(No Model.)

R. M. HUNTER.

ELECTRIC LIGHTING

No. 448,782. Patented Mar. 24, 1891.

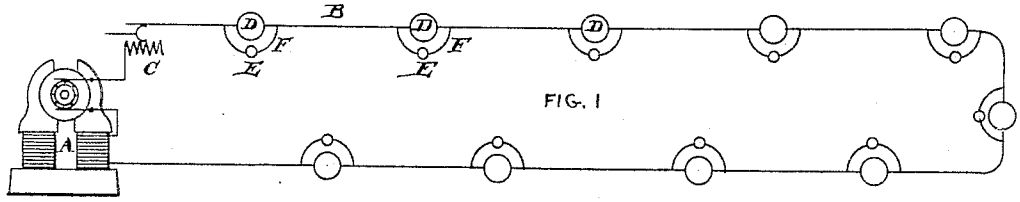

FIG. 1

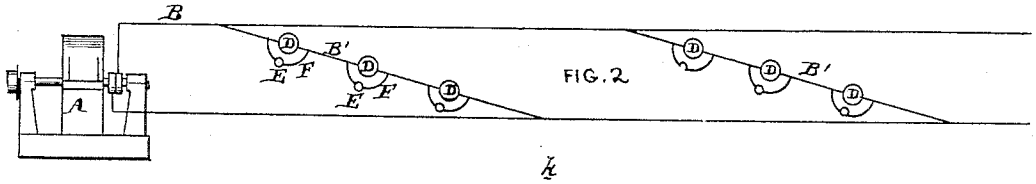

FIG. 2

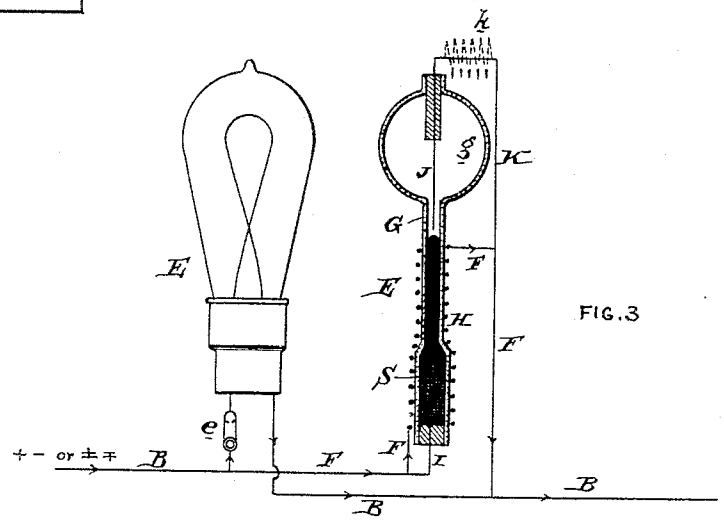

FIG. 3

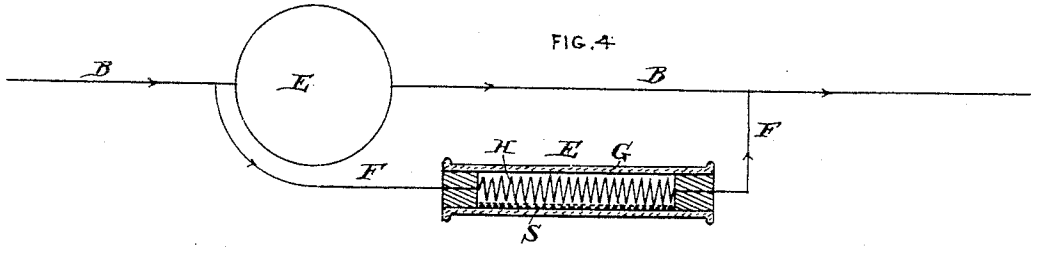

FIG. 4

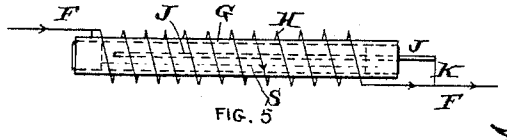

FIG. 5

Attest
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ELECTRIC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 448,782, dated March 24, 1891.

Application filed December 30, 1890. Serial No. 376,201. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia, and State of Pennsylvania, have invented an Improvement in Electric Lighting, of which the following is a specification.

My invention has reference to electric lighting; and it consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

This application (Case 186) comprehends an improved system of series lighting with the employment of continuous or alternating currents, and especially adapted to incandescent lamps.

In carrying out my invention I arrange the lamps in series or in series multiple, so that the current passing through one lamp traverses the next. Around each lamp I place a shunt containing an automatic resistance-changer which shall reduce the resistance in the shunt whenever the corresponding lamp shall be cut out of circuit by breakage of the lamp or otherwise.

In the employment of incandescent lamps in series lighting considerable difficulty has been experienced in insuring the proper supply of current to the line containing the other lamps upon any lamp giving out.

The object of my invention is to provide a method and means for maintaining the circuit in proper condition for the continued operation of the remaining lamps after the destruction of one or more lamps of the series. The current in the line is greater than that required in any one lamp in the series, and part of this current I shunt about each lamp, the resistance of the shunt being so proportioned that all of the current necessary for the lamp will pass through it. In addition to this last-mentioned resistance I provide an auxiliary resistance-reducer which shall still further reduce the resistance to the line-current upon the rupture of the lamp-filament or other cutting of the lamp out of circuit. This auxiliary resistance is cut out or reduced by the action of the heat produced by the heavy duty upon the shunt when the lamp is cut out. When the shunt is unduly heated by too great a flow of current, an expansible or vaporizable conducting substance like mercury is caused to either expand or vaporize, and thus reduce the resistance in the shunt about the lamps.

Several ways of accomplishing the reduction of the shunt-resistance embodying my invention are fully set out hereinafter.

Referring to the drawings, Figure 1 is a diagram showing a continuous-current dynamo and line-circuit with lamps in series. Fig. 2 is a similar view showing an alternating-current generator and the lamps in series multiple. Fig. 3 is a side elevation, with part in section, of the circuits and shunting devices for each lamp. Fig. 4 is a cross-section of a modified form of resistance-reducer for the shunt-circuit, and Fig. 5 is an elevation of still another modification of the resistance-reducer.

A is the electric generator, which may be a continuous-current machine, as shown in Fig. 1, or an alternate-current machine, as shown in Fig. 2.

B is the line-circuit and contains the lamps D in series. This circuit is also provided, if desired, with a regulator C. The lamps may be in simple series, as shown in Fig. 1, or in series multiple, as shown in Fig. 2. The lamp-circuit B in Fig. 1 and B′ in Fig. 2 is provided with a shunt-circuit F to each lamp, so that part of the current passes through the lamp and part through the shunt-circuit, which acts as a by-pass to the current in the line-circuit. The shunt-circuit is provided with an automatic resistance-reducer device E for reducing the resistance to flow of current about the lamp in case the lamp is out of order, broken, or cut out by a switch *e*. The resistance-reducer may be made in a variety of ways, but in all cases depends upon the expansion of a conducting medium, be that expansion manifested in only a change of volume of the substance or a change in form by vaporization.

Referring to Fig. 3, G is a vessel of iron or glass and contains mercury or other conducting substance S capable of expansion by application of heat. Surrounding this vessel is a coil H in the shunt F. The shunt connects with the mercury S by a conductor I or in any other suitable way. A conductor J, in-

sulated from vessel G, extends down from the top close to the normal level of the mercury and connects by a conductor K directly or through a resistance *k* with the shunt F, as shown.

When the lamp E is burning, the current divides, part passing through the lamp and part through the shunt F. If the lamp is broken or cut out, the whole current passes over the shunt F and heats the mercury S, causing it to rise in the vessel and make a contact with the conductor J, reducing the resistance to the line-current. The enlarged top *g* of the vessel G is to allow the mercury to expand without abnormally rising when expanding. If the vessel G is of glass, the wire coil H need not be insulated; but if of iron then there should be an insulation either of the vessel or of the coil.

In the construction shown in Fig. 4 the shunt F is provided with a coil H, which is inclosed and insulated from a glass or iron cylinder G. The vessel is horizontal and contains mercury or other conducting substance capable of conducting electricity. If an abnormal current passes over the coil H it heats it, and this vaporizes the mercury and instantly reduces the resistance produced by the coil. If iron is employed in the vessel G, then the vessel itself will be heated and vaporize the mercury, the vapors thereof surrounding the coils H and offering a path of less resistance. Normally the mercury or vaporizable substance S does not touch the coil.

In place of the devices shown in the above figures that shown in Fig. 5 might be used. In this case a tube or vessel G of iron incloses a conductor J, which is bare, but insulated from the tube G. The shunt F encircles the tube, as in the case of Fig. 3, and heats it. The conductor J is connected with the distant end of the shunt, and the other end of the shunt is electrically connected with the iron tube G. When the tube is heated by the excess of current flowing through the coil H, the mercury or other conducting substance is vaporized within the tube and forms a conducting-path from the tube to the conductor J, reducing the normal resistance of the shunt-circuit to compensate for the increase of the resistance put on the line by the destruction of the lamp. The mercury-level under normal conditions is indicated by the dotted line S. Fig. 5 is practically the device E shown in Fig. 3 turned on its side.

I do not limit myself to the minor details of construction, as they may be modified in various ways without departing from the principles of my invention.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination of a line-circuit, an electric lamp connected therein in series, a shunt-circuit in the line-circuit about said electric lamp, a heating-coil arranged in said shunt-circuit, a receptacle having fixed terminals connecting with the line-circuit, and an expansible fluid-conducting substance in said receptacle adapted to be expanded upon an excessive current passing through the heating-coil for the purpose of reducing the resistance to the passage of current in the line in case the lamp should burn out.

2. The combination of a line-circuit, an electric lamp arranged in series connection therewith, a shunt-circuit around the lamp and connecting with the line-circuit and including a heating-resistance, a receptacle inclosing said resistance, and an expansible substance within the receptacle adapted to be heated upon an excessive current being passed through the resistance by breakage of the lamp.

3. The combination of a line-circuit, an electric lamp in series therein, a shunt-circuit around the lamp, whereby the line-current is divided and part passed through the lamp and part through the shunt-circuit, a resistance in the shunt-circuit, a closed vessel having two fixed terminals connecting with the line on opposite sides of the resistance, and an expansible fluid-conducting substance in the receptacle adapted to reduce the resistance between the two terminals upon the resistance in the shunt-circuit upon becoming abnormally heated upon breakage of the lamp.

In testimony of which invention I have hereunto set my hand.

R. M. HUNTER.

Witnesses:

ERNEST HOWARD HUNTER,

S. T. YERKES.