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[56]

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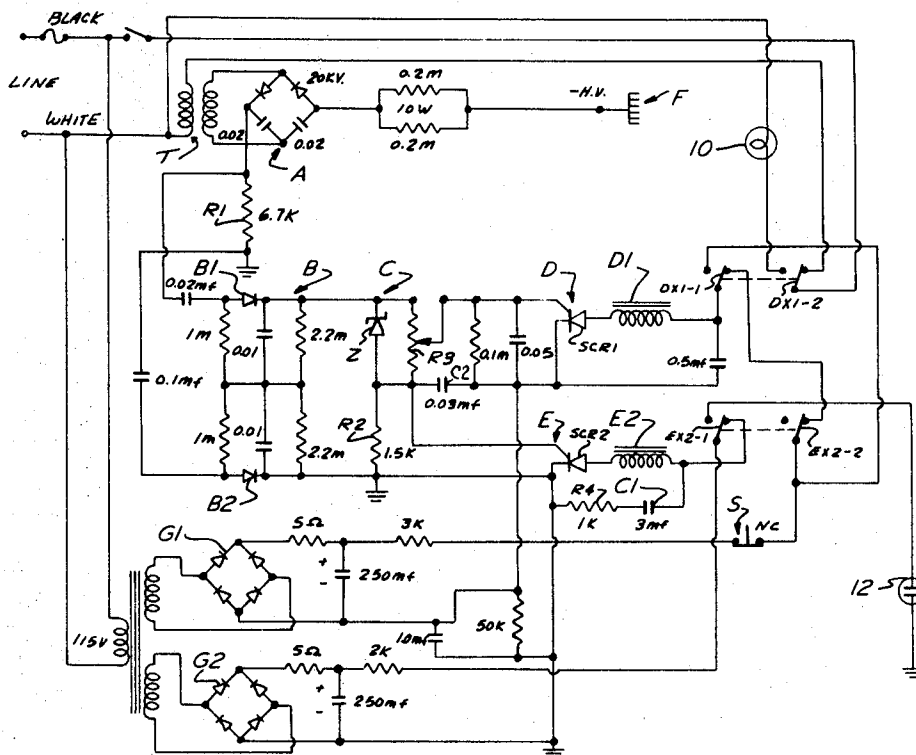
**[54] FIRE AND OVERLOAD PROTECTIVE CIRCUIT
FOR HIGH VOLTAGE POWER SUPPLIES
13 Claims, 2 Drawing Figs.**

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317/33, 317/53, 317/38

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[50] **Field of Search**..... 317/2, 2.6,
18, 50, 60, 38, 33, 53; 340/255

ABSTRACT: A fire and overload protective circuit for high voltage power supplies including a pulse detector for examining random frequency fluctuations in the power output line resulting from snap arcs and fire arcs. The output of the pulse detector is fed into a pulse amplitude discriminator which allows low current fire arc pulses to trigger a fire relay and cut out the power supply while nonrepetitive high current snap arc pulses disarm the fire arc relay.



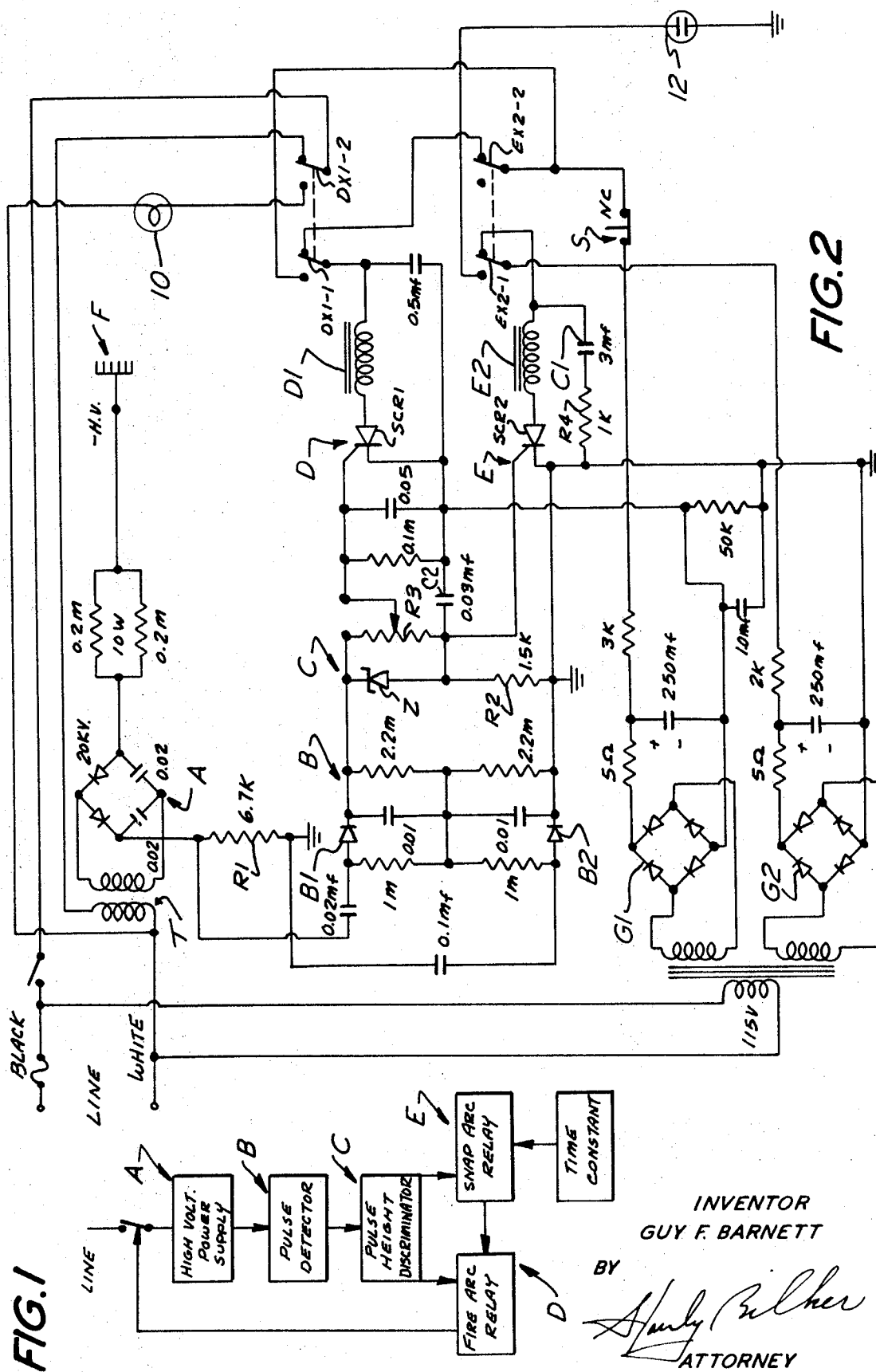


FIG. 2

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FIRE AND OVERLOAD PROTECTIVE CIRCUIT FOR HIGH VOLTAGE POWER SUPPLIES

This invention relates to fire and overload protective circuits for high voltage power supplies, such as are commonly used in static elimination devices and charging systems.

As is well known, high voltage static charging and/or static elimination systems are utilized in control of high speed web handling and sheet transfer devices, for example printing presses. These charging and/or neutralizing systems generally constitute a plurality of points which are connected to the hot side of a high voltage power supply, i.e. one which can generate 5,000 to 25,000 volts, AC in the case of a neutralizer or static eliminator and DC in the case of a charging bar. The application of the high voltage to the points causes ionization of the air and charges are deposited upon the surface of the sheet or web to be controlled. That is, positive or negative charges are deposited where one desires to cause the web or sheet to adhere to an adjacent surface, and both positive and negative charges are deposited where neutralization is the object.

On a printing press, for example, the accumulation of dirt, oil, ink, etc., upon the insulating surfaces of the charging bars forms an electrically conductive coating thereon, and there is a tendency for arcing to occur over the dirty surface to a ground location. That is, a coating of partially conductive dirt or oil film gradually builds up on the insulating surface of the bars between the ionizing points at high potential and any grounded metal in the vicinity. When the conductive film bridges the gap to a sufficient extent, low current arcs develop across the surface. These low current arcs, known as fire arcs, if sustained for 5 to 10 seconds, melt and sometimes vaporize the plastic insulation and cause it to carbonize. The now hotter arcs supported by heated ionized vapor and conductive tracks may not only burn up and destroy the bar, but also may set fire to any adjacent flammable material. Hence, they constitute a real fire hazard.

Almost all present day high voltage power supplies incorporate an overload current control which turns off the equipment when the current reaches a certain predetermined value. However, the current in a fire arc does not add appreciably to the operating current so that the sum of the two currents is below the preset overload control level. As the current in the fire arc increases, the regulation of the power supply usually causes the voltage to drop, with resultant decrease in load current through each point. In an extreme case, all the current may be discharged through a single path, but still without approaching the preset overload level.

Although the current in the fire arcs is usually below the overload limit current, these arcs have a very irregular waveform and therefore contain appreciable frequency information which is not present in the load current or in its accompanying ripple waveform.

Essentially, there are three types of arcing conditions which occur during the operation of the static charging bars; (1) a corona glow which surrounds the points in the ordinary course of operation; (2) high current arcs from the discharging points of the bar directly to ground, called "snap arcs"; and (3) the low current arcs previously referred to as fire arcs which are caused by conductive dirt films across the bar insulation. The corona glow is a regular desired occurrence during ordinary course of operation and does not produce any damage whatsoever. While snap arcs are undesirable, occasional fortuitous snap arcs cannot be avoided. As long as the snap arcs are isolated, nonrepetitive occurrences, they should not effect turn off of the power supply. However, protection must be provided for what would become a continuous succession of snap arcs.

It is therefore an object of this invention to provide a fire and overload protective circuit for high voltage power supplies.

Another object of this invention is to provide a protective circuit for high voltage power supplies which will discern between corona glow, high amplitude, high current snap arcs of occasional occurrence, high current snap arcs in rapid succession, and low amplitude, low current fire arcs.

Still another object of this invention is to provide a circuit for a high voltage power supply which will shut the equipment off upon the occurrence of a fire arc or a rapid succession of high current snap arcs, but will not shut the equipment off in the event of occasional high current snap arcs.

Yet another object of this invention is to provide a method for discriminating between current amplitude, frequency, and waveform of pulses produced during operation of high voltage power supplies.

Other objects of this invention are to provide an improved device and method of the character described which is easily and economically produced, sturdy in construction, and both highly efficient and effective in operation.

With the above and related objects in view, this invention consists of the details of construction and combination of parts as will be more fully understood from the following detailed description when read in conjunction with the accompanying drawing in which:

FIG. 1 is a block diagram of a fire and overload protective circuit embodying this invention.

FIG. 2 is an electrical schematic diagram embodying the circuit of this invention.

Referring now in greater detail to the drawing in which similar reference characters refer to similar parts, there is shown a fire and overload protective circuit for a high voltage power supply A comprising a pulse detector circuit, generally designated as B, a pulse height discriminator, generally designated as C, a fire arc relay circuit D for disabling the power supply, and a snap arc relay circuit for deactivating the fire arc relay circuit during high current pulses of isolated occurrence.

As shown in FIG. 2, the high voltage power supply A constitutes a high voltage doubler circuit which includes a pair of diode-capacitor arms coupled across a transformer T1. The primary of the transformer T1 is connected across the line through a set of normally closed contacts DX1-2 which are opened when fire relay D1 is energized. Opening of the contacts DX1-2 completely deactivates the high voltage power supply A. A DC charging bar F has its discharging points connected to the high side of the power supply A through a pair of 0.2 megohm, 10 watt resistors in parallel. In this case, approximately 20,000 volts negative are applied to the discharging points so that the charging bar F delivers negative ions. The low side of the power supply A passes to ground through a 6700 ohm resistor R1, and ordinarily a constant voltage is developed across the resistor R1. However, when a snap arc or fire arc occurs, a transient pulse of current, as distinguished from a steady state current form, passes through the resistor R1 so as to develop a voltage pulse or a series of voltage pulses thereacross.

The pulse detector circuit B includes a diode B1 which is connected across the resistor R1 through a 0.02 microfarad capacitor. A pair of 2.2 megohm resistors are connected to ground across the output of the diode B1 and act as a voltage divider network prior to application of the detected pulses to the pulse discriminator. A diode B2 on the low side of the pulse detector circuit acts as an RF filter in series with the 0.1 microfarad capacitor and in combination with two series connected 1 megohm resistors in parallel with the two series connected 0.01 microfarad capacitors so as to cut out response to ripple voltages.

The pulse discriminator C comprises a low voltage zener diode Z in series with a 1500 ohm resistor R2, and pulses from the detector B are applied to the Zener diode-resistor R2 network. If a pulse of an amplitude less than the Zener break over voltage (for example, 2 volts in this case) is applied, the Zener acts as a high resistance—in the neighborhood of a megohm or larger. Therefore, where a Zener voltage has not been

produced, substantially all of the voltage appears across the high resistance of the Zener Z rather than across the relatively low resistance 1500 ohm resistor R2 with which it is in series. On the other hand, if a larger amplitude pulse is applied, as from a snap arc, the Zener voltage is exceeded. When the Zener diode breaks down, it appears as a relatively low resistance, for example 800 ohms. Under the latter circumstances, appreciable voltage is developed across the 1500 ohm resistor R2 in series with the Zener diode Z.

The signal across the resistor R2 is applied to the gate of a silicon controlled rectifier SCR2 in the snap arc relay circuit E. Anode potential for the SCR2 is applied from a low voltage power supply G2 through the normally closed contacts EX2-1 of relay E2. In general, only a snap arc causes breakdown of the Zener diode Z which would correspondingly cause sufficient voltage to be developed across R2 as would trigger the gate of SCR2. When SCR2 conducts, relay E2 is energized, and its contacts EX2-1 and EX2-2 are moved from normally closed to open position. In this regard, relay E2 has a built in pickup time of approximately 6 milliseconds as compared to 15 milliseconds for relay D1. Therefore relay E2 opens before relay D1.

It is to be observed, however, that the current from power supply G1 which feeds relay coil D1 passes through the normally closed momentary switch S, through the contacts of EX2-2 when in normally closed position but which are now open, and through the normally closed contacts DX1-1 of relay D1. Consequently, when a snap arc occurs, the opening of contacts EX2-2 opens up the power supply line to relay coil D1 even before the latter has had a chance to become energized through its own silicon controlled rectifier SCR1. That is, even though a snap arc would cause sufficient voltage across the Zener diode Z as would trigger the SCR1 into conduction, the mechanical time delay built into relay D1 prevents actuation of its contacts DX1-1 and DX1-2 even though SCR1 is conducting. Therefore, with short duration snap arcs, the delay built into relay D1 prevents opening of its contacts DX1-2 to the power supply A.

On the other hand, if a low amplitude fire arc occurs, the voltage developed across the Zener diode Z — resistor R2 network is not sufficient to break down the Zener. Consequently, a signal is developed only across the Zener Z and across its potentiometer resistor R3 which acts as a fire sensitivity adjustment. The signal across R2 is not sufficient to trigger SCR2 into conduction. Accordingly, snap arc relay E2 remains deactivated, and its contacts EX2-1 and EX2-2 remain in the normally closed position. However, SCR1 is triggered into conduction by the fire arc signal and energizes relay D1 through its normally closed contacts DX1-1. This impetus is sufficient to cause contacts DX1-1 and DX1-2 to change from normally closed to open, and the power supply A is cut out. Since the relay D1 is now held in its energized position through the swinging of contact arm DX1-1 to the left-hand position, the power supply A remains deenergized until momentary switch S is opened. It is to be noted that a visible and/or audible alarm 10 which is across the primary of transformer T1 through the left-hand contact position of DX1-2, advises of the deactuation of the power supply A which is across the secondary of the transformer T1.

When the momentary switch S is opened, the anode potential applied to SCR1 by power supply G1 is removed, and SCR1 becomes nonconductive. Hence, the momentary switch S acts as a reset device after the power supply A has been cut out by a fire arc. In addition, the momentary switch S allows the pressman to adjust the voltage of the power supply A during initial setup without turning the latter off. That is, depression of the switch S to open position permits adjustment of the power supply voltage until arcing just begins during initial setup. The power supply voltage is then backed off until arcing just ceases. Neon glow lamp 12 blinks on each time a snap arc occurs so as to act as a guide for the pressman to set the voltage.

Because of irregularity in wave form of a spark or snap arc, it is sometimes possible for SCR2 to fall out of conduction momentarily, thus allowing relay E2 to return while a sufficient signal existed for relay D1 to close. Under such circumstances, contacts EX2-2 would prematurely close thereby permitting the fire arc relay D1 to become energized and shut off the power supply A. Also a slow decay of pulses in a snap arc might permit relay E2 to become deenergized while there was still sufficient voltage to actuate relay D1.

Accordingly, relay E2 is made self-dependent through the use of an RC network comprising a 3 microfarad capacitor C1 and a 1000 ohm resistor R4 across the relay coil E2 and SCR2 which provides a controlled return time for the relay E2. In addition, a 0.03 microfarad capacitor C2 is incorporated between the respective relay circuits in order to isolate the fire arc relay SCR1 and permit adjustment of its sensitivity independently of that of SCR2.

Finally, if a situation occurs which would favor continuous snap arcing, the protective circuit will shut down the power supply. Shutdown is effected by the irregularity in the time sequence of a series of successive snap arcs. Such a condition permits excitation voltage for relay D1 to exist at a time when relay E2 is not energized. The irregularity is so pronounced that turnoff is well within one second of arc initiation.

As is apparent from the foregoing description, the fire and overload protective circuit of this invention can see small fire arc currents in the presence of larger load currents and shut off the power supply to the static charging bars F. The present circuit tolerates the occurrence of fortuitous snap arcs without shutting off the bar power supply. Furthermore, the power supply A is turned off when a condition of continuous arcing occurs because the intermittency of continuous arcing is random whereas the return time of relay E2 is fixed by the capacitor C1, relay coil resistor R4, and relay coil resistance. Lastly, the power supply A is turned off in the event of a short circuit in the high voltage.

I claim:

1. A fire and overload protective circuit for a high voltage power supply comprising:

monitoring means for sensing the flow of current through said power supply;

means constituting a discriminator associated with said monitoring means detecting the difference between normal power supply operating current and irregular frequency variations in current which are produced in the power supply as a result of external arcing and generating a signal output upon occurrence thereof, and

control means actuated by the signal output for turning off the power supply upon the occurrence of fire arcs.

2. The circuit of claim 1 including means for differentiating in said signal output between low amplitude current produced by fire arcs and high amplitude current pulses produced by snap arcs, and means for disarming said control means upon occurrence of fortuitous high amplitude pulses created by nonrepetitive snap arcs.

3. The circuit of claim 2 including means to deactivate said means for disarming immediately subsequent to the incidence of each snap arc whereby snap arcs occurring in quick succession will trigger said control means.

4. The circuit of claim 3 wherein said means for differentiating comprises a voltage divider network including a Zener diode coupled in series with a resistor across said means for detecting.

5. The circuit of claim 2 wherein said control means includes first relay means for disconnecting the high voltage power supply when the pulses exceed a first predetermined value ordinarily produced by fire arcs, and said means for disarming includes second relay means cooperative with said first relay means and actuated by pulses of a second higher predetermined value produced by snap arcs, said second relay means rendering said first relay means inoperative when said first relay means are actuated by nonrepetitive snap arc pulses, whereby the power supply will be permitted to operate in

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the presence of high current, relatively short duration snap arcs.

6. The circuit of claim 5 wherein said second relay means has a shorter pickup time than said first relay means.

7. The circuit of claim 6 wherein said second relay means disarms said first relay means in the presence of high current, fortuitous snap arcs.

8. The circuit of claim 7 wherein said first relay means is actuated by the occurrence of a continuous succession of high current snap arcs.

9. The circuit of claim 7 including means for adjusting the sensitivity of said first relay means.

10. The circuit of claim 5 including means for signaling an alarm when said first relay means is actuated.

11. The circuit of claim 5 wherein said second relay means includes an RC network for determining the period of energization of said second relay means.

12. The circuit of claim 11 wherein each of said relay means is operated by a corresponding independent power supply.

13. The circuit of claim 5 wherein each of said relay means is triggered by a corresponding silicon controlled rectifier actuated by the signal output.

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