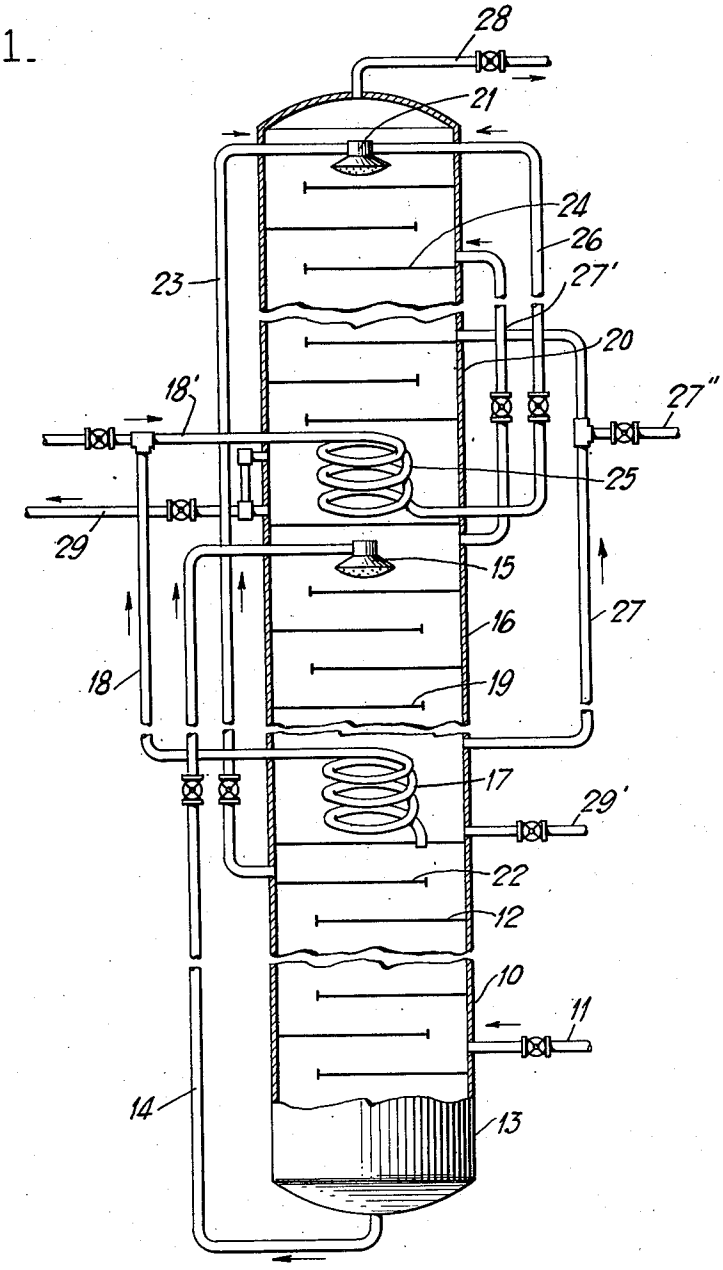
June 30, 1936. G. J. BOSHKOFF 2,046,284

APPARATUS FOR PRODUCING OXYGEN OF HIGH PURITY

Original Filed May 18, 1933 2 Sheets-Sheet 1

Fig. 1.



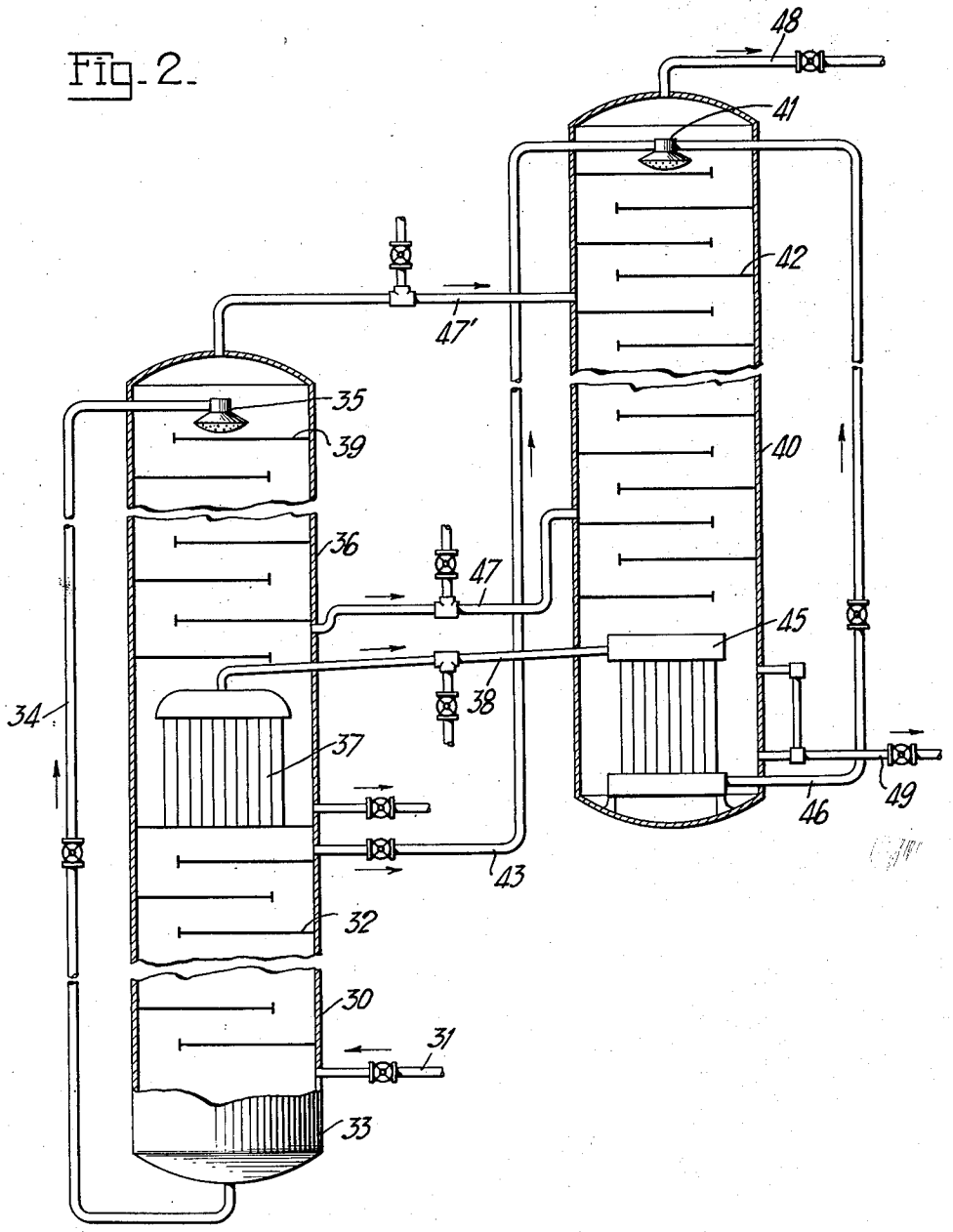
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Fig. 2.



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2,046,284

APPARATUS FOR PRODUCING OXYGEN OF HIGH PURITY

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Original application May 18, 1933, Serial No. 671,690, now Patent No. 1,985,763, dated December 25, 1934. Divided and this application August 22, 1934, Serial No. 740,902

5 Claims. (Cl. 62—122)

This invention relates to apparatus for producing oxygen of high purity and more particularly oxygen in the liquid phase free from high boiling point materials.

The invention has for its object generally, the provision of improved apparatus whereby oxygen, especially liquid oxygen, may be readily produced in an easy and expeditious manner with rectifying apparatus, whether operated continuously or discontinuously, so as to be substantially free from impurities of the character indicated.

More specifically, it is an object to provide apparatus for the manufacture of oxygen whereby it is produced substantially free from small amounts of hydrocarbons and rare gases ordinarily present in the incoming air, which is employed as the raw material from which the oxygen is to be separated.

It is also an object to provide gas separating apparatus with rectification chambers or columns so arranged that substantially pure oxygen is separated by fractional condensation and evaporation without contamination with undesired high boiling point materials and without interfering with the stability and operative balance in the cyclic operations taking place in the rectification columns or chambers.

It is also an object to provide an additional column or chamber in rectification apparatus which is to be operated in conjunction with the usual second or last chamber of ordinary two-column apparatus.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the claims.

This application is a division of my application Serial No. 671,690, filed May 18, 1933, issued as Patent No. 1,985,763, granted December 25, 1934.

For a fuller understanding of the nature and objects of the invention references should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a fragmentary vertical sectional view showing somewhat diagrammatically a rectification apparatus constructed in accordance with the invention; and

Fig. 2 is a similar view showing a modified arrangement in which the added column, provided in accordance with the invention, is operated separately.

In the manufacture of oxygen for industrial use, it is customary to employ air as the raw material and to separate the oxygen from the air in one or more stages by the rectification of liquid air, the atmospheric air having been compressed and cooled by heat exchangers and expanded in various stages by steps well known to the art. There are in air, as is well known, certain gas materials of high boiling point which frequently comprise undesirable impurities in oxygen obtained in this manner. Also, where oxygen is to be provided for industrial use, very small amounts of certain hydrocarbons and other undesirable gases may be present as impurities. By the present invention, these relatively high boiling point materials are separated from the liquid oxygen by steps which do not require the input of any more power than is now customarily employed in the operation of the usual rectification cycle.

In the practice of the present invention, the step of rectifying the gaseous mixture in the low pressure rectifying column or chamber is performed in two stages carried out successively. This is advantageously achieved by dividing the low pressure rectifying chamber or column into two parts and operating them in series. This division preferably affects what would ordinarily be the lower two-thirds of the low pressure rectifying column of a two-column rectifying apparatus.

Referring now to the drawings and particularly to Fig. 1, 10 denotes generally the high pressure column or chamber of a rectifying apparatus into which the gaseous mixture to be separated is introduced in a cooled state through the conduit 11, the cooling being carried out in any well-known manner, for example, by means of expansion or passage through heat interchangers, or both. This column is also provided with suitable dephlegmating means, for example, perforated partitions 12. The lower end 13 of this column serves as a kettle in which liquid collects and boils, the more volatile products passing upwardly in the column. From this kettle the conduit 14 leads to a distributing head 15 disposed in the upper portion of a low pressure chamber or column 16 preferably disposed above the high pressure chamber 10. In the lower end of this second chamber is disposed a condenser 17 which serves to receive the volatile material arising from the chamber 10, a substantial portion thereof being condensed and returned to

the chamber. From the upper end of this condenser a conduit 18 leads off the uncondensed material which is here utilized in the manner hereinafter more fully explained. The heat extracted by the condenser 17 in cooling the condensate returned to the high pressure chamber is supplied to vaporize the liquid which collects in the lower end of chamber 16. This second chamber also has suitable dephlegmating means, here represented as partitions 19 similar to those in the chamber 10.

To provide another chamber to be operated in series with the chamber 16, in accordance with the invention, a third chamber 20 is here shown as provided above the chamber 16. In the upper portion of this chamber is a distributing head 21, to which liquid condensate, caught on the partition or shelf 22 in the chamber 16, is supplied by means of a conduit 23 that communicates at its lower end with the chamber 10 just above the shelf. The chamber 20 is also provided with dephlegmating means, here shown as partitions 24, similar to those in chambers 10 and 16.

In order to vaporize the liquid which collects in the lower end of chamber 20 in a manner similar to that in chamber 16, a heating coil 25 is provided in this chamber and the uncondensed gaseous material led off by the conduit 18 supplied thereto through a branch connection 18'. The liquid obtained by condensation in coil 25 is supplied by another conduit 26 to the distributing head 21. Gaseous material, which is substantially pure oxygen, is led off from the chamber 16 to chamber 20 through conduit 27, this conduit being provided with a branch 27'' for bleeding off gaseous material when desired. It is also desirable to transfer gas material from the upper portion of chamber 16 to an intermediate point in chamber 20. A conduit for effecting this is shown at 27'. The uncondensable gas materials which have a very low boiling point, together with the major portion of the nitrogen, are preferably led off the top of the chamber 20 by means of a conduit here indicated at 28.

In operation, when the gaseous mixture supplied to the chamber 10 through the conduit 11 is cooled compressed atmospheric air, liquid collects in the kettle 13 which becomes relatively rich in oxygen, since the more volatile constituents, such as nitrogen, are being continually boiled off and washed, the condensate being returned by counter washing or refluxing. The oxygen content of the liquid which collects in the kettle 13 becomes relatively high, for example, from 35 to 45 per cent. While it is seen that the more volatile constituents, that is, the low boiling point constituents, are continually removed, the high boiling point constituents which include undesired impurities remain and are passed into the low pressure chamber 16 by way of conduit 14 with the liquid transferred.

In the chamber 16, the liquefied gas material of high oxygen content collects in the lower end and is heated, whereby further volatile constituents are removed. A liquid of very high oxygen content, in consequence, results, but still includes the high boiling point impurities. The oxygen portion is here vaporized without carrying off any of the high boiling point impurities.

By operating the chamber 20 in series with the chamber 16, a gaseous material comprising substantially pure oxygen free from high boiling point impurities is withdrawn through the conduit 27 and is condensed by counter-current washing, so as to collect about the coil 25, substantially all the remaining volatile or low boiling point material being removed and withdrawn through the connection 28. Gaseous material is also conducted by conduit 27' from the upper portion of chamber 16 to a point near the upper portion of chamber 20; the oxygen content thereof, however, is substantially lower than the oxygen content of the liquid introduced into chamber 16 through conduit 14. In consequence, substantially pure liquid oxygen may be withdrawn from the lower portion of this chamber through the withdrawal connection 29. A withdrawal connection 29' is advantageously provided for the lower end of chamber 16 in order to carry away when desired the high boiling point impurities which may collect.

In Fig. 2, a modified arrangement of apparatus for carrying out the process of the present invention is shown in which the divided low pressure chambers that are operated in series are shown as structurally separated. Here, a high pressure column or chamber is shown at 30, to which a cooled, compressed, gaseous mixture is supplied through a conduit 31. This chamber has dephlegmating means 32 and a kettle 33 at the lower end, from which liquid comprising a concentrate of oxygen is withdrawn through a conduit 34 and supplied to a distributing head 35 in a low pressure chamber or upper column 36 of a two-column rectifying apparatus. This apparatus may be generally of conventional design, except that the other chamber is shorter, as it is the lower two-thirds of the conventional upper chamber that is divided to provide a second low pressure chamber 40 separated as indicated from that at 36, but arranged to be operated in conjunction therewith.

In the lower end of the upper chamber 36 is disposed a condenser 37 adapted to return condensate to the lower chamber 30. Uncondensed gas material is withdrawn through the conduit 38 and supplied to the heat transfer means 45 disposed in the lower end of the chamber 40. The upper chamber 36 also has dephlegmating means 39 and gas withdrawal connections 47 and 47' which communicate with intermediate points in the chamber 40.

Chamber 40 has a distributing head 41 and dephlegmating means 42, conduit 43 being arranged to lead condensate of relatively high nitrogen concentration from an upper shelf in the chamber 30 to the head 41. A conduit 46 leads from the lower end of the heat transfer means 45 to supply gas material, in this case, condensate, to the head 41. A conduit 48 leads from the top of the chamber 40 to convey away uncondensed, low boiling point gas materials.

In operation, the apparatus shown in Fig. 2 operates similarly to that shown in Fig. 1. In consequence, a liquid having an increased concentration of oxygen collects in the kettle 33 along with the undesired high boiling point impurities. In the upper chamber 36, a liquid collects about the condenser 37, which is substantially pure oxygen but for the high boiling point impurities which are contained therein. The oxygen content is here vaporized and the gaseous oxygen and volatile materials are conveyed by conduits 47 and 47' into the chamber 40, where the low boiling point materials are separated out and conveyed away through the conduit 48, leaving a liquid to collect about the heat transfer means 45 which is substantally pure liquid oxy-

gen free of high boiling point impurities. This is withdrawn when desired through the conduit 49.

Since certain changes may be made in the above construction and different embodiments of the invention could be made wthout departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. Apparatus for producing oxygen substantially free from high boiling point material comprising in combination a high pressure rectifying column having a liquid space at its lower end and a gas space thereabove provided with dephlegmating shelves, a pair of low pressure rectifying columns arranged to be operated in series having liquid spaces at their lower ends and gas spaces thereabove provided with dephlegmating shelves inserted therein, a plurality of connections between the gas spaces of said low pressure rectifying column, a connection leading from the liquid space of said high pressure column and arranged to discharge in the gas space above the dephlegmating shelves of one of said low pressure rectifying columns, a connection leading from a shelf in said high pressure rectifying column arranged to discharge in the upper portion of the gas space of the other of said low pressure rectifying columns, a condenser in the liquid space of said first-named low pressure rectifying column arranged to receive uncondensed vapors from said high pressure rectifying column, a condenser in the liquid space of said second-named low pressure rectifying column arranged to receive uncondensed vapors from said first-named condenser, and a connection leading from said second-named condenser to the gas space above the dephlegmating shelves of said second-named low pressure rectifying column.

2. Apparatus for producing oxygen substantially free from high boiling point material, comprising, in combination, a high pressure rectifying column, a pair of low pressure rectifying columns, one of said low pressure columns being provided with a vent, a pair of independent connections leading from respectively different points in the gas space of said high pressure column to substantially the same point in the gas space of said vented low pressure column, another connection leading from the liquid space of said high pressure column directly to the gas space of the other of said low pressure columns whereby liquid fractions may be supplied thereto, a pair of condensers disposed respectively in the liquid spaces of said low pressure columns and connected in series in one of said independent connections whereby uncondensed vapors received therein from said high pressure column are successively cooled and supply the heat of fractionation to said low pressure columns, said condensers being arranged to pass the condensate resulting from said cooling to the gas space of said vented low pressure column, and a plurality of common connections disposed to effect free communication between the gas spaces of said low pressure columns at relatively different points.

3. Apparatus for producing oxygen substantially free from high boiling point material, comprising, in combination, a high pressure rectifying column, a pair of low pressure rectifying columns, one of said low pressure columns being provided with a vent, a pair of independent connections leading from respectively different points in the gas space of said high pressure column to substantially the same point in the gas space of said vented low pressure column, another connection leading from the liquid space of said high pressure column directly to the gas space of the other of said low pressure columns whereby liquid fractions may be supplied thereto, heat exchanging means disposed in each of said low pressure columns and connected in series in one of said independent connections leading to the gas space of said vented low pressure column, and common connections arranged to effect free communication betwen the gas spaces of said low pressure columns.

4. Apparatus for producing oxygen substantially free from high boiling point material, comprising, in combination, a high pressure rectifying column, a pair of low pressure rectifying columns, one of said low pressure columns being provided with a vent, a pair of independent connections leading from respectively different points in the gas space of said high pressure column to substantially the same point in the gas space of said vented low pressure column, another connection leading from the liquid space of said high pressure column directly to the gas space of the other of said low pressure columns whereby liquid fractions may be supplied thereto, a pair of condensers disposed in the liquid space of each of said low pressure columns and connected in series in one of said independent connections that lead to the gas space of said vented low pressure column, and a common connection arranged to effect free communication between the gas spaces of said low pressure columns.

5. Apparatus for producing oxygen substantially free from high boiling point material, comprising, in combination, a high pressure rectifying column, a pair of low pressure rectifying columns, independent connections leading from respectively different points in the gas space of said high pressure column to substantially the same point in the gas space of one of said low pressure columns, another connection leading from the liquid space of said high pressure column directly to the gas space of the other of said low pressure columns, heat exchanging means disposed in each of said low pressure columns and connected in series in one of said independent connections whereby the uncondensed vapors passing therein supply the heat of fractionation to said low pressure columns, and a common connection arranged to effect free communication betwen the gas spaces of said low pressure columns.

GEORGE J. BOSHKOFF.