Feb. 20, 1951 H. KLEMPERER 2,542,035

IONIZING DEVICE FOR ELECTRICAL PRECIPITATORS

Filed June 20, 1946

Fig. 1.

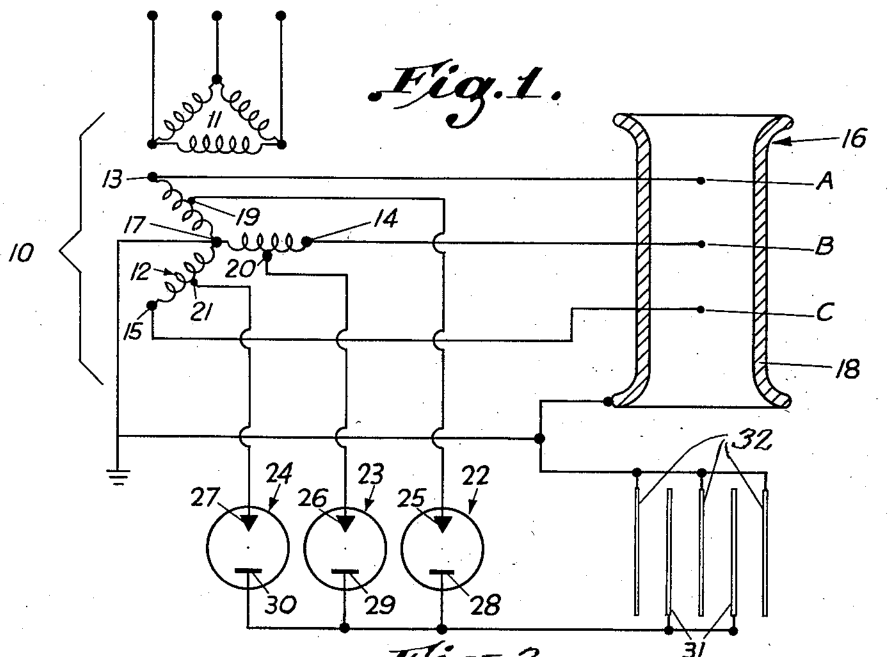
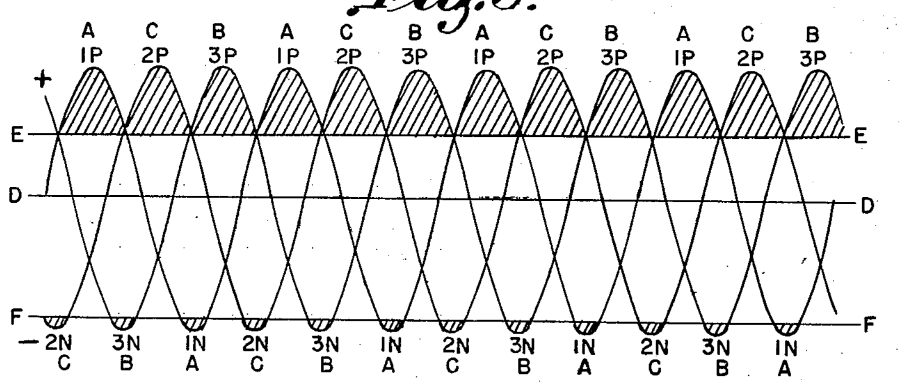


Fig. 3.



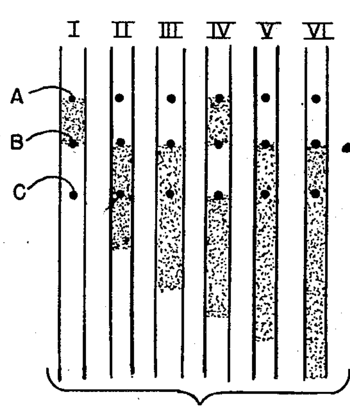


Fig. 2.

INVENTOR
HANS KLEMPERER
BY Elmer J. Gorn
ATT'Y.

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IONIZING DEVICE FOR ELECTRICAL PRECIPITATORS

Hans Klemperer, Belmont, Mass., assignor to Raytheon Manufacturing Company, Newton, Mass., a corporation of Delaware

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5 Claims. (Cl. 183—7)

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This invention relates to electrical precipitators, for electrically separating smoke and dust from air, flue gases and the like. As heretofore constructed it has been necessary to supply high voltage direct current to the ionizing wires of the precipitators. This requires rectifying tubes capable of handling such high voltages in order to supply the direct current from the usual alternating current supply source. Where it is attempted to use alternating current directly for ionizing purposes, only the positive peaks of the 60 cycle waves ionize the air and the time between peaks is lost for ionizing action.

It is among the objects of the present invention to provide a precipitator in which the ionizing device may be supplied with alternating current without the necessity of providing rectifiers.

The above and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a diagrammatic view of an electrical precipitator constructed in accordance with the invention;

Fig. 2 is a diagram useful in explaining the operation of the invention; and

Fig. 3 is a time-voltage graph illustrating the operation of the invention.

Referring to the drawing, reference numeral 10 indicates generally a three-phase transformer having Δ-connected primary windings 11 and Y-connected secondary windings 12. The outer terminals 13, 14 and 15 of the Y secondary windings of the transformer 10 are directly connected, respectively, to the ionizing wires A, B and C of an ionizing device 16. The neutral point 17 of the secondary windings is connected directly to the outer metallic casing 18 of the ionizing chamber 16. Preferably the connection between the center point 17 and the casing 18 is grounded. The wire electrodes A, B and C of the ionizing device are arranged in parallel relation and so spaced with respect to the direction of air flow and the speed of the air passing through the chamber 18 that during operation the air passing through the chamber is subjected, at all times, to the ionizing action of at least one of the electrodes A, B and C. The proper spacing of the electrodes in order that each of them will be effective in ionizing the air is given by the formula

$$d=\frac{v}{nf}$$

where d is the distance between two successive

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electrodes; v is the speed of air; n the number of phases of the power supply; and f the frequency in cycles per second.

When the wires are so spaced it will be seen that if the positive peak of one phase is effective at A, the body of air flowing from A to B will be ionized during this positive peak. The air between B and C will be un-ionized, the condition of the air at the end of this first positive peak effective at A being shown in column I of Fig. 2 in which the stippling represents ionized air. If the positive peak of the next successive phase is effective at C, the air flowing between B and C will now be ionized as it passes C. The body of ionized air between A and B will at the same time move to the space between B and C while a body of un-ionized air flows into the space between A and B, the condition of the air at the end of the second positive peak being shown in column II of Fig. 2. If the positive peak of the third phase is now effective at B, then the un-ionized air between A and B will be ionized during this period as it moves past B. The condition of the ionized air at the end of the third phase is shown in column III of Fig. 2. The cycle may then be repeated, the first phase of the second cycle being effective at A to ionize a body of incoming air as it passes into the space between A and B. At the end of the first phase of the second cycle the condition of the air will be as indicated in column IV of Fig. 2, in which it will be seen that the column of air ionized during the preceding cycle has moved past C. A body of un-ionized air is present between B and C while the body of air between A and B has been ionized. On the next succeeding phase the positive peak will again be effective at C to ionize the body of ionized air between B to C as it moves past C, and the ionized air spaced between A and B will during this period move in the space between B and C. The condition of the air at the end of this second phase of the second cycle will be shown in column V of Fig. 2. It will be seen that all of the air below B has been ionized, and a body of un-ionized air has moved into the space between A and B. In the third phase of this second cycle the positive peak is again effective at B and the un-ionized air present in the space between A and B at the beginning of this phase is ionized as it passes B, the condition of the air at the end of this phase being shown in column VI of Fig. 2. The cycle thus repeats itself and it will be seen that if the positive peaks of the third phase are effective in the order A, C, B, then each of the ionizing wires will be effective during the periods when un-ionized air is passing energized electrode and all portions of the air passing through the device are acted upon by at least one of the ionizing electrodes.

Referring to Fig. 3, the three phases from the transformer secondary windings 12 are illustrated graphically, about an axis D—D. The positive peaks of the first phase are denominated 1P and the negative peaks 1N. The positive and negative peaks of the second and third phases are correspondingly 2P, 2N, 3P and 3N, respectively. The positive voltage values above line E—E are above the level at which ionization of particles lying between any one of the electrodes A, B or C and casing 18 takes place. The areas of the curves above this line are shaded. The negative voltage values below line F—F are also above the level (in the negative direction) at which ionization of particles lying between the electrodes A, B or C and casing 18 takes place. It has long been recognized that with asymmetric electrodes such as A and casing 18 ionization occurs more readily when the smaller electrode is positive with respect to the larger electrode than when the polarity is reversed. This gives rise to a rectifying action due to the electrodes themselves. See for example Lissman Patent No. 2,326,237. Thus, with a given peak-to-peak voltage, the negative peaks may be made substantially completely ineffective, so that line F—F in Fig. 3 is moved below the negative peaks. As is apparent from the foregoing description, when the phase between electrode A and casing 18 is regarded as the first phase, the second phase is between electrode C and the casing, and the third phase is between electrode B and the casing, as is indicated in Fig. 3. Considering, therefore, only the positive peaks, it is apparent that the air passing between A and casing 18, that is, from A to B, is ionized during the shaded portion of the peak. Thereafter, the air flowing between C and casing 18, that is, from C out of the casing, is ionized during the shaded portion of the positive peak of the second phase. Thereafter, the air which is flowing between B and casing 18, that is, from B to C, is ionized during the shaded portion of the positive peak of the third phase.

The ionized air on passing from the ionizing chamber 16 may be precipitated on the plates of a precipitator chamber which may be of conventional design. In the instance shown, in order to supply a precipitating voltage to the precipitator plates at a lower voltage than that supplied to the ionizing device, center taps 19, 20 and 21 are provided on each of the windings of the secondary 12 and connected, respectively, to the cathodes of tubes 22, 23 and 24. The tubes 22, 23 and 24 are preferably of the gas-filled type having permanently energized cathodes 25, 26 and 27, and anodes 28, 29 and 30 jointly connected to the charged plates 31 of the precipitator chamber. The ground plates 32, which alternate with charged plates 31, are connected to the grounded neutral point 17 of the secondary windings.

By the construction described in the foregoing, all of the air passing through the ionizing zone is subjected to the ionizing effect of the electrodes A, B and C, portions of the air being treated by different electrodes without any intervening un-ionized portions. The potential of the ionizing wire electrodes A, B and C may be of the order of 12,000 volts and this voltage is applied without the intervention of rectifiers between the source of supply and the ionizing wires. The potential on the charged plates 13 may be of the order of 6000 volts.

While there has been herein described a preferred embodiment of the invention, other embodiments within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the form shown and the teachings hereof.

What is claimed is:

1. An ionizing device for an electrical precipitator comprising a plurality of spaced ionizing electrodes, a source of raw polyphase alternating potential for energizing said electrodes, the number of phases of said source being equal to the number of said electrodes and a separate one of said electrodes being connected directly to each of the phases of said source, whereby the peaks of said alternating potential are applied to first one and then another of said electrodes in a predetermined sequence and whereby all of said electrodes are supplied with alternating potential of the same frequency, means for passing the gas to be cleaned past each of said electrodes in succession, said electrodes being so spaced with relation to the velocity of said gas that each of said electrodes acts on an un-ionized portion of said gas and all portions of said gas are acted upon by at least one of said electrodes.

2. An ionizing device for an electrical precipitator comprising a plurality of spaced ionizing electrodes, a source of raw polyphase alternating potential for energizing said electrodes, the number of phases of said source being equal to the number of said electrodes and a separate one of said electrodes being connected directly to each of the phases of said source, whereby the peaks of said alternating potential are applied to first one and then another of said electrodes in a predetermined sequence and whereby all of said electrodes are supplied with alternating potential of the same frequency, a grounded electrode coacting with all of said ionizing electrodes to provide ionizing discharges therebetween, said grounded electrode defining a channel for passing the gas to be cleaned past each of said ionizing electrodes in succession, said ionizing electrodes being so spaced with relation to the velocity of said gas that each of said ionizing electrodes acts on an un-ionized portion of said gas and all portions of said gas are acted upon by at least one of said ionizing electrodes.

3. An ionizing device for an electrical precipitator comprising a plurality of fine wire ionizing electrodes extending in spaced parallel relation in a common plane, a source of raw polyphase alternating potential for energizing said electrodes, the number of phases of said source being equal to the number of said electrodes and a separate one of said electrodes being connected directly to each of the phases of said source, whereby the peaks of said alternating potential are applied to first one and then another of said electrodes in a predetermined sequence and whereby all of said electrodes are supplied with alternating potential of the same frequency, a grounded electrode coacting with all of said ionizing electrodes to provide ionizing discharges therebetween, said grounded electrode defining a channel for passing the gas to be cleaned past each of said ionizing electrodes in succession in a direction parallel to the common plane thereof, said ionizing electrodes being so spaced with relation to the velocity of said gas that each of said ionizing electrodes acts on an un-ionized portion of said gas and all portions of said gas are

acted upon by at least one of said ionizing electrodes.

4. An ionizing device for an electrical precipitator comprising a plurality of spaced ionizing electrodes, a source of raw polyphase alternating potential of a predetermined frequency for energizing said electrodes, the number of phases of said source being equal to the number of said electrodes and a separate one of said electrodes being connected directly to each of the phases of said source, whereby the peaks of said alternating potential are applied to first one and then another of said electrodes in a predetermined sequence, means for passing the gas to be cleaned past each of said electrodes in succession at a predetermined velocity, the spacing between said electrodes being equal to

$$\frac{v}{nf}$$

where v is the velocity of said gas, n is the number of phases of said source, and f is the frequency of said source.

5. An ionizing device for an electrical precipitator comprising a plurality of spaced ionizing electrodes, a source of raw polyphase alternating potential of a predetermined frequency for energizing said electrodes, the number of phases of said source being equal to the number of said electrodes and a separate one of said electrodes being connected directly to each of the phases of said source, whereby the peaks of said alternating potential are applied to first one and then another of said electrodes in a predetermined sequence, a grounded electrode coacting with all of said ionizing electrodes to provide ionizing discharges therebetween, said grounded electrode defining a channel for passing the gas to be cleaned past each of said ionizing electrodes in succession at a predetermined velocity, the spacing between said electrodes being equal to

$$\frac{v}{nf}$$

where v is the velocity of said gas, n is the number of phases of said source, and f is the frequency of said source.

HANS KLEMPERER.

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