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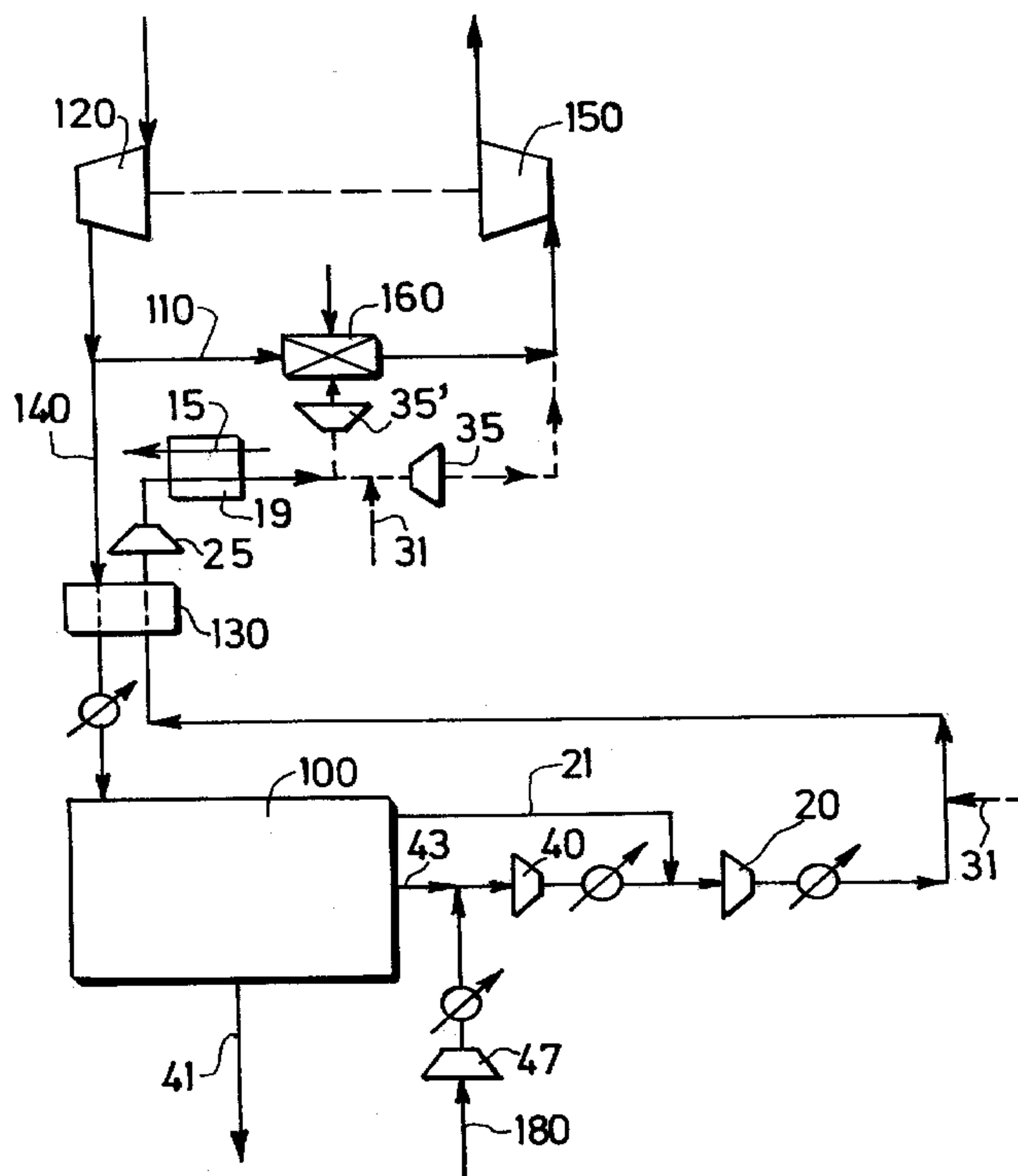
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(54) **SYSTEME INTEGRE DE PRODUCTION D'ENERGIE**

(54) **INTEGRATED POWER GENERATION SYSTEM**

(57) In an air separation plant integrated with another process, work is recovered from a nitrogen-enriched stream produced by an air separation process either by expanding the nitrogen-enriched stream directly in a turbine or by combustion of the nitrogen-enriched stream with a fuel stream and expanding gas produced by the combustion. The work produced by the expansion is maximized by mixing the nitrogen-enriched stream before the expansion step with a further gas stream which may be air or may contain at least about 2 mol.% oxygen and/or at least about 2 mol.% argon and/or at least about 10 mol.% carbon dioxide.

ABSTRACT OF THE DISCLOSURE

In an air separation plant integrated with another process, work is recovered from a nitrogen-enriched stream produced by an air separation process either by expanding the nitrogen-enriched stream directly in a turbine or by combustion of the nitrogen-enriched stream with a fuel stream and expanding gas produced by the combustion. The work produced by the expansion is maximized by mixing the nitrogen-enriched stream before the expansion step with a further gas stream which may be air or may contain at least about 2 mol.% oxygen and/or at least about 2 mol.% argon and/or at least about 10 mol.% carbon dioxide.

INTEGRATED POWER GENERATION SYSTEM

TECHNICAL FIELD

This invention relates to an air separation plant and an air separation
5 process integrated with another process. Work is recovered from the nitrogen-
enriched stream produced by the air separation either by expanding the nitrogen-
enriched stream directly or by combustion of the nitrogen-enriched stream with a
fuel stream and expanding gas produced by the combustion. The present
invention is related in particular to an integrated power generation system
10 process and apparatus in which a nitrogen-enriched stream from an air
separation unit is sent to a point upstream of the expander of a gas turbine.

BACKGROUND OF THE INVENTION

Such integrated systems are well known. For example, EP-A-0622535
15 discloses an integrated power generation system in which nitrogen from an air
separation unit is mixed with air and the mixture is sent to the compressor of a
gas turbine and subsequently to the combustor. The nitrogen is cooled by
expansion or addition of water before the mixing step to increase the gas
throughput in the compressor.

20 EP-A-0538118 describes mixing nitrogen and compressed air from the air
compressor before sending the mixture to the combustor of a gas turbine.

In US Patent No. 5,076,837, a nitrogen stream is heated using a waste
gas stream before being expanded in a turbine. The waste gas stream is
produced by a chemical process using oxygen from the air separation unit.

25 EP-A-0225864 uses combustion gases to preheat nitrogen from an
adsorption process before expanding the nitrogen in a turbine.

US Patent No. 4,785,621 discloses an air compressor which produces two
air streams, one of which is sent to an air separation unit. The other air stream
is mixed with the nitrogen produced by the air separation, warmed using waste
30 heat from a fired gas turbine and subsequently expanded in a turbine.

JP-A-57183529 and JP-A-57083636 describe a coal gasification power plant in which nitrogen from an air separation unit is mixed with air, compressed and sent to a combustor to produce combustion gas.

5 In US Patent No. 3,731,495 air from a gas turbine compressor is divided in three. One part feeds an air separation unit producing impure nitrogen, one part is sent to the combustor and the rest is mixed with the gases from the combustor and the impure nitrogen at a temperature of about 1350°F.

10 US Patent No. 4,557,735 shows a similar arrangement in which nitrogen which has served to regenerate the adsorbent beds is sent to the combustor of a gas turbine. In this case, an air stream is mixed with the compressed nitrogen and sent to the combustor.

EP-A-0568431 describes an air separation unit producing oxygen, argon and krypton/xenon which is integrated with a gas turbine.

15 SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided an integrated power generation system apparatus comprising an air separation unit, a gas turbine comprising a combustor and an expander, a first compressor, means for sending air from the first compressor to the combustor and to the air separation
20 unit, means for sending a nitrogen-enriched stream from the air separation unit to a point upstream of the expander, and means for sending a further gas enriched in a component chosen from the group comprising oxygen, argon and carbon dioxide to a point upstream of the expander.

25 BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to the following figures:

Figures 1, 2, 3, 4, 5 and 6 are schematic diagrams of six embodiments of the process of the present invention.

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DETAILED DESCRIPTION OF THE DRAWINGS

Further optional features of the invention disclosed under the Summary of the Invention include means for mixing the further gas with the nitrogen-enriched stream from the air separation unit to form a gaseous mixture, means for sending the gaseous mixture to the input of the expander or means for sending
5 the gaseous mixture to the input of the combustor.

In particular, the apparatus may comprise means for feeding a fluid from the air separation unit to a plant from which the further gas is derived.

The example shows means for sending oxygen from the air separation unit to a reformer and means for deriving a carbon dioxide-enriched stream from
10 the synthesis gas produced by the reformer. The carbon dioxide-enriched stream is then mixed with the nitrogen-enriched stream and heated using the synthesis gas or another gas before being expanded.

Optional features of the process for generating power include mixing the further gas with the nitrogen from the air separation unit to form a gaseous
15 mixture, sending the gaseous mixture to the input of the expander or sending the gaseous mixture to the input of the combustor.

In particular, the process may be an integrated gasification combined cycle process in which oxygen from the air separation unit is sent to gasify a carbon containing substance thereby producing fuel for the combustor.

20 Figure 1 shows the case where nitrogen is mixed with air to form a nitrogen-enriched air stream. The mixture is then warmed and sent to a point upstream of the expander.

Air is compressed in a compressor 120 of a gas turbine. Part of the air 110 is sent to the combustor 160 and the rest 140 is sent to an air separation
25 unit 100. The air separation unit may also receive air from another independent compressor (not shown). The air separation unit is typically a cryogenic distillation unit comprising at least two thermally linked columns containing trays or structured packings. It may additionally comprise an argon separation column fed from one of the other columns. Alternatively, it may simply comprise a single
30 column.

The air separation unit 100 in the case illustrated produces oxygen-enriched stream 41 which may, for example, be sent to a coal gasification unit (not shown) and nitrogen-enriched streams 21, 43 at two different pressures. An air stream 180 from compressor 47 is optionally mixed with the low pressure
5 nitrogen-enriched stream 43, compressed in compressor 40, mixed with the high pressure nitrogen-enriched stream 21 and further compressed in compressor 20. It is subsequently warmed in heat exchanger 130 against feed air 140 which is cooled in the heat exchanger 130 before cooling within the air separation unit 100 to a temperature suitable for distillation.

10 The air stream may alternatively be mixed with the nitrogen-enriched stream downstream of compressor 40 or compressor 20.

The mixed stream is then sent to the combustor 160 with the fuel stream. The combustion gases are sent to the expander and are used to generate electricity or drive a compressor.

15 The mixed stream may alternatively be sent to the input of the expander as shown in dashed line in Figure 1.

Alternatively, the air may be mixed with the nitrogen-enriched stream downstream of the warming step.

20 It may be advantageous to heat the nitrogen-enriched stream/air mixture in heat exchanger 19 downstream of heat exchanger 130 by heat exchange with a hot gaseous stream 15 as will be described in further detail below.

In all cases, the air stream may be replaced by a gaseous stream containing at least about 50 mol.% of gaseous oxygen, argon, carbon dioxide or another gas which may be expanded safely in the turbine, preferably at least
25 about 60 mol.% of gaseous oxygen, argon or carbon dioxide, more preferably at least about 70 mol.% of gaseous oxygen, argon or carbon dioxide, and still more preferably at least about 80 mol.% of gaseous oxygen, argon or carbon dioxide, for example an impure oxygen stream, an argon stream, a carbon dioxide stream.

In this way, it is possible to make use of a further gas to increase the mass of the stream to be expanded in the gas turbine and thereby increase the power that can be produced.

It will be appreciated that the gaseous nitrogen-enriched stream may be withdrawn in gaseous form from the air separation columns or may be withdrawn in liquid form and vaporized against the feed air stream or a nitrogen stream, following an optional pressurization step.

The nitrogen stream or mixed stream (depending whether stream 180 is mixed with the nitrogen-enriched streams 21, 43 or not) is preferably heated to a temperature of at least about 600°C, preferably around 1000°C in exchanger 19, which may be a pebble heater.

In Figure 2, the nitrogen stream or the mixed stream (depending whether stream 180 is mixed with the nitrogen-enriched streams 21, 43 or not) is compressed to a pressure of from about 10 to about 30 bara in compressor 20, then warmed to ambient temperature and compressed to from about 30 to about 100 bara in compressor 25 before being warmed to at least about 600°C, preferably around 1000°C in exchanger 19. The heated nitrogen stream or mixed stream is sent to turbine 35 or 35' depending whether it is to be sent to the combustion chamber 160 or directly to the expander inlet. Preferably, the compressor 25 and turbine 35, 35' are coupled.

In Figure 3, a cryogenic air separation unit 1 comprises a double column with a low pressure column operating in a range of from about 5 to about 10 bar (not shown). The nitrogen-enriched stream 3, containing about 90 mol.% nitrogen, produced by the low pressure column is mixed with a further gas, in this case gaseous carbon dioxide-enriched stream 5, containing about 90 mol.% carbon dioxide, at about the same pressure and compressed in compressor 7 to a pressure in a range of from about 15 to about 80 bara. The nitrogen from the high pressure column may also be compressed in compressor 7 and mixed with the carbon dioxide-enriched stream.

Alternatively, a nitrogen-enriched stream from only the low pressure column or only the high pressure column may be used.

The double column may be replaced by a single column or a triple column or a system comprising four or more columns. The air separation unit may also comprise an argon column or a mixing column.

5 The pure oxygen 9 from the air separation unit 1 is sent to an auto thermal reformer 29 or another type of reformer together with natural gas 11 and steam 13.

Synthesis gas 15 is removed from the reformer 29 at a temperature of about 1050°C and a pressure in a range of from about 20 to about 80 bar.

10 The synthesis gas is cooled against the mixture 17 of principally nitrogen and carbon dioxide compressed in compressor 7 in a heat exchanger 19 which may be a ceramic heat exchanger or a regenerator.

The synthesis gas is then purified in unit 27 to eliminate the carbon dioxide it contains and at least part of this carbon dioxide is recycled as stream 5 to compressor 7.

15 The mixture of carbon dioxide and nitrogen at about 1000°C coming from heat exchanger 19 is expanded in a turbine 21 to produce energy and/or to drive a compressor of the system, such as the compressor for the air separation unit 1.

20 The carbon dioxide-enriched stream 5 may be replaced by an impure argon-enriched stream (at least about 2 mol.% argon, preferably at least about 30 mol.% argon), an impure oxygen stream (at least about 25 mol.% oxygen, preferably at least about 60 mol.% oxygen) or an air stream. Alternatively, a mixture of any gases containing at least about 10 mol.% carbon dioxide and/or at least about 2 mol.% argon and/or at least about 25 mol.% oxygen and/or air
25 and/or at least about 80 mol.% nitrogen may be added to the nitrogen-enriched stream 3 upstream of the warming step in heat exchanger 19, upstream or downstream of the compressor 7 depending on the pressure at which it is available.

30 The argon- or oxygen-enriched streams may come from air separation unit 1, another air separation unit or another source.

Preferably, the added gases are produced by units consuming a fluid produced by the air separation unit or by the gas turbine.

The additional air may come from the same compressor 2 which compresses air for the air separation unit.

5 The mixture of nitrogen and the further gas may be the sole feed to the turbine. Alternatively, the turbine may be fed by combustion gases from a combustor in addition to the nitrogen mixture.

10 The mixture may be heated using sources of heat, such as slag from a gasifier, blast furnace gas, gas from the expander of a gas turbine, steam, and the like.

In particular, the source of heat may be a unit fed by oxygen-enriched, argon-enriched or nitrogen-enriched fluid from the air separation plant which produces a product gas or waste gas at above ambient temperatures and preferably above about 200°C.

15 The air compressor 2 may also produce air for a fuel combustor .

In Figure 4, the nitrogen gas is compressed in two compressors 7, 25 to bring it to a pressure from about 30 to about 100 bars. The heated gas is then expanded in two expanders 35, 21.

20 In Figure 5, there is shown an air separation unit in which compressed air from compressor 1 is cooled by indirect contact with water in heat exchangers 4, 5 before being fed to purification beds 6, 7, heat exchanger 9 and then to the air distillation apparatus 10. The water 17 is previously cooled in a cooling tower 16 by direct contact with waste nitrogen 19, 20 from the air separation unit 10. Nitrogen-enriched stream 19 has been used to regenerate the purification beds
25 6, 7 and consequently contains carbon dioxide. Either stream 19 or stream 20 or both streams 19 and 20 may be sent to the cooling tower 16. This type of cooling apparatus is described in detail in US Patent No. 5,505,050. At the top of the tower, there is produced a nitrogen stream saturated with water vapor 24 which is mixed with a stream of nitrogen-enriched gas 12. In the preferred case,
30 where only stream 20 is sent to the cooling tower, the stream 24 will contain from about 0 to about 10%, preferably from about 0 to about 2 mol.% oxygen, from

about 0 to about 2 mol.% argon, about 0% carbon dioxide and about 5 mol.% water and the rest of the stream is nitrogen.

The mixed stream 36 is then compressed in compressor 38 and sent to the combustor 160 of a gas turbine. The combustor is also fed with fuel and
5 compressed air 110 from compressor 120.

Optionally, the compressed stream coming from compressor 38 may be heated to an elevated temperature (e.g. above about 600°C) before being sent to the gas turbine. The heating may take place as described previously by indirect heat exchange with a waste stream or a stream which requires to be
10 cooled.

Alternatively, as shown in dashed lines, all or part of the mixed stream may be sent directly to the input of the expander 150.

Compressor 120 may alternatively supply all or part of the air for the air separation unit.

15 Dashed lines 31 on the figures show that other gas streams available on the site such as air, steam and/or gas streams containing at least about 20 mol.% nitrogen, argon, oxygen or carbon dioxide may be added at various points of the process.

Preferably, the added gases are produced by units consuming a fluid
20 produced by the air separation unit or by the gas turbine.

Figure 6 shows a variant of the other figures in which part of the heated nitrogen or heated gaseous mixture is fed back to the inlet of the exchanger 19. This step may take place at the pressure at which the exchange takes place or a lower pressure if compressor 25 and expander 35 are used. It may be
25 necessary to compress the recycled gas if the pressure drop in exchanger 19 is large.

Preferred processes for practicing the invention, as well as preferred apparatus for such processes, have been described. It will be understood that the foregoing is illustrative only and that other processes and apparatus can be
30 employed without departing from the true scope of the invention defined in the following claims.

We claim:

1. An integrated power generation system apparatus comprising an air separation unit, a gas turbine comprising a combustor and an expander,
5 means for sending air to the combustor and to the air separation unit, means for sending nitrogen from the air separation unit to a point upstream of the expander, and means for sending at least one further gas chosen from the group comprising impure oxygen, argon and carbon dioxide to a point upstream of the expander.
10
2. The apparatus of claim 1 comprising means for mixing the further gas with the nitrogen from the air separation unit at a mixing point to form a gaseous mixture.
- 15 3. The apparatus of claim 2 comprising means for sending the gaseous mixture to the input of the expander.
4. The apparatus of claim 2 comprising means for sending the gaseous mixture to the input of the combustor.
20
5. The apparatus of claim 4 comprising means for adding fuel to the gaseous mixture upstream of the combustor.
6. The apparatus of claim 1 comprising a compressor for supplying air to the
25 air separation unit and to the combustor.
7. The apparatus of claim 1 comprising respective compressors for compressing air for the combustion and the air separation unit.
- 30 8. The apparatus of claim 2 comprising means for warming the nitrogen upstream or downstream of the mixing point.

9. The apparatus of claim 8 wherein the means for warming the nitrogen comprise a heat exchanger and a gaseous product or waste stream from a plant in which an exothermic process takes place.
- 5
10. The apparatus of claim 9 wherein the plant in which the exothermic process takes place is fed by a product gas or liquid from the air separation plant.
- 10 11. The apparatus of claim 1 wherein the further gas is air and is not derived from the means for sending air to the combustor.
12. The apparatus of claim 1 comprising means for feeding a fluid from the air separation unit to a plant from which the further gas is derived.
- 15
13. The apparatus of claim 12 comprising means for sending oxygen from the air separation unit to a reformer and means for deriving carbon dioxide from a gas produced by the reformer.
- 20 14. An integrated power generation system apparatus comprising an air separation unit producing gaseous nitrogen, a gas turbine comprising a combustor and an expander, means for sending air to the combustor and to the air separation unit, means for mixing gaseous nitrogen from the air separation unit and air, means for warming the air and nitrogen mixture by indirect heat exchange and means for sending the warmed mixture of air and nitrogen from the air separation unit to a point upstream of the expander.
- 25
- 30 15. The system of claim 14 wherein said air separation unit produces oxygen, means for sending oxygen to a unit in which a exothermic reaction takes place and which produces a process stream or a waste stream, a heat

exchanger and means for sending the air and nitrogen mixture and the process or waste stream to the heat exchanger.

- 5 16. The system of claim 14 wherein the air separation unit is a cryogenic distillation unit.
- 10 17. An integrated power generation system apparatus comprising an air separation unit producing gaseous nitrogen, a gas turbine comprising a combustor and an expander, means for sending air to the combustor and to the air separation unit and means for sending a mixture nitrogen from the air separation unit and air to a point upstream of the expander wherein the air mixed with the nitrogen comes from a source other than the means for sending air to the combustor and to the air separation unit.
- 15 18. A process for generating power using an integrated power generation system apparatus having an air separation unit, a gas turbine comprising a combustor and an expander, comprising the steps of sending air to the combustor and to the air separation unit, sending fuel to the combustion unit, sending nitrogen from the air separation unit to a point upstream of the expander, and sending a further gas selected from the group comprising oxygen, argon and carbon dioxide to a point upstream of the expander.
- 20 19. The process of claim 18 comprising mixing the further gas with the nitrogen from the air separation unit to form a gaseous mixture.
- 25 20. The process of claim 18 comprising sending the gaseous mixture to the input of the expander.
- 30 21. The process of claim 18 comprising sending the gaseous mixture to the input of the combustor.

22. The process of claim 21 comprising mixing fuel with the gaseous mixture.
- 5 23. A process in which air is separated to produce at least a nitrogen-enriched stream, comprising the steps of the mixing the nitrogen-enriched stream with a stream of compressed air to form an enriched nitrogen air stream, warming the enriched nitrogen air stream by indirect heat exchange, sending air and a fuel gas stream to a combustor to generate a combustion stream, expanding the combustion stream in an expander, 10 and sending the enriched nitrogen air stream to a point upstream of the expander.
- 15 24. The process of claim 23 wherein the oxygen-enriched stream is used to gasify a carbon-containing fuel source to generate the fuel gas stream.
25. The process of claim 23 wherein the enriched nitrogen air stream is not compressed before being sent to the combustor.
- 20 26. The process of claim 23 wherein the enriched nitrogen air stream is warmed to a temperature of at least about ambient temperature before being sent to the point upstream of the expander by indirect heat exchange with a gaseous stream which is a product or a waste stream.
- 25 27. The process of claim 26 wherein the gaseous stream is produced by a unit fed by the oxygen-enriched stream.
- 30 28. The process of claim 23 wherein the nitrogen-enriched stream is mixed with a stream of a further compressed gas chosen from the group comprising carbon dioxide, argon and impure oxygen and the mixed stream is used to produce work in the expander.

29. The process of claim 23 wherein the nitrogen-enriched air is sent to the inlet of the expander.
- 5 30. The process of claim 23 wherein the nitrogen-enriched air is sent to the combustor.
- 10 31. An integrated air separation apparatus comprising an air separation unit, means for sending air to the air separation unit, means for sending a nitrogen-enriched gas stream from the air separation unit to a point upstream of an expander, and means for sending at least one further gas which is air or which contains at least about 2 mol.% oxygen, preferably at least about 25 mol.% oxygen, and/or at least about 2 mol.% argon and/or at least about 10 mol.% carbon dioxide and/or at least about 70% nitrogen to the nitrogen-enriched gas stream at a point upstream of the expander, 15 means for mixing the at least one further gas with the nitrogen-enriched stream from the air separation unit at a mixing point to form a gaseous mixture and means for sending the mixture upstream of the expander.
- 20 32. An apparatus according to claim 31 wherein the at least one further gas contains at least about 70 mol.% oxygen and/or at least about 30 mol.% argon and/or at least about 90% carbon dioxide.
- 25 33. An apparatus according to claim 32 wherein the at least one further gas contains at least about 80 mol.% oxygen and/or at least about 80 mol.% argon and/or at least about 95% carbon dioxide.
- 30 34. An apparatus according to any one of claims 31 to 33 comprising a heat exchanger, means for sending air to the heat exchanger, means for sending air from the heat exchanger to the air separation unit, means for sending the nitrogen-enriched gas stream from the air separation unit to the heat exchanger, means for sending nitrogen-enriched stream from the

heat exchanger to a point upstream of the expander, and means for sending the at least one further gas to the nitrogen-enriched gas stream at a point upstream or downstream of the heat exchanger.

- 5 35. An apparatus according to any one of claims 31 to 34 comprising means for sending the gaseous mixture to the input of the expander.
36. An apparatus according to Claim 35 wherein the expander is a turbine.
- 10 37. An apparatus according to any one of claims 31 to 34 comprising means for sending the gaseous mixture to an input of a combustor upstream of a gas turbine expander and means for sending the combustion gases from the combustor to the expander.
- 15 38. An apparatus according to claim 37 comprising means for adding fuel to the gaseous mixture upstream of the combustor.
39. An apparatus according to any one of claims 35 to 38 comprising a
20 compressor for supplying air to the air separation unit, the combustor, or both.
40. An apparatus according to any one of claims 35 to 38 comprising
 respective compressors for compressing air for the combustor and the air
25 separation unit.
41. An apparatus according to any one of claims 31 to 40 comprising means for warming the nitrogen-enriched stream upstream or downstream of the mixing point.
- 30 42. An apparatus according to claim 41 wherein the means for warming the nitrogen-enriched stream comprises a heat exchanger, and means for

sending a gaseous product or waste stream from a plant in which an exothermic process takes place and for sending at least the nitrogen-enriched stream to the heat exchanger.

- 5 43. An apparatus according to claim 42 wherein the plant in which the exothermic process takes place is fed by a gas or liquid produced by the air separation plant or compressed air from a compressor of the installation.
- 10 44. An apparatus according to any one of claims 31 to 43 wherein the further gas is air and is not derived from the means for sending air to the combustor.
- 15 45. An apparatus according to any one of claims 31 to 44 comprising means for feeding a fluid from the air separation unit to a plant from which the further gas is derived.
- 20 46. An apparatus according to claim 45 comprising means for sending an oxygen-enriched stream from the air separation unit to a reformer and means for deriving a carbon dioxide-enriched stream from a gas produced by the reformer and means for sending the carbon dioxide-enriched gas to the nitrogen stream.
- 25 47. An apparatus according to any one of claims 31 to 46 wherein the at least one further gas which is air or which contains at least about 25 mol.% oxygen and/or at least about 2 mol.% argon and/or at least about 10 mol.% carbon dioxide comes from the air separation unit.
- 30 48. An integrated power generation system apparatus comprising an air separation unit producing at least one nitrogen-enriched gas stream, a gas turbine comprising a combustor and an expander, means for sending

air to the combustor and to the air separation unit and means for sending a mixture comprising the nitrogen-enriched gas stream from the air separation unit and air to a point upstream of the expander wherein the air mixed with the nitrogen-enriched stream comes from a source other than the means for sending air to the combustor and to the air separation unit.

49. An integrated power generation system apparatus comprising an air separation unit producing a nitrogen-enriched gas stream, a gas turbine comprising a combustor and an expander, a heat exchanger for cooling air by indirect heat exchange with cooling water, means for sending cooled air to the air separation unit, and means for removing at least first and second nitrogen-enriched gas streams from the air separation unit, a cooling tower for placing in direct contact the first nitrogen-enriched gas stream and the cooling water upstream of the heat exchanger, means for removing a humidified nitrogen-enriched stream from the cooling tower, a compressor for compressing the humidified nitrogen-enriched stream and means for sending the humidified nitrogen-enriched gas stream from the compressor unit to a point upstream of the expander.

50. The system of claim 49 wherein the compressed humidified nitrogen-enriched stream is mixed with the second nitrogen-enriched stream.

51. The system of claim 49 or 50 wherein the first nitrogen-enriched stream does not regenerate the purification system of the air separation unit before being sent to the cooling tower.

52. A power generation system comprising an air separation unit, means for sending air to the air separation unit, means for removing a nitrogen-enriched stream from the air separation unit and heating it to a temperature above about 600°C, means for sending the heated gas to the

combustion chamber of a gas turbine or up-stream of the expander of a gas turbine.

53. A power generation system according to claim 52 comprising means for
5 compressing the nitrogen-enriched stream, preferably to a pressure from
about 30 to about 100 bars up-stream the heating means.
54. A power generation system according to claim 52 or 53 comprising means
10 for sending a fluid from the air separation unit to a unit which produces a
hot gas stream and means for sending at least part of the hot gas stream
to the heating means so as to heat the nitrogen-enriched gas.
55. A power generation system according to claim 52, 53 or 54 comprising
15 means for mixing the nitrogen-enriched gas with another gas upstream of
the heating means.
56. A power generation system according to claim 52, 53, 54 or 55 comprising
20 means for expanding the heated nitrogen-enriched gas stream upstream
of the combustion chamber or of the expander.
57. An integrated air separation process using an air separation unit and an
expander, comprising the steps of sending air to the air separation unit,
25 sending a nitrogen-enriched stream from the air separation unit to a point
upstream of the expander, and sending at least one further gas stream
other than a fuel stream to a point upstream of the expander to form a
mixture.
58. A process according to claim 57 wherein at least one further gas is air.
- 30 59. A process according to claim 57 or 58 wherein at least one further gas
contains at least about 2 mol.% oxygen, preferably about 25 mol.%

oxygen and/or at least about 2 mol.% argon and/or at least about 10 mol.% carbon dioxide.

- 5 60. A process according to claim 59 wherein at least one further gas contains at least about 70 mol.% oxygen and/or at least about 30 mol.% argon and/or at least about 90 mol.% carbon dioxide.
- 10 61. A process according to claim 60 wherein at least one further gas contains at least about 80 mol.% oxygen or at least about 80 mol.% argon or at least about 95 mol.% carbon dioxide.
- 15 62. A process according to any one of claims 58 to 61 comprising mixing the further gas with the nitrogen-enriched stream from the air separation unit to form a gaseous mixture.
- 20 63. A process according to any one of claims 58 to 62 comprising sending the gaseous mixture to the input of the expander.
- 25 64. A process according to any one of claims 58 to 63 comprising sending the gaseous mixture to the input of a combustor of an expander of a gas turbine.
- 30 65. A process according to any one of claims 58 to 64 comprising removing said further gas comprising at least about 25 mol.% oxygen and/or at least about 2 mol.% argon and/or at least about 10% carbon dioxide from the air separation unit.
66. A process according to any one of claims 62, 63 or 65 when dependent on claim 62 wherein the enriched nitrogen stream is warmed either before or after the mixing step to a temperature of at least ambient temperature

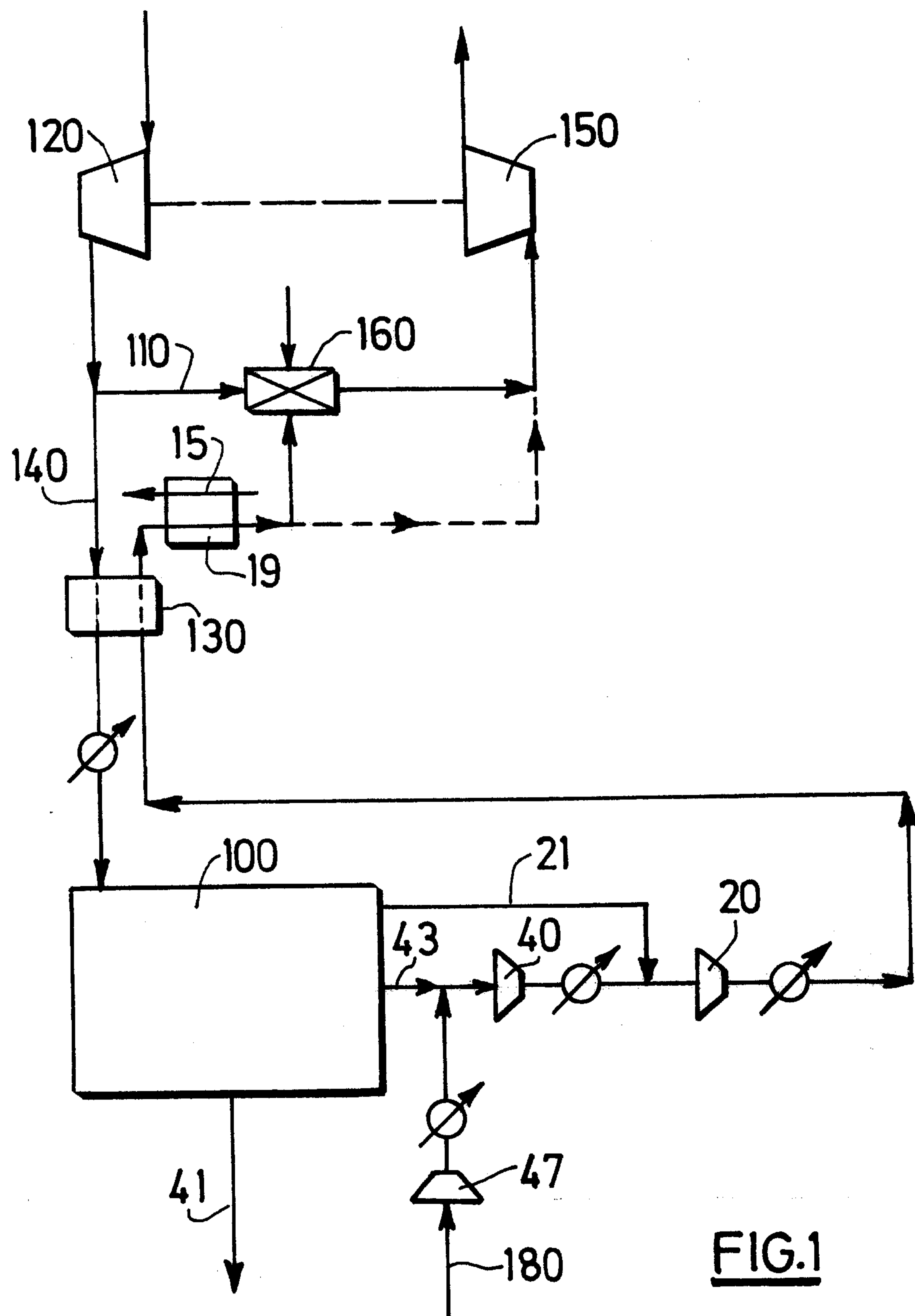
before being sent to the point upstream of the expander by indirect heat exchange with a gaseous stream which is a product or a waste stream.

- 5 67. A process according to claim 66 wherein the gaseous stream is produced by a unit fed by an oxygen-enriched stream or a nitrogen-enriched stream or an argon-enriched stream from the air separation unit or by a compressed air stream from a compressor which also feeds air to the air separation unit.
- 10 68. An integrated power generation process comprising cooling air by indirect heat exchange with cooling water in a heat exchanger, sending cooled air to the air separation unit, separating the air in the air separation unit, removing at least a first nitrogen-enriched gas stream from the air separation unit, placing in direct contact in a cooling tower the first
15 nitrogen-enriched gas stream and the cooling water to be sent to the heat exchanger, removing a humidified nitrogen-enriched stream from the cooling tower, compressing the humidified nitrogen-enriched stream in a compressor unit, sending the humidified nitrogen-enriched gas stream from the compressor unit to a point upstream of an expander of a gas
20 turbine, sending an oxygen-containing fluid and fuel to a combustor of the gas turbine to produce combustion gases and sending combustion gases from the combustor to be expanded in the expander.
- 25 69. An integrated power generation process comprising sending air to an air separation unit, removing a nitrogen-enriched stream from the air separation unit, heating the nitrogen-enriched stream to at least about 600°C by indirect heat exchange in a heat exchanger and sending the heated nitrogen-enriched stream either to the combustion chamber of a gas turbine or upstream of the expander of a gas turbine.

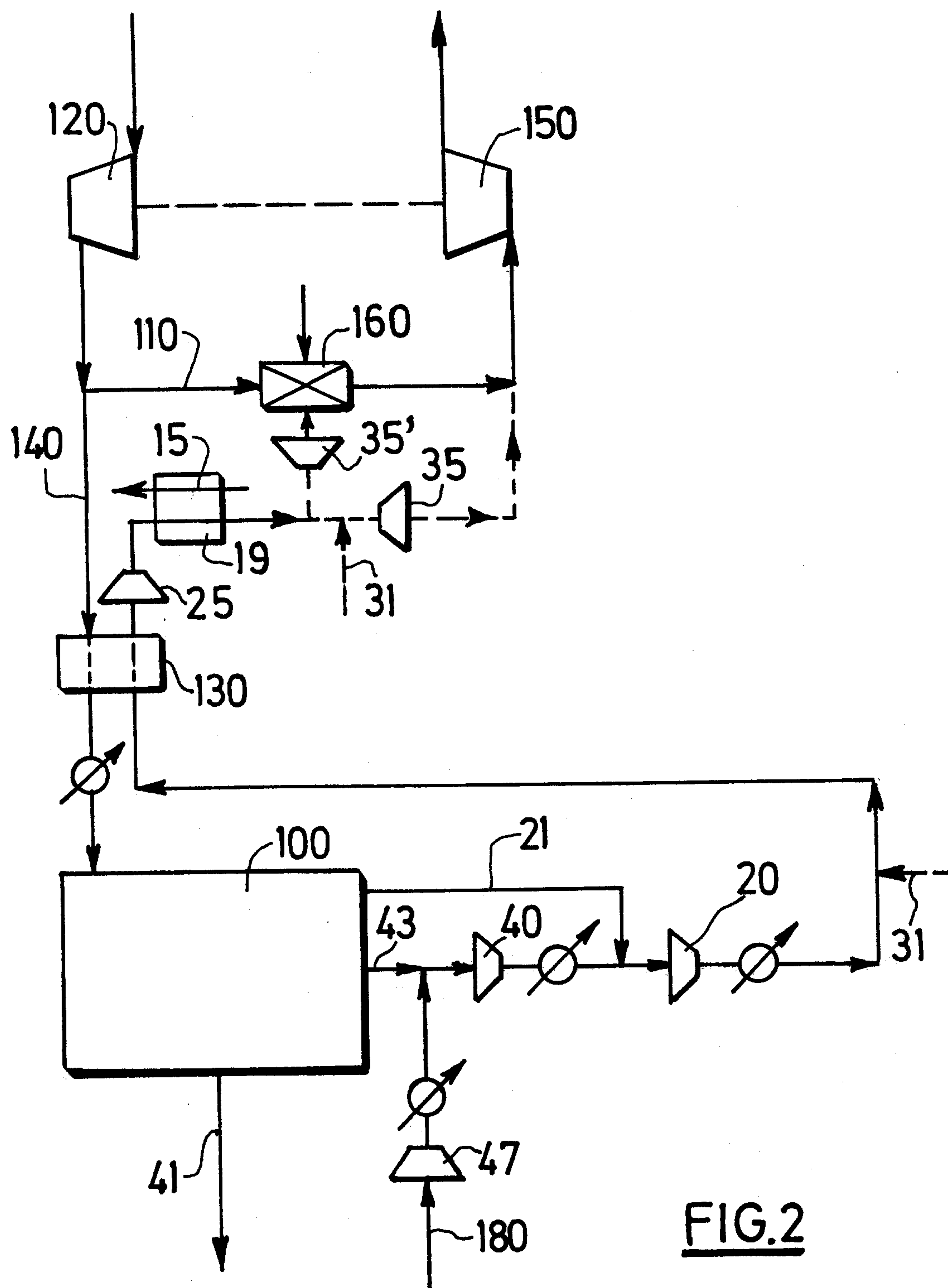
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70. A system according to claim 69 in which the nitrogen-enriched stream is expanded between the heating step and the combustion chamber or the inlet of the expander.
- 5 71. A system according to claim 69 or 70 in which the nitrogen-enriched stream is compressed to a pressure from about 30 to about 100 bars upstream of the heat exchanger.
- 10 72. A system according to any one of claims 69 to 71 in which the nitrogen-enriched stream is mixed with another stream upstream of the heat exchanger.

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FIG.1

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FIG.2

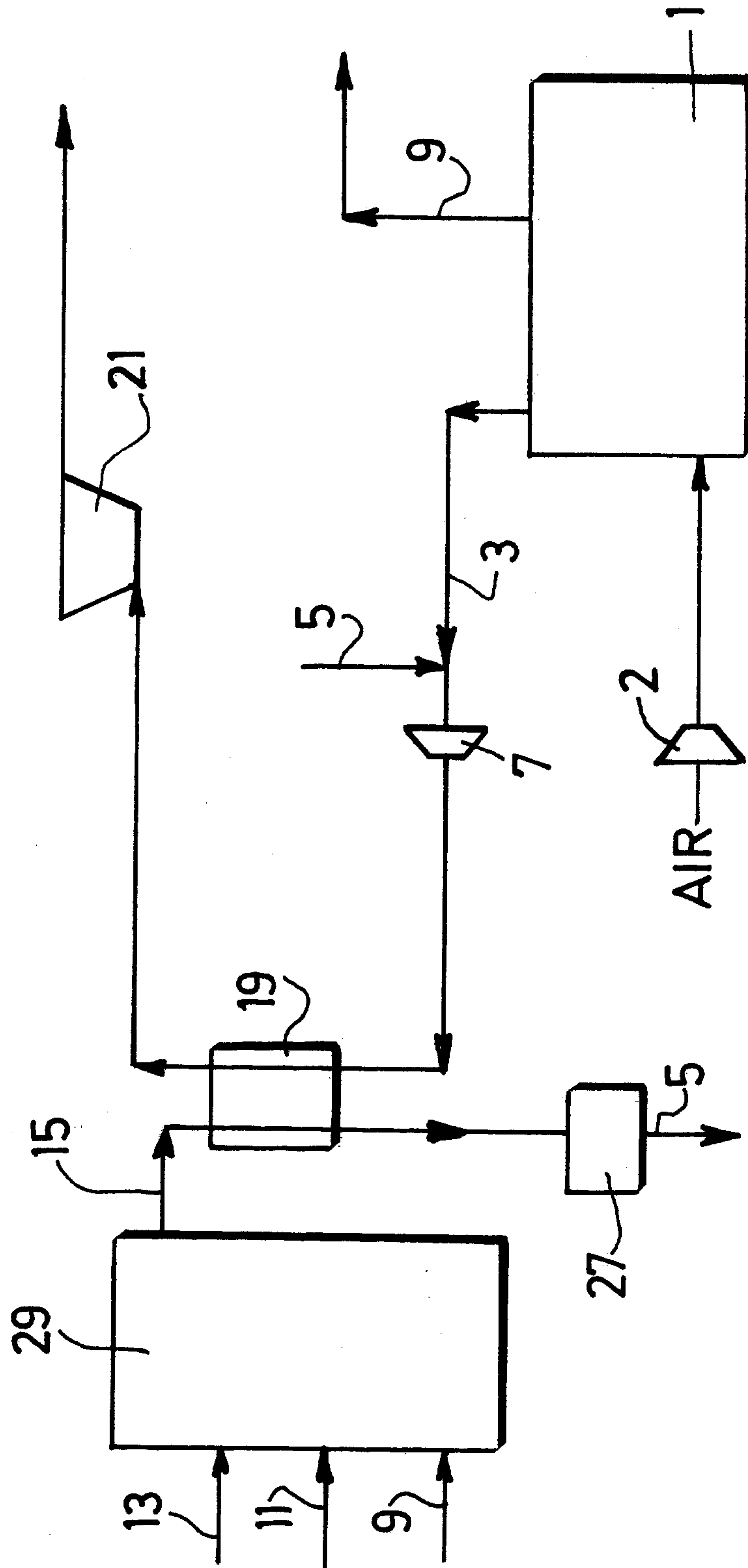
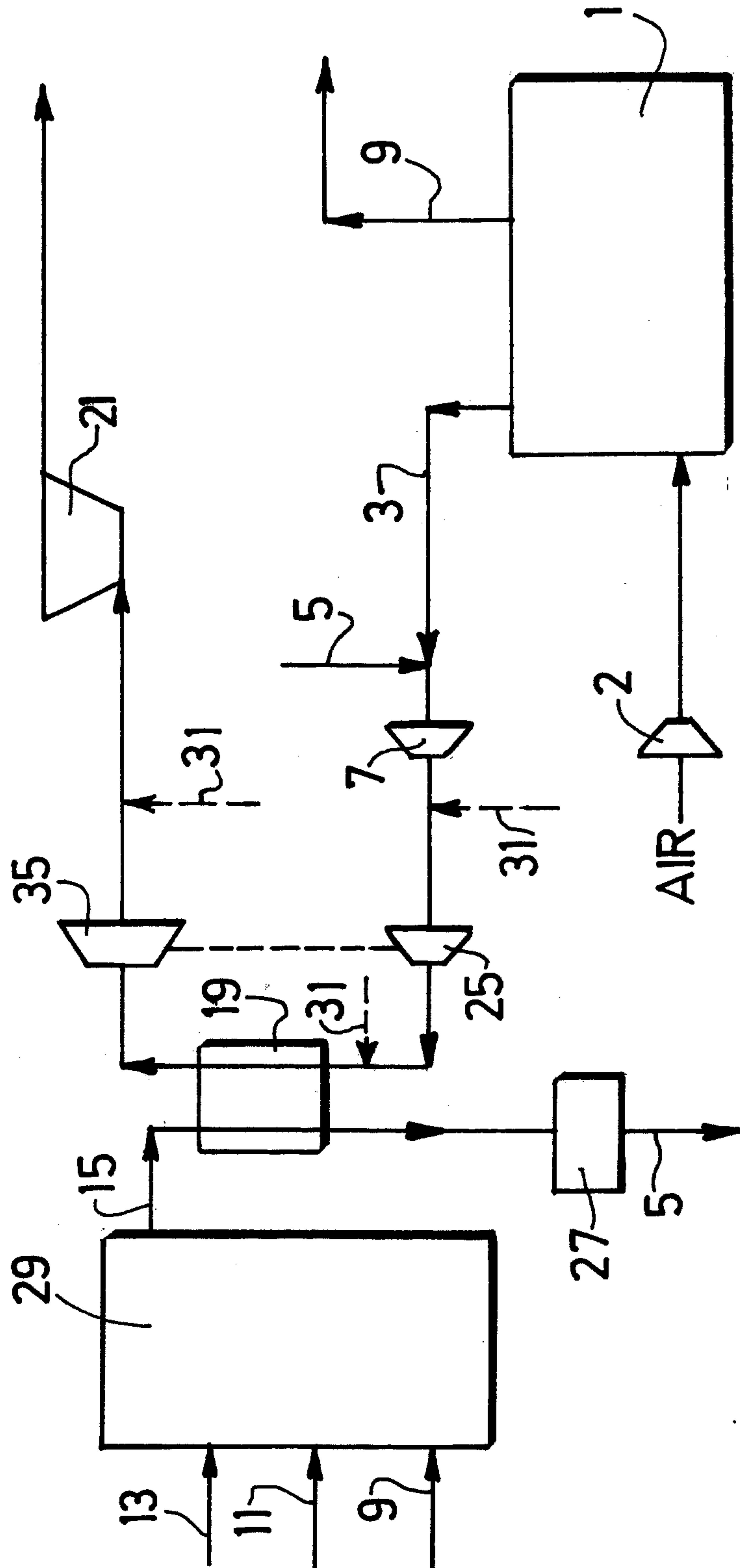
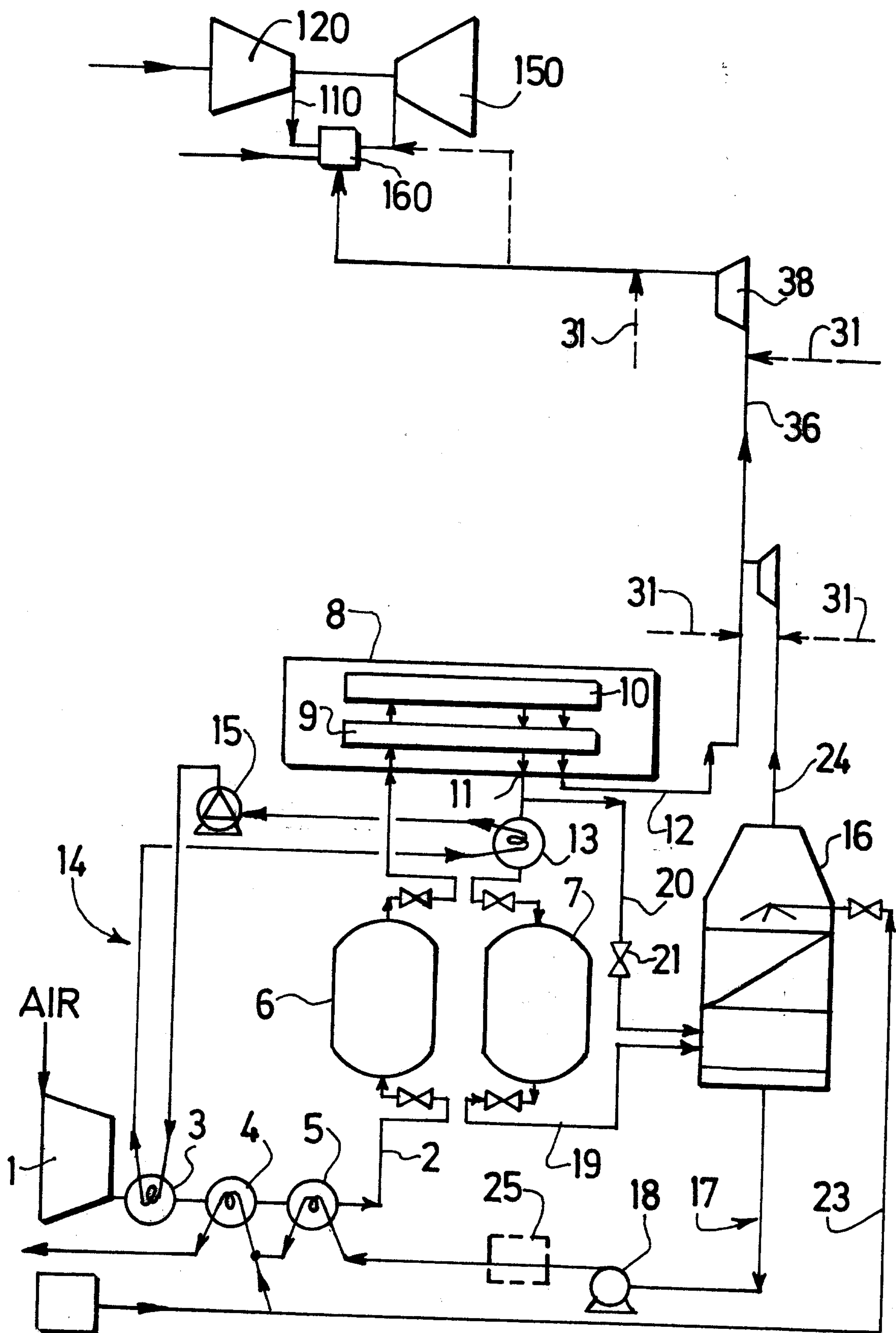


FIG. 3

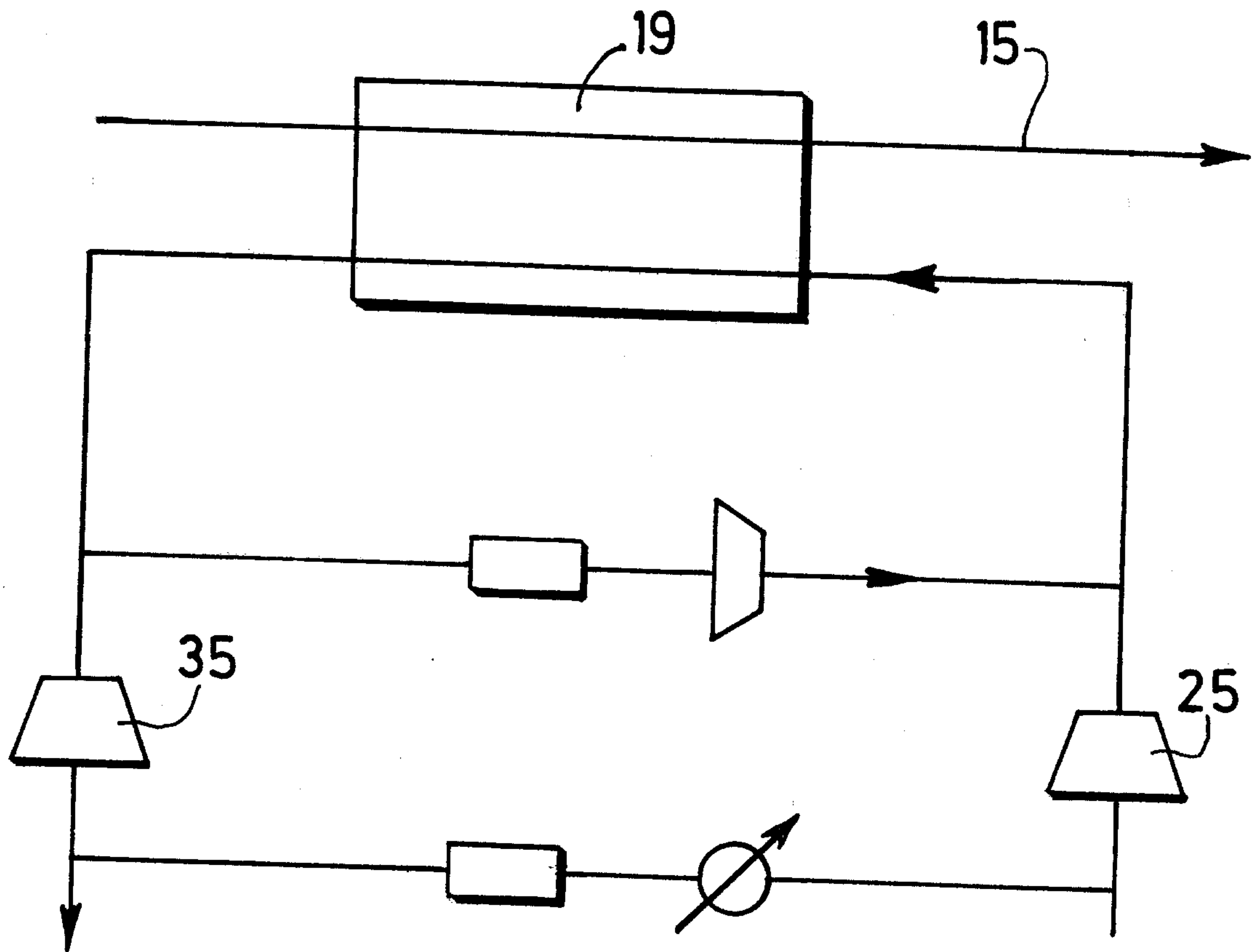
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FIG. 4

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FIG.5

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FIG.6

