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C. P. STEINMETZ.

APPARATUS FOR MANUFACTURING NITROUS COMPOUNDS.

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Fig. 2.

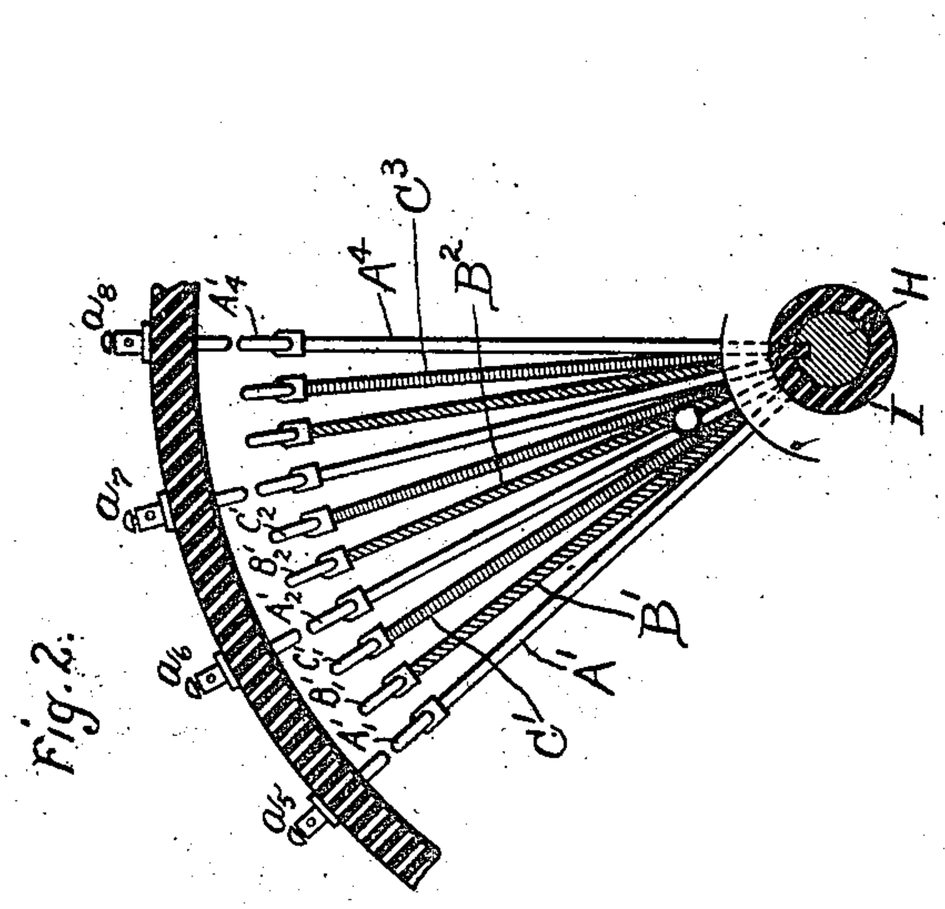
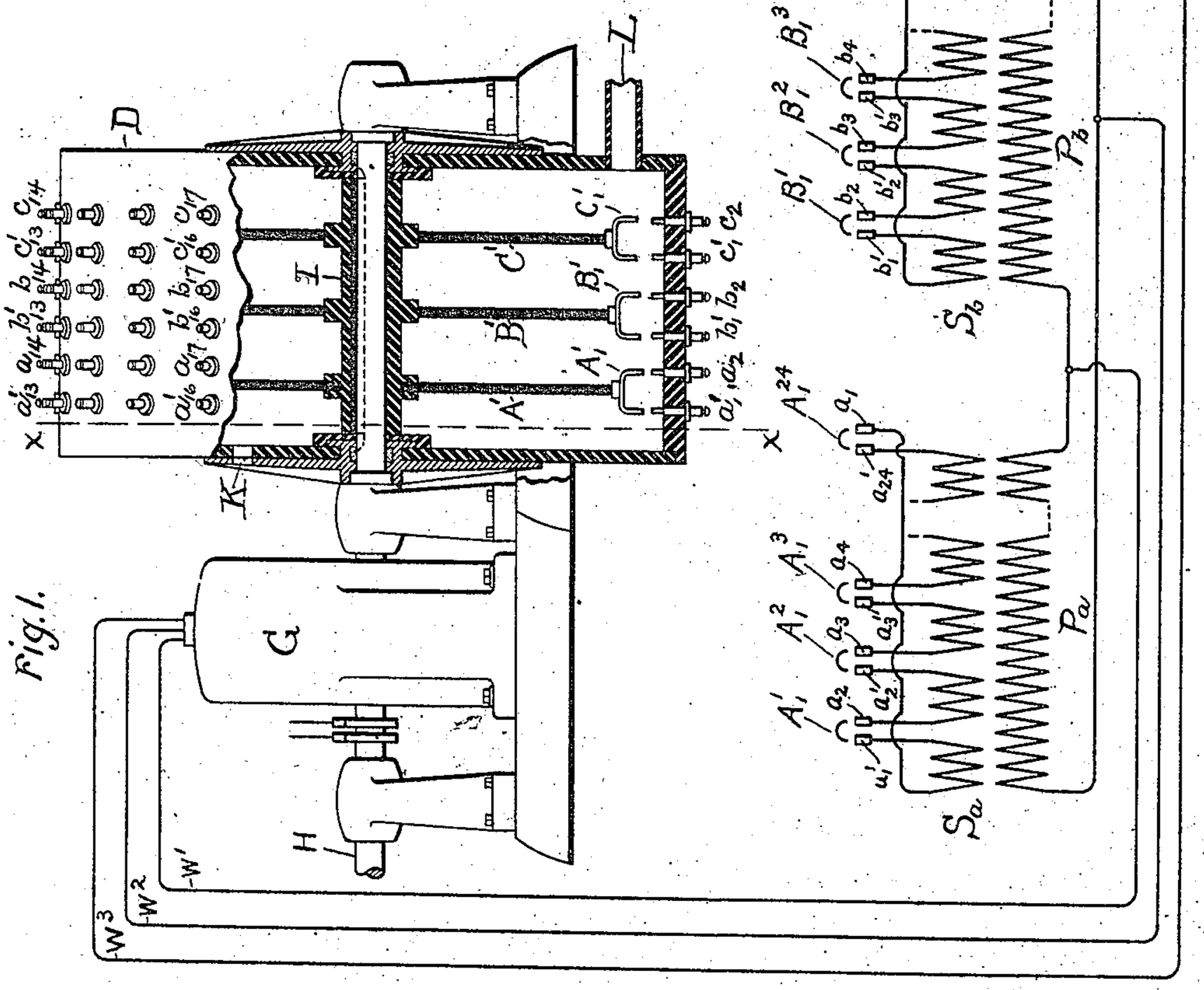


Fig. 1.



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APPARATUS FOR MANUFACTURING NITROUS COMPOUNDS.

No. 894,547. Specification of Letters Patent. Patented July 28, 1908.

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To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Apparatus for Manufacturing Nitrous Compounds, of which the following is a specification.

My invention has reference to improvements in apparatus for the manufacture of nitrous compounds from atmospheric air by exposing the air to the action of electric arcs of minimum volume and greatest practicable length in such manner as to prevent the subsequent dissociation of the compounds that have been produced. Since an arc of such small volume as is required for the efficient working of such process represents only very little energy and cannot be continuously maintained in a reliable manner, it is necessary to employ a large number of arcs simultaneously which, when established, are of short length and are then drawn out to their maximum length until they break; the arcs are then again established and drawn out until they break, and this process is repeated in rapid and continuous succession, while the air which is subjected to the action of the arcs is driven to and past the arcs in a continuous stream, thus removing the nitrous compounds which have been formed as rapidly as possible from the further action of the arcs, whereby the dissociation of the compounds is prevented.

Heretofore it has been deemed necessary to establish each of the numerous arcs either in an independent circuit or in a separate branch of a main circuit, and in either case, the expense of the apparatus was great and the complexity of the same considerable. The potential of the arc circuit is necessarily high, since the longest possible arc is aimed at, and since for mechanical reasons the arc must be established without actual initial physical contact of the electrodes. For independent arc circuits, therefore, it was necessary to have either a high potential generator with a great number of independent generating coils, or a low potential generator with many independent generating coils and in addition thereto as many independent step-up transformers. In either case, the apparatus was expensive and complex. When the arcs were placed in multiple branches of a high potential main circuit it was necessary to equip each branch with a reaction coil in order to prevent one arc from short-circuiting all the others; for it is in the nature of things that one arc will form before the others, and the resistance of the branch in which the arc is first formed will at once be lowered below the resistance of the other branches, and will thus short-circuit the latter and prevent the formation of the arc in the same. The reaction coils in the several branch circuits would largely prevent this short-circuiting, but these reaction coils are nearly, if not quite as expensive as independent transformers.

By my invention the difficulties which attended the former practice are avoided and the expense of the apparatus is considerably reduced.

My invention involves the use of a multiphase (preferably a three-phase) generator of medium potential, and of the ordinary kind, and a single three-phase step-up transformer having the independent secondary windings for each phase divided in open sections which are closed upon each other by two arcs for each section, so that all of the arcs fed by one phase are in series. When these arcs are broken, the arcs fed by the next phase of current are established, and these are in turn replaced by the arcs fed by the third phase. In this manner an ordinary three-phase generator and a single 3 phase, slightly modified transformer, take the place of the complicated apparatus formerly used. The arc-establishing device, however, must be modified to provide for the condition that each phase of current shall feed a separate group or set of numerous arcs in series.

In the accompanying drawing one form of my invention is illustrated as follows:—Figure 1 is a general view of the apparatus showing an elevation of the electric generator and of the nitrous compound producer, the latter being partly in section, and showing the transformer in diagram, and Fig. 2 is a sectional end view of a part of the interior of the nitrous compound producer, the section being taken on line X X of Fig. 1.

Like letters of reference indicate like parts.

The three-phase alternating current generator G, which may be assumed in the present case to have twenty-four (24) field poles, is driven by a suitable power and has its

shaft H extended, and upon the extended part of the shaft is keyed an insulating or insulated sleeve I from which three sets of radial arms, A′, A², A³, . . ., B′, B², B³, . ., C′, C², C³, . . ., extend. These arms are not necessarily made of insulating material, but if made of metal they should be coated with acid-proof material which would naturally be also an insulator; or they should be made of a metal that is not attacked by acids. The construction here shown provides for twenty-four (24) radial arms for each set, corresponding to the twenty-four (24) field poles assumed for the generator, and at the free ends of these arms are fixed the staples A'_1, A^2_1, . . . A^{24}_1, B'_1, B^2_1, ... B^{24}_1, C'_1, C^2_1, ... C^{24}_1, which are preferably made of platinum or copper.

Fixedly mounted upon the bearings of the extended shaft H is a drum D, which may be of glass or porcelain or other acid-proof and insulating material, and the sets of radial arms with the staples at their free ends rotate within the drum. The free points of the staples are turned toward the inner wall of the drum D, and in the plane of rotation of each of these free points is a series of pins fixed in the wall of the drum and projecting inwardly within a short distance of the sweep of the points of the staples; so that there are six (6) rows of pins which constitute or are connected with the terminals of a sectional transformer, as will presently appear.

The three-phase constant current generator G delivers its current to the primaries P_a, P_b, P_c, of the three-phase step-up transformer T, as indicated, and the three phases of the secondary current are separated in the independent secondaries S_a, S_b, S_c, which are disconnected from each other, and each is divided into sections, in the present instance into twenty-four (24) sections, the terminals of which are constituted by or are connected with the six (6) rows of pins projecting into the drum D. The terminals of the twenty-four (24) sections of S_a are marked a_1 a'_1, a_2 a', ... a_{24} a'_{24}, respectively; the terminals of the twenty-four (24) sections of S_b are marked b_1 b'_1, b_2 b'_2, . . . b_{24} b'_{24}, respectively; and the terminals of the twenty-four (24) sections of S_c are marked c_1 c'_1, c_2 c'_2, . . . c_{24} c'_{24}, respectively. These terminals are so arranged in the drum D with reference to the staples at the free ends of the radial arms that for each phase the outgoing terminal of one section is, or may be, bridged by a staple onto the incoming terminal of the next succeeding section. Thus, for the independent secondary coil S_a the outgoing terminal a'_1 of the first section and the incoming terminal a_2 of the second section are or may be bridged by any of the staples of the A order; similarly a'_2 and a_3 may be bridged by a staple of the A order, or the outgoing terminal a'_{24} and the incoming terminal a_1 may be bridged by a staple of the A order. In the same manner the terminals of the sections of the independent secondary coils S_b and S_c are, or may be, bridged by the staples of the B order and C order, respectively.

It will be seen from the foregoing that the sections of the three independent secondary coils are or may be bridged by the staples of one order, and when so bridged, the sections of each secondary coil are connected in a closed series. The length of the radial arms, the size of the staples and the length of the pins which constitute the terminals are, however, so chosen that actual contact between the staples and the terminals is not made, but that an arc passing from terminal to staple and from staple to terminal may close the series connection between the sections of each independent secondary coil. The air gaps in the secondary circuits are, therefore, in the operation of the apparatus bridged by electric arcs.

The radial arms of each order are spaced 15° apart, but the arms of the B order are shifted with reference to those of the A order by 5° and the arms of the C order are shifted in the same direction by 5° with reference to the arms of the B order, so that each set of radial arms is displaced with reference to the next adjacent set in such manner that the coincidences of the staples with the terminals of the *a* order, the *b* order and the *c* order are dephased with reference to each other by one-third of a period of the current delivered by the generator. This angular displacement of the three sets of arms is indicated in Fig. 2 by appropriate shading.

The clearance or air gap between the staples and terminals is so chosen that an arc will be established between them when the rising voltage in the secondary of the transformer has attained a certain rather low value. Consequently, the position of the arm-carrying sleeve I upon the extension of the shaft H must be such that the coincidence between the staples of the A order with the terminals of the *a* order shall occur at the moment when the predetermined voltage of one of three currents developed in the secondaries of the transformer has been reached, and the coincidence between the staples and terminals of the other two sets will then occur at the moments when the same predetermined voltage of the two other currents is attained.

Assuming now that the staples of the A order just coincide with the terminals of the *a* order when the voltage in S_a attains its predetermined value (this being the condition that must be observed), arcs will be established in the forty-eight (48) air gaps between the staples and terminals of these orders, and as the radial arms, by their rotation, recede from this coincidence, the forty-eight (48) arcs will be lengthened until they

finally break. At the same moment, or rather closely following it, there will be coincidence between the staples of the B order and the terminals of the *b* order, just at the time when the voltage in S^b attains its predetermined value, whereby forty-eight (48) new arcs will be formed, which will lengthen and break; and immediately after this, forty-eight (48) new arcs will be established, lengthened and broken between the staples of the C order and the terminals of the *c* order. This cycle of operation will now be repeated over and over again so long as the voltage of the generator is suitably maintained.

In the example here given there will, for each complete rotation of the shaft H, be formed, lengthened and broken three thousand four hundred and fifty-six (3456) arcs, which, acting upon the air in the drum D will cause the oxidation of the nitrogen, forming nitrous compounds in a cheap and expeditious manner.

The air is continuously drawn or pumped into the drum through the opening K and is continuously withdrawn, together with the nitrous compounds, by a pipe L; but the appliances for this purpose and for the collection of the nitrous compounds are not here shown, since these are well known in the art and form no part of my invention.

While I have here shown a three-phase generator and corresponding transformer and, consequently, three series of air-gaps, it is evident that a two-phase generator and corresponding transformer and, consequently, two series of air gaps may be employed; it is also evident that a larger number of phases may be employed and that the benefit derived from the series arrangement of the air gaps is still obtained if a single phase current is used. Moreover, the high tension currents for the establishment of the arcs in series may be obtained without the use of a step-up transformer.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The combination with an air chamber, of a high tension circuit or circuits traversing the same and having air gaps in series within the chamber, and means for bridging the gaps by electric arcs, substantially as described.

2. The combination with an air chamber, of a high tension circuit or circuits traversing the same and having air gaps in series within the chamber, means for establishing electric arcs in the air gaps, and means for lengthening and breaking the arcs, substantially as described.

3. The combination of an air chamber with a number of independent high tension electric circuits traversing the same, each having a number of air gaps in series within the chamber, and means for periodically establishing, lengthening and breaking the electric arcs in the series of air gaps in recurrent succession, substantially as described.

4. The combination of an air chamber and a number of independent circuits traversing the same, each having a number of air gaps in series within the chamber, a prime generator of multiphase currents, means for imposing a high potential upon the independent circuits in periodic succession by and in the order of the phases of the generator, and means for bridging the series of air gaps with electric arcs in the same periodic succession substantially as described.

5. The combination of an air chamber and a number of independent circuits traversing the same each having a number of air gaps in series within the chamber, a low potential multi-phase current generator, a step-up transformer for inductively charging the chamber circuits with high potential by and in the order of the phases of the generator, and means for establishing, lengthening and breaking the electric arcs in the different series of air gaps in the order of succession of the phases of the generator, substantially as described.

6. An apparatus for producing nitrous compounds from atmospheric air, containing a chamber through which a continuous air current can be maintained, one or more high tension circuits traversing the chamber and having air gaps in series within the chamber, and means for bridging the gaps by electric arcs, substantially as described.

7. An apparatus for producing nitrous compounds from atmospheric air, containing a chamber through which a continuous current of air can be maintained, one or more high tension circuits traversing the chamber and having air gaps in series within the chamber, means for establishing electric arcs in the air gaps, and means for lengthening the arcs to the breaking point, substantially as described.

8. An apparatus for manufacturing nitrous compounds from atmospheric air, containing a chamber through which a continuous current of air can be maintained, a number of independent high tension electric circuits traversing the chamber, each having a number of air gaps in series within the chamber, and means for periodically establishing, lengthening and breaking electric arcs in the series of air gaps in recurrent succession, substantially as described.

9. An apparatus for manufacturing nitrous compounds from atmospheric air, containing a chamber through which a continuous current of air can be maintained, a number of independent circuits traversing the chamber, each having a number of air gaps in series within the chamber, a prime generator of multi-phase currents, means for imposing a high potential upon the independent cir-

cuits in periodic succession by and in the order of the phases of the generator, and means for bridging the series of air gaps by electric arcs in the same periodic succession, substantially as described.

10. An apparatus for manufacturing nitrous compounds from atmospheric air, containing a chamber through which a continuous current of air can be maintained, a number of independent circuits traversing the chamber, each having a number of air gaps within the chamber, a low potential multiphase current generator, a step-up transformer for inductively charging the chamber circuits with high potential by and in the order of the phases of the generator, and means for periodically establishing, lengthening and breaking electric arcs in the different series of air gaps in the order of succession of the phases of the generator, substantially as described.

11. In an apparatus for manufacturing nitrous compounds from atmospheric air, the combination of a low potential multi-phase generator, a multi-phase step-up transformer having an independent secondary for each phase of the generator, each of said secondaries having a series of air gaps in a drum through which a current of air can be maintained, rotating gap bridges whereby the gaps of the different series are shortened to the arc establishing distance and lengthened to the arc breaking distance in the periodic succession of the phases of the generator, substantially as described.

In witness whereof, I have hereunto set my hand this 18th day of March, 1907.

CHARLES P. STEINMETZ.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.