

TITLE OF THE INVENTION: AIR SEPARATION DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to an air separation device, and in particular to a construction configuration capable of reducing the installation area and height.

BACKGROUND ART

[0002]

Patent Literature 1 discloses an air separation device for producing products such as oxygen, nitrogen, and argon. The air separation device comprises a plurality of distillation columns for efficiently producing these products, such as a high pressure distillation column, a low pressure distillation column, and a crude argon distillation column. Although these distillation columns may take on various layout configurations from the standpoint of construction, reducing both the installation area and the installation height is desirable to achieve optimized construction.

[0003]

Patent Literature 2 discloses installing a crude argon distillation column in an upper portion of a high pressure distillation column. With this method, however, the condenser installed on top of the high pressure distillation column must be installed in a middle portion of the crude argon distillation column, which greatly increases the total installation height.

[0004]

Patent Literature 3 discloses installing a crude argon distillation column above or beside a low pressure distillation column. Installing above the column, however, greatly increases the height, and installing beside the column enlarges the installation area. In the case that a low pressure distillation column is divided, a high pressure vessel end plate and distributor must be enlarged or a plurality of these installed, which increases installation costs.

PRIOR ART LITERATURE

PATENT LITERATURE

[0005]

PATENT LITERATURE 1	United States Patent Publication No.
2964451	

PATENT LITERATURE 2	International Patent Publication No.
88/01037	

PATENT LITERATURE 3	United States Patent Publication No.
6257656	

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006]

Reflecting on this situation, an object of the present invention is to provide an air separation device capable of lowering the share of height associated with a condenser installed on top of a high pressure distillation column without reducing product production efficiency compared with a conventional air separation device, without enlarging the installation area, and without dividing a low pressure distillation column.

MEANS OF SOLVING THE PROBLEMS

[0007]

The air separation device of the present invention is provided with:

- a first distillation column (11) provided with a first condenser (121, 122) in a location apart from above the column top (113);

- a second distillation column (21) comprising a lower pressure distillation column than the first distillation column (11), and arranged next to the first distillation column (11); and

- at least part of a crude argon distillation column (31) or all of a crude argon distillation column (30) arranged above the column top (113) of the first distillation column (11).

[0008]

In the invention:

- in the case that a part of the crude argon distillation column is arranged above the column top (113),

- the crude argon distillation column may have a lower distillation column (31) arranged above the column top (113), and an upper distillation column (32) arranged next to the second distillation column (21) and/or the first distillation column (11), and provided with a second condenser (324) inside or above the column top (323) thereof.

In the invention:

- in the case that all of the crude argon distillation column is arranged above the column top (113), the crude argon distillation column may be provided with a second condenser (324) inside or above the column top (323) thereof, and be arranged only above the column top (113).

[0009]

In the invention:

- the first condenser (121) may be arranged diagonally above the column top (113).

[0010]

In the invention:

the first condenser (122) may be arranged below or on the bottom (211) of the second distillation column (21).

[0011]

In the invention:

the first distillation column (11) may contain or not contain the first condenser (12), and may be arranged inside a first cold box (10).

[0012]

In the invention:

the first distillation column (11) and at least a part of the crude argon distillation column or all of the crude argon distillation column may be arranged inside the cold box (10); or

the first distillation column (11) may be arranged inside the cold box (10), and at least a part of the crude argon distillation column or all of the crude argon distillation column may be arranged inside a separate cold box from the first cold box (10).

[0013]

In the invention:

a pure argon distillation column may also be provided, arranged next to one or two or more of the first distillation column (11), the second distillation column (21), and the crude argon distillation column.

EFFECTS OF THE INVENTION

[0014]

According to the invention, the share of height associated with a condenser installed on top of a high pressure distillation column can be lowered without reducing product production efficiency compared with a conventional air separation device, without enlarging the installation area, and without dividing a low pressure distillation column. This reduction in height may be, for example, 5 to 10 m, which can significantly cut installation costs engendered by using a large crane or the like during installation of a very high distillation column such as for producing high purity gas.

[0015]

An air separation device (1) in a first embodiment of the present invention is provided with:

a first distillation column (11) arranged inside a first cold box (10), and provided with a first condenser (121) diagonally above the column top (113) thereof;

a second distillation column (21) arranged inside a second cold box (20), comprising a lower pressure distillation column than the first distillation column (11), and arranged next to the first distillation column (11); and

a crude argon distillation column (31, 32) having a lower distillation column (31) arranged inside the first cold box (10) or inside a third cold box (30a) and installed above (preferably vertically above) the column top (113) of the first distillation column (11), and an upper distillation column (32) arranged inside a fourth cold box (30b) and next to the second distillation column (21) and/or the first distillation column (11), and provided with a second condenser (324) inside or above the column top (323) thereof.

The air separation device (1) of the first embodiment may also be provided with a pure argon distillation column (36) arranged inside the fourth cold box (30b) and next to the upper distillation column (32).

The air separation device (1) of the first embodiment may also be provided with a first oxygen-enriched gas feed line (L1) for feeding a first oxygen-enriched gas from the first condenser (121) to the bottom (211) of the second distillation column (21);

a first oxygen-enriched liquid feed line (L2) for feeding a first oxygen-enriched liquid by a first liquid feed pump (5) from the bottom (211) of the second distillation column (21) to the first condenser (121);

a second oxygen-enriched gas feed line (L3) for feeding a second oxygen-enriched gas from a column middle portion (213) (or a column location lower than the middle) of the second distillation column (21) to the bottom (311) of the lower distillation column (31);

a second oxygen-enriched liquid feed line (L4) for feeding a second oxygen-enriched liquid from the bottom (311) of the lower distillation column (31) to the column middle portion (213) (or a column location lower than the middle) of the second distillation column (21);

a first argon-enriched gas feed line (L5) for feeding a first argon-enriched gas from the column top (313) of the lower distillation column (31) to the bottom (321) of the upper distillation column (32); and

a first argon-enriched liquid feed line (L6) for feeding a first argon-enriched liquid by a second liquid feed pump (6) from the bottom (321) of the upper distillation column (32) to the column top (313) of the lower distillation column (31).

[0016]

According to the air separation device (1) of the first embodiment, the bottom (311) of the lower distillation column (31) is configured so as to be located higher than the column middle portion (213) of the second distillation column (21). As a result, this difference in

height can be used to feed a second oxygen-enriched liquid without using a pump.

The device has a first distillation column (high pressure column), a second distillation column (low pressure column), and a crude argon distillation column comprising one or more spatially separated portions (such as at least an upper distillation column and a lower distillation column each containing a column), the second distillation column (low pressure column) is arranged at least partially next to the first distillation column (high pressure column) in the height direction, and the lower distillation column (low pressure portion) of the crude argon distillation column is arranged above at least the first distillation column (high pressure column). As a result, the height of the air separation device can be reduced.

In the case that the condenser is installed diagonally above the first distillation column (high pressure column), the share of height associated with the first condenser installed on top of the first distillation column can be reduced.

The first condenser can be installed diagonally above the first distillation column (high pressure column) without erecting a new saddle support by, for example, using a portion of a fifth cold box (50), containing a main heat exchanger (not shown) for cooling the second distillation column (low pressure column) and raw material air, as a saddle support.

A line is disposed for feeding an oxygen-enriched liquid from the bottom of the lower distillation column of the crude argon distillation column to a middle portion of the second distillation column (low pressure column), and a line is disposed for supplying an oxygen-enriched gas from a middle portion of the second distillation column (low pressure column) to below the lower distillation column of the crude argon distillation column. That is, by installing the lower distillation column of the crude argon distillation column above the first distillation column (high pressure column), liquid can be returned by a liquid head to a return point of the second distillation column (low pressure column) without requiring a complicated and expensive process for returning by a pump to a lower portion of a low pressure column divided in two as in the configuration in Patent Literature 3.

The first condenser (12) is configured so as to condense the top gas of the first distillation column (high pressure column) by using the bottom liquid of the second distillation column (low pressure column) as a cold source. The bottom liquid of the second distillation column (low pressure column) is fed from the bottom (lower portion) of the

second distillation column (low pressure column) to the first condenser (121), for example, by the pump (5).

[0017]

An air separation device (1) in a second embodiment of the present invention is provided with:

- a first distillation column (11) arranged inside a first cold box (10), and provided with a first condenser (121) diagonally above the column top (113) thereof;

- a second distillation column (21) arranged inside a second cold box (20), comprising a lower pressure distillation column than the first distillation column (11), and arranged next to the first distillation column (11); and

- a crude argon distillation column (30) arranged inside the first cold box (10) or inside a third cold box, and provided with a second condenser (304) inside or above the column top (303) thereof.

The air separation device (1) of the second embodiment may also be provided with a pure argon distillation column arranged next to the crude argon distillation column (30).

The air separation device (1) of the second embodiment may also be provided with a first oxygen-enriched gas feed line (L1) for feeding a first oxygen-enriched gas from the first condenser (121) to the bottom (211) of the second distillation column (21);

- a first oxygen-enriched liquid feed line (L2) for feeding a first oxygen-enriched liquid by a first liquid feed pump (5) from the bottom (211) of the second distillation column (21) to the first condenser (121);

- a second oxygen-enriched gas feed line (L3) for feeding a second oxygen-enriched gas from a column middle portion (213) (or a column location lower than the middle) of the second distillation column (21) to the bottom (301) of the crude argon distillation column (30); and

- a second oxygen-enriched liquid feed line (L4) for feeding a second oxygen-enriched liquid from the bottom (301) of the crude argon distillation column (30) to the column middle portion (213) (or a column location lower than the middle) of the second distillation column (21).

With a third embodiment, because the crude argon distillation column is not divided and is arranged as is above the first distillation column, the size is greater in the height direction, but the installation area can be smaller.

[0018]

An air separation device (1) in a third embodiment of the present invention is provided with:

a first distillation column (11) arranged inside a first cold box (10);

a second distillation column (21) arranged inside a second cold box (20), comprising a lower pressure distillation column than the first distillation column (11), and provided with a first condenser (122), arranged next to the first distillation column (11) and connected through piping to the column top (113) of the first distillation column (11), in a lower portion or the bottom (211) thereof; and

a crude argon distillation column (31, 32) having a lower distillation column (31) arranged inside the first cold box (10) or inside a third cold box (30a) and installed above the column top (113) of the first distillation column (11), and an upper distillation column (32) arranged inside a fourth cold box (30b) and next to the second distillation column (21) and/or the first distillation column (11), and provided with a second condenser (324) inside or above the column top (323) thereof.

The air separation device (1) of the third embodiment may also be provided with a pure argon distillation column (36) arranged inside the fourth cold box (30b) and next to the upper distillation column (32).

The air separation device (1) of the third embodiment may also be provided with a first nitrogen-enriched gas feed line (L11) for feeding a first nitrogen-enriched gas from the column top (113) of the first distillation column (11) to the first condenser (122);

a first nitrogen-enriched liquid feed line (L21) for feeding a first nitrogen-enriched liquid by a first liquid feed pump (5) from the first condenser (122) to the column top (113) of the first distillation column (11);

a first oxygen-enriched gas feed line (L3) for feeding a first oxygen-enriched gas from a column middle portion (213) of the second distillation column (21) to the bottom (311) of the lower distillation column (31);

a first oxygen-enriched liquid feed line (L4) for feeding a first oxygen-enriched liquid from the bottom (311) of the lower distillation column (31) to the column middle portion (213) of the second distillation column (21);

a first argon-enriched gas feed line (L5) for feeding a first argon-enriched gas from the column top (313) of the lower distillation column (31) to the bottom (321) of the upper distillation column (32); and

a first argon-enriched liquid feed line (L6) for feeding a first argon-enriched liquid by a second liquid feed pump (6) from the bottom

(321) of the upper distillation column (32) to the column top (313) of the lower distillation column (31).

[0019]

According to the air separation device (1) of the third embodiment, the bottom (311) of the lower distillation column (31) is configured so as to be located higher than the column middle portion (213) of the second distillation column (21). As a result, this difference in height can be used to feed a second oxygen-enriched liquid without using a pump.

The device has a first distillation column (high pressure column), a second distillation column (low pressure column), and a crude argon distillation column comprising one or more spatially separated portions (such as at least an upper distillation column and a lower distillation column each containing a column), the second distillation column (low pressure column) is arranged at least partially next to the first distillation column (high pressure column) in the height direction, and the lower distillation column (low pressure portion) of the crude argon distillation column is arranged above at least the first distillation column (high pressure column). As a result, the height of the air separation device can be reduced.

The first condenser (122) is arranged below the second distillation column (21). That is, the share of height associated with the first condenser installed on the column top of the first distillation column can be reduced.

The first condenser (122) is configured so as to condense the column top gas of the first distillation column (11) by using the bottom liquid of the second distillation column (21) as a cold source.

The column top gas/liquid of the first distillation column (11) liquefied by the first condenser (122) is fed as a reflux liquid to the column top (113) of the first distillation column (11), for example, by the pump (5).

[0020]

An air separation device (1) in a fourth embodiment of the present invention is provided with:

- a first distillation column (11) arranged inside a first cold box (10);

- a second distillation column (21) arranged inside a second cold box (20), comprising a lower pressure distillation column than the first distillation column (11), and provided with a first condenser (122), arranged next to the first distillation column (11) and connected through piping to the column top (113) of the first distillation column (11), in a lower portion or the bottom (211) thereof; and

a crude argon distillation column (30) arranged inside the first cold box (10) or inside a third cold box, and provided with a second condenser (304) inside or above the column top (303) thereof.

The air separation device (1) of the fourth embodiment may also be provided with a pure argon distillation column arranged next to the crude argon distillation column (30).

The air separation device (1) of the fourth embodiment may also be provided with a first nitrogen-enriched gas feed line (L11) for feeding a first nitrogen-enriched gas from the column top (113) of the first distillation column (11) to the first condenser (122);

a first nitrogen-enriched liquid feed line (L21) for feeding a first nitrogen-enriched liquid by a first liquid feed pump (5) from the first condenser (122) to the column top (113) of the first distillation column (11);

a first oxygen-enriched gas feed line (L3) for feeding a first oxygen-enriched gas from a column middle portion (213) of the second distillation column (21) to the bottom (311) of the lower distillation column (31); and

a first oxygen-enriched liquid feed line (L4) for feeding a first oxygen-enriched liquid from the bottom (311) of the lower distillation column (31) to a column middle portion (213) of the second distillation column (21).

With the fourth embodiment, because the crude argon distillation column is not divided and is arranged as is above the first distillation column, the size is greater in the height direction, but the installation area can be smaller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

FIG. 1A is a diagram showing the air separation device of Embodiment 1;

FIG. 1B is a diagram showing the air separation device of Embodiment 2;

FIG. 2A is a diagram showing the air separation device of Embodiment 3; and

FIG. 2B is a diagram showing the air separation device of Embodiment 4.

DESCRIPTION OF THE EMBODIMENTS

[0022]

Several embodiments of the present invention will be described hereinafter. The embodiments described hereinafter describe an example of the present invention. The present invention is not in any way limited to the following embodiments, and includes various

modifications executed within a range that does not alter the essence of the present invention. The configurations described hereinafter are not necessarily all of the essential configurations of the present invention.

[0023]

Embodiment 1

The air separation device 1 of Embodiment 1 will be described using FIG. 1A.

The air separation device 1 has a first distillation column (high pressure column), a second distillation column (low pressure column), and a crude argon distillation column comprising one or more spatially separated portions (such as at least an upper distillation column and a lower distillation column each containing a column). The second distillation column (low pressure column) is arranged at least partially next to the first distillation column (high pressure column) in the height direction, and the lower distillation column (low pressure portion) of the crude argon distillation column is arranged above at least the first distillation column (high pressure column). As a result, the height of the air separation device can be reduced.

[0024]

The first distillation column 11 is arranged inside a first cold box 10a, and is provided with a first condenser 121 diagonally above the column top 113 thereof (arranged so as not to be stacked vertically during installation).

The first condenser 121 is accommodated inside a first sub-cold box 10b. The first condenser 121 is installed using a portion of the second distillation column 21 or a fifth cold box 50, containing a main heat exchanger for cooling the second distillation column and raw material air, as a saddle support. The height of the first condenser 121 is configured so that a liquid flows at a location higher than the column top 113 without using a pump.

The second distillation column 21 is arranged inside a second cold box 20, comprises a lower pressure distillation column than the first distillation column 11, and is arranged next to the first distillation column 11.

[0025]

The crude argon distillation column comprises a spatially separated lower distillation column 31 and upper distillation column 32.

The lower distillation column 31 is arranged inside a third cold box 30a, and installed vertically above the column top 113 of the first distillation column 11. In a separate embodiment, the lower distillation column 31 may be arranged inside the first cold box 10a.

The upper distillation column 32 is arranged inside a fourth cold box 30b and arranged next to the second distillation column 21, and is provided with a second condenser 324 above the column top 323 thereof.

A pure argon distillation column 36 is arranged inside the fourth cold box 30b, and installed next to the upper distillation column 32.

The pure argon distillation column 36 is not essential to the air separation device 1, and may be omitted.

[0026]

A first oxygen-enriched gas feed line L1 is a line for feeding a first oxygen-enriched gas from the first condenser 12 to the bottom 211 of the second distillation column 21. The first oxygen-enriched gas feed line L1 comprises a pipe and a valve (not shown).

A first oxygen-enriched liquid feed line L2 is a line for feeding a first oxygen-enriched liquid by a first liquid feed pump 5 from the bottom 211 of the second distillation column 21 to the first condenser 12. The first oxygen-enriched liquid feed line L2 comprises a pipe and a valve (not shown).

[0027]

A second oxygen-enriched gas feed line L3 is a line for feeding a second oxygen-enriched gas from a column middle portion 213 of the second distillation column 21 to the bottom 311 of the lower distillation column 31. The second oxygen-enriched gas feed line L3 comprises a pipe and a valve (not shown).

A second oxygen-enriched liquid feed line L4 is a line for feeding a second oxygen-enriched liquid from the bottom 311 of the lower distillation column 31 to a column middle portion 213 of the second distillation column 21. The second oxygen-enriched liquid feed line L4 comprises a pipe and a valve (not shown).

The bottom 311 of the lower distillation column 31 is located higher than the column middle portion 213 of the second distillation column 21, and this difference in height is used to feed the second oxygen-enriched liquid without using a pump.

[0028]

A first argon-enriched gas feed line L5 is a line for feeding a first argon-enriched gas from the column top 313 of the lower distillation column 31 to the bottom 321 of the upper distillation column 32. The first argon-enriched gas feed line L5 comprises a pipe and a valve (not shown).

A first argon-enriched liquid feed line L6 is a line for feeding a first argon-enriched liquid from the bottom 321 of the upper distillation column 32 to the column top 313 of the lower distillation

column 31. The first argon-enriched liquid feed line L6 comprises a pipe and a valve (not shown).

[0029]

Although FIG. 1A does not show parts such as a main heat exchanger for cooling the second distillation column (low pressure column) and raw material air, a compressor for compressing raw material air, and an expansion turbine, this does not mean that these parts are not necessary in Embodiment 1. Naturally, these components are also some of the components of the air separation device 1 in Embodiment 1 (and likewise for the embodiments described hereinafter).

[0030]

Embodiment 2

The air separation device 1 of Embodiment 2 will be described using FIG. 1B. Configurations that differ from Embodiment 1 will be described, and the same configurations will not be described again or only briefly described.

A crude argon distillation column 30 is arranged inside a first cold box 10, and is provided with a second condenser 304 inside or above the column top 303 thereof. The crude argon distillation column 30 may also be arranged inside a separate cold box from the first cold box 10.

A pure argon distillation column is not essential in Embodiment 2, and may be omitted.

With the second embodiment, because the crude argon distillation column is not divided and is arranged as is above the first distillation column, the size is greater in the height direction, but the installation area can be smaller.

[0031]

Embodiment 3

The air separation device 1 of Embodiment 3 will be described using FIG. 2A.

The air separation device 1 has a first distillation column (high pressure column), a second distillation column (low pressure column), and a crude argon distillation column comprising one or more spatially separated portions (such as at least an upper distillation column and a lower distillation column each containing a column). The second distillation column (low pressure column) is arranged at least partially next to the first distillation column (high pressure column) in the height direction, and the lower distillation column (low pressure portion) of the crude argon distillation column is arranged above at least the first distillation column (high pressure column). As a result, the height of the air separation device can be reduced.

[0032]

The first distillation column 11 is arranged inside a first cold box 10.

The second distillation column 21 is arranged inside a second cold box 20, comprises a lower pressure distillation column than the first distillation column 11, and is provided with a first condenser 122, arranged next to the first distillation column 11 and connected through piping to the column top 113 of the first distillation column 11, in the bottom 211 thereof.

[0033]

The crude argon distillation column has a lower distillation column 31 arranged inside a third cold box 30a and installed above the column top 113 of the first distillation column 11, and an upper distillation column 32 arranged inside a fourth cold box 30b and next to the second distillation column 21, and provided with a second condenser 324 above the column top 323 thereof.

A pure argon distillation column 36 is arranged inside the fourth cold box 30b, and installed next to the upper distillation column 32.

The pure argon distillation column 36 is not essential to the air separation device 1, and may be omitted.

[0034]

A first nitrogen-enriched gas feed line L11 is a line for feeding a first nitrogen-enriched gas from the column top 113 of the first distillation column 11 to the first condenser 122. The first nitrogen-enriched gas feed line L11 comprises a pipe and a valve (not shown).

A first nitrogen-enriched liquid feed line L21 is a line for feeding a first nitrogen-enriched liquid by a first liquid feed pump 5 from the first condenser 122 to the column top 113 of the first distillation column 11. The first nitrogen-enriched liquid feed line L21 comprises a pipe and a valve (not shown).

[0035]

A first oxygen-enriched gas feed line L3 is a line for feeding a first oxygen-enriched gas from a column middle portion 213 of the second distillation column 21 to the bottom 311 of the lower distillation column 31. The first oxygen-enriched gas feed line L3 comprises a pipe and a valve (not shown).

A first oxygen-enriched liquid feed line L4 is a line for feeding a first oxygen-enriched liquid from the bottom 311 of the lower distillation column 31 to the column middle portion 213 of the second distillation column 21. The first oxygen-enriched liquid feed line L4 comprises a pipe and a valve (not shown).

The bottom 311 of the lower distillation column 31 is located higher than the column middle portion 213 of the second distillation column

21, and this difference in height is used to feed the first oxygen-enriched liquid without using a pump.

[0036]

A first argon-enriched gas feed line L5 is a line for feeding a first argon-enriched gas from the column top 313 of the lower distillation column 31 to the bottom 321 of the upper distillation column 32. The first argon-enriched gas feed line L5 comprises a pipe and a valve (not shown).

A first argon-enriched liquid feed line L6 is a line for feeding a first argon-enriched liquid from the bottom 321 of the upper distillation column 32 to the column top 313 of the lower distillation column 31. The first argon-enriched liquid feed line L6 comprises a pipe and a valve (not shown).

[0037]

Although FIG. 2A does not show parts such as a main heat exchanger for cooling the second distillation column (low pressure column) and raw material air, a compressor for compressing raw material air, and an expansion turbine, this does not mean that these parts are not necessary in Embodiment 3. Naturally, these components are also some of the components of the air separation device 1 in Embodiment 3.

[0038]

Embodiment 4

The air separation device 1 of Embodiment 4 will be described using FIG. 2B. Configurations that differ from Embodiment 2 will be described, and the same configurations will not be described again or only briefly described.

A crude argon distillation column 30 is arranged inside a first cold box 10, and is provided with a second condenser 304 inside or above the column top 303 thereof. The crude argon distillation column 30 may also be arranged inside a separate cold box from the first cold box 10.

A pure argon distillation column is not essential in Embodiment 4, and may be omitted.

With the fourth embodiment, because the crude argon distillation column is not divided and is arranged as is above the first distillation column, the size is greater in the height direction, but the installation area can be smaller.

KEY TO REFERENCE NUMERALS

[0039]

- 1 Air separation device
- 11 First distillation column
- 121, 122 First condenser
- 21 Second distillation column

- 30 Crude argon column
- 31 Lower distillation column
- 32 Upper distillation column

DOCUMENT TITLE Claims

CLAIM 1

Air separation device, provided with a first distillation column (11) provided with a first condenser (12) in a location apart from above the column top (113);

a second distillation column (21) comprising a lower pressure distillation column than the first distillation column (11), and arranged next to the first distillation column (11); and

at least part of a crude argon distillation column or all of a crude argon distillation column arranged above the column top (113) of the first distillation column (11).

CLAIM 2

Air separation device according to Claim 1, characterized in that in the case that a part of the crude argon distillation column is arranged above the column top (113):

the crude argon distillation column has a lower distillation column (31) arranged above the column top (113), and an upper distillation column (32) arranged next to the second distillation column (21) and/or the first distillation column (11), and provided with a second condenser (324) inside or above the column top (323) thereof; or

in the case that all of the crude argon distillation column is arranged above the column top (113): the crude argon distillation column is provided with a second condenser (324) inside or above the column top (323) thereof, and is arranged only above the column top (113).

CLAIM 3

Air separation device according to Claim 1 or 2, characterized in that the first condenser (12) is arranged diagonally above the column top (113).

CLAIM 4

Air separation device according to Claim 1 or 2, characterized in that the first condenser (122) is arranged below or on the bottom (211) of the second distillation column (21).

CLAIM 5

Air separation device according to any of Claims 1 to 4, characterized in that the first distillation column (11) contains or does not contain the first condenser (12), and is arranged inside a first cold box (10).

CLAIM 6

Air separation device according to Claim 1, characterized in that the first distillation column (11) and at least a part of the crude

argon distillation column or all of the crude argon distillation column is arranged inside the cold box (10); or

the first distillation column (11) is arranged inside the cold box (10), and at least a part of the crude argon distillation column or all of the crude argon distillation column is arranged inside a separate cold box from the first cold box (10).

CLAIM 7

Air separation device according to any of Claims 1 to 6, characterized in that a pure argon distillation column is also provided, arranged next to one or two or more of the first distillation column (11), the second distillation column (21), and the crude argon distillation column.