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ELECTRICAL CIRCUIT FOR INDICATING THE FAILURE OF DIODES

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Fig. 1.

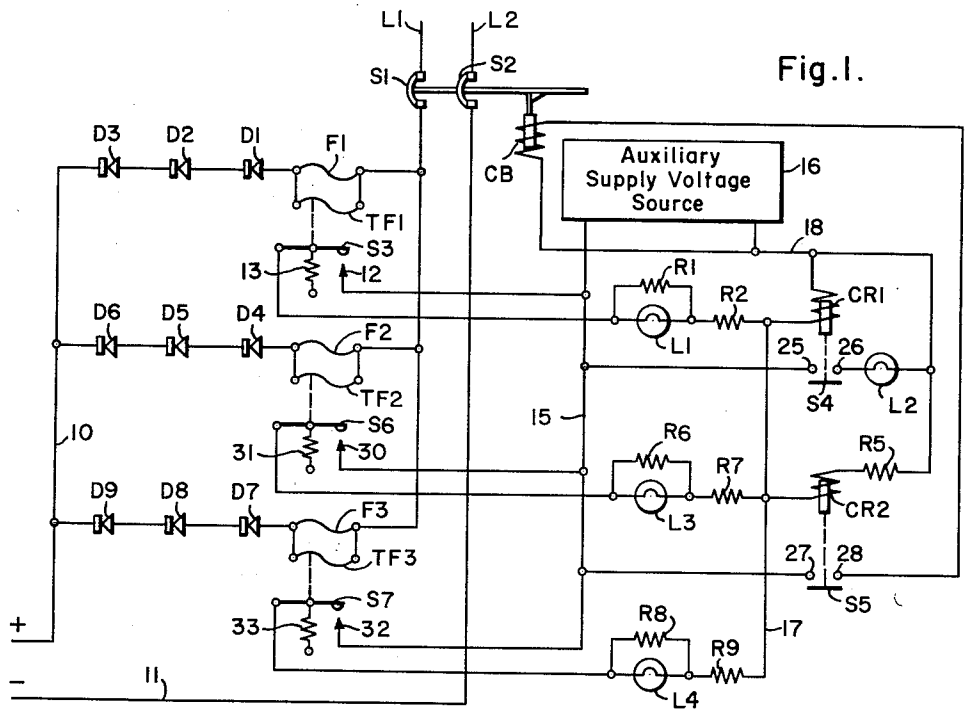
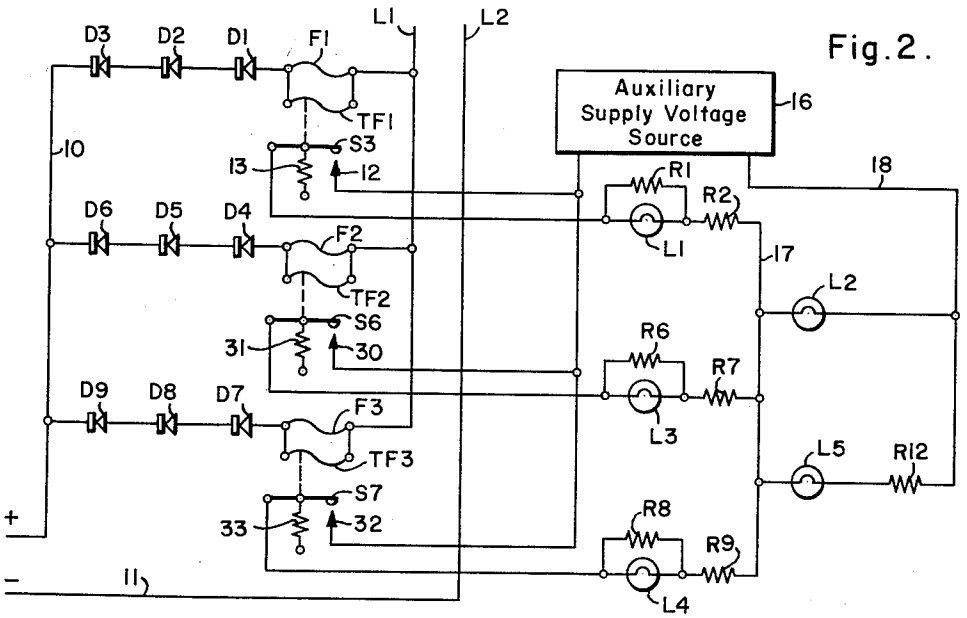


Fig. 2.



WITNESSES

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ELECTRICAL CIRCUIT FOR INDICATING THE FAILURE OF DIODES

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This invention relates to circuits for indicating the failures of diodes in rectifier circuits.

In prior circuits for indicating the failures of diodes, a local indicator lamp connected in series with a resistor, has been shunted across parallel-connected main and trigger fuses which are connected in series with the diodes of a string of series-connected diodes, and has been lighted when the fuses blow. Such a circuit has the disadvantage that the voltage across the indicator lamp is a function of the rectifier output which may vary over a wide range.

This invention places such indicator lamps in circuits where they are not affected by variations in the rectifier output voltage.

An object of this invention is to improve circuits for indicating the failures of diodes in rectifier circuits.

Another object of this invention is to supply constant voltage to a local indicator lamp when a diode in a rectifier circuit fails.

This invention will now be described with reference to the annexed drawings, of which:

FIG. 1 is a simplified circuit schematic of one embodiment of this invention, and

FIG. 2 is a simplified circuit schematic of another embodiment of this invention.

Referring first to FIG. 1, A.C. supply lines L1 and L2 which may be one phase of a multi-phase supply, are connected to switches S1 and S2 respectively, of circuit breaker CB. The line L1 is connected through the switch S1, a main fuse F1 shunted by a conventional trigger fuse TF1, and series-connected diodes D1, D2 and D3 to a positive D.C. output bus 10. Bus 11 connected to the switch S2 is the negative output bus. The trigger fuse TF1 is insulatedly connected to a switch S3 which is normally spaced from a contact 12, and is biased towards the contact 12 by a spring 13. The contact 12 is connected to one supply bus 15 of an auxiliary, constant voltage, supply source 16. The switch S3 is connected in series with a local indicator lamp L1, shunted by resistor R1, and a resistor R2 to a bus 17.

The line L1 is also connected through the switch S1, another main fuse F2, shunted by another conventional trigger fuse TF2, and series connected diodes D4, D5 and D6 to the output bus 10. The trigger fuse TF2 is insulatedly connected to a switch S6 which is normally spaced from a contact 30, and is biased by a spring 31 towards the contact 30. The contact 30 is connected to the bus 15, and the switch S6 is connected in series with another local indicator lamp L3, shunted by resistor R6, and resistor R7 to the bus 17.

The line L1 is also connected through the switch S1, another main fuse F3 shunted by another conventional trigger fuse TF3, and series-connected diodes D7, D8 and D9 to the output bus 10. The trigger fuse TF3 is insulatedly connected to a switch S7 which is normally spaced from a contact 32, and is biased by a spring 33 towards the contact 32. The contact 32 is connected to the bus 15, and the switch S7 is connected in series with another local indicator lamp L4, shunted by resistor R8, and resistor R9 to the bus 17.

Other strings of series-connected diodes with their main and trigger fuses, could be connected in parallel with the three strings shown, by way of example, by FIG. 1.

A control relay coil CR1 is connected to the busses 17 and 18. Another control relay coil CR2 is connected in series with a resistor R3 to the busses 17 and 18. Current for lighting the local indicator lamps from the source 16 flows through the two relay coils.

The relay coil CR1 has a switch S4 which normally is spaced from contacts 25 and 26 which are connected in series with a remote indicator lamp L2 across the supply busses 15 and 18 when the switch S4 touches the contacts 25 and 26. The relay coil CR2 has a switch S5 which normally is spaced from contacts 27 and 28 which are connected in series with the circuit breaker coil CB across the supply busses 15 and 18 when the switch S5 touches the contacts 27 and 28.

When one of the diodes D1, D2 or D3 fails as by being shorted, the increased current through the main and trigger fuses F1 and TF1 respectively, cause these fuses to blow. The switch S3 is then released by the trigger fuse TF1, and is urged by the spring 13 against the contact 12, connecting the local indicator lamp L1 through the parallel-connected relay coils CR1 and CR2 to the voltage source 16. The lamp L1 then lights to indicate the failure of its associated string of diodes.

When one of the diodes D4, D5 or D6 fails, the increased current through the main and trigger fuses F2 and TF2 respectively, causes these fuses to blow. The switch S6 is released by the trigger fuse TF2, and is urged by the spring 31 against the contact 32, connecting the local indicator lamp L3 through the relay coils CR1 and CR2 to the voltage source 16. The lamp L3 then lights to indicate the failure of its associated string of diodes.

When one of the diodes D7, D8 or D9 fails, the increased current through the main and trigger fuses F3 and TF3 respectively, causes these fuses to blow. The switch S7 is then released by the trigger fuse TF3, and is urged by the spring 33 against the contact 32, connecting the local indicator lamp L4 through the control relays CR1 and CR2 to the voltage source 16. The lamp L4 then lights to indicate the failure of its associated string of diodes.

When the first of the trigger fuses TF1, TF2 or TF3 blows, the current flow through the control relay coil CR1 is sufficient to energize the latter, causing it to pull up its switch S4 against the contacts 25 and 26, connecting the remote indicator lamp L2 to the voltage source 16. The lamp L2 then lights, indicating that one of the three strings of diodes has failed. The control relay CR2 would not operate at this time due to having the resistor R5 in series with it.

When a second trigger fuse blows, the current through the control relay coil CR2 is sufficient to energize the latter, causing it to pull up its switch S5 against the contacts 27 and 28, connecting the circuit breaker CB to the voltage source 16. The circuit breaker CB then opens its switches S1 and S2, deenergizing the rectifier system. The operation of the circuit breaker is, of course, an indication that a second string of diodes has failed.

Thus, the local lamps L1, L3 and L4 indicate which of the three strings of diodes has failed. The remote lamp L2 indicates when any one string of diodes has failed. The operation of the circuit breaker indicates that a second string of diodes has failed, by deenergizing the rectifier system.

The circuit breaker coil CB could be replaced by another remote indicator lamp to indicate that two strings of diodes have failed. Such additional lamp if used, and the remote lamp L2 could be replaced by sections of an annunciator.

Each string of series-connected diodes could be replaced by a single diode, in which case, the lamps L1, L3 and L4 would indicate which diode has failed.

FIG. 2 is an embodiment of this invention similar to

FIG. 1 except that the two control relays CR1 and CR2 of FIG. 1 are replaced by remote indicator lamps. In FIG. 2, the lamp L2 which indicates when a first string of diodes has failed, is connected as is the relay coil CR1 in FIG. 1, to the busses 17 and 18. An additional remote indicator lamp L5, used to indicate that a second string of diodes has failed, is connected to the bus 17, and through the series-connected resistor R12 to the bus 18. The remainder of the components of FIG. 2 are identical with those given the same reference characters in FIG. 1, and operate in the same manner as in FIG. 1.

In the circuit of FIG. 2, when one of the three strings of diodes fails, its local indicator lamp L1, L3 or L4 is lighted as in FIG. 1 except that the current drawn by such lamp flows through the remote lamps L2 and L5 instead of through the control relay coils CR1 and CR2. The current flow through the lamp L2 is sufficient to light the latter to indicate that a first string of diodes has failed. The current flow through the lamp L5 is insufficient to light the latter at this time due to the series connected resistor R12. When a second string of diodes fails, the current flow through the remote lamp L5 is sufficient to light the latter to indicate that a second string of diodes has failed.

The lamps L2 and L5 of FIG. 2 could be replaced by two sections of an annunciator.

The resistor R5 should be considered a part of the relay CR2 for the winding of the relay could be made to include the resistance of the resistor. Likewise, the resistor R12 should be considered a part of the lamp L5 for the filament of this lamp could be made to include the resistance of the resistor R12. Thus, the relays CR1 and CR2 are to be considered as connected in parallel even though there is a resistor R5 in series with the relay CR2. Likewise, the lamps L2 and L5 of FIG. 2 should be considered as connected in parallel even though there is a resistor R12 in series with the lamp L5.

What is claimed is:

1. A failure indicating circuit for a plurality of diodes connected in parallel circuit relationship between a supply bus and a load bus, said circuit comprising main fuses in series with said diodes, trigger fuses shunting said main fuses, said trigger fuses having switches which close when said trigger fuses blow, an auxiliary voltage source, a local failure indicator for each of said trigger fuses, a first remote failure indicator, a second remote failure indicator, means connecting said first and second indicators in parallel circuit relationship to said auxiliary voltage source, said second indicator requiring more current flow through it to operate it than said first indicator requires to operate, and means including each of said switches and said parallel-connected indicators for connecting a corresponding one of said local failure indicators to said auxiliary voltage source when a corresponding one of said trigger fuses blow.

2. A failure indicating circuit for a plurality of diodes connected in parallel circuit relationship between a supply bus and a load bus, said circuit comprising main fuses, trigger fuses shunting said main fuses, said trigger fuses having switches which close when said trigger fuses blow, an auxiliary voltage source, a local failure indicator lamp for each of said trigger fuses, a first control relay, a second control relay, means connecting said relays in parallel circuit relationship to said auxiliary voltage source, said second relay requiring a greater current to operate it than said first relay requires to operate, means including each of said switches and said parallel-connected relays for connecting a corresponding one of said lamps to said source when a corresponding one of said trigger fuses blow, means operated by said first relay when a first one of said trigger fuses blow for indicating that a first trigger fuse has blown, and means operated by said second relay when a second one of said trigger fuses blow for indicating that a second trigger fuse has blown.

3. A failure indicating circuit for a plurality of diodes connected in parallel circuit relationship between a supply bus and a load bus, said circuit comprising main fuses in series with said diodes, trigger fuses shunting said main fuses, said trigger fuses having switches which close when said trigger fuses blow, an auxiliary voltage source, a local failure indicator lamp for each of said trigger fuses, a first remote indicator lamp, a second remote indicator lamp, means connecting said first and second remote indicator lamps in parallel circuit relationship to said auxiliary voltage source, said second lamp requiring a larger current flow through it to light it than said first lamp requires to light, and means including each of said switches and said parallel connected lamps for connecting a corresponding one of said local lamps to said auxiliary voltage source when a corresponding one of said trigger fuses blow.

4. A failure indicating circuit for a plurality of diodes connected in parallel circuit relationship between a supply bus and a load bus, said circuit comprising a circuit breaker and main fuses in series with said diodes, trigger fuses shunting said main fuses, said trigger fuses having switches which close when said trigger fuses blow, said circuit breaker having an operating coil, an auxiliary voltage source, a local failure indicator lamp for each of said trigger fuses, parallel-connected first and second control relays, said second relay requiring a greater current flow through it to energize it than said first relay requires to operate, means including each of said switches and said parallel-connected relays for connecting a corresponding one of said lamps to said auxiliary voltage source when a corresponding one of said trigger fuses blow, a remote failure indicator, means including a switch of said first relay for connecting said indicator to said auxiliary voltage source when said first relay is energized, and means including a switch of said second relay for connecting said operating coil of said circuit breaker to said source for energizing said coil to open said circuit breaker when said second relay is energized.

5. A failure indicating circuit for a diode connected between a supply bus and a load bus; said circuit comprising a main fuse connected in series with said diode; a trigger fuse shunting said main fuse, a first pair of switch contacts which are closed when said trigger fuse blows; an auxiliary power source; a relay having a coil and a contact closing member; a local failure indicator for said trigger fuse; said first pair of switch contacts connecting said local failure indicator, said relay coil, and said auxiliary power source in series circuit relationship upon the blowing of said trigger fuse; a second circuit comprising said auxiliary power source; a second pair of switch contacts and a remote indicator; said second pair of contacts being closed by the contact closing member of said relay upon the failure of said trigger fuse to energize said remote indicator.

6. A failure indicating circuit for a diode connected between a supply bus and a load bus; said circuit comprising a main fuse connected in series with said diode; a trigger fuse shunting said main fuse; a first pair of switch contacts which are closed when said trigger fuse blows; an auxiliary power source; a relay having a coil and a contact closing member; said first pair of switch contacts connecting said relay coil, and said auxiliary power source in series circuit relationship upon the blowing of said trigger fuse; a second circuit comprising said auxiliary power source, a second pair of switch contacts and an indicator; said second pair of contacts being closed by the contact closing member of said relay upon the failure of said trigger fuse to energize said indicator.

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