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2,079,019

PROCESS FOR ENRICHING BLOWER BLAST WITH OXYGEN

Filed April 3, 1935

2 Sheets-Sheet 1

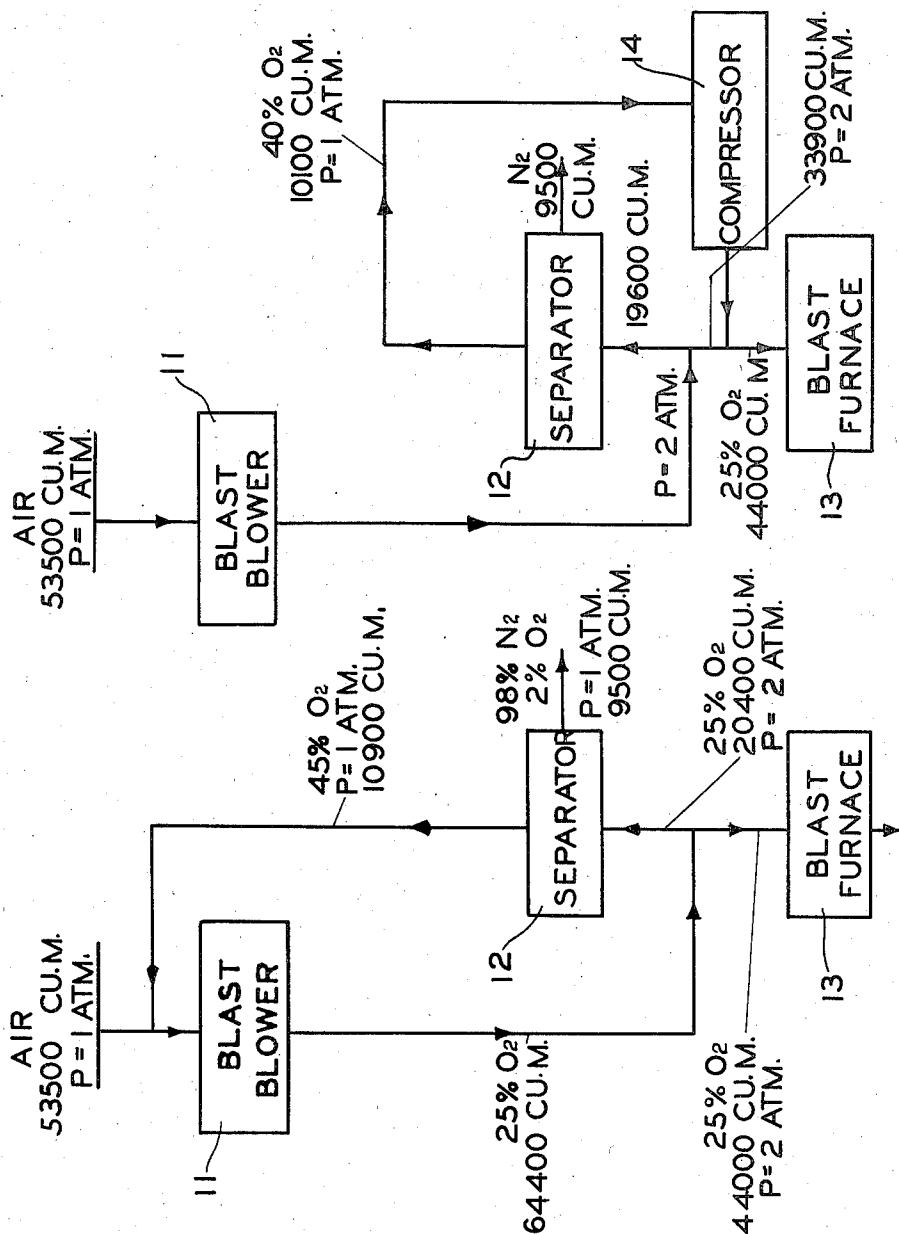


FIG 2

FIG 1

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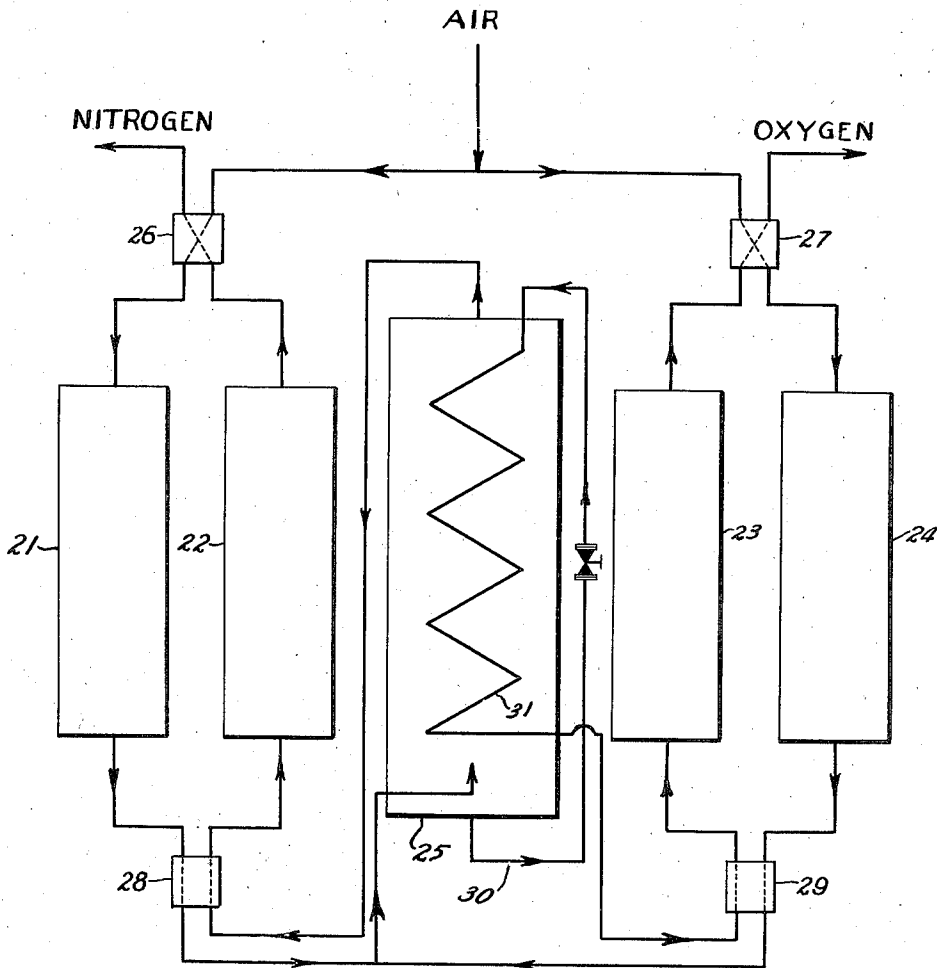


FIG. 3

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2,079,019

PROCESS FOR ENRICHING BLOWER BLAST
WITH OXYGENErnst Karwat, Grosshesselohe by Munich, Ger-
many, assignor, by mesne assignments, to Union
Carbide and Carbon Corporation, a corpora-
tion of New YorkApplication April 3, 1935, Serial No. 14,541
In Germany May 17, 1934

6 Claims. (Cl. 75-41)

It has been repeatedly proposed to enrich with oxygen the blast of converters, blast furnaces, or the like, for which was required, in addition to the low temperature cooling apparatus for separating the constituents of air, compressors and blowers for compressing the air to be separated to the separation pressure as well as for compressing the produced oxygen to the blast pressure. Upon conversion of the furnace operation from an air blast to oxygen-enriched blast the volume of gas to be handled by the blast blower is appreciably decreased (to approximately one-half normal capacity) due to the removal of part of the nitrogen and to the saving in carbon fuel, and consequently in atmospheric oxygen, brought about by the utilization of the oxygen-enriched blast. The efficiency of the blowers designed to handle an ordinary air blast is thereby reduced to such a point that their operation becomes uneconomical. In addition, the high plant costs have heretofore also stood in the way of the utilization of oxygen.

The object of the present invention is a process for enriching the furnace blast with oxygen which permits the utilization of the available blast blowers and thus reduces the plant costs. In accordance with the invention the nitrogen removal plant is not supplied with air, but rather with an oxygen-nitrogen mixture having the composition and pressure of the furnace blast required at the point of consumption and is preferably separated under this pressure into nitrogen and a residue containing oxygen in higher concentration. The latter fraction is mixed with air until the oxygen concentration desired for the furnace blast is reached and is then compressed by the blast blower to the pressure required for the furnace operation.

The process is explained with reference to the accompanying drawings which show as an example the enrichment of the blast, of a blast furnace having a daily capacity of 400 metric tons, to an oxygen content of 25%.

Figure 1 of the drawings is a flow sheet of a preferred form of the process of the invention in which a mixture of air and oxygen-enriched air, the latter containing about 45% oxygen, is compressed by the blast blower 11. The compressed mixture at about 2 atmospheres pressure and containing about 25% oxygen is then divided into two fractions, one of which goes directly to the blast furnace 13 while the other passes through a separator plant 12 where it is enriched to about 45% oxygen and passed on to the intake of the blast blower 11.

Figure 2 of the drawings is a flow sheet of a modification of the process of Fig. 1 in which only free air is compressed in the blast blower 11. The compressed air is then divided into two fractions, one of which passes through a gas separating plant 12 where part of its nitrogen content is removed. The oxygen enriched air (about 40% oxygen) so produced is then compressed to blast pressure by a compressor 14 and mixed with the second fraction of compressed air to form a blast of desired composition, for example about 25% oxygen. The mixture is then passed to the blast furnace 13.

Fig. 3 of the drawings is a detailed flow sheet of the separator apparatus indicated at 12 of Figs. 1 and 2, in which are shown four regenerative heat exchangers or "cold accumulators" 21, 22, 23, 24; a fractionation chamber 25; a heat exchange coil 31 within said chamber; directional control valves 26, 27, 28, 29; a pipe 30 for circulating condensate from the bottom of chamber 22 through coil 31 within said chamber 22.

A detailed description of such apparatus and its mode of operation may be found in United States Patent No. 1,890,646, issued December 13, 1932, to M. Fränkl.

In a blast furnace having the stated capacity and utilizing air as furnace blast, assuming 10% blast losses, the blast blower must compress 62,600 cubic meters per hour. When utilizing 25% oxygen, the furnace, because of the saving in coke, and with the same losses, requires only 44,000 cubic meters blast. For this purpose heretofore 18,000 cubic meters of air were compressed in a separate compressor, and from this portion of air about 8000 cubic meters of oxygen-enriched air containing about 42% oxygen were produced at atmospheric pressure in a separator plant. This oxygen-enriched air was then compressed to blast pressure (about 2 atmospheres) and mixed with about 35,500 cubic meters of air compressed by the blast blower, to supply the furnace with about 44,000 cubic meters of blast containing about 25% oxygen. It will be observed that the volume of air compressed by the blast blower is in such case only about

$$\frac{35500}{62600}$$

or 57% of the normal furnace blast volume while the balance of the air required must be handled through a separate compressor.

In the process of the present invention as illustrated in Fig. 1, the separator plant 12 is supplied not with atmospheric air, but with oxygen-

enriched air (about 25% oxygen) from the main blast line. The main blast blower then compresses 64,400 cubic meters of mixture containing 25% oxygen, that is, practically the same volume as in air operation, and no other blower or compressor is required. Of the mixture compressed to 1 atm. gauge, 44,000 cubic meters are conducted to the blast heaters, while 20,400 cubic meters are conducted to the separation apparatus and separated into 9500 cubic meters of nitrogen containing approximately 2% oxygen and 10,900 cubic meters of gas containing about 45% oxygen. The latter gas fraction is then led to the suction side of the main blast blower and mixed with 53,500 cubic meters of air.

In the modified process as illustrated in Fig. 2, the separator plant 12 is supplied with a fraction of ordinary air compressed to blast pressure in the blast blower 11, instead of with oxygen-enriched blast as in Fig. 1. This air is fractionated to about 40% oxygen, compressed in a separate compressor, and added to the blast. In this modification the blast blower handles about

25 53500
 62600'

or 86% of the normal furnace blast volume, and the separate compressor handles about

30 10100
 62600'

or 16% of the normal furnace blast volume. Thus, existing blast blowers are not used to as great advantage as in the process of Fig. 1, but they are used to much better advantage than in the case of processes heretofore known for enriching the blast.

In order to carry out the nitrogen removal as much as possible without after-compression, that is, solely with the blast pressure, it is advisable to utilize periodically alternating cold accumulators in the separation plant for the cold exchange for the purpose of reducing the flow resistances, and to carry out the condensation of the mixture introduced into the separation plant with reflux of the condensates and the evaporation of the 42% oxygen co-currentwise with its vapors. Apparatus suitable for such methods is described, for example, in U. S. Patents #1,963,840, #1,890,646 and Reissue #19,140, all to Mathias Fränkl.

In regard to selecting the concentration of the oxygen to be produced in the separation apparatus, one may be guided entirely by the pressures available for the blast compression. With relatively low blast pressures, for example, 1 atm. and lower, one will produce in the separation plant an oxygen-nitrogen mixture containing only 42% oxygen.

If, on the other hand, the mixture to be separated is available at higher pressures as, for example, in a Thomas converter, it is preferable to produce oxygen having a higher concentration, for example 80%, inasmuch as in this event smaller volumes are processed in the separation apparatus and the size and costs of the plant are thereby reduced.

If the pressure required for blast compression is not sufficient for the separation, the mixture treated in the separation plant may be evaporated under less than atmospheric pressure or the mixture supplied to the separation plant may be subjected to a slight pre-compression.

The advantages of the new method of operation consist therein that it eliminates the necessity for separate compressors for the air supplied

to the separation plant and for the produced oxygen and that simultaneously the blast blower can operate, practically independently of the oxygen concentration of the blast, at full capacity and at a higher efficiency. Furthermore, practically the entire power requirement for enriching the blast with oxygen is transferred to the blast blower and consequently supplied by means of blast furnace gas, while heretofore it has been necessary to employ steam or electric power for this purpose in order to operate turbo-compressors. Even in the case where a slight after-compression of the mixture compressed by the blast blower becomes necessary, there is a saving in power due to the advantageous division of the work of compression.

I claim:

1. Process for the production of oxygen-enriched air for use as furnace blast or the like, comprising the steps of compressing to the desired blast pressure in a blast blower or the like, a mixture of air and oxygen-enriched air, said mixture having the desired blast composition; dividing said compressed mixture into a major and a minor fraction, and delivering said major fraction as blast; passing said minor fraction through a gas separation plant whereby a portion of its nitrogen content is removed; passing the oxygen-enriched air thus obtained to the intake of said blast compressor or the like; and there mixing it with air to form as feed to said compressor a mixture of air and oxygen-enriched air having the desired blast composition.

2. Process according to claim 1, wherein the minor fraction of compressed blast mixture delivered to the gas separation plant is passed in heat exchange relationship with the nitrogen and oxygen-enriched air products of said separation plant, by means of periodically alternating cold accumulators of the type described, whereby the back pressure of the system is decreased to a minimum and the necessity of extra compression is avoided.

3. Process according to claim 1, wherein the separation of nitrogen in the separation plant is accomplished by means of fractional condensation with reflux of the condensates and the evaporation of the oxygen-enriched mixture co-current-wise with the separation products, in the manner described, whereby the degree of compression required to effect separation of nitrogen is greatly decreased.

4. Process according to claim 1, wherein the separation of nitrogen is completed at sub-atmospheric pressure, and the oxygen-enriched air thus obtained is compressed to atmospheric pressure in a separate compressor before it is delivered to said blast compressor.

5. Process for the production of oxygen-enriched air for use as furnace blast or the like comprising the steps of compressing the required volume of air in a blast blower or the like, to the desired blast pressure; dividing said compressed air into a major and a minor fraction; passing said minor fraction through a gas separation plant whereby a portion of its nitrogen content is removed; compressing the oxygen-enriched air thus obtained to the desired blast pressure; mixing said oxygen-enriched air and said major fraction of compressed air to produce a mixture of air and oxygen-enriched air having the desired blast composition; and delivering said mixture as blast.

6. Process for the production of oxygen-enriched air for use as furnace blast, or the like,

comprising the steps of compressing a mixture of oxygen and nitrogen to the desired blast pressure in a blast blower or the like; dividing the compressed mixture so produced into a major
5 and a minor fraction, and delivering said major portion as blast; passing said minor fraction

through a gas separation plant whereby a portion of its nitrogen content is removed; and adding the oxygen-enriched air thus produced to the air employed to produce the blast.

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