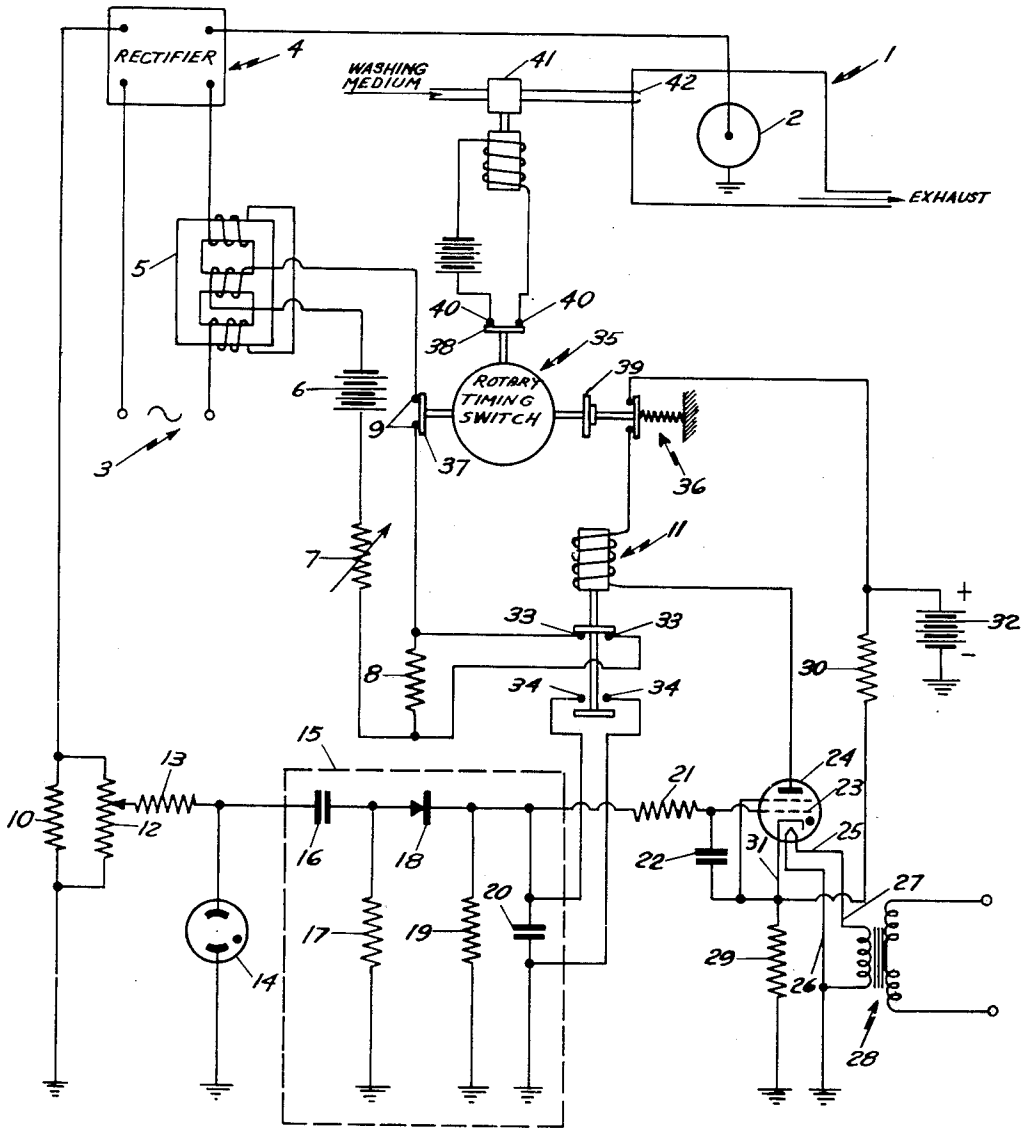
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PROTECTIVE RELAY CIRCUITS

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PROTECTIVE RELAY CIRCUITS

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This invention relates generally to an electronic protective circuit, and more particularly to such a circuit designed to be used in conjunction with an electrostatic precipitator for cleaning a gaseous medium. As is well known in the art it has been found desirable to utilize precipitators with a high D. C. voltage applied to the ionizers in an effort to obtain the maximum possible gas-cleaning efficiency from the system. The use of these high voltages has been accompanied by the disadvantage that the ionizers may be subjected to high arc-over currents, commonly called flashovers, which occur as a result of electrical breakdown in the gaseous medium passing through the ionizers and act to lower the operating efficiency of the system. These flashovers may be caused, for example, by accumulations of large quantities of dust in the system, by a change in the temperature of the gas feeding through the ionizers, by a mechanical deficiency such as a bent electrode or the like. The precipitator system under consideration is of such design that transient flashovers may be quickly extinguished without involving a serious reduction of the operating efficiency. However, when these disruptive discharges persist, the high voltage is effectively removed from the ionizers for a comparatively long period of time thereby allowing a considerable quantity of gas to pass through the system without being ionized with the result that the efficiency is seriously impaired. In addition, the high short circuit current which flows through the system during a flashover will, if prolonged, damage the ionizers to a considerable extent.

In accordance with the invention, electronic means, including switching means, are provided with accomplish the dual purpose of protecting the ionizers and enabling the precipitator to ionize the gaseous medium more continuously even though at a voltage which provides less than the desired maximum efficiency. It is, therefore, the main object of this invention to furnish a protective circuit for a precipitator which will be sensitive to an excessive number of flashovers during a given time interval, while at the same time being insensitive to occasional flashovers such as may occur during normal operation of the precipitator.

This object is realized by the use of a novel integrating circuit arrangement which registers the frequency of incoming current pulses or flashovers. When the frequency of these pulses exceeds a certain predetermined value, a thyratron is caused to fire thereby energizing a relay in its plate circuit, said relay having contacts connected in the primary control circuit of a high voltage power supply in such a manner that the high voltage input to the ionizers is reduced.

Other objects and advantages of the invention will become apparent as the following description proceeds taken in conjunction with the accompanying drawing wherein the single figure represents a schematic diagram of a system embodying the invention.

Referring now to the figure, there is shown a portion of a precipitator system having an ionizing section 1 containing any desired number of ionizers 2, of which only

one is depicted for the sake of clarity and simplicity. A suitable source of supply voltage 3, after rectification by rectifier 4, furnishes ionizers 2 with the desired high D. C. operating potential. One side of input section 3 is provided with saturable reactor 5 having in its control circuit an energizing source 6, variable resistor 7, resistor 8, and contacts 9. Resistor 8 may be included in or excluded from the control circuit by the operation of relay 11 in a manner which will be later explained.

Rectifier 4 has one of its output terminals connected to one electrode of ionizers 2, the other electrode of which is grounded. The other output terminal of rectifier 4 is connected to ground through resistor 10 and vernier 12. A voltage regulating or clipping network consisting of resistor 13 and glow lamp 14 provides an input signal which is impressed on an integrating circuit included within dotted area 15. A thyratron 24, having its grid 23 connected to the output of counting circuit 15 is heated in a conventional manner by heating filament 25 connected through leads 26 and 27 to the low voltage side of step-down transformer 28. Bleeder resistor 30 connected between a source of D. C. voltage 32 and cathode 31, acts in conjunction with cathode resistor 29 to provide the bias for thyratron 24. A filter network comprising resistor 21 and condenser 22 prevents unwanted spurious signals from being applied to grid 23 to eliminate accidental firing of tyratron 24 due to a false signal.

When an arc-over occurs in the precipitator the high short circuit current pulse flowing through resistor 10 and vernier 12 produces a signal voltage which after clipping action by resistor 13 and glow lamp 14 is impressed on integrating circuit 15. Assuming that selenium rectifier 18 is a perfect rectifier, this signal feeds into a capacitive voltage divider network comprising condenser 16, resistor 17, selenium rectifier 18, resistor 19, and condenser 20. The values of condenser 16 and condenser 20 are selected so that the voltage developed across condenser 20 is much less than the voltage developed across condenser 16. Resistors 17 and 19 are of such value that the RC time constant of resistor 19 and condenser 20 is much greater than the RC time constant or resistor 17 and condenser 16. With the application of each high voltage signal pulse, condensers 16 and 20 are supplied with charging current. At the end of an arc-over current pulse condensers 16 and 20 tend to discharge through their respective resistors 17 and 19, rectifier 18 preventing current flow through it toward the left thereby confining the discharge path of condenser 20 to resistor 19.

Thus it can be seen that with the proper choice of time constants the occurrence of several flashovers in quick succession will result in charging condenser 20 to a point where grid 23 to which it is connected will assume a voltage sufficient to fire thyratron 24 as determined by the characteristics of the tube. When thyratron 24 conducts, the current flow therethrough energizes relay 11 thereby opening contacts 33, and simultaneously closing contacts 34, the purpose of which will be pointed out below. With contacts 33 open, the additional resistance 8 thus inserted in the control circuit of saturable reactor 5 causes the high input voltage to ionizers 2 to be reduced.

A rotary timing switch 35 having contact makers 37, 38, and 39 sequentially arranged to alternately open and close their respective contacts 9, 40, and reset switch 36, provides a means for washing the ionizers 2, and also restoring thyratron 24 to a non-conducting condition. Assuming that thyratron 24 has fired and relay 11 is energized, the operation of the timing switch is as follows. Contact-maker 37 will disengage itself from contacts 9 thereby opening the control circuit of saturable reactor 5 to effectively remove the voltage being applied to the ionizers 2. At a later time contact-maker 38 will have engaged contacts 40 thus opening coil-actuated valve 41 to allow

a washing medium which may be gaseous to enter the de-energized ionizers **2** through nozzle **42**. At substantially the same time contact-maker **39** will engage reset switch **36** thereby breaking the plate circuit of thyratron **24**. Since the accumulated charge on condenser **20** which caused thyratron **24** to fire was removed when shorting contacts **34** were closed by energization of relay **11**, grid **23** is thus allowed to once more assume control of the tube.

In the precipitator under consideration, peak flashover currents on the order of 2 to 5 amperes with a maximum frequency of 4/sec. may be encountered. The constants for the integrating circuit may have been so chosen that thyratron **24** will fire after eight 2.5 ampere pulses at the rate of 4/sec. have occurred. It should be understood that the constants are referred to only by way of example, and not in a limiting sense since integrating circuit **15** may be made responsive to any desired pulse frequency by proper selection of the constants.

While there has been described what is considered to be a preferred embodiment of this invention, it will be obvious to those skilled in the art that certain changes and modifications may be made without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a gas cleaning system, means for ionizing a gaseous medium to be cleaned, a source of input voltage for said ionizing means, integrating means adapted to register the frequency of current pulses which may occur in said ionizing means, first switching means controlled by said integrating means and adapted to operate when said current pulses exceed a predetermined frequency, means in circuit with said input voltage source and adapted to reduce said input voltage when said first switching means function, washing means connected to said ionizing means, and second switching means adapted to sequentially remove said input voltage from said ionizing means, actuate said washing means, and restore said first switching means to its pre-functioning condition.

2. In a gas cleaning system: means for ionizing a gaseous medium to be cleaned; a source of input voltage for said ionizing means; integrating means adapted to register the frequency of current pulses which may occur in said ionizing means including a first condenser, a first resistor in series with said first condenser, a rectifier in series with a second resistor, said rectifier and said second resistor being connected in parallel with said first resistor, a second condenser connected in parallel with said second resistor; first switching means controlled by the voltage across said second condenser and adapted to operate when said current pulses exceed a predetermined frequency; means in circuit with said input voltage source and adapted to reduce said input voltage when said first switching means function; washing means connected to said ionizing means; and second switching means adapted to sequentially remove said input voltage from said ionizing means, actuate said washing means, and restore said first switching means to its pre-operating condition.

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