W. A. PHILLIPS.

METHOD OF OBTAINING OXIDS OF NITROGEN.

APPLICATION FILED JULY 10, 1911.

**1,035,732.** **Patented Aug. 13, 1912.**

*Fig. 1.*

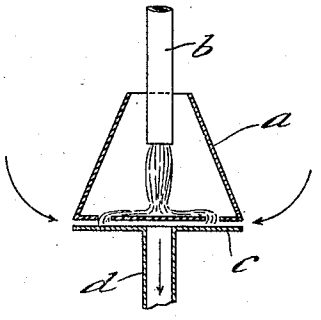
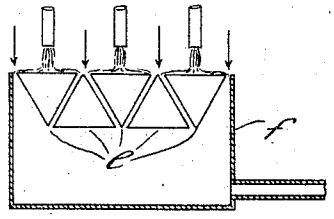



*Fig. 2.*




Witnesses.

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# UNITED STATES PATENT OFFICE.

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## METHOD OF OBTAINING OXIDS OF NITROGEN.

1,035,732. Specification of Letters Patent. Patented Aug. 13, 1912.

Application filed July 10, 1911. Serial No. 637,726.

*To all whom it may concern:*

Be it known that I, WILLIAM ALFRED PHILLIPS, of London, England, (whose post-office address is "Brambledown," Crough Hill, in the county of London, England,) electrical engineer, have invented a certain new and useful Method of Obtaining Oxids of Nitrogen, of which the following is a specification.

It was discovered by Priestley in 1788 that when hydrogen and air are exploded together in a glass vessel the water produced is acid, and that the acid was nitrous acid was proved by Withering. In Gmelin's *Handbook of Chemistry* published in 1849 it is mentioned that "water produced by the combustion of hydrogen gas contains nitric acid if the gas consumed contains nitrogen." Loew in 1870 pointed out that when air is blown through the upper half of a Bunsen burner flame ozone is produced and he succeeded in detecting nitrous acid in the water condensed from a jet of steam which had been blown through a Bunsen burner flame. The matter has also been investigated by Fischer (*Berichte der Deutschen Chemische Gesellschaft* 39 (1906) 940, 2557), and it is now generally admitted that atmospheric nitrogen can be oxidized by the combustion of gases in air.

The chief attempts which have been made to apply flames of burning gases to the commercial production of oxids of nitrogen have consisted in burning combustibles, nitrogen and oxygen in a furnace whose mouth is immersed in water; in burning carbon monoxid under pressure and in the form of a steady flame in the presence of oxygen and nitrogen while avoiding the presence of hydrogen; and in causing air to pass up a chamber containing a number of jets of hydrogen or hydro-carbon flame, the direction of travel of air being parallel to the flame, the object being to produce as complete an intermixture of the air with the burning gases as may be possible.

My experiments have led me to the conclusion that the formation of oxidized nitrogen occurs on the surface of the flame and that the problem of the commercial application of the phenomenon is to be solved by sweeping the surface of the flame by a rapid current of air. For a commercial yield it is essential that the surface area of the flame should be as large as possible per unit volume of gas consumed, and that products of incomplete combustion should be prevented as far as possible from passing forward with the air.

With these objects in view my invention consists in spreading the substantially completely oxidized flame or portion of the flame over a surface and causing air or a mixture of nitrogen and oxygen to travel over this spread out flame at a speed higher than that of the hot gases constituting the flame.

In my early experiments I caused the flame to impinge on a mass of pieces of refractory material and drew a current of air through the mass so as to sweep away the oxidized nitrogen. A certain success attends this method but it was found difficult to prevent products of imperfect combustion passing forward with the current of gases.

It is preferable to cause that part of the flame which is generally regarded as substantially completely oxidized, namely in the usual hydrocarbon flame that portion which is beyond what is commonly called the inner cone, to play upon a single surface so that it is spread out thereon and to cause the current of air to pass over this spread out flame along a path which is removed from the immediate neighborhood of the main stream of burning gas. The temperature of this surface should be lower than that of the flame, in fact I have found that the best results were obtained when the surface was cooled. The temperature at which the surface should be kept is however to a certain extent determined by the speed of flow of the air over the surface of the flame. I find that for the flame the heat of an ordinary Bunsen burner is quite sufficient, though a blow pipe may be used.

Apparatus for carrying out the process may be constructed in many different manners.

Two constructions are shown in vertical section in the accompanying drawings by way of example.

In Figure 1, *a* is a hollow truncated cone in the base of which is a number of perforations arranged on the circumference of a circle. The flame of a gas blow pipe *b* is directed into the top of the cone and so adjusted that the end of the flame extends

through the perforations in the base of the cone so as to form a number of very short flames protruding from the cone. The base of the cone is placed opposite the flange *c* of a tube *d*, at a very short distance therefrom, say at about 5 mm. Suction being applied to the end of pipe *d*, air is drawn between the flange *c* and the base of the cone *a* and spreads the small flames over the under surface of the base. The suction must be such that the air travels faster than the hot gases constituting the small flames, but not so fast that the flames are extinguished.

Fig. 2 represents a number of parallel bars of iron *e* placed at a distance of about 3 mm. apart over a box *f* in which a diminished pressure is maintained. Over each bar is a row of Bunsen burners placed at such a distance from the bar that the draft of air between the bars draws the parts of the flame in which combustion is substantially complete over the edges of the bars. The suction in box *f* must be such as to produce between the bars a current of air which is more rapid than the speed of travel of the hot gases of combustion moving over the surfaces of the bars. It will be noted that the width of the bars is such that the air current travels in a path well removed from the main gas flame.

It is obvious that any suitable mixture of oxygen and nitrogen may be substituted for air in the process.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim:—

1. A process of producing oxids of nitrogen which process consists in causing a substantially completely oxidized flame of combustible fluid to spread over a surface and causing a mixture of oxygen and nitrogen to travel over the spread out flame at a speed higher than that of the hot gases constituting the flame.

2. A process of producing oxids of nitrogen which process consists in causing a substantially completely oxidized portion of a flame of combustible fluid to spread over a surface and causing a mixture of oxygen and nitrogen to travel over the spread out portion of flame at a speed higher than that of the hot gases constituting the flame and along a path removed from the portion of the flame which is not spread out.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM ALFRED PHILLIPS.

Witnesses:

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