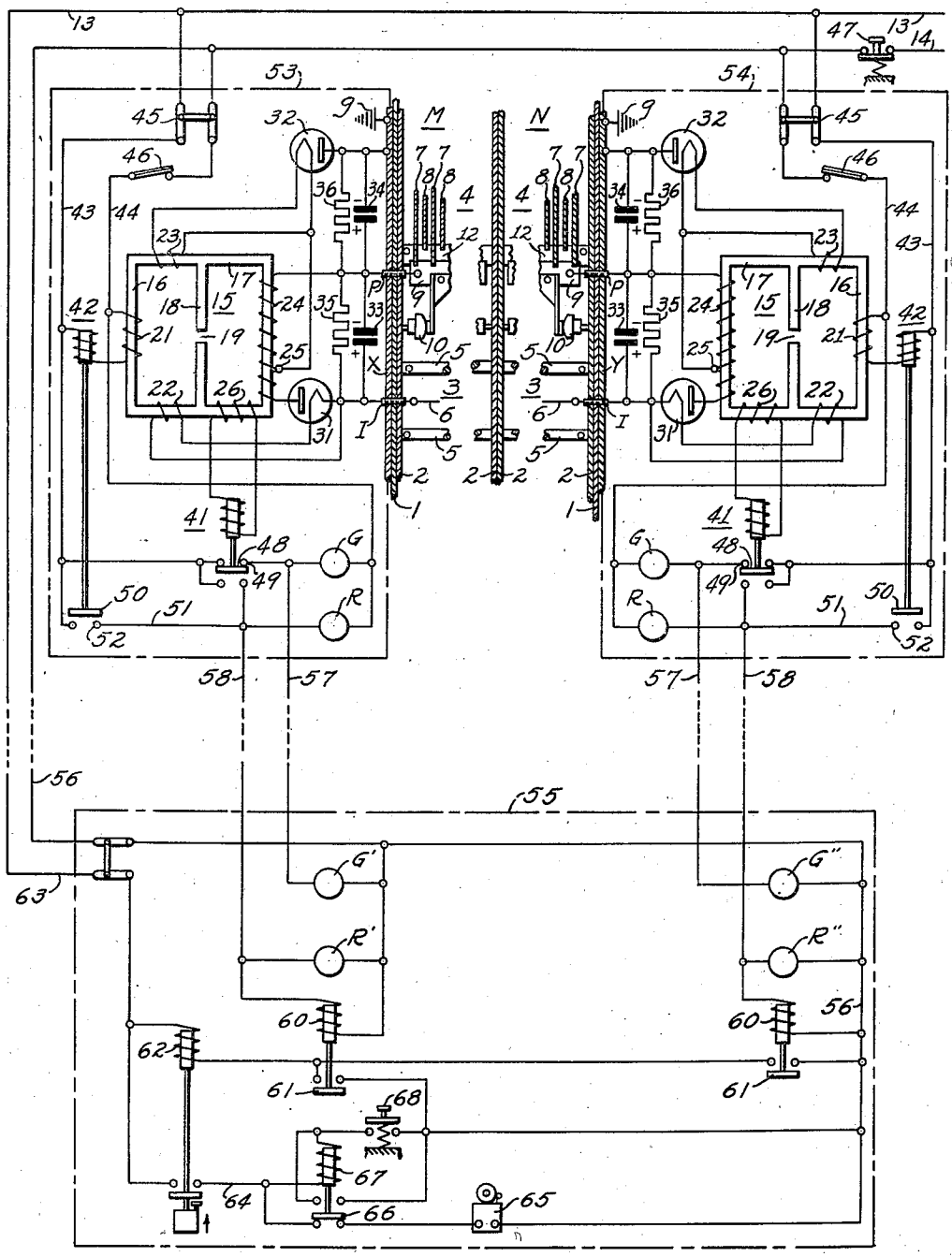
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ELECTRICAL DUST PRECIPITATOR INDICATING SYSTEM

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ELECTRICAL DUST-PRECIPITATOR INDICATING SYSTEM

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My invention relates generally to indicating and alarm systems applied to electrostatic gas-cleaning precipitator installations, and more particularly relates to convenient signalling systems for indicating the operating condition of separate subdivisions of a large precipitator installation, with individual subdivision indications near each subdivision, and combined indications for all of the subdivisions located at a remote central panel or station.

More specifically, my invention relates to the multi-zone type of gas-purifying precipitator assembly which comprises gas-cleaning means in which the gas is first blown or drawn through an ionizing zone where the gas-borne dust particles are electrically charged, and then blown or drawn through a separate precipitating zone or zones where the charged dust particles are electrically acted upon for precipitation. Preferred forms of such precipitators, are shown and described in G. W. Penney Patent No. 2,129,783, granted September 13, 1938, and the E. H. R. Pegg Patent No. 2,215,298, granted September 17, 1940.

In such electrical multi-zone precipitators the ionizing zones usually comprise spaced curved ground electrodes between which ionizing wires are insulatedly supported, the ground electrodes being relatively large in comparison to the ionizing wires which are relatively fine, being less than 32 mils in thickness, and in practice being as fine as mechanical limitations will permit, 5 mil tungsten wire being satisfactory. The precipitating zones usually comprise a plurality of spaced precipitator plates, adjacent ones of which are relatively insulated, the plates having dust-collecting surfaces or provisions for collecting the dust particles previously charged in the ionizing zone. The plates may be flat as shown, for example, in the aforesaid patents, or they may be bent as shown, for example, in the Pound et al. Patent No. 2,212,885, granted August 27, 1940. Such multi-zone precipitators are built in housing units or cells, each of a certain limited capacity, for cleaning precipitator installations, and more parcipitator-units are arranged side by side in vertical or horizontal rows, or both, to make up the total capacity required for a particular gas-cleaning installation, a large number of precipitator-units generally being necessary for large installations of high capacity.

The gas-purifying precipitator assembly further comprises a means for energizing the precipitator-units which require unidirectional or direct-current voltage supplies of potentials above that generally available and sufficiently high to be dangerous, being in the order of 12,000 to 14,000 volts, more or less, in the ionizing zones, and in the order of up to 6,000 volts and sometimes above, in the precipitating zones. This energizing means is usually in the form of a relatively high-voltage voltage-conversion means which converts the customary low-voltage alternating-current power distribution system generally available into the required supply of limited-energy high-voltage power; and in practical application the parts for such a voltage-conversion means are mounted in a suitable grounded metal casing, forming a power supply casing-unit for the precipitator installation or assembly.

For practical application, the voltage-conversion casing-units are built in selected sizes capable of suitably energizing a certain number of precipitator-units; and for large gas-purifying precipitator installations, requiring a large number of precipitator-units, more than one voltage-conversion casing-unit is employed, each supplying power to a subdivision of the total number of precipitator-units.

The relatively high voltages at the output of the casing-units are dangerous, and to reduce the accompanying hazards, each casing-unit is mounted directly on or at the gas-conduit containing the precipitator-units, abutting the conduits so that the necessary power for the precipitator-units can be supplied through short unexposed well-insulated high-voltage leads or connections which pass directly through a wall of the casing-unit and the abutting wall of the gas-conduit. Since the precipitator-units are encased in the gas-conduit and the voltage-conversion means are encased in the metal casing-unit, it is desirable to provide signal means, which heretofore have been incorporated in the casing-unit, for the voltage-conversion means, these signal means being operated upon the occurrence of the known types of possible electrical faults or operation-conditions in the precipitator-units, by which the resulting effects of such faults or operation-conditions express themselves in the voltage-conversion means—the signal means being incorporated in such manner that their signal responses or indications also reflect the operation-conditions of the voltage-conversion means.

In the form of the apparatus herein described, a green light, when visible, indicates that the precipitator-assembly subdivision, comprising the voltage-conversion means and the particular precipitator-unit or -units energized thereby, is operating properly; a visible red light alone indicates an excess-current drain by the particular

precipitator-assembly subdivision, which may be variously caused, as, for example, by shorting between precipitator plates, a broken energized ionizing wire falling on a grounded element, a defective rectifier in the voltage-conversion means passing more current than it should, or other faults causing an excess-current drain from the available low-voltage supply lines or causing a lowering of the output voltage of the limited-energy voltage-conversion means; and visible combined red and green lights indicate an open circuit, which also may be variously caused, as, for example, by a broken ionizing wire hanging loosely out of contact with metals at other potentials, a burned-out transformer secondary winding, or other faults causing insufficient current-drain by the precipitator-assembly subdivision, or overvoltage at the high-voltage output of the voltage-conversion means.

As aforementioned, the high voltage delivered by the voltage-conversion casing units makes it necessary to mount them against or at the gas-conduit encasing the precipitator-assembly. Such locations, however, frequently are in awkward and, perhaps, almost inaccessible places, so that the signal indications can only be observed with extreme difficulty or with great inconvenience; and it is an object of this invention to provide a low-voltage signalling system for apparatus such as hereinbefore described which includes a convenient, readily observable arrangement calling attention to a faulty operation-condition of the precipitator-assembly.

It is an additional object of my invention to incorporate in the system as hereinbefore described duplicate signals, conveniently located, which will enable an operator to observe and determine the operating conditions of the precipitating-assembly, the central or remote signals being preferably arranged on a central panelboard and duplicating the signals of the power-supplying voltage-conversion casing-units for the different subdivisions of the precipitator-assembly, so that an operator or maintenance man can tell at a glance how the respective subdivisions are operating.

It is a more particular object of my invention to provide a signalling system utilizable with an electrical precipitator which will indicate at a convenient remote location faulty operation-conditions thereof, the signalling system starting an alarm upon the occurrence of a fault, but having operable means operable by an operator for canceling the alarm without disturbing the conditioning of the signalling system for subsequent operation of the alarm. Consequently, when the operator seeks to remedy the faulty operation-condition at the precipitator subdivision or assembly where it occurs, the alarm will again immediately sound if the fault has not been removed or a second fault occurs.

The foregoing and other features, objects and advantages of my invention will be apparent from the following description thereof which is to be taken in conjunction with the accompanying drawing, the single figure of which is a diagrammatic view of circuits and apparatus schematically illustrating my invention in its preferred form.

In the illustrated embodiment of my invention, air to be cleaned is forced through a metal gas-conduit 1 which encases a number of precipitator-assembly subdivisions such as M and N, each subdivision comprising a plurality of precipitator-units. Each precipitator-unit may take any suitable form, and the aforesaid Pound et al. and Pegg patents illustrate and describe different forms of self-contained units. Such units are housed in a metal housing or casing 2, and each includes an ionizing chamber or zone 3 followed, in the direction of gas or air-flow, by a precipitating zone or chamber 4. The ionizing chamber of each precipitator-unit comprises cooperating ionizing-electrodes disposed transversely with respect to the air-flow, but for simplicity of illustration, only a few of these ionizing-electrodes are illustrated, and these shown somewhat, schematically. In this ionizing chamber, the air first passes between two spaced parallel tubular ground electrodes 5 which are grounded to the gas-conduit 1 through metal casing 2 which supports the ground electrodes. Between each pair of ground electrodes a fine ionizing wire 6 is supported of the type whose characteristics are more particularly described in the aforesaid Penney patent.

Each precipitator-unit also comprises a precipitating chamber including a relatively large number of precipitator-electrodes comprising alternately insulated and non-insulated plates 7 and 8, respectively, these plates paralleling the gas-flow and following the ionizing chamber. The insulated plates 7 are supported on notched metal bars 9 which are carried by insulators 10, while the non-insulated plates 8 are carried by notched metal bars 12 which are grounded on the metal housing 2 for the precipitator-unit. The housings of the different precipitator-units are usually in direct electrical contact with each other, and certain or all of them in direct contact with the metal gas-conduit. Electrical energy for each subdivision of precipitator-units is supplied to one or more of these precipitator-units by means of a power unit, which derives its energy from a customary 110-volt alternating-current power line, such as a single-phase power line having power conductors 13 and 14. The power unit may comprise a specially designed step-up transformer 15 having a magnetizable circuit including a primary portion 16, a secondary portion 17, and a magnetic-leakage path 18 therebetween, which includes an air-gap 19 or its equivalent, by means of which the leakage is initially regulated. The primary portion 16 of this transformer carries a low-voltage primary winding 21, and may have two separately insulated auxiliary windings 22 and 23 for supplying a very low voltage for energizing filaments of tube rectifiers to be later described. The secondary portion 17 of the magnetizable circuit carries a high-voltage secondary winding 24 provided with an intermediate tap 25 near one end. A separate low-voltage tertiary winding 26 is also carried by this secondary portion 17.

For rectifying the high voltage supplied by the secondary winding 24, two rectifier tubes 31 and 32 are utilized in the illustrated embodiment, having filamentary cathodes which are energized from the auxiliary transformers 22 and 23, respectively. The rectifier tubes are designed to withstand a high inverse peak-voltage of about 20,000 volts, and are capable of carrying a continuous load of about 20 milliamperes of rectified direct current. These rectifier tubes are connected to the transformer and to two serially-connected capacitors 33 and 34 in such manner as to cumulatively charge the capacitors, the charges being indicated by plus and minus signs on the drawing. The size of the capacitors is such that they act to smooth, or reduce the ripple of, the pulsating rectified current-output of the tubes. The capacitors 33 and 34 may be shunted

by discharging-resistors 35 and 36, respectively, for dissipating the charge on the capacitors after the power is turned off. The foregoing elements of the limited energy voltage-conversion means, comprising the transformer and windings, the tubes, the capacitors and resistors are conveniently arranged in a metal casing, such as X or Y, which is mounted at or on the gas-conduit as schematically illustrated in the drawing. Each of these casing-units is capable of supplying energy to a limited number of precipitator-units through output leads P for the insulated precipitating-electrodes and I for the ionizing-electrodes, these circuits being completed through grounds *g*, including the gas-conduit. The leads P and I are made very short and are well insulated, passing through suitable small holes in the metal casings X and Y and the gas-conduit 1, the periphery of the holes preferably being protected and closed as far as possible by rubber washers. In practice, the leads P and I are connected only to one precipitator-unit, the other precipitator-units energized by the particular voltage-conversion means being energized by metal bridging bars or jumpers suitably interconnecting the corresponding insulated elements of the precipitator-units of a precipitator-assembly subdivision, as well known to the art.

The casing-unit X supplies energy to a limited number of precipitator-units associated with M, in accordance with the capacity of the casing-unit; and where the precipitator-assembly includes a greater number of precipitator-units, additional casing-units are utilized to energize the additional precipitator-units arranged in subdivisions, each subdivision having no more precipitator-units than the associated casing-unit is rated to suitably and safely energize. The casing-units of the particular embodiment are basically alike, so that the description of one will suffice for all.

Briefly, the actual connections are such that the negative terminal of the capacitor 34 is grounded, as at *g*, to the metal casing-unit, and the positive terminal of this capacitor is connected by the lead P to energize the insulated precipitator plates of the precipitator-unit subdivision energized thereby. The negative terminal of the capacitor 33 is conductively connected within the casing-unit to the output connection for the output lead P, while the positive terminal of this capacitor is connected to the lead I, which energizes the ionizing wire or wires 6 of the same precipitator-unit subdivision. The plate of the tube 32 is also grounded while the plate of the tube 31 connects to one terminal of the secondary winding 24, the other terminal being common to the output terminal for the lead P. The intermediate tap 25 of the secondary winding is conductively connected to the filament of the tube 32, while the filament of the tube 31 is conductively connected to the terminal for the output lead I.

As a result of the foregoing construction it is possible, in a particular embodiment, to supply a voltage in the order of 5000 to 6000 volts between the relatively insulated precipitator-electrodes 7 and 8, and a voltage in the order of 12,000 to 14,000 volts between the ionizing-wires 6 and ground electrodes 5.

In the illustrated embodiment, the precipitator-unit M represents a subdivision energized by one casing-unit, and the precipitator-unit N represents a subdivision energized by a second casing-unit.

In order to indicate the different operation-conditions of a precipitating subdivision, a voltage relay 41 is connected across the tertiary winding 26, and a current relay 42 is connected in series with the primary winding 21, the energizing circuit for this winding being completed through leads 43 and 44, including a disconnect switch 45, a thermal-responsive protective switch 46, and one or more series-connected door switches 47 in the main line 14, each door switch automatically opening the energy supply to all of the voltage-conversion means or casing-units when a door, or the equivalent, of the gas-conduit means is opened for access to any of the precipitator-units.

The voltage relay 41 is designed to attract its movable contact 48 when the voltage across it, and consequently the voltage across the tertiary winding 26, is at or above a predetermined voltage indicative of normal or proper operating voltages on the electrodes of the precipitator-units, and completes a circuit, including a contact terminal 49, to a green light G mounted in the casing-unit and shining through an appropriate bull's-eye lens. Upon the occurrence of an undervoltage, the relay drops its contact 48 to deenergize the green light, and energize a red signal light R.

The relay 42 attracts its movable contact 50 when the primary winding draws a current of a value equivalent to or above the transformed value of the current drawn by the precipitator subdivision under normal or proper operation-conditions, and when the current falls below this value, the relay releases this contact to energize the same red signal light R by means of a branch circuit 51, including a contact terminal 52.

The equipment within the casing-unit is schematically indicated in the illustration by an enveloping broken line 53 indicative of the metal casing-unit X, and by the broken line 54 indicative of the metal casing-unit Y, each casing-unit being provided in practice with a suitable door to permit access to the encased parts.

The operation of the signals under the different fault operation conditions of the precipitator apparatus is more particularly described in Patent No. 2,217,481, granted October 8, 1940, to I. A. Yost and myself.

In general, an excess-current condition in a precipitator subdivision will lower the voltage across its relay 41, causing the green light G to go out and the red light R to go on. If the fault should be an open circuit, then the primary current drops, causing the relay 42 to release its contact 50 and thereby energize the red signal R through the branch circuit 51. However, the contact 48 of the relay 41 is still in its attracted position, because of the higher voltage across the tertiary winding 26 so that this faulty operation-condition of the precipitating-subdivision is indicated by the combined display of the red and green lights.

During normal operation, the movable contacts 48 and 50 are in their up positions so that only the green light is energized. It should be noted that during excess-current conditions the primary is drawing excess current so that the contact 50 is in its up position during such a faulty operation-condition.

Since the high-voltage output of the voltage-conversion means forces each casing-unit to be placed at locations as near to the precipitator-

units it supplies as is practically possible, and such locations may be difficult to reach and inconveniently located, it is desirable, in such instances, to augment the local casing-unit signals by additional remotely-located signals more conveniently located, and to this end I provide a central panel, indicated by the broken lines 55, upon which the signals indicated by each of the voltage-conversion casing-units are duplicated.

The signals G' and R' are arranged on the central panel 55 in the same manner as the signals G and R of the casing-unit X, and the signals G'' and R'' are arranged in the same manner as the signals for the casing-unit Y, and as many additional similar signals may be provided on the panel 55 as there are casing-units in the particular gas-purifying precipitator-assembly. In order to suitably energize each set of signals, the signal G' is connected between a power-conductor extension 56 of the power-conductor 14 and a lead 57 to the conductor between the green light G and the contact terminal 49, and the signal R' is connected between the extension 56 and a lead 58 between the red light R and the contact terminal 52, so that the illumination of the signal G' alone indicates normal or proper operation of the precipitator subdivision, illumination of the signal R' alone indicates an excess-current operation-condition in the precipitator subdivision, which may be variously caused, and a combination of the two signals G' and R' indicates an overvoltage operation-condition in the precipitator subdivision, which may be also variously caused. Similar connections are provided for the different respective sets of signals on the central panel for the other voltage-conversion casing-units, the broken lines in the connecting conductors being indicative of length.

The central panel signalling system further includes a relay 60, for each casing-unit, each relay 60 being connected across, or in parallel with, the red signal light of the casing-unit with which it is associated, so that it is energized simultaneously with its associated red light. Each relay 60 has a movable contact 61, the respective contacts being connected in parallel between power-conductor extension 56 and a wire for energizing a time delay relay 62, so that whenever any red light indication responds this time delay relay 62 is also energized, its circuit being completed to the power-conductor extension 63 of the power conductor 13. The time delay relay 62, after a predetermined time, operates its contact to close a circuit 64, including an alarm 65 and a normally-closed serially-connected movable contact 66 of a normally-deenergized relay 67, so that the alarm 65 is sounded only if any faulty operation-condition of the gas-purifying precipitator-assembly persists, this being desirable to prevent actuation of the alarm by momentary flashovers or short-circuits in the gas-cleaning equipment, such flashovers frequently occurring, for example, when large particles of dust are trapped which momentarily bridge the precipitator plates. These short-circuiting flashovers or arcs quickly disappear when the particles are burned out by the excess-current through them.

In order to prevent this alarm from continuously sounding while at the same time maintaining the signalling system in operating condition for indicating a fault in any precipitator subdivision, an operator at the remote point at which the central panel 55 is located may depress a normally spring-opened circuit maker 68 which completes the circuit to the coil of the relay 67 when the contact of the time delay relay is in its up or circuit closing position. Consequently, the contact 66 will be raised, interrupting the energizing circuit to the alarm 65 and establishing an obvious holding circuit for the coil of the relay 67 in the raised position of its contactor. However, any red light indication R' or R'' is not disturbed so that the operator is fully informed of which precipitating subdivision requires attention. Accordingly, he may attend to the matter at the location of the faulty precipitator subdivision, and in order to do this he must open a door of a casing-unit or a door of the gas-conduit, all of which are provided with door operated switches, such as 47, or other expedients assuring disconnection of the power supply, for deenergizing the equipment, the gas-conduit door switch or switches 47 preferably deenergizing all of the casing-units. Upon deenergization of the precipitating-apparatus, the signal lights, both at the local casing-units X and Y and at the remote panel 65 will go out and the different relays 60 will become deenergized, thereby deenergizing the time delay relay 62, which is of the quick release type. The deenergization of the time delay relay 62 releases its contact, thereby interrupting the holding circuit of the relay 67 which drops its contact 66 to prepare the alarm circuit for subsequent operation without any further manual operation on the part of the operator. If a double fault has occurred, and only one remedied, the alarm will resound when the energy is restored. It should be noted that when all of the lights at the central panel go out, this itself is an indication that the precipitator installation is deenergized.

From the foregoing, it is apparent that I have extended the present available signalling systems for electrical precipitators of the type described, so that remote indications and an alarm will inform an operator of the operation-condition of large precipitator apparatus, the alarm being continuously primed to respond to any kind of fault in any subdivision of the precipitator apparatus.

I claim as my invention:

1. The combination with a gas-purifying precipitator-assembly comprising gas-duct means having therein electrostatic gas-cleaning means for charging foreign particles in the gas, and for electrostatically precipitating said charged particles, means for energizing said gas-cleaning means comprising relatively high-voltage voltage-conversion means comprising step-up transformer means, rectifying means and capacitor voltage-smoothing means having output terminals adapted to supply rectified voltages, insulated short-lead electrical connections for connecting said output terminals to said gas-cleaning means; of low-voltage signal means cooperating with said transformer means, comprising a signal and a remote alarm for actively indicating a faulty operation-condition of said precipitator-assembly as reflected in said transformer means, normally-inactive means operable for cancelling said alarm operation but retaining said signal operation during said faulty operation-condition, said gas-duct means comprising door means for controlling the energization of said gas-cleaning means by said high-voltage voltage-conversion means, and for automatically restoring said normally-inactive means and alarm to inactive but operable condition for sub-

sequent operation in accordance with their operations as aforesaid, upon deenergization of said gas-cleaning means.

2. The combination with a gas-purifying precipitator-assembly comprising electrostatic gas-cleaning means for charging foreign particles in the gas, and for electrostatically precipitating said charged particles, means for energizing said gas-cleaning means comprising relatively high-voltage voltage-conversion means comprising step-up transformer means, rectifying means and capacitor voltage-smoothing means having output terminals adapted to supply rectified voltages, insulated electrical connections for connecting said output terminals to said gas-cleaning means; of remotely located low-voltage signal means cooperating with said transformer means, comprising a signal and an alarm for actively indicating a faulty operation-condition of said precipitator-assembly as reflected in said transformer means, normally-inactive means operable for cancelling said alarm operation but retaining said signal operation during said faulty operation-condition, and means whereby said normally-inactive means and alarm are automatically restored to inactive but operable condition for subsequent operation in accordance with their operations as aforesaid, upon deenergization of said gas-purifying precipitator-assembly and by removal of said faulty operation-condition.

3. In combination, a gas-conduit means, a gas-purifying precipitator-assembly comprising electrostatic gas-cleaning means in said gas-conduit means, having relatively insulated ionizing electrodes for charging foreign particles in the gas, and having relatively insulated precipitator electrodes for electrostatically precipitating said charged particles, voltage-conversion relatively high-voltage means comprising a step-up transformer means, rectifying means and capacitor voltage-smoothing means for electrically energizing said gas-cleaning means, insulated electrical connection means passing through said gas-conduit for connecting said capacitor voltage-smoothing means to supply a rectified voltage to said ionizing electrodes and to supply a rectified voltage to said precipitator electrodes; low-voltage signal means cooperating with said voltage-conversion relatively high-voltage means, having a signal for indicating a normal or proper operation-condition of said gas-purifying precipitator-assembly, and having a second signal for indicating one type of a faulty operation-condition of said gas-purifying precipitator-assembly, said signal means indicating a second type of a faulty operation-condition of said gas-purifying precipitator-assembly by the combination of both of said signals, said signal means being operated by the effect of said operation-conditions on said transformer means, and single alarm means operable a predetermined time after operation of said second signal, either alone or in combination with the first said signal.

4. The combination with a gas-purifying precipitator-assembly comprising electrostatic gas-cleaning means for charging foreign particles in the gas, and for electrostatically attracting said charged particles; voltage-conversion relatively high-voltage means having output means for supplying rectified electrical energy for said gas-cleaning means; insulated short-lead electrical connection means for connecting said output means to said gas-cleaning means; and signal means having circuit-means locally associated with said voltage-conversion relatively high-voltage means for causing an indication for indicating a faulty operation-condition of said gas-purifying precipitator-assembly as reflected in said voltage-conversion relatively high-voltage means; of remote signal means including alarm means operable by said circuit means after said faulty operation-condition persists for a predetermined time.

5. The combination with a gas-purifying precipitator-assembly comprising electrostatic gas-cleaning means having relatively insulated ionizing electrodes for charging foreign particles in the gas, and having relatively insulated precipitator-electrodes for electrostatically precipitating the charged particles, and relatively high-voltage voltage-conversion means for supplying electrical energy to said gas-cleaning means; of low-voltage signal means cooperating with said voltage-conversion means, having a signal with a response to excess-current operation-conditions in said gas-purifying precipitator-assembly, and an alarm operable with said signal but after said excess-current operation-conditions have persisted for a predetermined time, so that there will be no alarm response to momentary flashes in said precipitator-electrodes.

6. In combination: a gas-purifying precipitator-assembly comprising a plurality of precipitator-units, each precipitator-unit comprising a plurality of current-consuming relatively insulated electrode-means; a plurality of high voltage energizing means, each for supplying energy to an associated selected number of said precipitator-units; a plurality of responsive means, each associated with a one of said energizing means, and each responsively operative in one manner to a condition of excess current-consumption by the electrode-means of the precipitator-units which are associated therewith through the associated energizing means, and responsively operative in another manner to a condition of inadequate current-consumption by such electrode-means; a signal means associated with each of said responsive means for indicating, at a plurality of places, in which of said manners the associated responsive means is responsively operative; remote alarm means; means for causing said remote alarm means to operate with an indication by any of said signal means of either of said current-consumption conditions if such current-consumption condition persists for a predetermined time; and normally-inactive means manually momentarily operable for causing discontinuance of the operation of said alarm means, said manually-operable normally-inactive means being automatically restored to normally-inactive but operable condition when the last said current-consumption condition ceases.

7. In combination: a gas-conduit means; a gas-purifying precipitator-assembly in said gas-conduit means, comprising a plurality of precipitator-units, each precipitator-unit comprising a plurality of current-consuming relatively insulated electrode-means; a plurality of power-supply means, comprising high-voltage energizing means outside said gas-conduit means, a power-supply means being provided for energizing an associated selected number of said precipitator-units; a plurality of responsive means, each associated with a one of said power-supply means, and each responsively operative in one manner to a faulty condition of current-consumption by the electrode-means of the precipitator-units which are associated therewith through the associated power-supply means, and responsively operative

in another manner to a normal condition of current-consumption by such electrode-means; a signal means for each of said responsive means, for indicating to which of said conditions the associated responsive means is responsively operative; alarm means for producing a remote alarm indication with a faulty condition indication by any of said signal means, which persists for a predetermined time; and normally-inactive means manually momentarily operable for causing discontinuance of the alarm indication of said alarm means without disturbing the last said faulty condition indication, said manually-operable normally-inactive means being automatically restored to normally-inactive but operable condition when such faulty condition indication ceases.

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