C. BLAGBURN.

APPARATUS FOR OBTAINING NITROGEN FROM AIR.

APPLICATION FILED FEB. 16, 1910.

993,017. Patented May 23, 1911.

FIG. 1

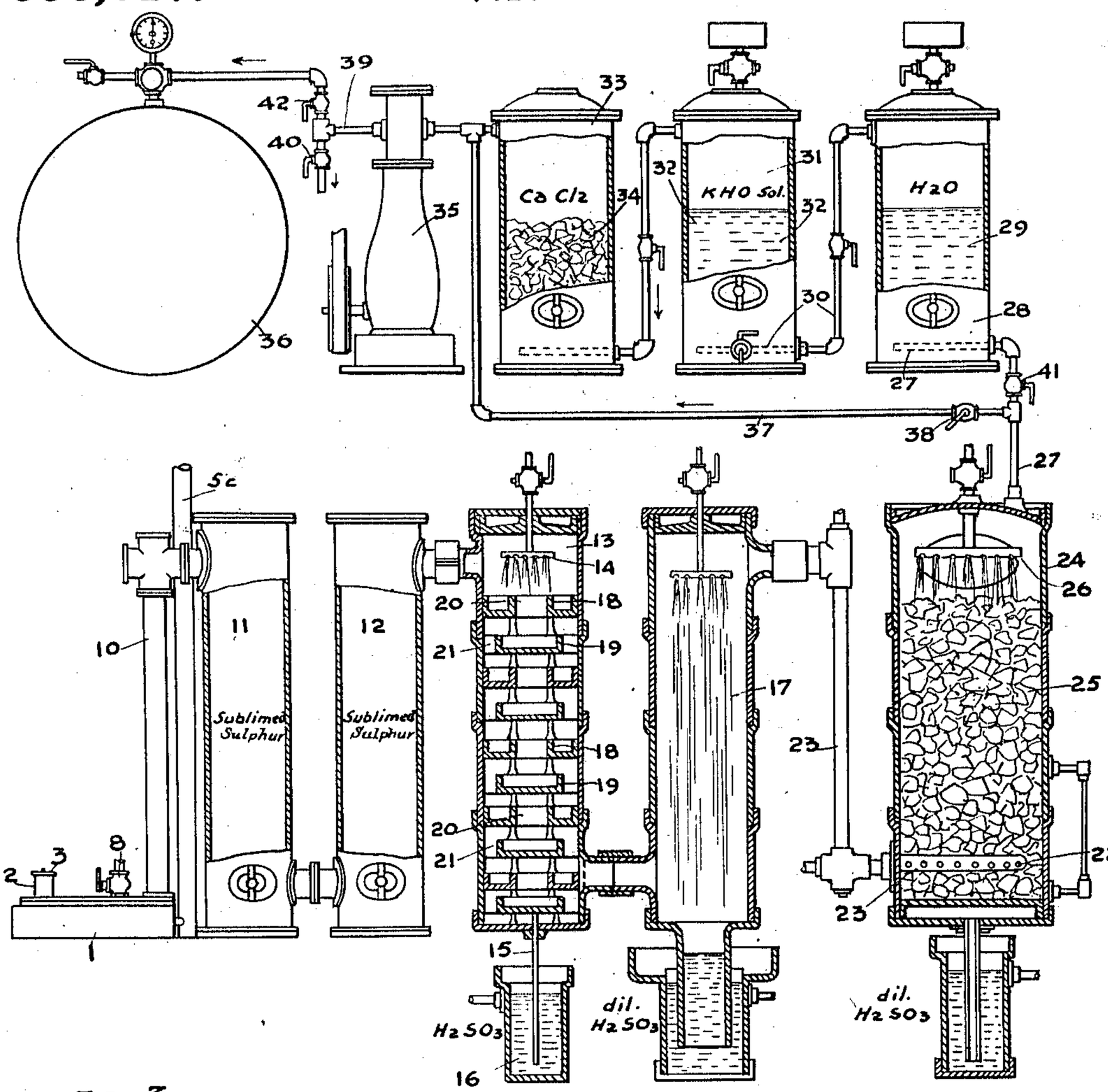


FIG. 3

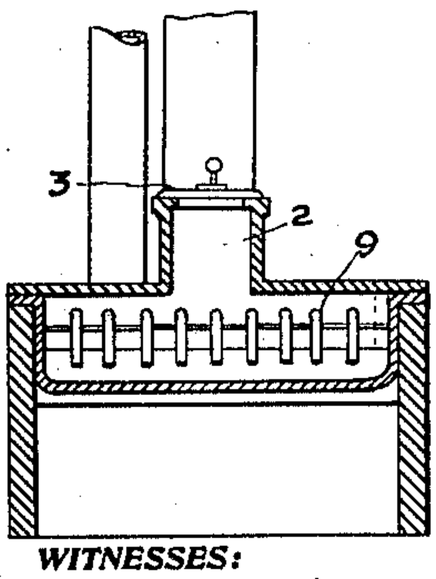
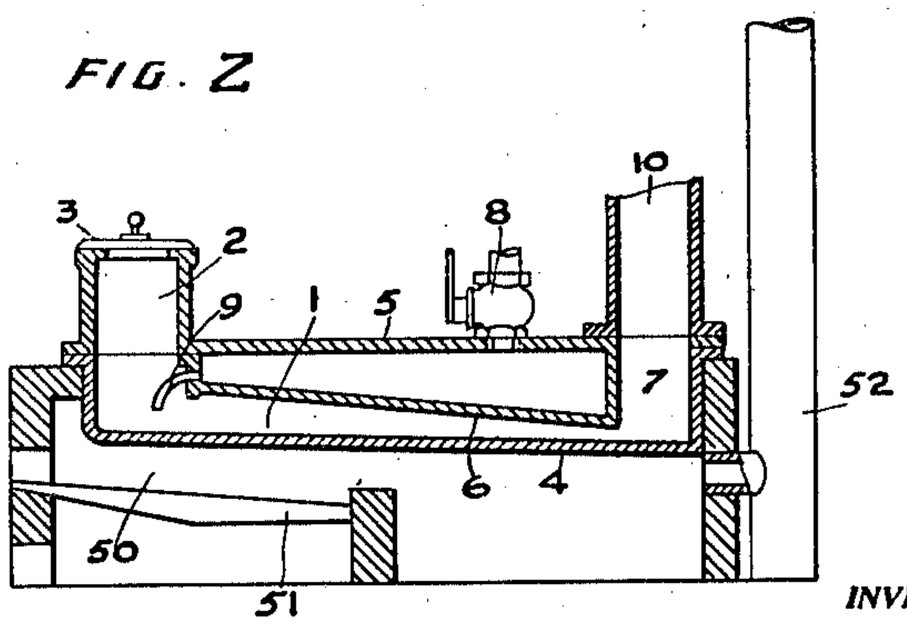


FIG. 2



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APPARATUS FOR OBTAINING NITROGEN FROM AIR.

993,017. Specification of Letters Patent. Patented May 23, 1911.

Original application filed November 27, 1907, Serial No. 404,120. Divided and this application filed February 16, 1910. Serial No. 544,212.

To all whom it may concern:

Be it known that I, CHARLES BLAGBURN, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented new and useful Improvements in Apparatus for Obtaining Nitrogen from Air, of which the following is a specification.

The object of the present invention is to provide an apparatus for obtaining from the air practically pure nitrogen, the present application being a division of an application filed by me November 27, 1907, Serial No. 404,120.

The problem of obtaining nitrogen from the air at a low cost has become in recent times extremely important; first, on account of the greatly increased demand for nitrate fertilizers to enrich poor or exhausted soils; second, on account of the extensive and increasing use of cyanids in mining and the arts; and, third, on account of the utility of nitrogen gas as a preservative medium for preserving edibles and other perishable articles in air-tight receptacles.

I have invented an apparatus, by means of which sulfur may be so burned on a commercial scale as to remove all of the oxygen from the stream of air supplied for its combustion, thus solving the "nitrogen" problem, since this apparatus, on account of the cheapness of sulfur, enables the nitrogen to be obtained at quite a low cost.

In the accompanying drawing, Figure 1 is a diagrammatic sectional view of my apparatus; Fig. 2 is a longitudinal section of the furnace; Fig. 3 is a transverse section thereof.

1 indicates a combustion chamber, which is very shallow in proportion to its length and width, in order to expose a large surface of sulfur to the air of combustion. To said combustion chamber sulfur is fed by means of a charging passage 2 which can be closed when desired by means of a suitable cover 3. Beneath said combustion chamber is a fire box 50, having a grate 51 and a flue 52, in which a fire can be kindled to heat the sulfur initially, or, if desired, suitable fuel can be burned during the process, although I have not found this to be necessary. The bottom 4 of the combustion chamber 1 slopes very slightly, (the slope being exaggerated in the drawing) from front to rear, to insure the melted sulfur flowing over the entire surface of said bottom. In said combustion chamber and extending across its entire width is an air heating chamber 5, which has a bottom 6, which thus forms the top of the combustion chamber. It slopes downward from a point near the charging end of the combustion chamber to the outlet 7 thereof. Into said heating chamber air is drawn by suction, as hereinafter described, through a pipe 8, and impinges upon the sloping bottom thereof. The air in this heating chamber, being highly heated by the combustion of sulfur in the chamber beneath, emerges from the heating chamber through downwardly extending pipes 9, by which means it is fed to the sulfur in the bottom of the combustion chamber. However, while it is thus desirable in many cases, as for making nitrogen on a very large scale, to heat the air before supplying it to the sulfur, I am enabled to carry out my process by burning the sulfur with air not heated before being introduced into the combustion chamber, this air being supplied through the charging opening 2, the cover 3 being thus removed.

In order to successfully practice this invention, two main conditions are necessary. First, the furnace must be so constructed that the air of combustion is compelled, before escaping from the combustion chamber, to pass into close proximity to the sulfur, which, near the point of exit, would be in a molten condition with sulfur vapors arising therefrom; and, secondly, the sulfur must be in excess, or at any rate no more air must be supplied to the sulfur than is necessary to supply the oxygen for combustion thereof.

As will hereinafter appear, the gases from the furnace have to pass through a long series of purifying chambers, and, therefore, in order to supply any air to the furnace, a suction pump is necessary at the end of said series. Now, for a given rate of feeding the sulfur, the suction pump must be so operated that the current of air supplied thereby is never more than necessary, as above mentioned. So long as sulfur vapor passes off unconsumed, as evidenced by the formation of sublimed sulfur in the condensing chambers, the process is being properly carried out.

I realize that the apparatus may be greatly varied in form and construction, and still satisfy the other essential condition, namely, that the air be compelled to pass into close proximity to the highly heated sulfur, so that no oxygen can escape, and all such variations I regard as within the scope of my invention.

From the outlet 7 of the furnace, the gases pass upward by a pipe 10. Should any oxygen have been unconsumed by the sulfur before reaching the pipe 10, it will certainly combine with the excess sulfur vapor therein, the pipe 10 being intensely hot. From the pipe 10 the gases, consisting of nitrogen, sulfurous anhydrid, sulfur vapor, and a small amount of steam, due to the presence of moisture in the atmospheric air supplied to the furnace, then pass in succession through two subliming chambers 11, 12, which are sufficient to condense and precipitate in the form of sublimed sulfur nearly all the excess of sulfur which has passed off in the form of vapor.

From the top of the second subliming chamber 12, the nitrogen and sulfurous anhydrid pass into the top of a sulfurous acid tower 13, in the top of which is arranged a spraying device 14 which sprays water thereinto. In said tower are placed one above the other alternating trays 18, 19, of two series, the trays 18 of one series having a central passage 20, and those of the other having an annular space 21 between the side of the tray and the side of the tower, through which the gases can pass. The water is compelled to flow from one tray to the next below it either through a central opening 20, or through one of the annular passages 21. This water, if not too much, passing through the nitrogen and sulfurous anhydrid gases, forms from the latter strong sulfurous acid solution, which is collected by a pipe 15 from a liquid seat 16 at the bottom of said tower. The nitrogen and part of the sulfurous anhydrid gases then pass into the bottom of a second tower 17, into the top of which water is also sprayed, the amount of water supplied in this tower being greater than that in the first tower, so that sulfurous acid solution in much larger quantity, but greatly diluted, is collected therefrom.

From the tower 17 the gases pass through perforations 22 of a supply pipe 23 entering the bottom of a wash vessel 24 and pass upward between pieces of some porous substance 25, such as coke, which exposes a great extent of surface, upon which water is sprayed by means of a sprayer 26, so that the sulfurous anhydrid gas coming in contact with the moist surface forms with the water diluted sulfurous acid, which is collected at the bottom in the same manner as before.

From the top of the wash vessel 24 the gases pass by a perforated pipe 27 into the bottom of a wash vessel 28, which contains a sufficient quantity of water 29 or other suitable liquid which will recover ammonia. I have found that in this process ammonia is formed, which is probably due to the acid attacking the iron of the apparatus, and liberating hydrogen, which then forms ammonia with the nitrogen.

From the top of the wash vessel 28 the gases pass through a perforated pipe 30 into the bottom of a wash vessel 31, about half filled with a solution 32 of caustic potash, which serves to effectually arrest any trace of sulfurous acid or carbonic acid gas, and forming sulfate of potassium, which is valuable in the arts. From the top of the vessel 31 the gases pass into a vessel 33 which is about half filled with calcium chlorid 34 to take up the moisture. This vessel is used when dry nitrogen is required for use as a preservative, but in other cases, when the nitrogen is not so used, the calcium chlorid may be omitted. From the top of the latter vessel the gas passes to a suction pump 35, which creates the current which draws the air into the furnace and the gases through the series of chambers, and, which likewise, forces the nitrogen gas into a suitable receiver 36, from which it may be drawn out as required for use.

In order to economize in respect of the chemical reagents in the vessels 31, 33, there is provided a bypass pipe 37, having a valve 38, which is opened in commencing the process, and is closed as soon as the gas is sufficiently free from oxygen. On the other side of the pump is a discharge pipe 39 having a valve 40 therein. A valve 41 is interposed between the vessels 24 and 28, and a valve 42 between the suction pump and the receiver. The valves 38 and 40 are opened and the valves 41 and 42 are closed on commencing the process, and the gas emerging through the pipe 39 is tested until it is found to be sufficiently free from oxygen, and then said valves are closed and the valves 41, 42, are opened, and the gas is passed into the receiver 36.

It will be understood that in all cases the vessels are composed of suitable material, such as earthenware, or, in certain cases, of iron lined with lead, to withstand the action of the acids passing therethrough. It is also important that said vessels are made perfectly air-tight.

I have found that with the above apparatus nitrogen of great purity can be obtained from the atmosphere. In practicing the process, it has been my custom to reject all nitrogen gas which does not reach a purity of 99.6 to 99.8 per cent. Generally speaking, it is only retained at the latter degree of purity. By placing iron filings in the receiver for a few days, even this small per-

centage of oxygen, .2 per cent., is removed, and the receiver then contains absolutely pure nitrogen.

The cost of obtaining nitrogen by the above process is very much less than those by processes heretofore attempted commercially, so far as my knowledge extends.

I claim:—

1. An apparatus for obtaining nitrogen from atmospheric air consisting of a furnace of considerable area in proportion to its height to expose a large body of sulfur to oxidation and so concentrated as to compel the whole of the air supplied to said sulfur to flow into contact with the sulfur in the furnace, means for supplying sulfur and air at one end of said furnace, a conduit at the other end of said furnace for the resulting gases, means for removing from said gases the sublimated sulfur, means for washing from said gases the sulfurous acid, and means for confining the residual nitrogen, substantially as described.

2. An apparatus for obtaining nitrogen from atmospheric air comprising a furnace of considerable area in proportion to its height and having a top sloping downward from the inlet to the outlet of the furnace, means for supplying sulfur and air to the inlet end of said furnace, a conduit at the outlet end of said furnace for the resulting gases, means for removing from said gases the excess of sulfur and the sulfurous acid, a suction pump at the advance end of the conduit for drawing the air into the furnace and the gases from said furnace, and means for confining the nitrogen, substantially as described.

3. An apparatus for obtaining nitrogen from atmospheric air comprising a furnace of considerable area in proportion to its height and having a top and bottom both sloping downward from the inlet to the outlet of the furnace, means for supplying sulfur and air to the inlet end of said furnace, a conduit at the outlet end of said furnace for the resulting gases, means for removing from said gases the excess of sulfur and the sulfurous acid, a suction pump at the advance end of the conduit for drawing the air into the furnace and the gases from said furnace, and means for confining the nitrogen, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES BLAGBURN.

Witnesses:

FRANCIS M. WRIGHT,

D. B. RICHARDS.