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LIGHTING OR RADIATING SYSTEM

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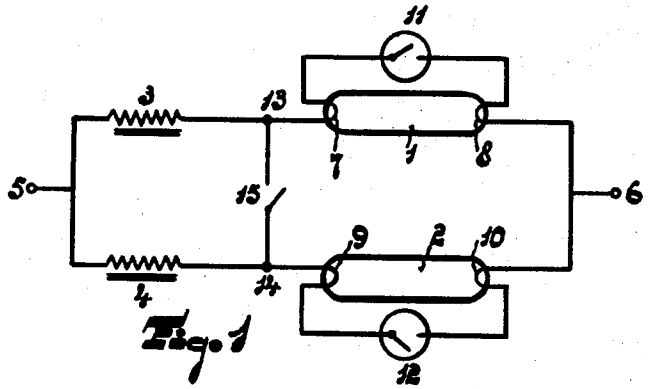


Fig. 1

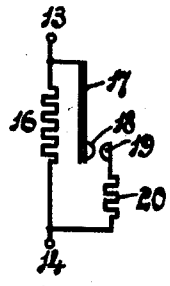


Fig. 2

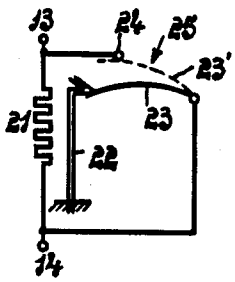


Fig. 3



Fig. 4

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LIGHTING OR RADIATING SYSTEM

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8 Claims. (Cl. 315—258)

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The invention relates to lighting or radiating system comprising two parallel-connected current circuits, each comprising the series combination of a gas- and/or vapor discharge tube and its series impedance, the series-connected elements of the two current circuits having substantially equal complex impedances and being arranged in the same order.

When one of the tubes becomes defective, so that it fails to ignite, or when it extinguishes during operation, various disadvantages are involved. In the first place the quantity of emitted light or radiation diminishes. If the tubes are provided with automatic ignition switches, the switch of the defective tube becomes operative and results in an overload of the current circuit of the defective tube and of the ignition switch. Moreover, radio reception in the neighborhood of the system is disturbed and troublesome flashes of light may occur in the defective tube.

The object of the invention is to mitigate these disadvantages.

According to the invention, provision is made of means which connect the series impedances in parallel with one another, when one of the tubes breaks down. These means are furthermore adapted to connect also the tubes in parallel with one another.

The means preferably establish a connection between the ends of the tubes facing the series impedances, the impedance of this connection being many times smaller than that of the series impedances.

The means are preferably constituted by a relay energized with time-lag and controlled by the voltage between the said ends of the tubes.

For this purpose a thermally controlled relay is particularly suitable, the relay being closed by a resistor connected in parallel with the contacts of the relay, the ends of the resistor being connected to the said ends of the tubes, the resistance of which is many times higher than the operation impedance of a single tube.

In this case this relay may be provided with a heating element connected in series with the contacts, and proportioned and arranged so that the closed relay remains closed until the system is switched off. Since this heating element constitutes the said connection between the tubes, its impedance is to be many times lower than the value of the series impedances as stated above.

According to another construction of the thermally controlled relay, the heat-sensitive element of the relay is provided with a lock-shaped member, under which, in the cold state of the heat-sensitive element, is adapted to be held a resilient member, which constitutes the movable contact of the relay and which is released by the parallel resistor, when the heat-sensitive element is heated, upon which it engages the fixed contact of the relay. In this solution the energized relay remains closed, even in the idle state of the system. In order to reopen the relay, the resilient member must be introduced under the lock of the heat-sensitive element; this may be effected by means of an incorporated push-button, which may at the same time serve as an indicator, since the length by which the push-button protrudes from a casing enveloping the relay indicates whether the relay has become operative or has not.

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As an alternative, the relay may be constituted by a resistor having a negative temperature coefficient, constituting the said connection in the heated state, the impedance of this resistor being, in the cold state, many times higher than that of the series impedances.

In order that the invention may be readily carried into effect, a number of examples will now be described in detail with reference to the accompanying drawings.

Fig. 1 of the accompanying drawings shows a system comprising two discharge tubes, for example, low-pressure mercury-vapor discharge tubes 1 and 2, which are each connected in series with a series impedance 3 and 4 respectively to the connecting terminals 5 and 6 of the system. The tubes may comprise heating electrodes 7, 8 and 9, 10 respectively, of which the ends remote from the connecting terminals 5 and 6 are each interconnected by an automatic ignition switch, for example a glow discharge switch 11 and 12 respectively, the ignition voltage of which lies between the supply voltage of the system and the burning voltage of the associated tube. When the connecting terminals 5 and 6 are connected to the terminals of a suitable voltage source, the tubes are started in known manner.

When one of the tubes is defective, it will not start or when the tube becomes defective, during the operation, it will extinguish. In both cases only one of the tubes will burn, so that a smaller quantity of light or radiation is produced than in the normal state of the system. Furthermore, in the case under consideration, in which the tubes are provided with automatic ignition switches, the ignition switch of the defective tube will continue operating or become operative, which has a harmful and troublesome effect.

Points 13 and 14 of the current circuits are

interconnected, when one of the tubes becomes defective. This possibility of connection is shown diagrammatically by a switch 15. This switch being closed, the series impedances 3 and 4 are parallel to one another and together in series with the burning tube, which will thus produce a greater quantity of light or radiation. By closing the switch 15, the tubes 1 and 2 are, moreover, connected in parallel with one another, which results in that the burning voltage of the non-defective tube 1 for example, is applied to the defective tube 2, so that the ignition switch 12 ceases operating.

Figs. 2 to 4 of the drawings show three embodiments of the electric connection between points 13 and 14, in which use is made of the voltage difference occurring between the said points when one of the tubes becomes defective.

Referring to Fig. 2, reference numeral 16 designates a resistance element of, for example, 50,000 ohms, which is connected to points 13 and 14 and which is arranged so near to a bi-metallic element 17 connected to point 13, that the current passing through the resistor 16, when one of the tubes is defective, causes the contact 18 of the bi-metallic element to engage the stationary contact 19 of the relay. Between the stationary contact 19 and point 14 is included a second heating element 20 of, for example, 3 ohms, which is arranged so near to the bi-metallic element 17 that the contacts 18 and 19 engaging one another remain engaged as long as the connecting terminals 5 and 6 of the systems are connected to the current source.

In the embodiment shown in Fig. 3, there is also provided between the points 13 and 14 a heating element 21, which may, in principle, be of the same value as the heating element 16 shown in Fig. 2. When current passes, the resistor 21 causes the lockshaped end of a bi-metallic element 22 to draw aside to the left, so that a resilient member 23 held under the lock and connected to point 14 is released. The member 23 thus takes up the position 23', indicated in broken lines, this member then engaging a stationary contact 24, which is connected to point 13. Between points 13 and 14 is thus formed a short circuit connection, which subsists until pressure is exerted on the resilient member 23' in the direction of the arrow 25, so that the movable end of this member is again inserted under the lock of the bi-metallic element 22, which has in the meantime cooled down.

In the embodiment shown in Fig. 4, points 13 and 14 are interconnected by a resistor 26, having a strongly negative temperature coefficient. This resistor may be composed on the basis of semi-conductive metal oxides, for example iron oxide. The impedance of this resistor may at room temperature be, for example, 10,000 ohms. During normal operation, i. e. when both tubes are burning, there is substantially no potential difference between points 13 and 14, so that the resistor remains cold. When one of the tubes becomes defective, however, a material potential difference occurs between points 13 and 14, so that the resistor is heated and the resistance value drops down to, for example, 15 ohms. In this state the resistor constitutes a low impedance connection between points 13 and 14. Thus the series impedance of the defective tube is connected in series with the burning tube, so that a strong current passes through the resistor 26. The latter thus maintains its temperature until the system is put out of circuit.

It should be noted that, in the cases described above, the burning tube is loaded to a higher degree than in the normal condition. However, it has been found that, if the overload is not excessive, for example if it lasts for 24 hours, no harmful effects occur.

In a case in practice the system had been connected to a mains of 225 v., f=50 c./s. In this case the burning voltage of the tubes (40 W fluorescent tubes) amounted to about 105 v., the normal discharge current about 420 mA., the impedance of each tube about 240 ohms and the impedance of each of the series impedances 3 and 4, constituted by chokes, about 400 ohms.

What I claim is:

1. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube.

2. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, and means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means connected between the junctions of said impedances and said tubes responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube and to connect the tubes in parallel with one another.

3. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means to connect the impedance in series with one of said tubes in parallel with the impedance connected in series with said other tube including an impedance normally having a value relatively large compared to either of said complex impedances and having a value relatively low compared to either of said complex impedance upon occurrence of an inoperative condition in one of said tubes.

4. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube, said latter means for connecting the two impedances in series-parallel connection with the operative tube comprising a time delay relay responsive to a

voltage of given magnitude generated thereacross by the inoperative condition of said tube.

5. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means connected to one end of each tube which is in series with its respective impedance responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube, said means comprising a thermally responsive relay having normally open contacts and a resistor connected across the contacts of the relay, said resistor having a resistance value very much larger than the operative impedance of one of said tubes.

6. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means connected to one end of each tube which is in series with its respective impedance responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube, said means comprising a thermally responsive relay having normally open contacts, a heating element in series with said contacts and positioned to maintain said contacts in a closed position when the contacts are closed until the lamps are deenergized, and a resistor connected across the contacts of the relay, said resistor having a resistance which is very much larger than the operative impedance of one of said tubes.

7. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means connected to one end of each tube which is in series with its respective impedance responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube, said means comprising a thermally responsive relay having normally open contacts, a resistor connected across said contacts, said resistor having a resistance value very much larger than the operative impedance of one of said tubes, and means to lock said contacts in a closed position when the contacts are closed as a result of an inoperative condition of one of the tubes.

8. A circuit arrangement for energizing a pair of parallel operated electric discharge tubes comprising a pair of substantially equal complex impedances each connected in series with one of said tubes, means to connect said tubes in series with said impedances in parallel to a source of potential, said impedances being connected to the same side of said source of potential, and means responsive to an inoperative condition in one of said tubes to connect the impedance in series therewith in parallel with the impedance connected in series with said other tube, said latter means comprising a negative temperature coefficient resistance having a resistance value at the ambient temperature which is very much larger than the impedance value of each of said series impedances.

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