Dec. 7, 1937. W. DEUTSCH 2,101,168

ELECTRICAL PRECIPITATION APPARATUS

Filed Feb. 23, 1937

Fig. 1.

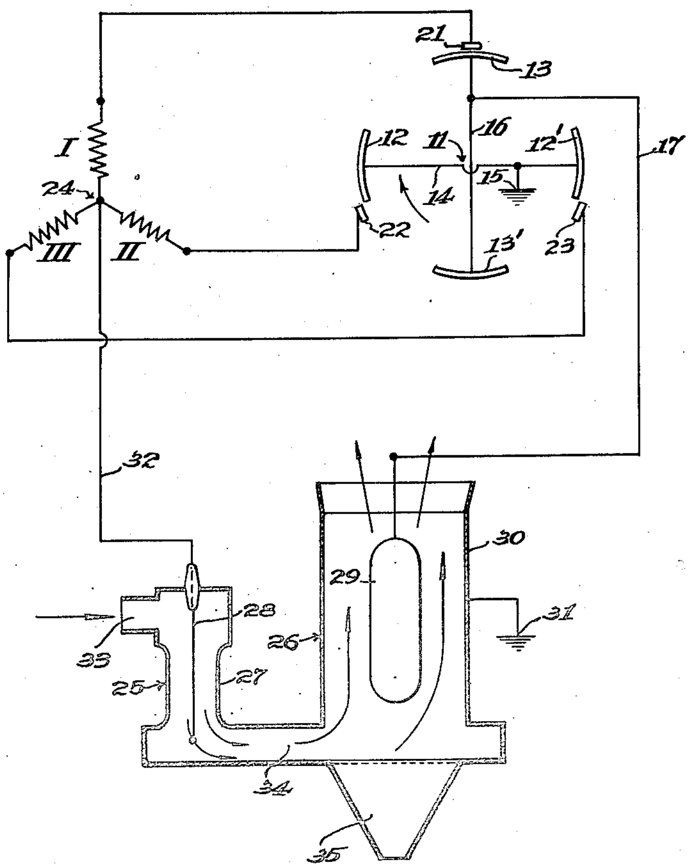


Fig. 2.

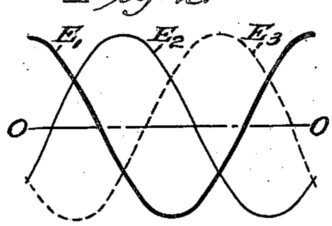


Fig. 3.

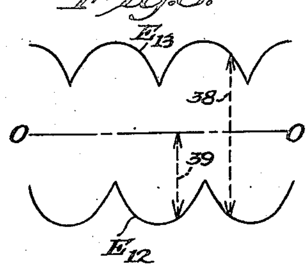
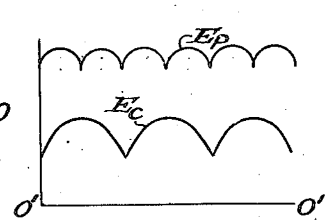


Fig. 4.



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2,101,168

ELECTRICAL PRECIPITATION APPARATUS

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1 Claim. (Cl. 183—7)

This invention relates to the electrical treatment of fluids, in which a fluid to be treated—either a gas or a liquid—is passed through an electrical field between opposing electrode means. As examples of such treatments, there may be mentioned the electrical precipitation of suspended particles from gases, and the electrical de-emulsifying or separation of liquid emulsions. The present invention is concerned particularly with electrical fluid treating apparatus in which a unidirectional high potential field is maintained between the opposing electrode means.

In such apparatus, it is frequently desirable to pass the fluid successively through two electrical fields maintained between two separate sets or systems of oppositely charged electrode members, and in these cases it is sometimes advantageous to apply potentials of different magnitudes between the opposing electrodes of the respective sets or systems. For example, in the treatment of either gases or liquids, it may be desired to first subject the fluid to the action of an electrical field at relatively low potential and then to the action of a higher potential field. In other cases, different arrangements or spacings of the opposing electrodes, or different types of electrodes, may be employed in the successive fields, making it either necessary or preferable to utilize potentials of different magnitudes.

The principal object of the invention is to provide a simple and advantageous means of obtaining two unidirectional potentials of different magnitudes and applying these potentials to the respective electrode systems in an apparatus such as above described.

A further object is to provide for obtaining the two different unidirectional potentials from a common source of alternating electric current, and with the employment of a single mechanical rectifying apparatus of simple design and construction.

The rectifier employed according to this invention is a polyphase mechanical rectifier, which may be of the general type described in German Patent No. 406,663.

This type of rectifier ordinarily comprises fixed contact members connected to the extremities or points of the several phases of a Y-wound source of polyphase alternating current at high potential, such as the Y-connected secondary phase windings of a polyphase transformer, and synchronously rotating contact means connected to the respective terminals of the load to which rectified high potential is to be supplied (such as the respective electrodes of an electrode system), whereby successive pairs of phases are successively connected in series to the terminals of the load. The operation is such that one terminal of the load is substantially continuously connected to a point of highest positive potential of the polyphase source and the other terminal is substantially continuously connected to a point of highest negative potential of said source, so that the effective unidirectional potential supplied to the load is approximately twice the effective potential of the individual phases. According to the present invention, a separate unidirectional potential is also supplied to another load (in this case the respective electrodes of a separate electrode system) by connecting one terminal of this other load to one of the rotating contact members of the rectifier, and connecting the other terminal of this load to the star-point or common connection of the several phase windings of the alternating current source, so that the rectified voltages of the individual phases are successively connected to this other load. Thus, the potential applied to the last mentioned load is approximately half the potential applied to the first mentioned load. It will be understood that rectification may be obtained in a similar manner by connecting the loads to fixed contact means and connecting the several phases of the polyphase source to rotating contact means, but the arrangement first described is ordinarily preferred, since it minimizes the number of brush contacts required to maintain connection to the rotating contact means.

The following specific description will serve to illustrate the application of this invention to one particular type of apparatus for electrical precipitation of suspended material from gas, but it will be understood that the invention may be employed in a like or comparable manner in connection with any apparatus in which a fluid, either gas or liquid, is passed successively between two separate electrode systems, and in which it is desired to supply unidirectional potentials of different magnitudes to the opposing electrodes of the respective systems.

According to one method which has long been known for the electrical separation of suspended solid or liquid particles from gases, the gas is first passed through a unidirectional electrical field in which ionization is caused to occur, for the purpose of electrically charging the suspended particles, and is then passed through a separate unidirectional field in which substantially no ionization is produced, for the purpose of precipitating the charged particles. In apparatus of this type, some difficulty has been encountered in obtaining sufficient ionization in the first or charging field to effectively charge the suspended particles, without causing an objectionably large proportion of the suspended particles to be actually precipitated in this field instead of in the second or precipitating field in which, according to this method, the actual separation may be more advantageously carried out.

For the above reason, it is advantageous in some cases to pass the gas through the charging field at a velocity several times as great as the velocity at which it is passed through the precipitating field. This may be accomplished advantageously by placing the electrodes relatively close together in the charging field, to provide a gas passage space therebetween of relatively small cross-sectional area, and placing the electrodes relatively farther apart in the precipitating field, to provide a gas passage space therebetween whose cross-sectional area is several times that of the charging field. For example, the charging electrode system may comprise a discharging electrode formed as a wire of sufficiently small diameter to provide effective corona discharge or ionization, disposed axially within a substantially cylindrical tube or pipe which constitutes the opposing non-discharging electrode of extended surface, while the precipitating electrode system may comprise two concentric cylindrical electrode members, both of sufficiently extended surface to substantially prevent corona discharge therefrom, and spaced from one another by a distance somewhat greater than the spacing of the two electrodes of the charging field, so as to provide the desired increase in cross-sectional area of the gas passage space therebetween.

With such an arrangement, it becomes desirable to apply a higher potential to the electrodes of the precipitating electrode system than to the electrodes of the charging electrode system, and the arrangement according to the present invention may be employed advantageously for this purpose.

The accompanying drawing illustrates the invention as applied to an apparatus of this type, and referring thereto:

Fig. 1 is a diagrammatic representation of an electrical precipitation apparatus of the type above described and an associated electric circuit arrangement according to this invention;

Fig. 2 is a diagram of the polyphase potential supplied by the alternating current source;

Fig. 3 is a diagram representing the positive and negative potentials applied to the respective rotating contact members of the rectifier; and

Fig. 4 is a diagram of the rectified potentials supplied to the respective electrode systems, it being understood that the relationships shown in Figs. 3 and 4 are somewhat idealized for purposes of illustration.

Referring to Fig. 1, the secondary phase windings of a high potential three-phase transformer are shown at I, II and III.

The rectifier comprises a rotating assembly indicated diagrammatically at 11 provided with two diametrically opposed contact segments 12 and 12' and another pair of diametrically opposed contact segments 13 and 13' disposed circumferentially midway between the contact segments 12 and 12'. The contact segments 12 and 12' are electrically connected together as at 14 and are shown as grounded at 15. This connection may be made either through the shaft of the rotating assembly or by means of a brush or other suitable contact arrangement. The contact segments 13 and 13' are also electrically connected together as indicated at 16, and are connected by conductor 17 to one of the electrodes of one electrode system of the precipitator as hereinafter described. The contact segments 13 and 13' are at high potential with respect to ground and the connection thereof to conductor 17 may be made by means of a brush or other suitable contact device.

The rectifier further comprises three fixed contact members 21, 22 and 23 spaced 120° apart in position for effective spark contact with the rotating contact segments and connected respectively to the extremities of the several phase windings I, II and III. The inner ends of the several phases are connected together at a common point 24, commonly referred to as the star-point.

It will be understood that the rotating contact assembly of the rectifier may be mounted in the usual manner upon the shaft of a synchronous motor for rotation in the proper direction, for example as shown by the arrow in Fig. 1, and that suitable insulating means are provided for electrically insulating the segments 12 and 12' and conductor 14 from segments 13 and 13' and conductor 16. Owing to the fact that the device is shown as provided with two contact segments for each polarity of the rectified potential, the rotating assembly is operated at one-half synchronous speed, as by means of a four-pole synchronous motor, so that 180° rotation thereof corresponds to 360 electrical degrees. It will be understood, however, that only one rotating contact segment for each polarity may be provided, in which case the two segments would be located 180° apart in space, and the rotating assembly would be operated at synchronous speed.

The electrical precipitator is shown as comprising a charging zone or field 25 and a precipitating zone or field 26. The electrode system in the charging field comprises a non-discharging pipe electrode 27 and a discharge electrode member 28, such as a wire or the like, extending axially within said pipe and insulated therefrom. The electrode system of the precipitating zone comprises a non-discharging cylindrical electrode member 29 of sufficiently extended surface, and preferably rounded at its ends as shown, to prevent corona discharge therefrom, and a pipe or cylindrical electrode member 30, concentrically surrounding and insulated from the electrode 29. Electrodes 27 and 30 are electrically grounded as indicated at 31. The other electrode 29 of the precipitating electrode system is connected through the above mentioned conductor 17 to the high tension contact segments 13 and 13', while the other electrode 28 of the charging electrode system is connected by conductor 32 to the above mentioned star-point or common connection of the three phases I, II and III of the alternating current source.

The gas to be cleaned enters the charging zone at 33 and is conducted from this zone by a flue or pipe connection 34 to the precipitating zone. The cleaned gas is discharged from the open upper end of the tubular electrode 30, and suitable means, such as a hopper 35, are provided below the precipitating zone for receiving and collecting the precipitated material.

Referring to Fig. 2, the potentials of the several phase windings I, II and III (and consequently the potentials maintained at the fixed contacts 21, 22 and 23) are represented at E_1, E_2 and E_3, respectively. This figure represents approximately one full cycle of alternating current, in which electrical degrees are plotted horizontally, while the ordinates of the respective curves with respect to the zero axis 0—0 represent the difference in potential between the respective fixed contacts 21, 22 and 23 and the star-point 24.

In the operation of the rectifier, the effective contacts between the fixed and rotating contact elements are made and broken at times corresponding substantially to the points of intersection of the respective curves in Fig. 2. For purposes of illustration, it may be assumed that the high tension electrodes 28 and 29 of the respective electrode systems are to be maintained at positive potentials with respect to the grounded electrodes 27 and 30, respectively. In this case, the rectifier is so operated that one or the other of the high tension rotating contact segments 13 or 13′ is substantially at all times in contact with a fixed contact member which is at the greatest positive potential, while one of the grounded rotating contact segments 12 or 12′ is substantially at all times in contact with a fixed contact member which is at the greatest negative potential, so that, at any instant, the combined potentials of the two phases corresponding to the two fixed contact members so contacted are impressed in series upon the respective electrodes 29 and 30 of the precipitating electrode system, while the potential of the individual phase corresponding to the fixed contact which is at that time contacted by one of the grounded rotating contact segments 12 and 12′ is impressed upon the electrodes 27 and 28 of the charging electrode system, due to the premanent connection of high tension electrode 28 to the star-point 24 of neutral or intermediate potential.

Referring to Fig. 3, the positive potential supplied to the set of rotating contact segments 13 and 13′ is represented by the curve E_{13}, which corresponds in position to the positive peak portions of the several phase potential curves E_1, E_2 and E_3 of Fig. 2. Similarly, the negative potential supplied to the high tension set of rotating contact segments 12 and 12′ is represented by the curve E_{12}, which corresponds to the negative peak portions of the several phase potential curves E_1, E_2 and E_3. Thus, the vertical distance between these two curves, as indicated by the line 38, represents the unidirectional potential supplied to the precipitating electrodes 29 and 30, while the vertical distance between curve E_{12} and the zero axis 0—0, as indicated by the line 39, represents the unidirectional potential supplied to the charging electrodes 27 and 28.

The fluctuating unidirectional potentials of the respective electrode systems are more clearly shown in Fig. 4, in which curve E_p represents the potential of the electrode 29 with respect to the grounded electrode 30 of the precipitating zone, while E_c represents the potential of the electrode 28 with respect to the grounded electrode 27 of the charging zone, the ground potential line being shown at 0′—0′. It will be seen that the curve E_p has six peaks per cycle of the alternating current, while the curve E_c has three peaks per cycle of the alternating current, and that the effective potential in the precipitating zone is approximately twice the effective potential in the charging zone.

It will be understood that the spacing between electrodes 27 and 28 in the charging zone is such as to provide the desired corona discharge from electrode 28, without producing disruptive discharge or arcing, while the spacing between electrodes 29 and 30 is such as to provide a high electrostatic field therebetween without disruptive discharge. Due to the difference in the potentials in these two fields, the electrode spacing in the precipitating field may be in the neighborhood of twice that in the charging field, thus obtaining the above mentioned advantage of a relatively high velocity in the charging field as compared with the precipitating field.

I claim:

An apparatus for electrical treatment of fluids comprising two separate electrode systems each comprising two opposing electrode members spaced from one another to accommodate flow of gas therebetween; a polyphase transformer with Y-connected secondary phase windings having a common point connected to one end of each winding; means electrically connecting one electrode member of one of said electrode systems to said common point; and synchronously operated mechanical rectifying means associated with the other terminals of said windings, and with the other electrode member of said one system, and also with the two electrodes of the other electrode system, said rectifying means being operable to successively connect the several phases individually to said other electrode member of said one system and to successively connect different successive pairs of phases in series between the two electrode members of said other system.

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