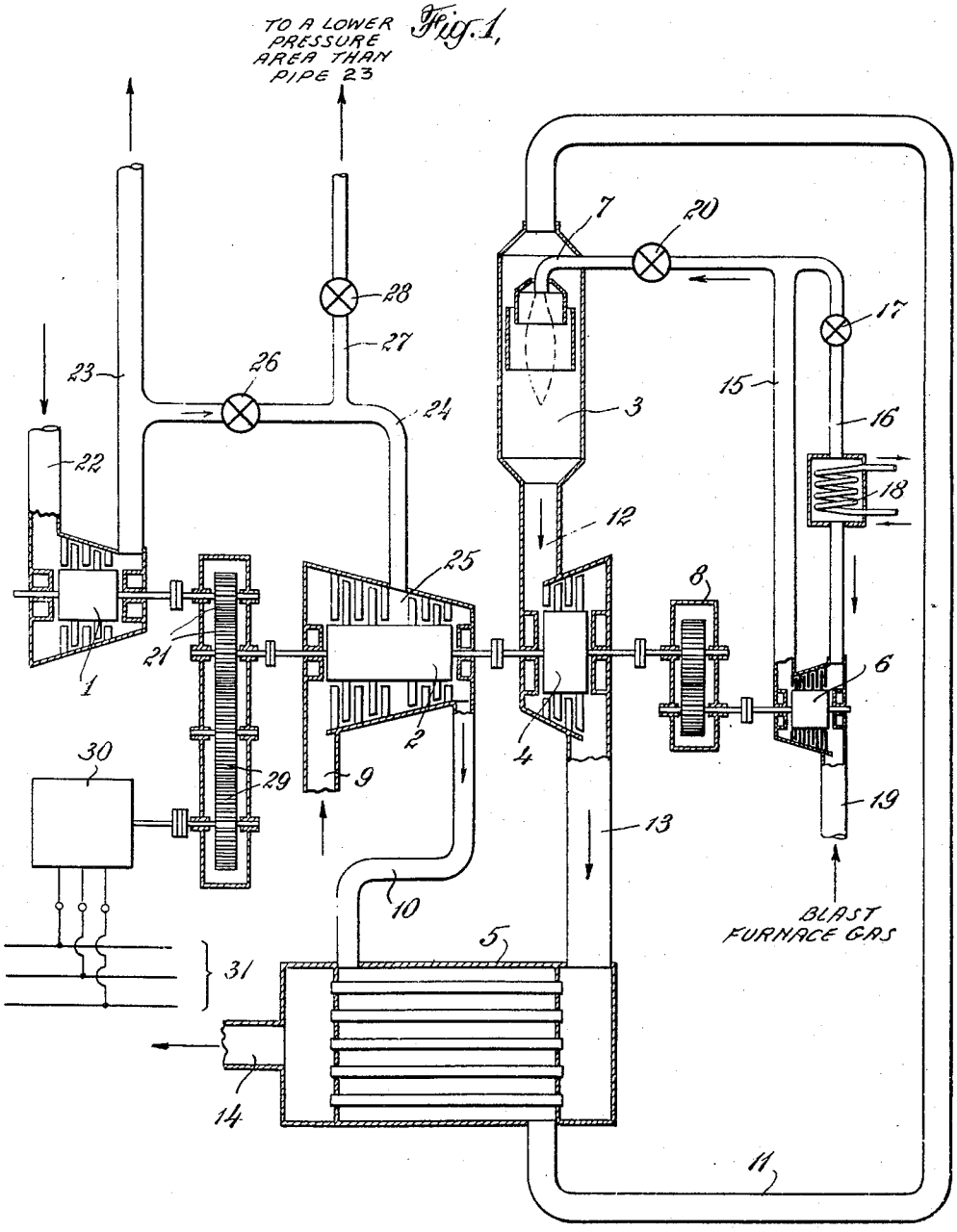
Aug. 5, 1958 W. TRAUPEL 2,845,776

GAS TURBINE DRIVEN PLANT FOR SUPPLYING COMPRESSED AIR

Original Filed March 12, 1952 4 Sheets-Sheet 1

Fig. 1.

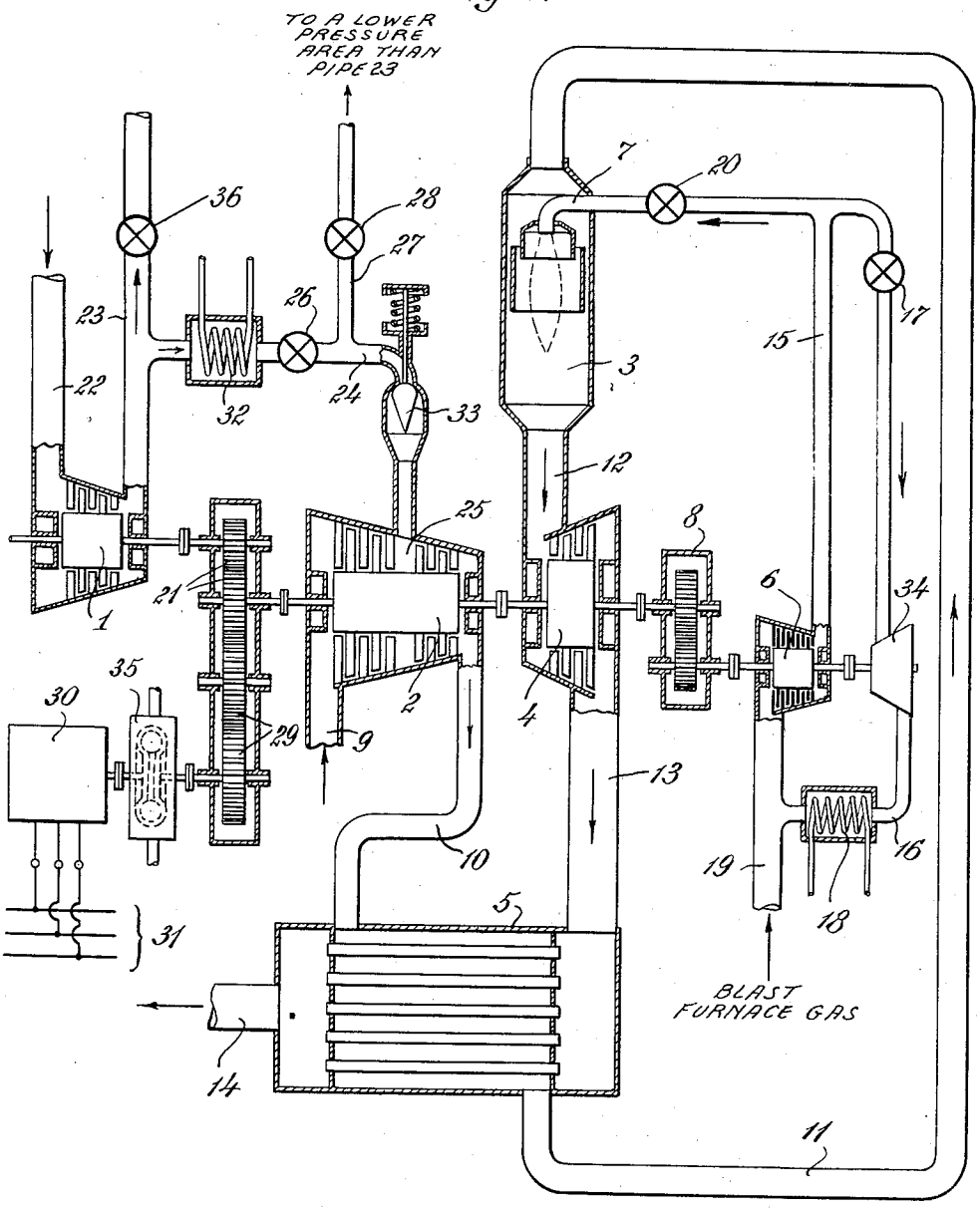


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Fig. 2.



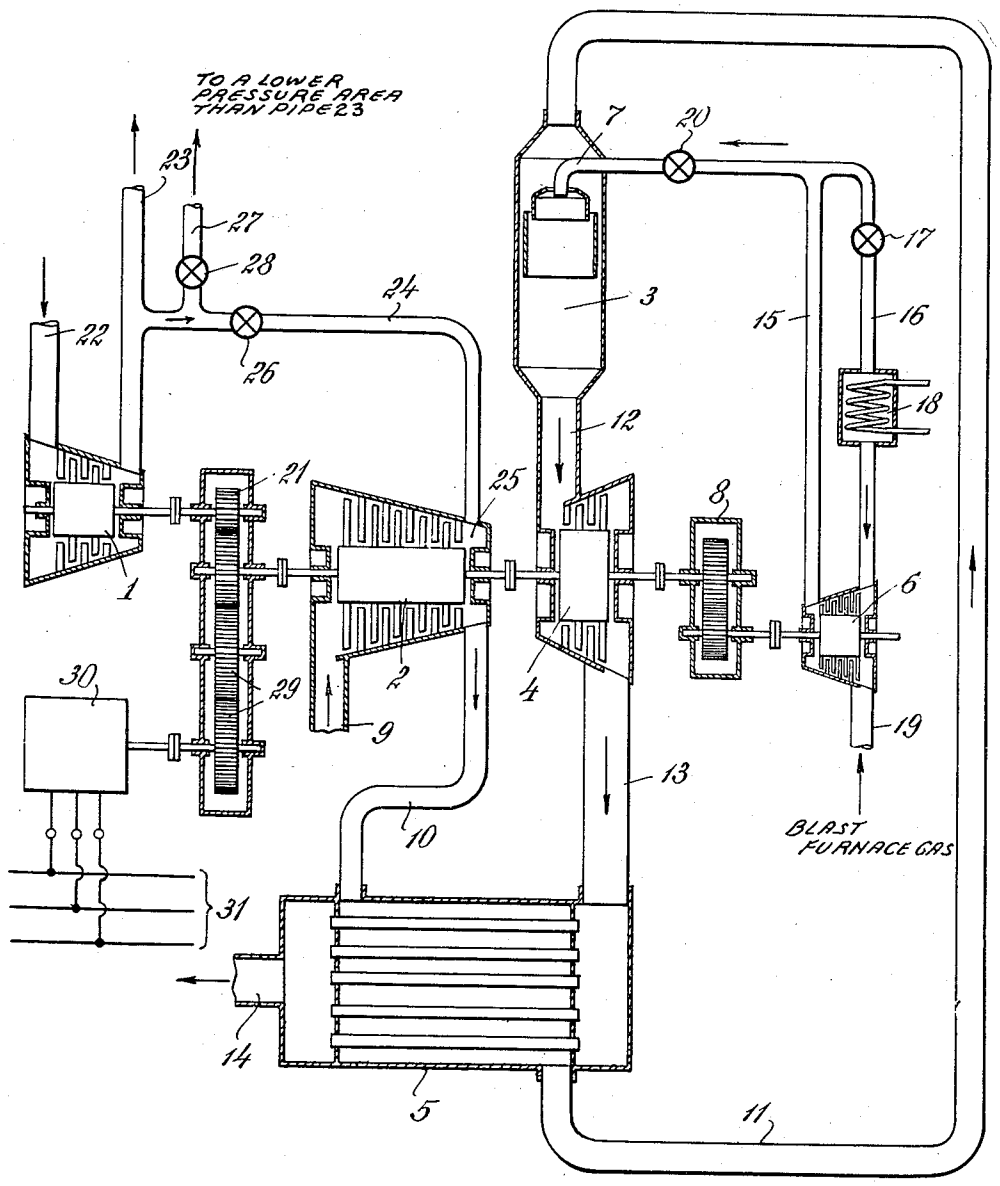
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Fig. 3.



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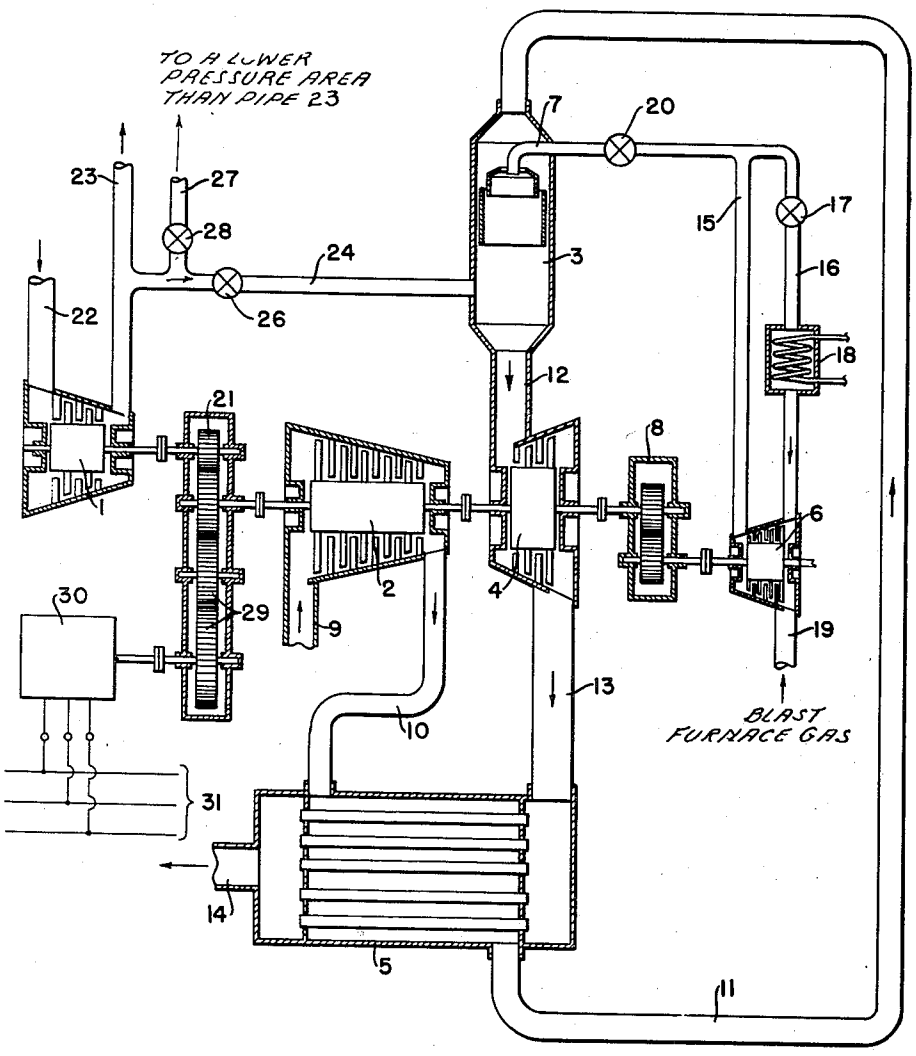


Fig. 4

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GAS TURBINE DRIVEN PLANT FOR SUPPLYING COMPRESSED AIR

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Continuation of abandoned applications Serial No. 276,179, March 12, 1952, and Serial No. 282,103, April 14, 1952. This application July 30, 1954, Serial No. 446,916

9 Claims. (Cl. 60—39.07)

This invention relates to a gas turbine driven installation for the production of a supply of compressed air. The installation has an output compressor (hereinafter for clarity called a "blower") which is driven by a gas turbine plan having its own separate compressor (hereinafter for clarity called the "main compressor") which in turn compresses the turbine working medium, in the example shown, the combustion air supplied to the combustion chamber. In closed or semi-closed cycle gas turbine plants, the fluid compressed in the main compressor might be not at all or only partly used as combustion air. This application is a continuation of my applications Serial No. 276,179 and Serial No. 282,103 filed March 12, 1952 and April 14, 1952 respectively, now abandoned.

Recently, attempts have been made to accelerate combustion processes in general, and in particular, in blast furnaces, by increasing the pressure of the combustion air supplied by blowers. Pressures so increased are in the range of pressures which are also sufficient for the operation of gas turbine plants. The use of a gas turbine as a prime mover plant makes possible a particularly favorable regulation of the blower. According to this invention, the delivery side of the blower is connected by a regulating pipe to a part of the gas turbine plant containing the plant working medium where the pressure of the working medium is less than that of the air on the discharge side of the blower. Means are provided in the regulating pipe for adjusting flow from the blower to the point in the working medium path where the pressure is less than that of the delivery side of the blower. Air will then flow because of the pressure differential from the blower to the main compressor under all conditions of normal plant operation if the regulating means in the regulating pipe are left open. If there is a sudden drop in the demand for air, the surplus can be diverted without loss to the gas turbine plant proper and the energy therein contained can be utilized instead of wasted.

The blower may, in addition, be connected through a discharge pipe with a point outside the plant, which has a lower pressure, at least during normal operations, than prevails at the entrance into this discharge pipe. An element for the adjustment of its through-flow cross-section may also be disposed in the discharge pipe. The gas turbine installation may also be coupled additionally with an electric machine, which is connected to an electric power distribution network. A cooler and, if necessary, a non-return valve can be arranged in the regulating pipe, which non-return valve prevents an outflow of working medium from the compressor of the gas turbine installation. In the delivery pipe of the blower an element for the adjustment of the through-flow cross-section may be disposed. In certain cases the blower may be driven by the gas turbine installation through speed multiplication gearing. The electric machine may be driven by the gas turbine installation through a friction clutch disengageable at will.

The invention is explained in more detail below, in

connection with three examples of compressed air plants diagrammatically illustrated in the accompanying drawings, in which like numerals denote like parts and in which:

Fig. 1 shows a simple plant;

Fig. 2 discloses a more complicated plant having a number of additions to the plant shown in Fig. 1;

Fig. 3 shows a plant having a main compressor different from that shown in Figs. 1 and 2; and

Fig. 4 shows a plant wherein a regulating pipe runs from the delivery side of the blower to the combustion chamber of the gas turbine installation.

In the plants according to both Figs. 1 and 2, there is a blower **1**, which is driven by a gas turbine installation. The gas turbine installation in both comprises basically a compressor **2**, a combustion chamber **3**, a gas turbine **4** and a recuperator **5**. A gas, for example blast furnace gas, is used in the installations illustrated as fuel for the combustion chamber **3** and is supplied through a compressor **6** to a burner **7**. The compressor **6** is driven by the gas turbine **4** through a speed multiplying gear **8**.

The compressor **2** of the gas turbine installation sucks combustion air through an intake pipe **9**, compresses the same and conveys it through a pipe **10** into the recuperator **5**. Here it is preheated by exhaust gas from the gas turbine **4** and then led through a pipe **11** into the combustion chamber **3**. The fuel gas introduced through the burner **7** burns in the air delivered from compressor **2**, producing a heated gaseous mixture of combustion products and excess air gases. These heated and compressed gases then pass through a pipe **12** into the turbine **4** and, after being expanded therein to produce power, pass through a pipe **13** into the recuperator **5**. After giving off a part of their heat in recuperator **5** to the freshly compressed air, these gases flow through a pipe **14** away from the gas turbine installation.

For regulating the output of the gas turbine installation, the pipe **15**, through which fuel gas is supplied to the burner **7**, has a by-pass pipe **16**, through which, according to the adjustment of the flow regulating element **17**, a part of the compressed fuel gas can be led back to the compressor **6**. In order to avoid an inadmissible heating in this case, a cooler **18** is arranged in by-pass pipe **16**, which cools returned gas to about the temperature of the fuel being supplied through pipe **19**. In pipe **15** there is also a flow regulating element **20** by which regulation of the gas turbine installation can be still further improved.

The described gas turbine installation is coupled through a speed multiplying gear **21** with the blower **1**. This production compressor sucks in air, e. g. from the open air, through a pipe **22** and conveys it through the pipe **23** to a point of use not shown, for example as combustion air into a blast furnace.

According to the invention the blower is connected through a regulating pipe **24** with an intermediate stage **25** of the compressor **2** of the gas turbine installation. This intermediate stage has, during normal operations, a lower pressure than that prevailing at the entrance into the regulating pipe **24**. Furthermore an element **26** is disposed in the regulating pipe **24**, which serves for the adjustment of the through-flow cross-section. In addition there is connected to the regulating pipe **24** a discharge pipe **27** with a flow regulating element **28**, through which compressed air can be discharged outside the plant to a point where a lower pressure prevails than in the pipe **27**.

The gas turbine installation is, in addition, coupled through gearing **29** with an electric machine **30**, which in its turn is connected to an electric power supply network **31**.

By adjustment of the cross-section of the regulating

element **26** the amount of air conveyed through the pipe **23** to the point of use can be easily determined within desired limits. The more regulating element **26** is closed, the greater portion of the air delivered by the blower is supplied to the point of use. Conversely, the more the cross-section of the regulating element **26** is made larger, the smaller amount of air flows to the point of use. If the regulating element **26** is completely open, the delivery pressure of the blower and the pressure of the intermediate stage **25** of the compressor **2** of the gas turbine installation are practically equal. Then the greatest possible amount of air flows from the blower over into the compressor **2**. If one wishes to decrease still more the amount of air supplied through pipe **23** to the point of use, valve **28** in discharge pipe **27** is opened, so that a part of the air is discharged outside the plant. In this manner a practically loss-free regulation of the amount of production air delivered by the plant can be attained over the normal range of operations. By this means the efficiency of operation is improved.

A further simplification of the regulation is produced by the electric machine **30**. This machine runs synchronously with the network **31**. If the gas turbine installation generates more power than is required by the blower, the surplus is supplied to the network **31** in the form of electric energy. Without any regulating adjustments the supply of electric energy, surplus energy, is always adapted to the difference between gas turbine output and the power required by the blower. If the output of the gas turbine installation is smaller than the power demanded by the blower, the electric machine **30** operates as a motor and supplements the lack of power. In most cases, however, it will be desirable to so proportion the plant that in any foreseeable state of operation power will be supplied to the network by the electric machine **30**. If the electric machine **30** is mechanically disconnected from it, the gas turbine **4** can be operated at a greater or lesser speed independently of the frequency of the network **31**.

As shown in Fig. 2, a cooler **32** can be disposed in the regulating pipe **24**, by which the efficiency of the gas turbine installation can be still further improved. In addition, it is desirable to arrange a check valve **33** in pipe **24** in order to prevent a return flow of air from compressor **2** to the discharge pipe **27**.

The fuel gas compressor **6** can also be equipped with a recuperation motor **34** disposed in the bypass pipe **16**. By these measures the efficiency of the delivery of fuel gas can be still somewhat improved.

Finally, a hydraulic coupling **35** can be used between the gas turbine **4** and the electric machine **30**, so that the operation of the gas turbine installation can be adjusted independently of the frequency of the network. The coupling **35** is constructed as hydraulic gear so that the speed and thus the transmitted moment can be altered suitably. In the place of such hydraulic gear, a suitable equivalent mechanical gear could also be used.

A flow regulating element **36** may also be advantageously disposed in the pipe **23** supplying air from the blower to point of use.

Of course, it will be readily understood that the gas turbine installation can be operated on other fuel, for example on coal or oil. In using coal, this would preferably be in dust form.

In Fig. 3, a slightly different embodiment of the invention is shown than that disclosed in Fig. 1. Here the

regulating pipe **24** is connected to the discharge side of the main compressor **2** which is so dimensioned that it generates a lower pressure than the blower **1** under normal plant conditions. It is also possible when using a main compressor dimensioned according to this embodiment of the invention to have the regulating pipe **24** connect to any point in the path of the flow of the working medium between the recuperator **5** and the gas burner or even to the burner itself, as seen in Fig. 4.

I claim:

1. In an installation for producing compressed air for external use of the type in which a blower for the product air is driven by a gas turbine power plant which includes a separate main compressor to compress air from the atmosphere for intra-power plant use, a regulating pipe, and a pipe running from the discharge side of said blower to the point of external use, the improvement characterized in that the outlet of the blower is connected by said regulating pipe to a point in the path of the at least partially compressed working medium of said gas turbine power plant which has a lower pressure than the delivery pressure of said blower, means in said regulating pipe for adjusting flow of compressed air from said blower to said point in the path of said working medium and an electric machine connected to an electrical power supply network in driving and driven coupling to the gas turbine power plant.

2. An installation according to claim 1 wherein the point in the path of the working medium having less pressure than the delivery side of said blower is at an intermediate stage of said main compressor and wherein said regulating pipe leads to said intermediate stage.

3. An installation according to claim 1, wherein the pressure of the working medium on the delivery side of the main compressor is less than the pressure of the compressed air on the delivery side of the blower and wherein said regulating pipe intersects the path of the working medium downstream of said main compressor.

4. An installation according to claim 1 wherein the delivery side of the blower is connected to a conduit having therein a regulating means for regulating flow to a point outside of said installation, said conduit being in addition to said regulating pipe and said pipe running to the point of external use.

5. An installation according to claim 1 wherein there is a cooler mounted in said regulating pipe.

6. An installation according to claim 1 wherein said regulating pipe is provided with a check valve to prevent flow of the working medium from said main compressor through said regulating pipe.

7. An installation according to claim 1 wherein said blower is mechanically coupled with the turbine of said turbine power plant by a speed increasing gear train.

8. An installation according to claim 7 wherein the coupling of the electric machine is capable of engaging or disengaging.

9. An installation according to claim 7 wherein said regulating pipe is connected with a combustion chamber of the gas turbine plant.

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