F. W. LYLE.

SYSTEM OF DISTRIBUTION.

APPLICATION FILED SEPT. 18, 1912.

1,094,732.

Patented Apr. 28, 1914.

Fig. 1.

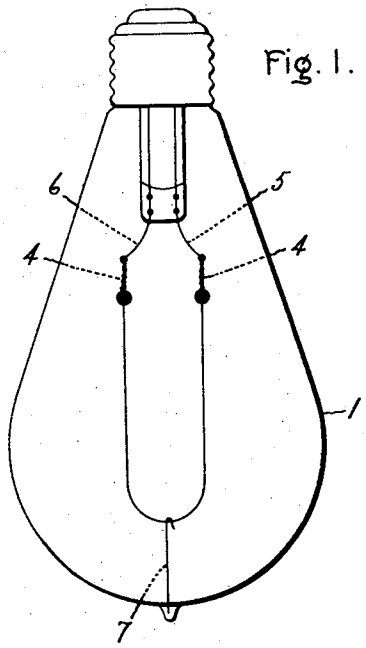


Fig. 2.



Fig. 3.

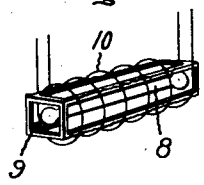


Fig. 4.

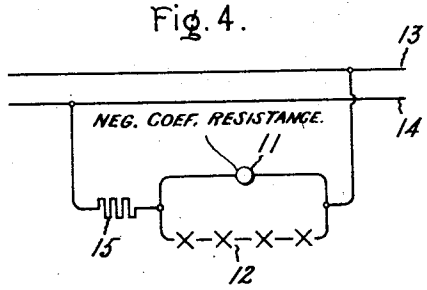


Fig. 5.

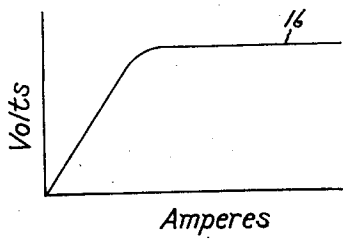
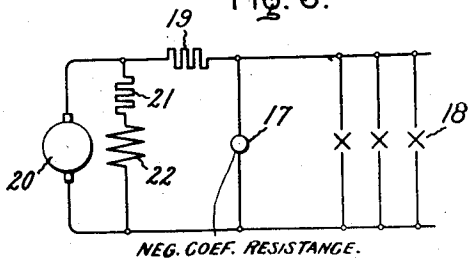


Fig. 6.



Witnesses:

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His Attorney.

UNITED STATES PATENT OFFICE.

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SYSTEM OF DISTRIBUTION.

1,094,732. Specification of Letters Patent. Patented Apr. 28, 1914.

Application filed September 18, 1912. Serial No. 720,997.

To all whom it may concern:

Be it known that I, FRED W. LYLE, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Systems of Distribution, of which the following is a specification.

The present invention relates to the regulation of electrical circuits and it is particularly directed to the maintenance of substantially constant voltage on a load supplied with current from a variable voltage source, such as the incandescent lamps in electrical railways, automobiles or the like.

In accordance with my invention, the terminals at which the voltage is to be maintained steady, are connected across a regulator containing a solid resistor which has a substantially constant voltage drop over a varying range of current, and which is connected to the source of current in series with a resistance having a positive temperature coefficient.

In the accompanying drawings, Figures 1 and 2 illustrate one form of regulator, Fig. 3 an alternative form; Figs. 4 and 6 are diagrams of connections; and Fig. 5 is a curve showing the volt-ampere characteristic of the regulator.

The incandescent lamps of street cars and electric railways are conveniently supplied with energy from the power line, and hence are subjected to severe voltage fluctuation particularly during the starting and stopping of the car, with a consequent dimming of the light. Some means of voltage regulations for the lamps, therefore, is important. A suitable regulator must operate rapidly, should be simple, inexpensive and rugged enough to withstand the vibration and rough usage encountered in this class of service. It should also be suitable for the moderately high voltages at which railways are operated. These conditions are well filled by connecting across the lamps a solid resistor having a negative temperature resistance coefficient of such value that the voltage drop across its terminals is substantially constant over the working range of applied voltage. In other words, I employ a resistor which upon increase of current decreases in resistance in such proportion that the product of current and resistance remains substantially constant.

In the preferred form of my invention, the resistor comprises a material such as boron having a marked negative characteristic which is electrically connected in parallel with a heater having a relatively high conductivity and a slight temperature coefficient. The heater is in good heat conductivity relation with the negative resistance material, and is so proportioned as to give substantially constant voltage over a considerable range of current. An incipient or momentary increase of voltage, raises the temperature of the heater which in turn lowers the resistance of the negative resistor and thus maintains the voltage drop constant.

As illustrated in Figs. 1 and 2 and as more fully described in my copending application, Serial No. 720,998, filed concurrently herewith, I construct the resistor used in the preferred form of my invention by depositing upon a thin filament of carbon, tungsten, tantalum or other suitable refractory material, a substance such as boron, or silicon, having a marked negative temperature resistance coefficient. Boron may be deposited by heating of the filament in contact with a mixture of boric chlorid and hydrogen as described in Patent No. 1,019,569 to E. Weintraub.

The structure of the resistor is illustrated by Fig. 2. The thickness of the coating or shell 2, as compared with the core 3, is determined by the characteristic desired in the regulator. For example, for a regulator connected across a source varying in voltage from 200 to 300 volts, a carbon filament 1½ mils. in diameter and 6″ long is coated with boron so that the finished filament is about 10 mils. in diameter. Such filament has a very low heat capacity and will respond to changes of current very quickly. The filament is preferably mounted in a sealed container 1 containing hydrogen. As illustrated in the figure, the resistor is preferably connected to leading-in wires 5, 6 by means of fine stranded copper conductors 4. The holder 7 prevents the excessive swinging of the resistor. In some cases the container may be evacuated but the presence of a gas such as hydrogen having a high heat conductivity is desirable to increase the energy dissipation. The filament is preferably connected to the conductors 4 by

means of a paste consisting of about 70 parts boron and 10 parts of tungsten mixed with an agglutinant, such as pitch.

The resistor as here described consists of two components, the core 3 acting as a heater and carrying most of the current at lower voltages and the outer boron conductor carrying an increasing current at higher voltage when the temperature is raised. By properly proportioning these components the filament can be made to maintain a constant voltage drop over a considerable range of current.

In case the regulator has a slightly drooping characteristic a small amount of compensating positive temperature coefficient resistance may be used directly in series with it, to give it the desired characteristic.

In some cases, the resistor may be provided with a separate heater as shown in Fig. 3. In this case, a resistor 8 is conveniently mounted within a frame 9 of inert refractory material, such as silica, upon which is wound a heater wire 10 which is electrically connected in parallel with the resistor. In this case, the resistor 8 may consist of boron, silicon, magnetite or other negative temperature resistance material. Electrical connection may be made as above described or by welding to tungsten terminals.

As shown in Fig. 4, the regulator 11 is connected in parallel with a lamp load 12 across the supply conductors 13, 14. In series with both the regulator and the load is a resistance 15 having a marked positive temperature resistance coefficient. This resistance consists, for example, of tantalum or tungsten wire operating in hydrogen. As illustrated by the volt-ampere curve 16 and shown in Fig. 5, the resistor 11 maintains a constant voltage across its terminals with a wide range of current fluctuation. As the regulator and the lamps consume a constant voltage, the excess of voltage is consumed by the resistor 15, and as the line voltage varies this excess voltage varies with it. The current through the regulator 11 varies sufficiently to produce this voltage variation in 15 but the voltage across 11 and the lamps in multiple with it remains always constant.

In some cases it may also be desirable to place a positive temperature coefficient resistance in the field circuit of a generator, as well as placing it in series with the regulator and load, such an arrangement is shown in Fig. 6, in which the regulator 17 and load 18 have a series resistance 19 as above described and the generator 20 has a ballast or other suitable positive temperature coefficient resistance 21 in series with its shunt field winding 22.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination of conductors carrying a variable current, a solid resistor of filamentary cross-section connected across said conductors, said resistor having a substantially constant voltage drop between predetermined working limits of current, a load in parallel with said resistor, and a resistance having a marked positive temperature resistance coefficient in series with the resistor and load.

2. The combination of a current consuming device, a regulator connected in shunt to said device, said regulator comprising material having a negative temperature resistance coefficient and a heater having a small temperature resistance coefficient electrically in parallel therewith and in intimate heat conveying relation thereto, the elements of said regulator being proportioned to secure a substantially constant voltage drop over the working range of current and a resistance having a high positive temperature resistance coefficient in series with said regulator.

3. The combination of a source of current subject to voltage variation, a load connected thereto, a resistor containing boron having a substantially constant voltage drop over the working range of current, connected in shunt to said load, and a resistance having a high positive temperature resistance coefficient in series with said load and resistor.

4. In a system having a variable line voltage, the combination of a resistance unit having a negative temperature resistance coefficient, a heater electrically in shunt therewith, said resistance and heater being proportioned to give an essentially constant voltage drop over a wide range of current, and a resistance in series with said regulator proportioned to absorb the differences between line voltage and regulator voltage.

In witness whereof, I have hereunto set my hand this 12th day of September 1912.

FRED W. LYLE.

Witnesses:

JOHN A. McMANUS, Jr.,

FRANK H. JOHNSON.