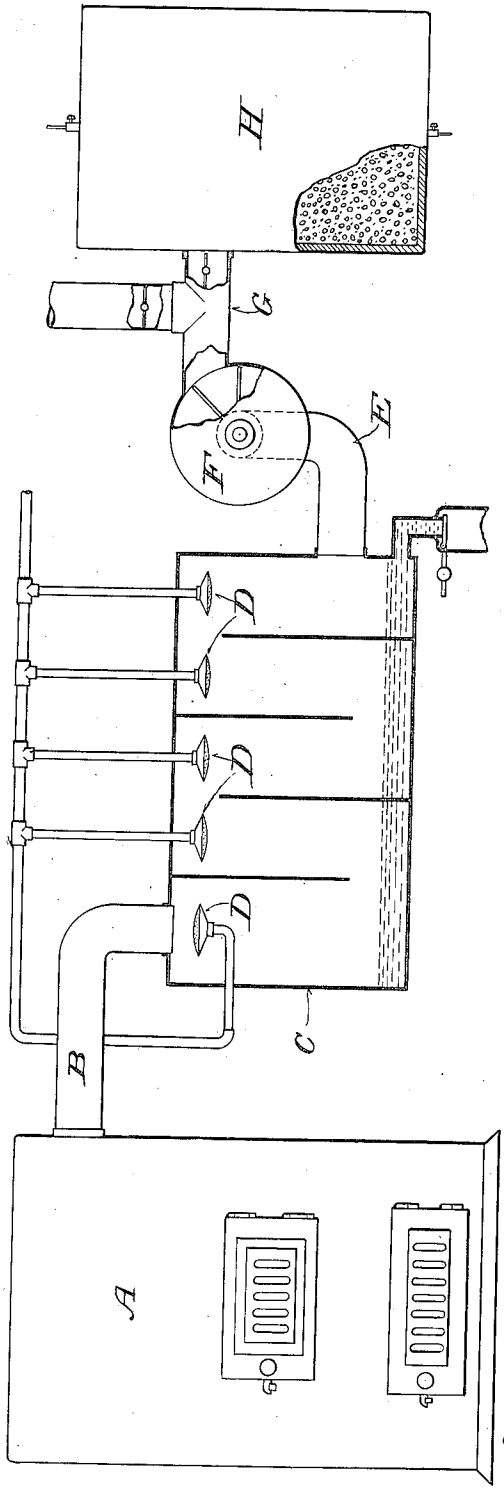
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PROCESS OF OBTAINING NITROGEN FROM AIR.

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UNITED STATES PATENT OFFICE.

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PROCESS OF OBTAINING NITROGEN FROM AIR.

No. 914,279. Specification of Letters Patent. Patented March 2, 1909.

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To all whom it may concern:

Be it known that I, OLIVER PERRY HURFORD, a citizen of the United States, and resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Processes of Obtaining Nitrogen from Air; and I do hereby declare that the following is a full, clear, and exact description thereof.

This invention relates to a process of obtaining nitrogen from air through the combustion of any ordinary fuel, thereby supplying the nitrogen in a practically pure state, in large quantities at a low cost, to be used in the manufacture of any compound into which nitrogen enters as a constituent part. These fuels are compounds of carbon, oxygen and hydrogen in the main, together with various other elements which are present in small proportion and may be regarded as impurities.

The atmospheric air which constitutes the material from which the nitrogen is to be extracted is constituted by about three parts of oxygen by weight to ten parts of nitrogen, or about twenty-one parts of oxygen by volume to eighty parts of nitrogen. Certain small percentage of aqueous vapor, carbon dioxid and various other impurities occur in this air, but these are in such small amounts that for the purpose in view they may be neglected.

As far as I am aware the only methods heretofore used for the production of free nitrogen in commercial quantities are as follows viz: 1st. Atmospheric air is passed through red hot copper filings or over red hot copper plates, where the oxygen is burned out and becomes oxid of copper and the free nitrogen collected for use. 2nd. By liquefaction of the air and separation of the oxygen and nitrogen by fractional distillation. While this second process is the latest method for obtaining free nitrogen, it will be apparent that it is a very expensive method as compared with mine.

To separate the nitrogen from the oxygen it is the purpose of the said process to transform the free oxygen into combined oxygen in the form of carbon dioxid (CO_2) or aqueous vapor (H_2O) or both. This is done by the process of combustion, the elements hydrogen and carbon necessary for this combustion being most cheaply obtained in the form of coal, gas, or other combustible fuel. The purpose of effecting this chemical union of oxygen with carbon and hydrogen is to transform it into a substance which is more easily separable from the nitrogen than is oxygen uncombined.

The first essential part of the apparatus employed in effecting the process is, therefore, a combustion chamber suitable for maintaining the complete combustion of a fuel, with suitable means for introducing air into the combustion chamber, and suitable regulating devices for controlling the rate of flow of air, and the temperature and rate of combustion.

By complete combustion is meant the combustion which will result in the gaseous products of combustion containing carbon dioxid (CO_2), water vapor (H_2O) and nitrogen, to the practical exclusion of carbon monoxid (CO) oxygen in combined state, and hydrogen or unoxidized hydrocarbons. The presence of such gases in the products of combustion would result in a contamination of the resulting nitrogen, inasmuch as the apparatus is not designed to extract them. Close approach to perfect combustion can be attained by suitable regulation of air supply and temperature and proper feeding of the fuel to the combustion chamber. Sulfur being almost invariably present in fuel will, during the process of complete combustion, be transformed mainly into sulfur dioxid (SO_2) and in small part of sulfur trioxid (SO_3) which pass over as gases into the condensing chamber where they will be extracted in the manner to be described.

The compound, carbon dioxid, (CO_2) is absorbed under ordinary pressure by water in equal quantities, *i. e.* the water absorbs its own bulk of the gas. By increasing the pressure to twice the ordinary atmospheric pressure, the amount of gas absorbed will be twice the quantity of water in bulk. This apparatus is so arranged by means of an extra forced draft at the furnace to increase the pressure in the condenser at will, and thus increase the absorption of carbon dioxid (CO_2). Thus the carbonic acid gas, is absorbed, separating it entirely from the nitrogen leaving it free from its oxygen. The next compound which is formed in the combustion of the fuels above named, is water, through the union of the hydrogen contained in illuminating fuels and oxygen, the water appearing in the form of steam, during combustion. This steam is immediately con-

densed into water on entering the condenser and coming in contact with the cold water used therein.

The gaseous products are conducted through a channel into the condensation chamber, a suitable by-pass in this channel being provided for discharging the products of combustion to the chimney when the combustion is not perfect.

In the condensing chamber of the apparatus the main object is to separate the carbon dioxid from the nitrogen, this being accomplished through the property which carbon dioxid possesses of being far more soluble in water than nitrogen. Under ordinary conditions of temperature and pressure one volume of carbon dioxid is soluble in about one volume of water, the solubility increasing as the temperature is lowered and as the pressure is increased. The condensing chamber is so constructed that the gases flowing through it take a winding path, coming in contact at various points with sprays of water which serve the double purpose of cooling and absorption of the carbon dioxid. The water after performing this function accumulates in the bottom of the condenser, an overflow being provided which allows the continual removal of the water charged with the carbon dioxid.

The sulfur dioxid and sulfur trioxid which exist in the products of combustion are absorbed by the water forming sulfurous acid and sulfuric acid respectively, and are thereby extracted from the nitrogen.

The aqueous vapor which comes from the combustion chamber in coming in contact with the water sprays is cooled and condensed and is thereby carried away in the overflow.

It is known that on account of the presence of carbon dioxid and also of the sulfurous and sulfuric acids in the water, it is necessary as an essential feature of this apparatus that it be constructed with a non-corrodible lining in the condenser chamber.

In the accompanying drawing which illustrates the invention and which is an elevation, partly in section, A is a furnace to which the carbonaceous fuel is fed and into which the atmospheric air, under any desired pressure is introduced, and in which the step of combustion is carried out, producing carbon dioxid and other gaseous products of combustion. A flue B connects the furnace with a covered tank C of the condenser. This condenser has water-spraying devices D, separated by plates I whereby the gases are led alternately up and down in a crane-like movement so as to receive a thorough scrubbing. By means of these finely spraying devices mounted at intervals in the wave-like path of the gases, a thorough contact of the water with the gases is obtained and also the temperature of the water is greatly lowered, thereby increasing the condensing and absorbing action of the water upon the carbon dioxid, whereby with a constant flow of water through the condenser as is carried on in my process, the carbon dioxid is separated from the nitrogen with sufficient rapidity to permit the nitrogen to be obtained at an economically practicable cost of production.

The condenser is provided with a valve-controlled drain-nozzle J, whereby the water charged with the carbon dioxid is removed. The action of the condenser is to separate the nitrogen from the carbon dioxid and from the impurities of the air as before described and then the nitrogen is led from the condenser by a flue E in communication with a fan-casing F.

The nitrogen may be suitably collected in a vessel to receive it or may be at once led to a place of intermixture with other elements or substances to form desired compounds.

In the drawings, the nitrogen is shown as conducted by a pipe G to an electric furnace H, in which may be placed a calcium carbid to produce calcium cynamid. It is obvious however that the nitrogen may be employed for other purposes than to form such compound.

Having thus described my invention what I claim is:

1. The process of obtaining free nitrogen from the air which consists in first burning a carbonaceous fuel in the presence of air of sufficient quantity for complete combustion to carbon dioxid and substantially free from carbon monoxid, then subjecting the gaseous products to the condensing action of water to condense the steam and separate the carbon dioxid from the nitrogen and then leading off the nitrogen from the condensing chamber, substantially as described.

2. The process of obtaining free nitrogen from atmospheric air which consists in burning a carbonaceous fuel by admitting air in amounts sufficient for complete combustion of the fuel, leading the gaseous products of combustion only when the same are substantially free of carbon monoxid from the combustion chamber directly to a suitable condensing chamber, and drawing the gases through said chamber in a continuous stream in contact with a continuously flowing supply of water in finely divided sprays whereby the carbon dioxid is rapidly absorbed and the steam condensed, and then leading off the nitrogen, substantially as described.

3. The process of obtaining nitrogen from atmospheric air which consists in burning a carbonaceous fuel, admitting air in amounts sufficient for complete combustion to carbon dioxid and without carbon monoxid, leading the gaseous products substantially free from such carbon monoxid directly to a condensing chamber and entraining said gases in a

wave-like movement against separated finely divided sprays of water continuously supplied to the chamber to condense the steam and to rapidly and continuously absorb the carbon dioxid and then drawing off the separated nitrogen, substantially as described.

In testimony that I claim the foregoing invention I have hereunto set my hand at Chicago in the county of Cook and State of Illinois in the presence of two witnesses.

OLIVER PERRY HURFORD.

Witnesses:

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