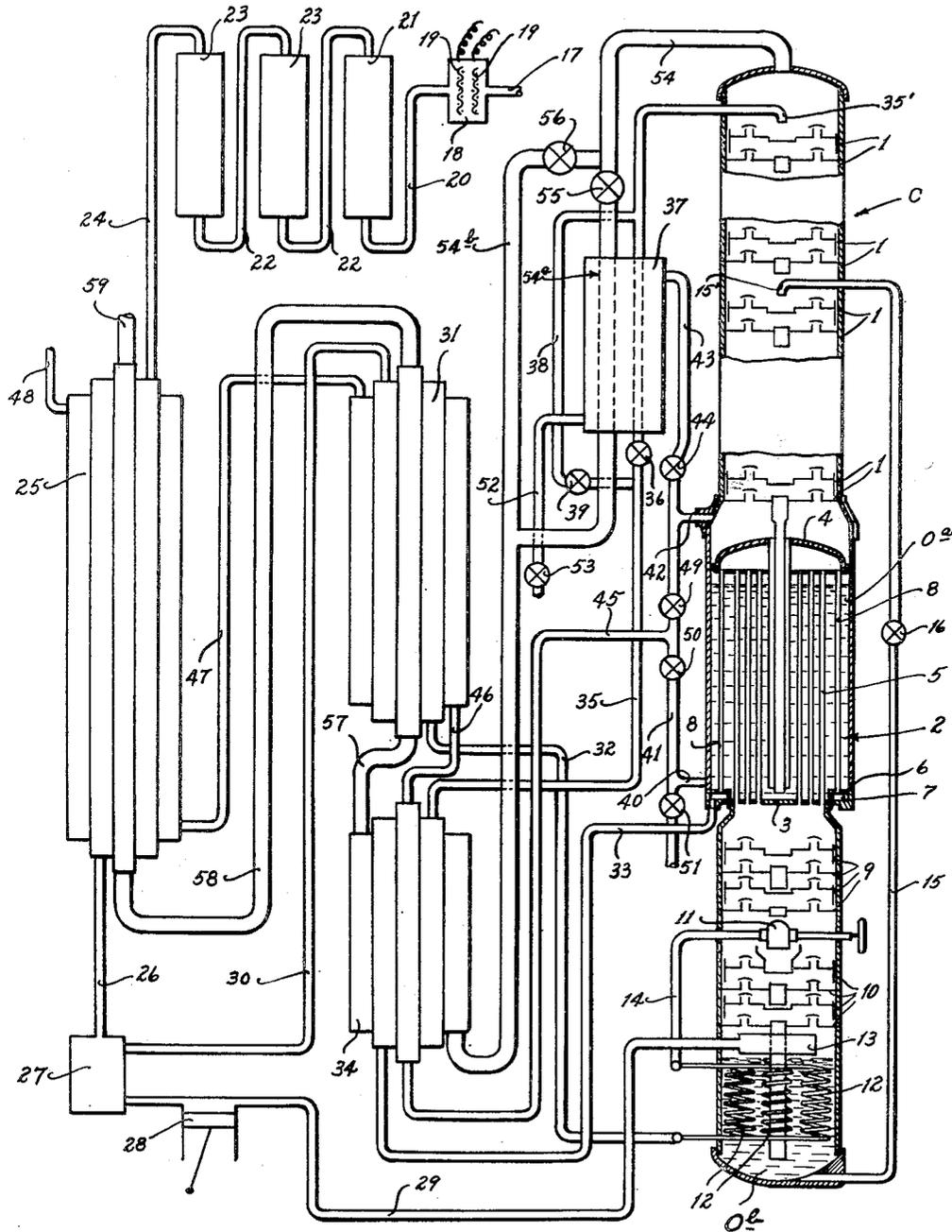


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METHOD OF SEPARATING THE CONSTITUENTS
OF GASEOUS MIXTURES
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METHOD OF SEPARATING THE CONSTITUENTS OF GASEOUS MIXTURES

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This invention relates generally to the separation of the constituents of gases by the liquefaction and rectification process, and more specifically to an improved method of recovering oxygen and nitrogen from atmosphere and the removal from the atmosphere being treated, and from the separated liquid oxygen, of acetylene and other hydrocarbons present therein, the predominant object of the invention being to provide an improved method in the use of which liquid oxygen may be recovered from atmosphere which is free from acetylene and other hydrocarbons that may have been originally present in the high pressure air under treatment, and in the separated liquid oxygen prior to its final delivery from the liquefaction and rectification column.

It is generally believed by persons familiar with the subject that many explosions in oxygen columns are attributable to the presence in the columns of acetylene. Acetylene may be present in the crude, high pressure air delivered to the columns, or it may be produced as a result of the breakdown of the lubricating oils employed in the air compressors which deliver air to the columns. Oxygen boils at -183° C. and acetylene freezes at -81° C., hence substantially all of the acetylene entering an oxygen column will remain, unless some provision is made for the elimination of the acetylene.

The predominant object of the present invention, therefore, is to provide an improved method of separating the constituents of atmosphere so that during the course of such separation acetylene, and other hydrocarbons, are completely eliminated with the result that liquid oxygen finally delivered from the column is entirely free from acetylene, or other hydrocarbons.

In the drawing, wherein is illustrated a single diagrammatical view which illustrates the improved method of the present invention, C designates, generally, a liquefaction and rectification column. The column C comprises a vertically disposed housing, in the upper portion of which is arranged a plurality of conventional rectification trays 1 disposed in the usual vertical spaced relation. Arranged within the housing of the column C, beneath the upper rectification trays 1 is a dephlegmator 2, said dephlegmator comprising a bottom wall 3, an upper, hollow head 4 spaced vertically from said bottom wall, and a bank of tubes 5 which are supported by said bottom wall and said head so that they communicate at their upper ends with the interior of the hollow head, and at their lower ends with the portion of the housing of the column located beneath the bottom

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wall of the dephlegmator. At the bottom of the dephlegmator 2 an annular portion 6 is present which is hollow so as to provide an annular chamber 7, the tubes of an outer, annular row of tubes 8 of the dephlegmator 2 communicating at their upper ends with the interior of the hollow dephlegmator head 4, and at their lower ends with said annular chamber 7.

Located within the housing of the column C beneath the dephlegmator 2 is a group of rectification trays 9 and a group of rectification trays 10, said groups of rectification trays 9 and 10 having interposed therebetween an expansion valve 11. The extreme lower portion of the housing of the column C provides the boiling pot of the column wherein a plurality of coils 12 are located, and located within the housing of the column C, between the lowermost tray of the group of rectification trays 10 and the boiling pot coils 12, is a discharge head 13. The boiling pot coils 12 are connected by a conductor 14 to the expansion valve 11, and also, a conductor 15 leads from the bottom of the boiling pot of the column C to the discharge point 15' of said conductor which is located intermediate of the height of the group of rectification trays 1. The conductor 15 is provided with a valve 16 for controlling passage of medium therethrough.

The apparatus for carrying out the present invention which is illustrated in the drawing, includes a conductor 17 which conducts high-pressure air from a suitable compressor (not shown) to a housing 18 wherein is disposed one or more electrical heating elements 19. During passage of the high-pressure air through the housing 18, which functions as a furnace, acetylene, and other hydrocarbons carried by the incoming air are burned so that the high-pressure air which leaves the housing 18 is substantially free of such hydrocarbons. From the housing 18 the high-pressure air passes by way of a conductor 20 to a cooler 21, and thence by way of the conductors 22 to and through a plurality of caustic dryers 23 wherein entrained moisture and products of combustion are removed. After passing through the last dryer 23 the high-pressure air passes through a conductor 24 to a heat interchanger 25. High-pressure air which passes from the dryers 23 to the heat interchanger 25 passes from said heat interchanger by way of the conductor 26 to a receiver 27 wherein said air is divided, one portion passing to an expansion engine 28 and from said expansion engine by way of a conductor 29 to the discharge head 13 in the upper portion of the boiling pot of the column C, and another

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portion of said divided air passing from the receiver 27 by way of the conductor 30 to and through a liquefier 31, and thence by way of the conductor 32 to the coils 12 within the boiling pot of the column C. From the boiling pot coils the medium delivered thereto by the conductor 32 passes to the expansion valve 11 for descent through the trays 10.

Connected into the annular chamber 7 at the bottom of the dephlegmator 2 is a crude nitrogen conductor 33 which leads from said annular chamber 7 to a sub-cooler 34, the nitrogen which passes to said sub-cooler by way of the conductor 33 passing from said sub-cooler by way of a conductor 35 to the top of the column C where it is discharged at the point 35'. The conductor 35 is provided with a valve 36 which is operable to control passage of nitrogen through said conductor, and said conductor 35 extends through a condensing unit 37 so that nitrogen conducted by said conductor 35 to the top of the column is passed through said condensing unit.

Under certain circumstances, however, it may be desirable to cause the nitrogen which passes by way of the conductor 35 to the top of the column, to by-pass the condensing unit 37 and not pass therethrough. For this purpose a by-pass conductor 38 is provided which connects at its opposite ends into the conductor 35 below and above the condensing unit 37, and which is provided with a valve 39. When it is desired to cause the nitrogen moving through the conductor 35 to the top of the column to pass through the condensing unit 37 the valve 36 of the conductor 35 is opened and the valve 39 of the by-pass conductor 38 is closed. On the other hand, when it is desired that the nitrogen moving to the top of the column through the conductor 35 shall by-pass the condensing unit 37, the valve 36 of the conductor 35 is closed while the valve 39 of the by-pass conductor 38 is opened.

Oxygen may be taken off of the column in either liquid form or gaseous form, the liquid oxygen being taken off of the column at a low point of the dephlegmator 2 through the conductor 40 which is connected into a conductor 41. Also the conductor 41 has connected therein a gaseous oxygen conductor 42 which communicates also with the interior of the column C at a point immediately above the dephlegmator 2. The upper end of the conductor 41 is connected to the upper portion of the condensing unit 37 by a conductor 43, there being provided a valve 44 which controls passage of gaseous oxygen through said conductor 43 to the upper portion of the condensing unit 37. Also, a conductor 45 is connected into the conductor 41, and this conductor leads to a portion of the sub-cooler 34, medium delivered to the sub-cooler 34 by the conductor 45 being conducted therefrom by a conductor 46 to a portion of the liquefier 31, and from liquefier by a conductor 47 to the heat interchanger, from which it is delivered by a conductor 48. The conductor 41 is provided with valves 49 and 50 at opposite sides of the point where the conductor 45 connects into said conductor 41, and also, said conductor 41 is provided with a valve 51 which is located below the point where the conductor 40 connects into said conductor 41. Additionally, the condensing unit 37 has connected into its lower portion a conductor 52 which is provided with a valve 53.

Communicating with the top of the column C is nitrogen conductor 54 which includes a portion 54a that passes through the condensing unit 37, and a portion 54b which provides a nitrogen by-

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pass around said condensing unit 37. The nitrogen conductor portions are interconnected above the condensing unit and below same, there being provided valves 55 and 56 which are operable in an obvious manner to direct nitrogen coming from the top of the column either through the condensing unit 37 or around same. The conductor 54 extends to a portion of the sub-cooler 34, and from said sub-cooler nitrogen is conducted by a conductor 57 to the liquefier 31, and from said liquefier by a conductor 58 to the heat interchanger 25, nitrogen passing from the heat interchanger by way of a conductor 59.

In separating the constituents of atmosphere in accordance with the present invention, and with the aid of such an apparatus as that illustrated in the drawing, high-pressure air moving to the column C passes through the housing 18 wherein acetylene and other hydrocarbons carried by the high-pressure air are consumed by the heat of the electric heating elements 19 within said housing 18. The high pressure air then passes through the cooler 21 and the caustic dryers 23, and through the heat interchanger 25 to the receiver 27 wherein said high-pressure air is divided into two parts, one part passing through the liquefier 31 to the boiling pot coils 12 for subsequent delivery to the expansion valve 11, and the other part being delivered by the expansion engine 28 to the discharge head 13 in the upper portion of the boiling pot of the column C. Also, crude liquid oxygen is conducted by the conductor 15 from the boiling pot of the column C to the discharge point 15' of said conductor 15 for descent through the upper portion of the column.

The column C functions in the usual and well understood manner to separate from the atmosphere being acted on, by liquefaction and rectification, oxygen and nitrogen forming parts thereof, a body of liquid oxygen Oa gathering at the dephlegmator 2, and a body of crude liquid oxygen Ob gathering in the boiling pot of the column. Also, a body of crude nitrogen gathers in the chamber 7 provided by the annular portion 6 at the bottom of the dephlegmator 2. As previously stated, crude nitrogen passes from the annular chamber 7 by way of the conductor 33, through the sub-cooler 34, and from said sub-cooler by way of the conductor 35, to the top of the column, while crude, liquid oxygen passes through the conductor 15 from the boiling pot of the column to a point intermediate of the height of the trays 1, the nitrogen being either passed through the condensing unit 37 or around same, as desired, by manipulation of the valves 36 and 39.

Liquid oxygen may be withdrawn directly from the body of oxygen Oa, at the dephlegmator 2, through a portion of the conductor 41, by closing the valve 50 and opening the valve 51, and also gaseous oxygen may be drawn from the portion of the column C at the upper end of the dephlegmator by closing the valve 49 and opening the valve 44, said gaseous oxygen being discharged into the condensing unit 37 where it is converted into a liquid state. Additionally, liquid oxygen from the body of oxygen Oa may be withdrawn from the lower portion of the dephlegmator 2, and gaseous oxygen may be withdrawn from the portion of the column immediately above the dephlegmator 2, and such liquid and gaseous oxygen may be mixed and directed through the conductor 45, and thence successively through the sub-cooler 34, liquefier 31, and heat interchanger 25 to the outlet conductor 48 thereof. When liquid and gaseous oxygen is to be mixed as described,

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the valves 44 and 51 are closed, and the valves 49 and 50 are opened. The liquid oxygen which is obtained from gaseous oxygen within the condensing unit 37 is purer than the liquid oxygen received from the lower portion of the dephlegmator 2, in that the liquid oxygen from the lower portion of the dephlegmator may contain some acetylene, or other hydrocarbons, which have not been consumed in the housing 18. However, substantially all of the acetylene, or other hydrocarbons, are burned as the incoming high-pressure air passes through the housing 18, and therefore very little of the undesirable hydrocarbons will be present in the liquid oxygen withdrawn from the lower portion of the dephlegmator 2.

The nitrogen that passes from the top of the column C through the conductor 54, passes through or around the condensing unit 37, the valves 55 and 56 being actuated to cause the nitrogen to follow the desired course, and said nitrogen is successively passed through the sub-cooler 34, the liquefier 31 and the heat interchanger 25, to provide the refrigeration necessary for the performance by said parts of the apparatus of their intended functions.

It is obvious, therefore, that the improved method of the present invention provides for the removal of acetylene, or other hydrocarbons in two ways, so as to produce oxygen which is free from such hydrocarbons, first, by burning the acetylene, or other hydrocarbons, as they pass with the incoming high-pressure air through the housing 18, and, secondly, by recondensing gaseous oxygen, which, because of its gaseous state, is free from such hydrocarbons, in the condensing unit 37.

We claim:

1. The method of separating the constituents of atmosphere under pressure so as to obtain therefrom oxygen of a purity suitable for commercial purposes, said method comprising preliminarily removing from the atmosphere being treated hydrocarbons contained therein by burning away said hydrocarbons, cooling the atmosphere from which hydrocarbons have been removed, directing the cooled atmosphere to a liquefaction and rectification column for treatment therein which separates the oxygen and nitrogen of the atmosphere being treated within the liquefaction and rectification column, withdrawing from the liquefaction and rectification column oxygen in gaseous form, and thereafter liquefying said gaseous oxygen.

2. The method of separating the constituents of atmosphere under pressure so as to obtain therefrom oxygen of a purity suitable for commercial purposes, said method comprising preliminarily removing from the atmosphere being treated hydrocarbons contained therein by burning away said hydrocarbons, cooling the atmosphere from which hydrocarbons have been removed, directing the cooled atmosphere to a lique-

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faction and rectification column for treatment therein which separates the oxygen and nitrogen of the atmosphere being treated within the liquefaction and rectification column, withdrawing from the liquefaction and rectification column oxygen in gaseous form, and thereafter liquefying said gaseous oxygen, with the aid of colder nitrogen recovered from the atmosphere being treated within the liquefaction and rectification column.

3. The method of separating the constituents of atmosphere under pressure so as to obtain therefrom oxygen of a purity suitable for commercial purposes, said method comprising preliminarily removing from the atmosphere being treated hydrocarbons contained therein by burning away said hydrocarbons, cooling the atmosphere from which hydrocarbons have been removed, directing the cooled atmosphere to a liquefaction and rectification column for treatment therein which separates the oxygen and nitrogen of the atmosphere being treated within the liquefaction and rectification column, and withdrawing oxygen and nitrogen from the liquefaction and rectification column.

4. The method of separating the constituents of atmosphere under pressure so as to obtain therefrom oxygen of a purity suitable for commercial purposes, said method comprising preliminarily removing from the atmosphere being treated hydrocarbons contained therein by burning away said hydrocarbons, cooling the atmosphere from which hydrocarbons have been removed, and directing the cooled atmosphere to a liquefaction and rectification column for treatment therein which separates the oxygen and nitrogen of the atmosphere being treated within the liquefaction and rectification column.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,549,236	Van Nuys	Aug. 11, 1925
1,774,462	Van Nuys et al.	Aug. 26, 1930
1,785,491	Messer	Dec. 16, 1930
1,958,553	Van Nuys	May 15, 1934
2,040,107	Schlitt	May 12, 1936
2,154,668	De Baufre	Apr. 18, 1939
2,238,012	Clark	Apr. 8, 1941
2,287,137	Ross	June 23, 1942
2,287,158	Yendall	June 23, 1942
2,327,459	Rice	Aug. 24, 1943
2,406,003	Dennis	Aug. 20, 1946
2,409,458	Van Nuys	Oct. 15, 1946
2,411,711	De Baufre	Nov. 26, 1946
2,423,273	Van Nuys	July 1, 1947