

Oct. 21, 1958

J. W. L. KÖHLER

2,856,756

COLD-GAS REFRIGERATING MACHINE AND METHOD

Filed June 26, 1953

4 Sheets-Sheet 1

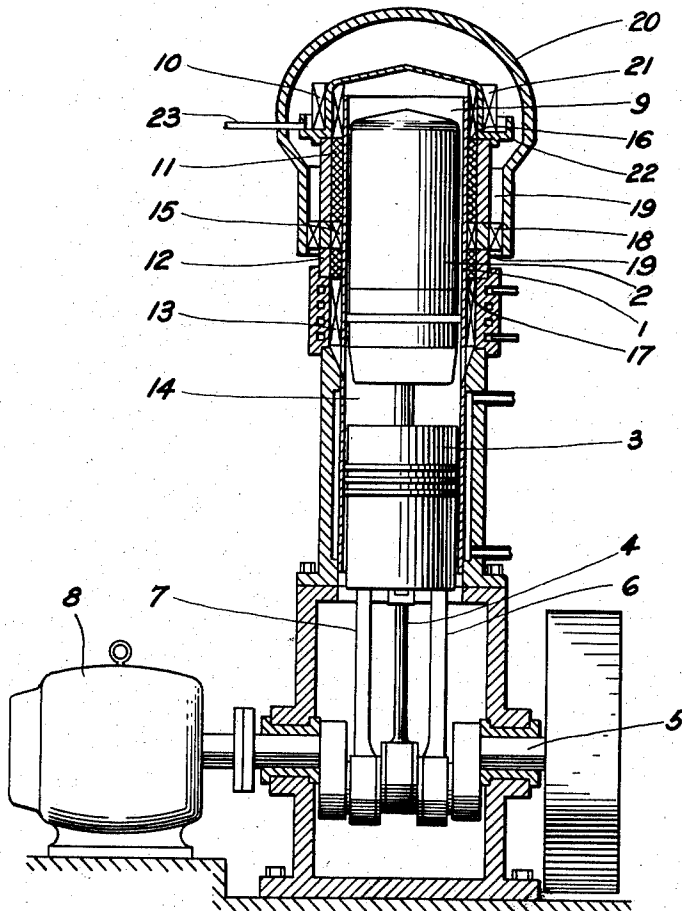


Fig. 1.

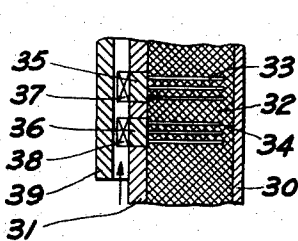


Fig. 2.

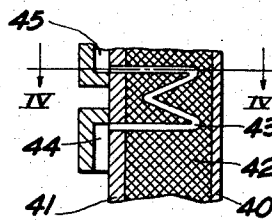


Fig. 3.

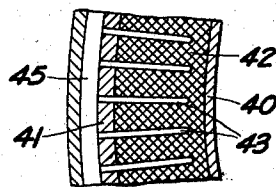


Fig. 4.

INVENTOR.
JACOB WILLEM LAURENS KÖHLER

BY

Ther M. Vogel

AGENT.

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J. W. L. KÖHLER

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4 Sheets-Sheet 2

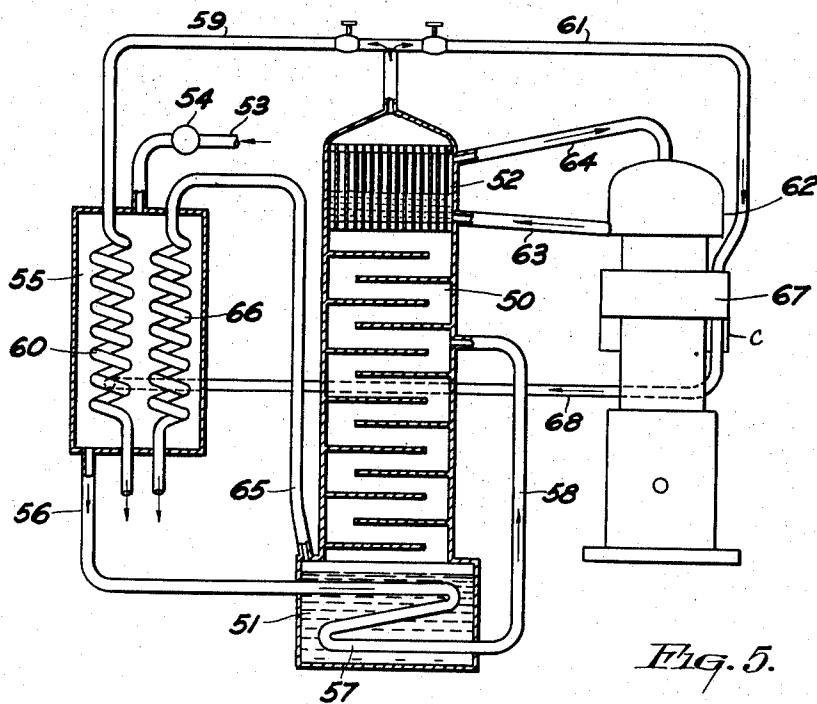


Fig. 5.

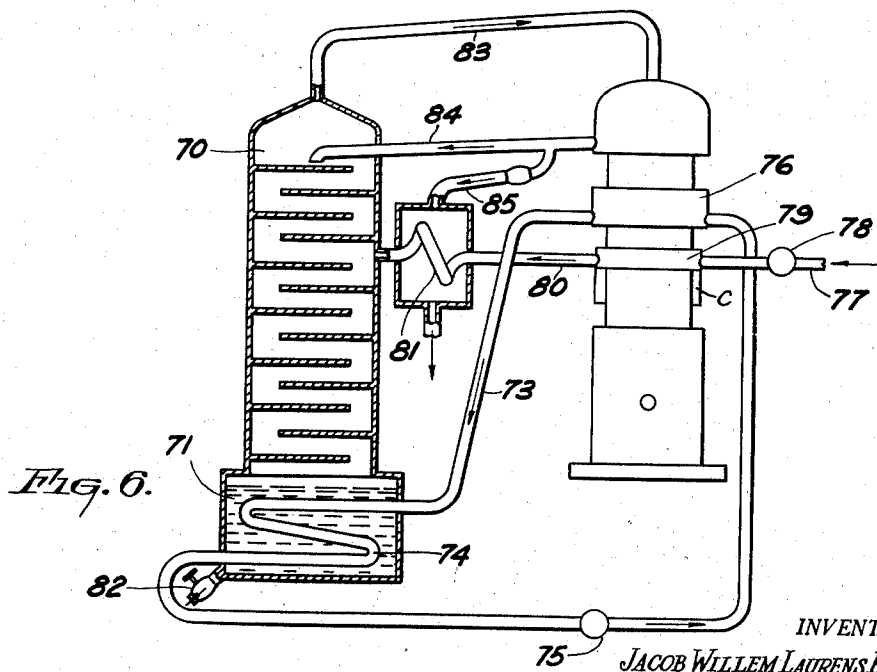


Fig. 6.

INVENTOR.

JACOB WILLEM LAURENS KÖHLER
BY

[Signature]

AGENT.

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J. W. L. KÖHLER

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4 Sheets-Sheet 3

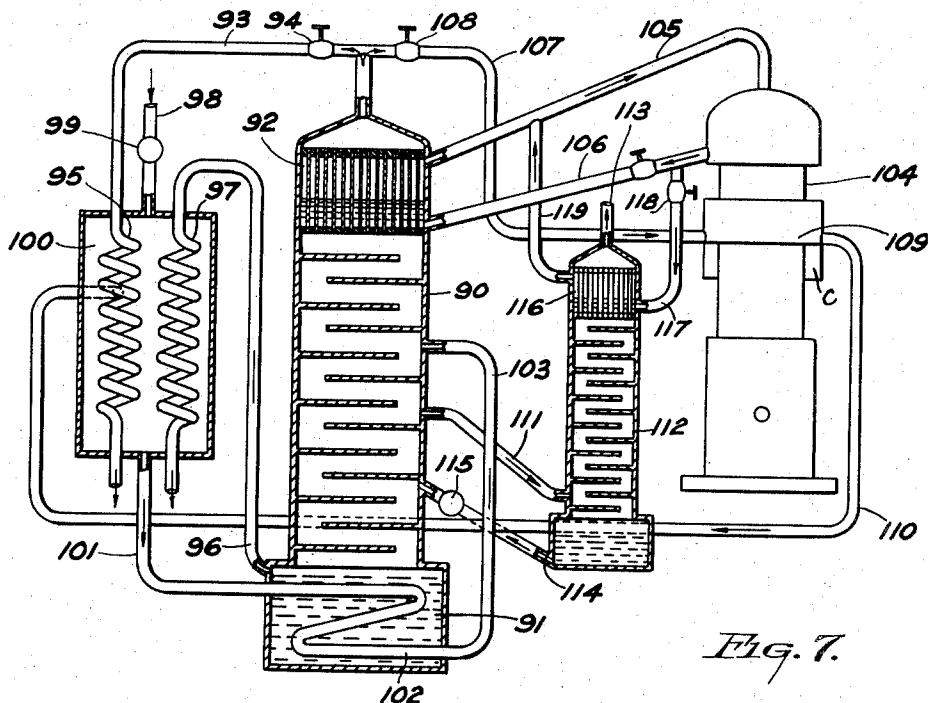


Fig. 7.

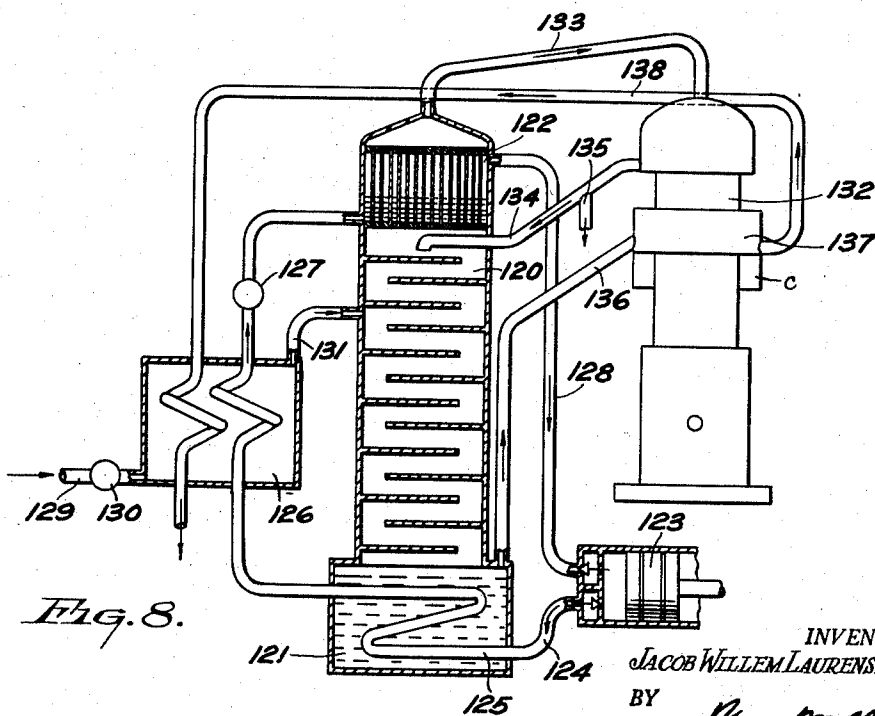


Fig. 8.

INVENTOR.
JACOB WILLEM LAURENS KÖHLER
BY *J. M. V. Nijl*
AGENT.

Oct. 21, 1958

J. W. L. KÖHLER

2,856,756

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4 Sheets-Sheet 4

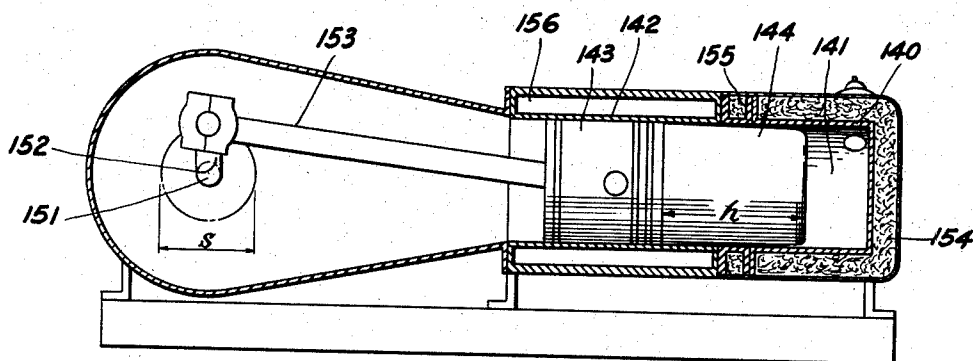


Fig. 9.

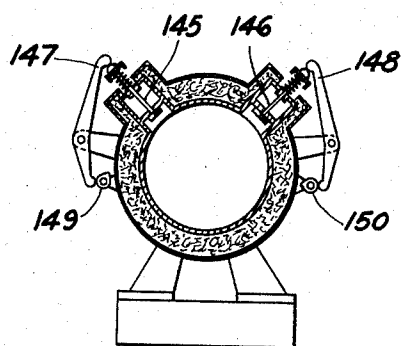


Fig. 10.

INVENTOR.
JACOB WILLEM LAURENS KÖHLER
BY
J. M. O'Neil
AGENT.

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2,856,756

COLD-GAS REFRIGERATING MACHINE AND METHOD

Jacob Willem Laurens Köhler, Eindhoven, Netherlands,
assignor, by mesne assignments, to North American
Philips Company, Inc., New York, N. Y., a corpora-
tion of Delaware

Application June 26, 1953, Serial No. 364,395

11 Claims. (Cl. 62—6)

The invention relates to a cold-gas refrigerating machine comprising at least one cylinder, two piston-like members reciprocating in said cylinder defining at least two spaces the volumes of which vary continuously with a substantially constant phase difference. One of said spaces has a lower temperature than the other spaces and a freezer, regenerator and cooler, said spaces communicating with one another through said freezer, regenerator and cooler thus forming the total working space of the machine contained in said cylinder is a gaseous working medium of invariable composition performing a closed thermodynamic cycle in the total working space and being always in the same state of aggregation. Such cold-gas refrigerating machines include also the cold-gas refrigerating machines operating on the so-called reversed hot-gas reciprocating engine principle.

It is known that the medium flowing through the regenerator absorbs heat from the regenerator mass during its flow from the colder end of the regenerator to the hotter end thereof and gives up heat to the regenerator mass during its flow from the hotter end to the colder end. It has been found that the working medium is not capable of exchanging such a quantity of heat with the regenerator that the temperature difference between the colder end and the hotter end of the regenerator is completely overlapped. Consequently, when leaving the regenerator at the colder end the medium has a higher temperature than the colder end surface and when leaving the regenerator on the hotter end it has a lower temperature than the hot end surface.

This phenomenon causes the so-called regeneration loss which may be imagined to be due to a cold flow, the working medium of the machine transferring cold from the cold end of the regenerator to the hot end. Particularly with cold-gas refrigerating machines this regeneration loss has a detrimental effect, since this loss reduces the production of cold of the machine. The loss may be so high that, particularly if the refrigerating machine is required to produce cold at low temperatures, for example, temperatures lower than -150°C ., no cold at all is produced and that even the required temperature level is not at all reached.

Hitherto it has been attempted to minimize the regeneration loss by providing the best possible construction for the regenerator, so that the output of the regenerators of these refrigerating machines may amount even to 98%. Nevertheless, even in this case, the regeneration loss caused heavy losses of cold.

According to the invention, the filler of the regenerator is provided with elements through which at least a portion of the gaseous working medium flows and is in thermal contact with said second medium. These elements form one or more intermediate heat exchangers. In such an intermediate heat exchanger the second medium may be heated or cooled by the working medium of the machine.

If the said thermal contact is between the second medium having a lower temperature than the working medium the said working medium is cooled. This may

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result in a reduction of the regeneration loss of the cold-gas refrigerating machine.

On the contrary, if a thermal contact is established between the working medium and a second medium having a higher temperature than the working medium, the said working medium is heated and the exchange of heat may be used efficiently in cooling the second medium.

In one embodiment of the invention the elements of the intermediate heat exchanger may be comprised of studs or vanes.

In a cold-gas refrigerating machine in accordance with a further embodiment of the invention in which the regenerator is subdivided into layers, the elements of the intermediate heat exchanger are arranged between two successive layers of the regenerator filler.

In a third embodiment of the invention the elements of the intermediate heat exchanger are shaped in the form of one or more tubes arranged in the regenerator filler, the second medium which is independent of the cycle in the machine passing through these tubes.

In a further preferred embodiment of the invention the working medium passing through the regenerator filler is in thermal contact through the elements of the intermediate heat exchanger with a second medium, which is pre-cooled owing to this thermal contact before it is further cooled by the cold furnished by the freezer of a cold-gas refrigerating machine. In this embodiment the cold which would be transferred from the freezer to the cold space is transferred at least partly through the elements of the intermediate heat exchanger to the second medium outside the refrigerating machine, so that this second medium is cooled. If the latter medium is to be cooled by cold from the freezer of the cold-gas refrigerating machine a smaller amount of heat energy will have to be withdrawn from this pre-cooled second medium than if this medium were not pre-cooled by the aforesaid flow of cold. Consequently, in this construction according to the invention the output of the regenerator is not improved, but the operation of the refrigerating machine as a whole may be improved.

In a further embodiment of the invention the aforesaid pre-cooling of the second medium to be cooled by the cold-gas refrigerating machine may be such that contamination of this medium is thereby reduced. If the cold-gas refrigerating machine is used for cooling air, water vapour may be extracted from the air in this manner and in certain cases even carbon dioxide.

In a further embodiment of the invention the elements of one or more of the intermediate heat exchangers extend over not more than 75% of the height of the regenerator filler, preferably extending over not more than 50% of this height.

The height of the regenerator filler is measured in the main direction of flow of the working medium. Where the heat exchanging elements are provided within the regenerator filling said height is the distance between the end surfaces of the regenerator filling, but where the heat exchanging elements are provided between portions of said regenerator it is the sum of the distances of the end surfaces of all said portions. If such an intermediate heat exchanger is utilized for cooling a second medium which is independent of the cycle in the machine, it is desirable for the elements of this intermediate heat exchanger to extend over not more than three quarters of the height of the filler measured from the hot end surface of the regenerator. If, on the contrary, the regeneration loss is reduced by means of a cold second medium, it is desirable for the elements to extend over not more than three quarters of the height of the filler measured from the cold end surface of the regenerator.

The temperature of the working medium in the machine at the position of the intermediate heat exchanger varies

with the position of this intermediate heat exchanger relative to the hot and cold end surface of the regenerator. Consequently, the amount of cold supplied to or withdrawn from the working medium in this intermediate heat exchanger varies with the position of this intermediate heat exchanger.

The cold-gas refrigerating machine may be used in gas fractionating systems. In such systems there exist various media of low temperature which may be utilized to supply heat energy to the intermediate heat exchanger of the cold-gas cooling machine at low temperatures.

A method of fractionating gaseous mixtures, for example, air into fractions of different volatility in gas fractionating systems is characterized in that the system comprises a cold-gas refrigerating machine as described above and the gaseous mixture to be fractionated is supplied under atmospheric or substantially atmospheric pressure to a gas fractionating column of this system operating under the same pressure at a suitable point between the ends of the column, the gaseous mixture being fractionated in this column into fractions, heat energy being withdrawn from the top end of the column with the aid of cold furnished by the cold-gas refrigerating machine, the working medium passing through the regenerator of this machine being in the intermediate heat-exchanger in thermal contact with at least one of the media associated with the gas fractionating system. These media comprise the gaseous mixture to be fractionated and the fractions obtained in the column.

In a further method one of the fractions fractionated in the column constitutes the said second medium and is in thermal contact with the working medium of the cold-gas refrigerating machine at such an area between the cold and the hot end surface of the regenerator that cold is withdrawn from this fraction.

In an alternative method the liquid fraction of the higher or highest boiling point constitutes the said second medium and is in thermal contact with the working medium of the cold-gas refrigerating machine whereby heat is supplied to the fraction, so that at least part of this fraction evaporates.

For carrying out the aforesaid methods the gas fractionating column may be constructed in the form of a single column to which the gaseous mixture to be fractionated is supplied under atmospheric or substantially atmospheric pressure.

In a further alternative method provision is made of a third medium which is compressed in a compressor at a maximum temperature of 0° C. Then the compressed medium gives off heat energy in the evaporator of the gas fractionating column, its pressure being then reduced and the medium then absorbing heat energy in the condenser of the gas fractionating column and subsequently flowing back to the compressor. At least one of the media associated with the gas dissociating system constituted the said second medium and is in thermal contact in the intermediate heat exchanger with the working medium of a cold-gas refrigerating machine.

In a further alternative method, if the gaseous mixture comprises at least three components and a third fraction is to be obtained, a gas containing a quantity of the third component is withdrawn from the column at a point where this third component is available in a higher percentage than in the gas mixture supplied. The mixture so withdrawn is separated into fractions in a second column, the third fraction being withdrawn from the colder end of this second column and this second column being cooled by means of cold furnished by the cold-gas refrigerating machine.

In order that the invention may be readily carried into effect, it will now be described in detail with reference to the accompanying drawings, given by way of example in which embodiments of a cold-gas refrigerating machine according to the invention and of gas fractionating sys-

tems comprising a cold-gas refrigerating machine are shown.

Fig. 1 shows a cold-gas refrigerating machine in which the regenerator is divided into two portions between which an intermediate heat exchanger is provided.

Fig. 2 shows part of a modification in which the intermediate heat exchanger comprises studs provided within the regenerator filling.

Figs. 3 and 4 show another part of a modification in which the intermediate heat exchanger comprising a tube system provided within the regenerator filler which can be traversed by a second medium provided outside the machine.

Fig. 4 is a sectional view taken on the line IV—IV of Fig. 3.

Fig. 5 shows diagrammatically a gas fractionating system in which part of the fraction obtained at the cold side of the column is supplied through the intermediate heat exchanger of a cold-gas refrigerating machine.

Fig. 6 shows a gas fractionating system in which the fraction in the evaporator of the column is in thermal contact with the intermediate heat exchanger of a cold-gas refrigerating machine.

Fig. 7 shows diagrammatically a gas fractionating system in which a third fraction may be obtained from a gas mixture to be fractionated, having three or more components.

Fig. 8 shows a gas fractionating system in which a third medium compressed in a separate compressor is utilized.

Figs. 9 and 10 show the compressor used in the system shown in Fig. 8.

The refrigerating machine shown in Fig. 1 comprises a cylinder 1, in which a displacer piston 2 and a piston 3 are adapted to reciprocate with constant phase difference. By means of a connecting rod mechanism 4 the displacer piston 2 is coupled with a crank of a crank shaft 5 and the piston 3 is coupled with cranks of the same crank shaft by means of connecting rods 6 and 7. The refrigerating machine is driven by an electric motor 8. The space 9 over the displacer piston 2 is the freezing space which communicates through a freezer 10, a regenerator divided into two portions 11 and 12 and a cooler 13 with the space 14 between the piston and the displacer piston. The latter space is the cold space of the machine. Between the portions 11 and 12 of the regenerator provision is made of an intermediate heat exchanger 15, through which the working medium of the cold-gas refrigerating machine is in thermal contact with a second medium independent of the cycle performed in the machine. In this case the latter medium is the air to be condensed. References 16 and 17 are respectively the colder and the hotter end of the regenerator.

In the operational condition of the cold-gas refrigerating machine the temperature of the freezing space and of the freezer is, for example, -190° C. and the temperature of the cooler and of the cooled space is, for example, +20° C. The temperatures of the portions 11 and 12 of the regenerator contained between the hotter and the colder end surface of the regenerator lie between the two aforesaid values. Consequently, the intermediate heat exchanger 15 assumes a temperature lying between these values.

The medium to be condensed, for example, air, flows along vanes 18 of the intermediate heat exchanger 15, its temperature being thus reduced. During the pre-cooling of the medium, contamination, for example, water vapour, may be extracted from the medium by such cooling. The intermediate heat exchanger 15 extends over a distance equal to 1/5 of the height of the regenerator filler and the height of the intermediate heat exchanger 15 is also 1/5 of the height of the filler. Then the medium passes through a duct 19 in a jacket 20 to vanes 21 of the freezer 10 where the air condenses; the liquid air is collected in an annular trough 22 and is carried off through a duct 23. In accordance with the position of

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the intermediate heat exchanger 15 the temperature at the area of the intermediate heat exchanger will lie between the aforesaid levels. If the intermediate heat exchanger 15 is located comparatively near the cooler 13 so that the height of the regenerator portion 12 is comparatively small, the temperature of the heat exchanger will be comparatively high, so that the temperature of the second medium passing along the vanes 16 is reduced less than if the intermediate heat exchanger 15 is further spaced apart from the hotter end surface 17 of the regenerator. As stated above, a flow of cold will pass in the cold-gas refrigerating machines from the cold side 16 of the regenerator to the hot side 17; this flow of cold causes the so-called regeneration loss. In this embodiment of the invention this flow of cold is conducted to the outside for a great part through the intermediate heat exchanger 15. Provision may be made of more than one intermediate heat exchanger.

Fig. 2 shows, on a larger scale, a regenerator in which two intermediate heat exchangers are provided within the regenerator filling, these exchangers comprising studs provided within the regenerator filling. The housing of the regenerator, bounded by walls 30 and 31, contains a filler 32. Herein are arranged elements 33 and 34 of the intermediate heat exchangers 35 and 36 respectively. Vanes 37 are provided on the outer side of the intermediate heat exchanger 35 and vanes 38 are provided on the outer side of the exchanger 36. The space between these vanes is bounded by a wall 39 so that a duct is formed through which may flow a medium for example air. Cold may be withdrawn or supplied in this embodiment in accordance with the distance of the vanes from the end surfaces of the regenerator.

The intermediate heat exchanger shown in Figs. 3 and 4 comprises a plurality of parallel tubes provided within the regenerator filler. The housing of the regenerator formed by the walls 40 and 41 contains a filler 42 in which are provided a plurality of parallel tubes 43. The second medium flows through an annular duct 44 with which communicate all parallel tubes 43 and after it has flowed through the tubes 43 it enters an annular duct 45 by which it is conducted away.

Fig. 5 shows a gas dissociating system comprising a cold-gas refrigerating machine according to the invention. The system comprises a fractionating column 50 having an evaporating space 51 and a condenser 52. The gaseous mixture to be fractionated, for example air, is supplied to the gas fractionating column through a duct 53, comprising a pump 54, through a space 55, a duct 56, a heat exchanger 57 and a duct 58. In this column 50 the gaseous mixture is separated into fractions, the liquid oxygen being collected in the evaporating space 51 and the gaseous nitrogen rising upwards. In the condenser 52 cold is withdrawn from the nitrogen. A part of the nitrogen leaves the column through a duct 59 and flows through a cooling coil 60 arranged in the space 55. A further part flows through the duct 61 to a space around the intermediate heat exchanger associated with the regenerator of the refrigerating machine 62, as is shown in the Figs. 1 to 4 described above. Then the nitrogen is supplied to the coil 60.

Cold is withdrawn from the gas fractionating system by means of a cold-gas refrigerating machine 62. This machine may be constructed as is shown in Fig. 1. In Fig. 5 it is shown only diagrammatically. The cold developed in the freezer and the freezing space of the refrigerating machine is transferred by means of a second medium, for example nitrogen to the condenser 52. The nitrogen condensed in the cold-gas refrigerating machine is led through a duct 63 to the condenser 52 where it evaporates and withdraws cold from the column while the nitrogen vapour is conducted away from the condenser 52 through a duct 64 and re-supplied to the cold-gas refrigerating machine 62 for condensation.

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Oxygen is led away from the evaporator 51 through a duct 65 and a cooling coil 66 arranged in the space 55.

The system operates as follows: the air to be fractionated is supplied by the pump 54 to the duct 53 and cooled in the space 55 by the fractions already separated flowing through the cooling coils 60 and 66. Then the air is further cooled in the heat exchanger 57 and in the evaporating space 51 of the column the liquid oxygen evaporates owing to the supply of heat, the air being then supplied to the column and separated therein into fractions. A part of the nitrogen produced therein flows through the duct 61 to the intermediate heat exchanger 67 of the cold-gas refrigerating machine thus constituting the second medium, this exchanger also being transversed by the working medium passing through the regenerator. Located below the heat exchanger 67 is the cooling means for the cold-gas refrigerating machine shown diagrammatically and referred to by the reference character C. Then the nitrogen flows through the duct 68 to the cooling coil 60. In this embodiment the intermediate heat exchanger extends over not more than $\frac{3}{4}$ of the height of the regenerator from the colder end surface, for example, over $\frac{1}{4}$ of this height from the colder end surface. Owing to the thermal contact between the nitrogen and the working medium of the refrigerating machine heat energy is withdrawn from the working medium of the refrigerating machine at a low temperature so that the regeneration loss is reduced or may even be completely obviated. The gas fractionating column is constructed in the form of a single column and operates under atmospheric or substantially atmospheric pressure.

The system described above when used, for example, for fractionating air has the advantage that the gas fractionating column may be very simple and of small size, this being in contradistinction to the conventional gas fractionating systems in which the so-called double columns must be used.

Fig. 6 shows a further embodiment of the invention, in which also a cold-gas refrigerating machine of the type described above may be used. The system comprises a fractionating column 70 having an evaporating space 71. Cold is supplied to the evaporating space 71 by an auxiliary so-called "third" medium. The third medium circulates in a closed system comprising a duct 73 having a heat exchanger 74 in the evaporating space 71 and a pump 75 and communicating with a space 76 of an intermediate heat exchanger associated with a regenerator of the cold-gas refrigerating machine. The aforesaid system is traversed by an auxiliary medium, for example, nitrogen, which gives off heat to the evaporating space, so that the oxygen contained in this space evaporates at least in part and then gives off cold in the space 76 of the intermediate heat exchanger of the cold-gas refrigerating machine, the regeneration loss of this machine being thus reduced. The intermediate heat exchanger in the space 76 is constructed as is shown in Figs. 1 to 4 and extends, for example over half of the height of the regenerator filler.

The gaseous mixture to be fractionated flows through a duct 77 in which a pump 78 is provided to a second intermediate heat exchanger 79, which is, for example, arranged at $\frac{1}{4}$ of the height of the regenerator from the hotter end surface; the temperature of the mixture is reduced and then the mixture flows through a duct 80 which comprises a heat exchanger 81 to the gas fractionating column 70. In this column the gaseous mixture is separated into fractions; the fraction having the highest boiling point is assembled in the liquid state in the evaporating space 71 and a portion of this fraction evaporates again and a further portion is conducted away through a duct 82. The fraction having the lowest boiling point rises upwards and is led through a duct 83 to the freezer of the cold-gas refrigerating machine where it condenses. A part of the fluid thus obtained is re-supplied through a duct 84 to the column 70, a further

part, however, is led away through a duct 85 comprising the heat exchanger 81. In contradistinction to the conventional systems, this column is a single column and the gaseous mixture and its fractions maintained at atmospheric or substantially atmospheric pressure throughout fractionation. The system has, moreover, a favourable output.

In the system shown in Fig. 7 air may be separated into three fractions and the third fraction, for example, argon obtained. The column 90 comprises an evaporating space 91 and a condenser 92. The fraction obtained at the colder end of the column, for example, nitrogen, is led away through a duct 93, comprising a cock 94 and a heat exchanger 95. In a similar manner the fraction having the higher or the highest boiling point is led away from the evaporating space 91, for example, oxygen, is led away through a duct 96 and a heat exchanger 97. The air to be fractionated is supplied to the column through a duct 98 comprising a pump 99 through a space 100 where the air is cooled by the fractions obtained from the column, through a duct 101, a heat exchanger 102 and a duct 103. In this embodiment the column is constructed in the form of a single column, and the medium to be fractionated is supplied to the column under atmospheric or substantially atmospheric pressure.

The system comprises a cold-gas refrigerating machine 104 which communicates through ducts 105 and 106 with the heat exchanger 92. An auxiliary medium, for example nitrogen, is circulated from the condenser 92 to the cold-gas refrigerating machine 104 and conversely, cold being thus withdrawn from the column.

A portion of the nitrogen led away from the column constitutes the second medium and is supplied through a duct 107 comprising a cock 108 to a space 109 around an intermediate heat exchanger of the regenerator so that at low temperature cold is supplied to the working medium of the cold-gas refrigerating machine, the regeneration loss of the cold-gas refrigerating machine being thus reduced. From the space 109 the nitrogen is supplied through the duct 110 to the heat exchanger 95.

At a point in the column 90 where the third fraction is available in a higher quantity, then in the gaseous mixture supplied a gaseous mixture which may, for example consist of nitrogen and argon is led away through a duct 111 and supplied to a second gas fractionating column 112 in which the constituents of the gaseous mixture are separated. The argon is led away from the top of the column 112 through a duct 113 and the nitrogen is re-supplied through a duct 114, comprising a pump 115, to the column 90.

At its top, the column 112 is provided with a heat exchanger 116, which communicates through a duct 117 comprising a cock 118 with the duct 106 and through a duct 119 with the duct 105 so that heat energy can be withdrawn from this second column by means of an auxiliary medium which is cooled by the cold-gas refrigerating machine.

The system shown in Fig. 8 comprises a compressor 123 with the use of which a third medium is caused to perform a cycle. At the bottom, the system comprises a gas-fractionating column 120, having an evaporating space 121 and at the top it comprises a heat exchanger or condenser 122. The system furthermore comprises a compressor 123, which will be explained more fully with reference to Figs. 9 and 10. By means of this compressor a third medium for example nitrogen or oxygen is compressed. This medium passes through a duct 124, a heat exchanger 125 in the evaporating space 121 of the column, a heat exchanger 126, a reducing valve 127, the condenser 122 and a duct 128 back to the compressor. In the evaporator the compressed medium gives off heat, so that the fraction evaporates. Then the pressure of the medium is reduced and the medium withdraws cold from the condenser 122.

The gaseous mixture to be fractionated is supplied through a duct 129 having a pump 130 to the heat exchanger 126 where the temperature of the medium is reduced; then the medium flows through a duct 131 to the column 120 where the mixture is separated into fractions.

Since it is necessary to withdraw heat energy in addition to the heat energy withdrawn from the column by the third medium, provision is made of a cold-gas refrigerating machine 132, by which the fraction having the lowest boiling point withdrawn from the column is condensed. This fraction is supplied through a duct 133 to the cold-gas refrigerating machine 132 and the condensed product is supplied through a duct 134, one part back to the column and a further part to an outlet duct 135. From the evaporating space 121 the fraction having the higher or highest boiling point is supplied in the gaseous state through a duct 136 to a space 137 of the intermediate heat exchanger associated with the regenerator. In this space this part constitutes the second medium and supplied cold at low temperature to the regenerator so that the regeneration loss of the cold-gas refrigerating machine is reduced. Then the fraction, for example oxygen, flows through the duct 138 to the heat exchanger 126, where the fraction cools the supplied gaseous medium to be fractionated.

In the gas fractionating systems described herein, use is generally made of air as the gaseous mixture to be decomposed. It will be obvious that other gaseous mixtures, for example, coke oven gas, may be separated into fractions by the aforesaid methods and by means of the systems described above.

Figs. 9 and 10 show one embodiment of the compressor used in the system shown in Fig. 8. This compressor comprises a cylinder having a portion 140 having a compression space 141, and a part 142, in which a piston 143 is adapted to reciprocate. The piston 143 is provided with a cap 144. The height h of this cap is at least 0.8 times the stroke S of the machine, for example, 1.5 times this stroke. As is shown in Fig. 10, the cylinder portion 140, bounding the compression space, is provided with two valves, i. e. an inlet valve 145 and an outlet valve 146. These valves may be opened and closed in known manner by means of rockers 147 and 148 and cams 149 and 150 respectively. The motion of these cams is derived also in known manner from the movement of a crank shaft 151. The crank shaft 151 has a crank 152, which is connected to the piston of the machine by means of a connecting rod 153. The compression space 141 is insulated by means of an insulating layer 154. Between the cylinder portion 140 and the cylinder portion 142 provision is made of a cylinder portion 155 having a thermal conductivity coefficient of less than 0.1 cal./cm. sec. ° C.; and for example, it may be made of chromium-nickel-steel. The cylinder portion 142 is heated with the aid of a water jacket 156. The compressor may be driven by means of a motor (not shown). The above described cold-gas refrigerating machine may be a so-called displacer machine in which two piston like members move in one cylinder or a double acting machine in which each piston like member moves in its one cylinder, and both end-surfaces influence working spaces.

While I have shown and described the preferred embodiment of my invention, it will be understood that the latter may be embodied otherwise than as herein specifically illustrated or described and that in the illustrated embodiment certain changes in the details of construction and in the arrangement of parts may be made without departing from the underlying idea or principle of the invention within the scope of the appended claims.

What is claimed is:

1. A cold-gas refrigerating machine comprising at least one cylinder, two piston-like members reciprocating in said cylinder and defining therewith at least two spaces,

the volume of which vary continuously with a substantially constant phase difference, one of said spaces having a lower temperature than the other space, a freezer, regenerator and cooler, said spaces communicating with one another through said freezer, regenerator and cooler, thus forming the total working space of the machine, a gaseous working medium of invariable composition in said total working space performing a closed thermodynamic cycle therein, said regenerator having at least two heat exchangers therein and one of said heat exchangers having a plurality of elements, a second medium independent of said cycle performed in the total working space being supplied to one of said heat exchangers, and at least a portion of said gaseous working medium flowing through said regenerator being in thermal contact with said second medium.

2. A cold-gas refrigerating machine as claimed in claim 1, wherein said elements are constructed in the form of vanes.

3. A cold-gas refrigerating machine as claimed in claim 1 wherein said regenerator is subdivided into layers and said elements are constructed in the form of a heat exchanger arranged between successive regenerator layers.

4. A cold-gas refrigerating machine as set forth in claim 1 wherein said elements form a heat exchanger constructed in the form of tubes through which said second medium flows.

5. A cold-gas refrigerating machine comprising at least one cylinder, at least one piston-like member reciprocating in said cylinder defining at least two spaces, the volume of which vary continuously with a constant phase difference, one of said spaces having a lower temperature than the other space, a freezer, regenerator and cooler, a gaseous working medium of invariable composition in said spaces and said freezer, regenerator and cooler, at least one heat exchanger provided with a plurality of elements in said regenerator, means for supplying a second medium independent of said gaseous working medium to a part of said cold-gas refrigerating machine, and at least a portion of said gaseous working medium flowing through said elements and being in thermal contact with said second medium.

6. A cold-gas refrigerating machine as set forth in claim 5 wherein said elements are positioned at a location no greater than 75% of the height of said regenerator filler.

7. A method of separating gaseous mixtures into fractions of different volatility in a gas fractionating system comprising the steps of supplying the gaseous medium to be fractionated under substantially atmospheric pressure at an area between the ends of the gas fractionating column of said gas fractionating system, fractionating said gaseous medium in said column into fractions, withdrawing heat energy from the top of said column by

means of cold furnished by a cold-gas refrigerating machine wherein the gaseous working medium passing through the regenerator of said cold-gas refrigerating machine is in thermal contact with at least one of said fractions of said gaseous medium.

8. A method of separating gaseous mixtures into fractions of different volatility in a gas fractionating system as set forth in claim 7 wherein the liquid fraction of the higher or highest boiling point constitutes a second medium and is in thermal contact with the working medium of said cold-gas refrigerating machine, whereby heat is supplied to said fraction in order that at least a part of said fraction evaporates.

9. A method of separating gaseous mixtures into fractions of different volatility in a gas fractionating system as set forth in claim 7 further comprising a third medium being the fraction with the lowest boiling point compressed at a maximum temperature of 0° C., which gives off heat energy in the evaporator of said gas fractionating column, the pressure of the third medium being then reduced, and the said third medium absorbing heat energy in the condenser of said gas fractionating column and flowing back to the compressor while from the bottom of said column the fraction having the higher boiling point is supplied to said regenerator and is in thermal contact with said gaseous medium of said cold-gas refrigerating machine.

10. A method of separating gaseous mixtures into fractions of different volatility in a gas fractionating system as set forth in claim 7 wherein said gas fractionating column is constructed in the form of a single column to which a gaseous mixture to be fractionated is supplied under substantially atmospheric pressure.

11. A method of separating gaseous mixtures into fractions of different volatility in a gas fractionating system as set forth in claim 7 in which said gaseous mixture to be fractionated comprises at least three components and a third fraction is to be obtained wherein gas containing a quantity of the third component is withdrawn from the column at a point where this third component is available in a higher percentage than in the gas mixture supplied, the mixture so withdrawn being separated into fractions in a second column, the third fraction being withdrawn from the colder end of this second column and this second column being cooled by means of cold furnished by the cold-gas refrigerating machine.

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