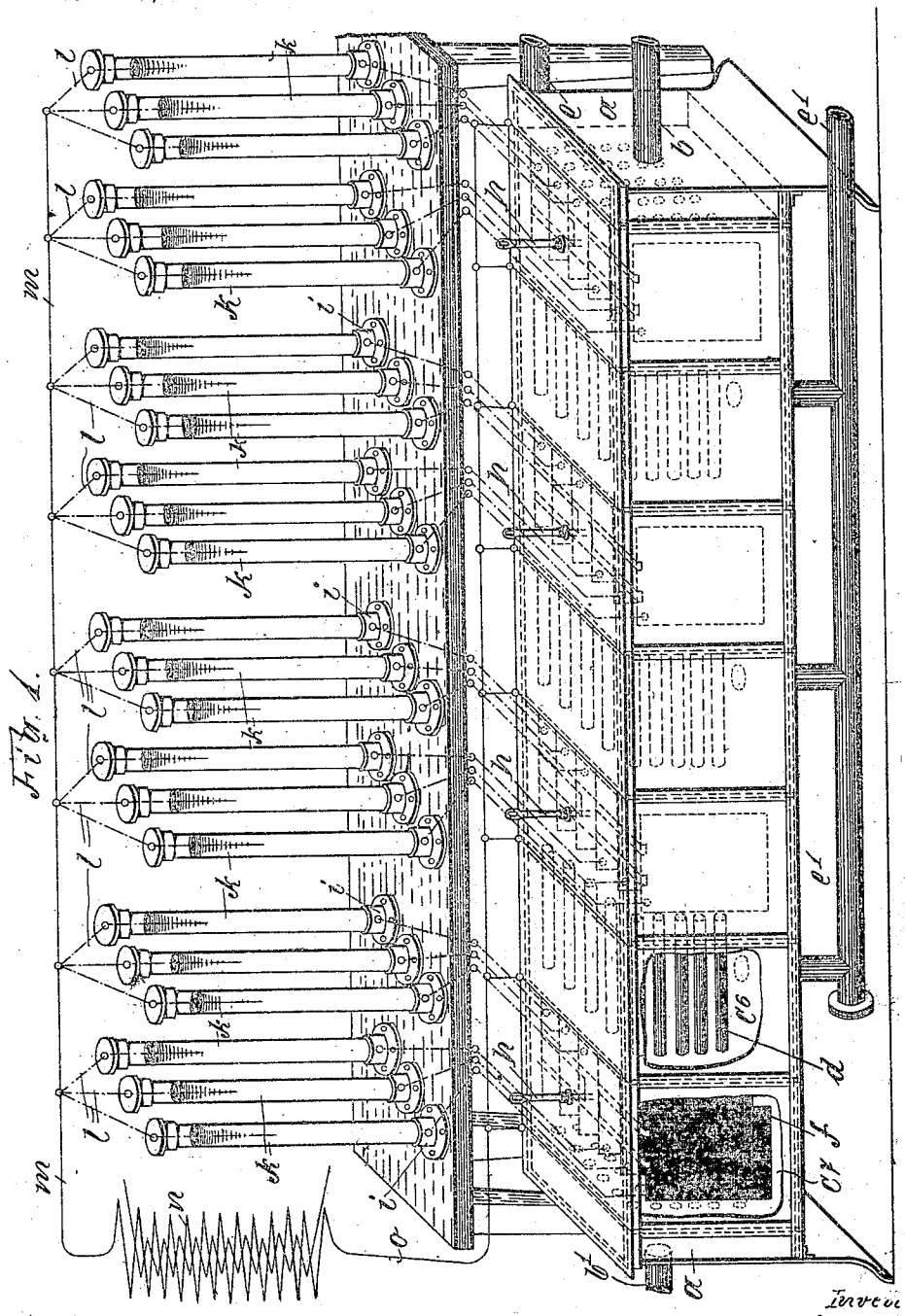
(No Model.) 2 Sheets—Sheet 1.

N. VANDER SLEEN & A. SCHNELLER.

APPARATUS FOR CAUSING CHEMICAL CHANGES IN GASES.

No. 587,770. Patented Aug. 10, 1897.



Witnesses:
Emil Kayser
Paul Wallenberg.

Inventors:
Nicolas van der Sleen
August Schneller
by Baker & Hopkins
Attorneys

(No Model.) 2 Sheets—Sheet 2.

N. VANDER SLEEN & A. SCHNELLER.

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Fig. 5.

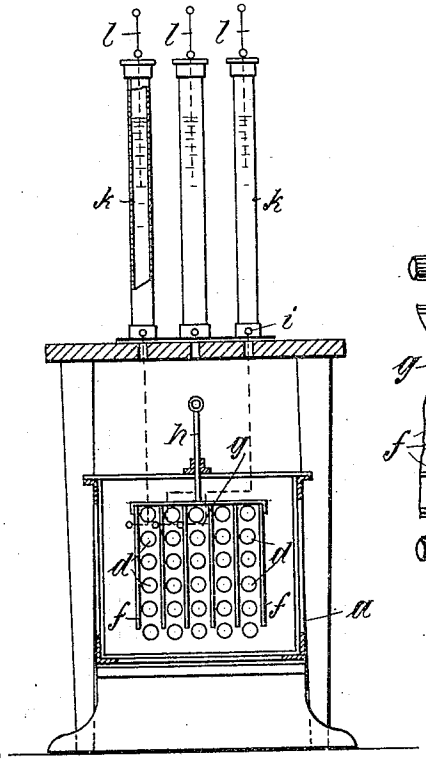


Fig. 2.

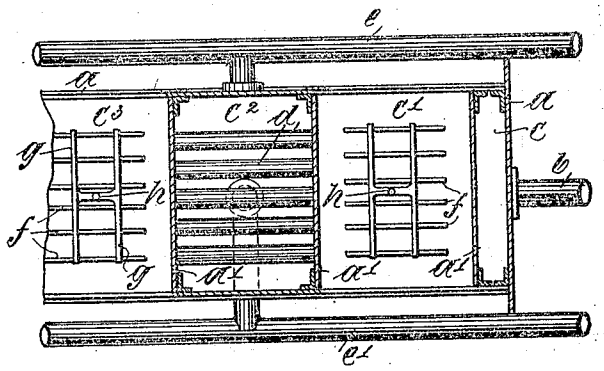


Fig. 4.

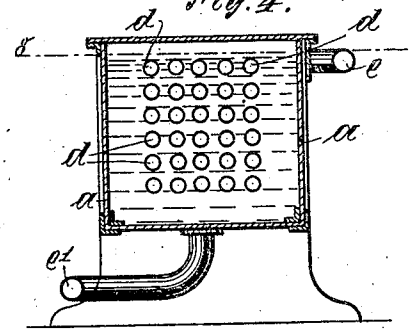
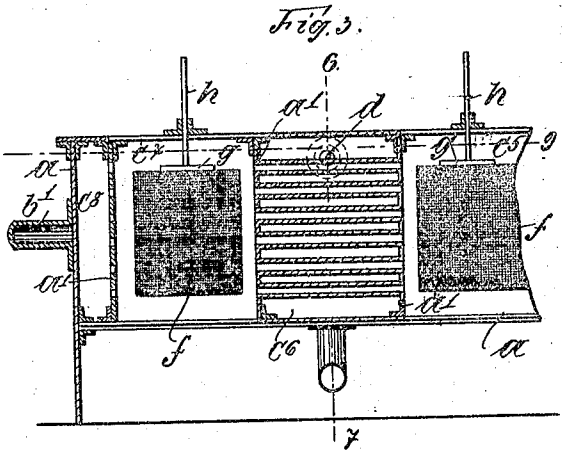


Fig. 3.



Witnesses
Emil Kayser.
Paul Wellenberg.

Inventors
Nicolas vander Sleen
August Schneller
by Peter Reichle
Attorney.

UNITED STATES PATENT OFFICE.

NICOLAAS VAN DER SLEEN AND AUGUST SCHNELLER, OF ALFEN-OUDSHOORN, NETHERLANDS, ASSIGNORS TO HENRY TINDAL, OF AMSTERDAM, NETHERLANDS.

APPARATUS FOR CAUSING CHEMICAL CHANGES IN GASES.

SPECIFICATION forming part of Letters Patent No. 587,770, dated August 10, 1897.

Application filed January 18, 1895. Serial No. 535,404. (No model.) Patented in Germany November 30, 1894, No. 83,298; in England December 1, 1894, No. 23,297; in Belgium December 29, 1894, No. 113,388; in Italy December 29, 1894, No. 421; in Switzerland December 29, 1894, No. 9,745; in Luxemburg December 29, 1894, No. 2,209; in Sweden December 29, 1894, No. 6,629; in Norway December 29, 1894, No. 4,183; in France December 29, 1894, No. 243,980; in Spain March 30, 1895, No. 16,792, and in Austria September 30, 1895, No. 45/3,518.

To all whom it may concern:

Be it known that we, NICOLAAS VAN DER SLEEN, chemist, and AUGUST SCHNELLER, engineer, subjects of the Queen of the Netherlands, and residents of Alfen-Oudshoorn, in the Kingdom of the Netherlands, have invented an Improved Apparatus for Causing Chemical Changes of Gases by Dark Electric Discharges, (for which patents have been obtained in the following countries: Germany, No. 83,298, dated November 30, 1894; Belgium, No. 113,388, dated December 29, 1894; Italy, No. 421, Bd. 24, dated December 29, 1894; Switzerland, No. 9,745, dated December 29, 1894; Luxemburg, No. 2,209, dated December 29, 1894; Sweden, No. 6,629, dated December 29, 1894; Norway, No. 4,183, dated December 29, 1894; France, No. 243,980, dated December 29, 1894; Spain, No. 16,792, dated March 30, 1895; Austria, No 3,518/45, dated September 30, 1895, and Great Britain, No. 23,297, dated December 1, 1894,) of which the following is an exact specification.

The apparatus known up to now for causing chemical changes of gases and mixtures of gases—as, for instance, for ozonizing air or oxygen—have in the practical use met with general approval in that a continuous working was made possible by them, and the quantity of the ozone or other gas produced by them was, in fact, corresponding to the quantity of energy consumed. Therefore the production of ozone or other gases by means of dark electric discharges could be carried out on a commercial scale and with a favorable commercial result. What, however, has not been attained up to now is bringing with the expense of a given quantity of energy the quantity of gas produced in correspondence to the degree of concentration demanded—that is to say, it has not been possible to produce with the expense of a given quantity of energy an equally great quantity of ozone or other gas if a greater degree of concentration was demanded for the same. One has tried to obtain a greater degree of concentration by letting the gas treated already by one apparatus pass through one or more other apparatuses, but the quantity of ozone or other gas produced by the second, third, &c., apparatus is far from being the same as that produced by the first apparatus, provided the quantity of energy consumed by the subsequent apparatuses is equal to that of the first.

According to the present invention any desired concentration of the ozone or other gas produced by the successive application of two or more apparatuses may be obtained by inserting a cooling device between each of the electric gas-generating apparatuses. Therefore the oxygen, air, or other gas or mixture of gas treated or produced by the first apparatus and having reached a certain degree of concentration is cooled before it is allowed to enter the second apparatus. After the concentration of the gas has been increased by said second apparatus the said gas is again cooled before allowed to enter the third apparatus, and so on. This procedure is to be well distinguished from that consisting in cooling the discharging plates or poles of the apparatus in that the said latter procedure is in some sorts of apparatuses necessary for preventing the heated dielectrica from being destroyed by the electric current. There is, it is true, also an extremely slight cooling of the gas gained by cooling the dielectrica, but that is not the purpose of cooling the latter. In every process of chemically changing a gas or gases by dark electric discharges the energy of the latter is transformed not wholly into latent heat bound to the ozone or other gas, but part of said heat becomes sensible and is communicated to the poles as well as to the air, oxygen, or other gas treated.

In cooling the poles there is destroyed the heat imparted to the poles only. According to the present invention, however, the heat imparted to the air, oxygen, or other gas is to be destroyed, too, before another treatment within another apparatus can take place. Cooling the poles in apparatus without a di-

electric intermediate layer is not necessary at all, as in apparatus of that kind the heating cannot result in a destruction by sparks getting through.

In combination with the aforedescribed first improvement the second improvement consists in inserting in apparatus without a dielectric intermediate layer between one pole of the apparatus and the high-tension transformer a column of liquid as a specific resistance for the purpose of preventing the formation of a voltaic arc or of sparks thereby. It is known that the dark discharges may be secured by inserting a resistance of suitable height without allowing sparks or a voltaic arc to come into existence. There was, however, the difficulty of keeping the said resistance approximately constant. We have succeeded in working with a tension of sixty thousand volts at a distance of fifty millimeters between the poles. The resistance ought in this case to be chosen equal to twenty megohms. With this arrangement there is obtained between the poles an extremely intense field of discharge, there being no sparks or voltaic arcs whatever. Making such resistances from wire is practically as well as commercially nearly an impossibility. Making the said resistances from any other solid material is hindered from the fact that the very few apparently suitable materials existing are absolutely unreliable with regard to their constancy. We therefore manufacture resistances of the required kind by the use of distilled water, glycerin, or alcoholic solutions, these being liquors of good constancy. Resistances of this kind have proved well from a practical as well as from a commercial point of view. The liquors in question are contained in glass tubes connected at one end with the transformer and at the other end with one pole of the discharging parts.

In order to make our invention more clear, we refer to the accompanying drawings, in which similar letters denote similar parts throughout the several views, and in which—

Figure 1 is a perspective view of the whole apparatus. Fig. 2 is a horizontal section through the right-hand portion of the lower part of the apparatus, the section being taken on line 8 9 of Figs. 3 and 4. Fig. 3 is a vertical longitudinal section through the left-hand portion of the lower part of the apparatus. Fig. 4 is a vertical cross-section taken on line 6 7 of Fig. 3, and Fig. 5 is a vertical cross-section through the whole apparatus.

The apparatus is constructed as follows: A longish casing a, having at one end an inlet-pipe b for the gas or gases to be treated and at the other end an outlet-pipe b' for the gas or gases treated, is by means of partition-walls a' divided into a number of chambers $c\ c'\ c^2\ c^3$, Figs. 2 and 3. Said partition-walls are perforated, and the second and third, the fourth and fifth, and the sixth and seventh are connected by parallel tubes d, serving as passages for the gas on its way from one discharging-chamber to the next following one. Each of the chambers containing said tubes d is in communication with a pipe e, leading water into said chambers, and with a pipe e', leading that water again off. The said pipes d are therefore constantly cooled while the gas is passing through them.

The discharging-plates f contained within the chambers $c'\ c^3\ c^5\ c^7$ are hung in vertical position to frames g, fixed to the lower ends of rods h, held by the lid or cover of casing a. (Compare Figs. 2, 3, and 5.) Each of said discharging-plates is connected to the metallic foot or base i of a glass tube k, Figs. 1 and 5, containing the liquor forming the specific resistance aforementioned.

Wires l, connected to wire m, Fig. 1, are hanging down into the liquor contained within the tubes k. Said wire m is connected to one end of the secondary coil of the transformer n. The other end of said coil is connected by means of the wire o to each of the partition-walls a', whereby the circuit is completed. The dark or silent discharges will thus take place between the discharging-plates f of each chamber and the partition-walls forming the same, and the gas or gases flowing through between the said plates f from one partition-wall to the other will thus be caused to undergo the action of the electric discharges, so as to be chemically changed in the desired way.

The gas to be treated enters the apparatus through pipe b and flows first into the fore chamber c, from which it is distributed by the first partition-wall a', Fig. 2. After being electrically treated within the first discharging-chamber c' the gas, now more or less hot, is led through the first cooling-chamber c^2 or through the pipes d of the same, and after having been cooled down to its former temperature (or, perhaps, even to a still lower one) the gas enters the second discharging-chamber c^3. Owing to the low temperature the ozonization of the gas will now be repeated with exactly the same effect—*i. e.*, the degree of concentration will be doubled. When the gas has passed all the discharging-chambers, (four in the present case,) the degree of concentration will be the fourfold of what it was in the first chamber.

We wish it to be understood that the number of the discharging as well as of the cooling chambers employed may be chosen as desired or according to the degree of concentration demanded, and that, further, the cooling devices used may be of any desired construction. If there are used the cooling devices shown in the drawings, the number and length of the pipes may be as desired.

Having thus fully described the nature of our invention, what we desire to secure by Letters Patent of the United States is—

1. As a means for causing chemical changes of gases, or mixtures of gases, by dark or silent electrical discharges, the combination with two or more electrical discharging appa-

ratuses containing each a number of separated electrodes of the same polarity connected each to a separate specific resistance, and electrodes of the other polarity, of cooling devices arranged so as to alternate with said electrical discharging apparatuses, for the purpose as described.

2. As a means for causing chemical changes of gases or mixtures of gases by dark or silent electric discharges, the combination with two or more electrical discharging apparatuses containing each a number of separated electrodes of the same polarity connected each to a separate specific resistance, of cooling devices arranged so as to alternate with said electrical discharging apparatuses; the electrode or electrodes of the other polarity being arranged opposite to the edges of said former electrodes, for the purpose as described.

3. As a means for causing chemical changes of gases or mixtures of gases by dark or silent electric discharges, the combination of two or more electrical discharging apparatuses containing each a number of separated electrodes of the same polarity connected each to a separate specific resistance formed by liquor, of cooling devices arranged so as to alternate with said electrical discharging apparatuses; the electrode or electrodes of the other polarity being arranged opposite to the edges of said former electrodes, for the purpose as described.

4. As a means for causing chemical changes of gases, or mixtures of gases, by dark or silent electrical discharges, the combination with two or more electrical discharging apparatuses, of cooling devices, arranged so as to alternate with said electrical discharging apparatuses, and containing each a number of pipes adapted to lead the gas from one of the said apparatus to the next following one; the electrodes of one polarity of each of the said electrical discharging apparatus being each connected to a separate specific resistance formed by a liquor, the electrodes of the other polarity having no such resistances connected to them, for the purpose as described.

5. As a means for causing chemical changes of gases or mixtures of gases by dark or silent electric discharges, the combination with two or more electrical discharging apparatuses, containing each a number of separated electrodes of the same polarity connected each to a separate specific resistance formed by liquor, of cooling devices containing each a number of pipes adapted to lead the gas from one of said electrical discharging apparatuses to the next following one; the electrode or electrodes of the other polarity of the said apparatuses being arranged opposite to the edges of said former electrodes, for the purpose as described.

6. In an apparatus for causing chemical changes of gases, or mixtures of gases by dark or silent electric discharges, the combination with two or more electrical discharging-chambers containing each a number of parallel separated electrodes of the same polarity connected each to a separate specific resistance formed by liquor, of cooling-chambers arranged so as to alternate with said electrical discharging-chambers, and containing each a number of pipes adapted to lead the gas from one of the said discharging-chambers to the next following one; the electrode or electrodes of the other polarity of the discharging-chambers forming the partition-walls between said latter chambers and said cooling-chambers, and supporting the pipes passing the latter, substantially and for the purpose as described.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

NICOLAAS VAN DER SLEEN.
AUGUST SCHNELLER.

Witnesses:
ARTHUR ALBERT STOKES,
AUGUST SIEGFRIED DOER.