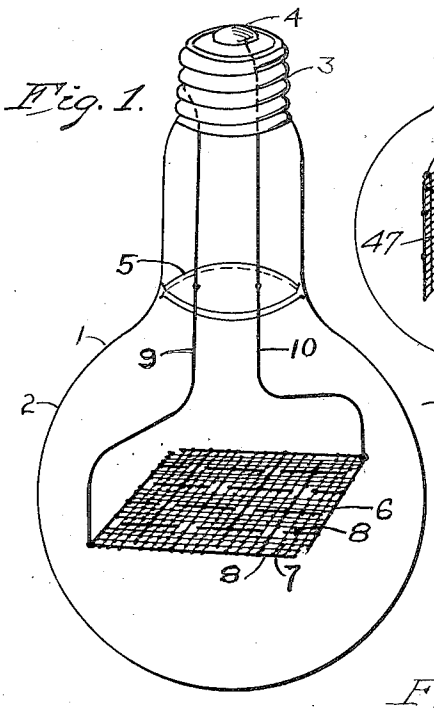
Feb. 18, 1936. J. H. SMITH 2,031,182

INCANDESCENT LAMP

Filed May 2, 1931

Fig. 1.



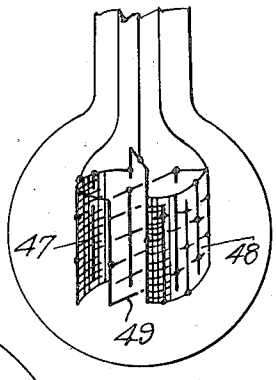


Fig. 7.

Fig. 3.

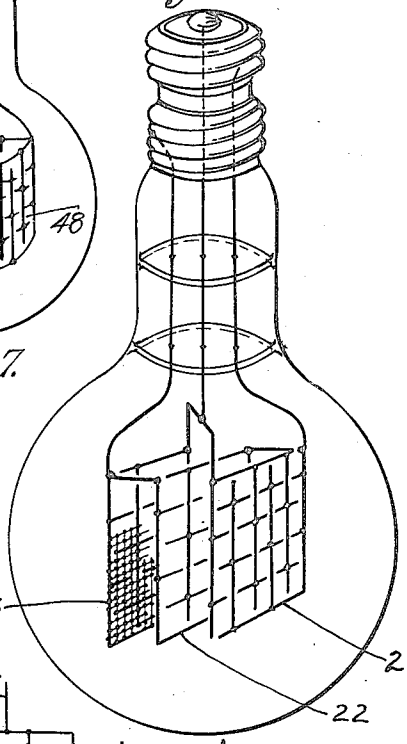


Fig. 6.

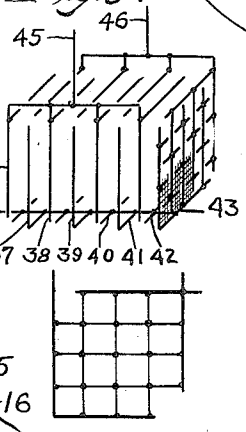


Fig. 5.

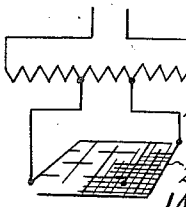


Fig. 4.

Fig. 2.

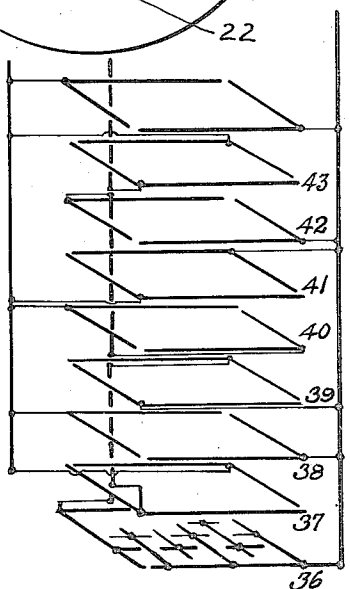


Fig. 8.

INVENTOR

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2,031,182

INCANDESCENT LAMP

John Hays Smith, Camp Hill, Pa.

Application May 2, 1931, Serial No. 534,488

23 Claims. (Cl. 176—40)

My invention relates to incandescent lamps and more particularly to the construction, support and electrical connections for lamp filaments. In my Patent 1,771,273, July 22, 1930, I have described and claimed an electrical heating device comprising a network of interconnected resistors and current supplying conductors of better current conducting properties than the resistors. Certain of the fundamental principles of the heating network described in that patent are applicable to incandescent lamps, as hereinafter more specifically pointed out.

In the construction of incandescent lamps a straight or curved conductor having incandescent characteristics is supported in a transparent globe which is often filled with an inert gas. Such lamps usually operate on 100–120 volt systems. As substantially the entire voltage drop of the system is dissipated in heating such a filament to incandescence, very careful and close workmanship is required to insure the proper length of conductor. Great care is also required in soldering the filament to the supply conductors. Such incandescent lamps become useless when the single filament is broken. For lamps of large rating it is difficult to get a single elemental resistor of sufficient capacity to develop the required candle power without making the lamp of excessive size.

I propose an incandescent lamp in which one or more network filaments is or are employed. Each network filament comprises a network of resistors and current supplying conductors. The lengths of the current paths through the resistors between the current supplying conductors are designed so that a plurality of current paths of substantially the same impedance are available.

In the claim structure appears also the phrase "designed network." This phrase has no reference in this application to the statutory patentability of designs, trade-marks, etc.

The phrase, "designed network", is a technical one analogous to the phrase in line 34 "conductors are designed", or to a designed circuit and has the same meaning. Both phrases mean that the circuits or the member circuits of a network have electrical characteristics predetermined by calculation which considers the position of junction points, the path between said junction points, resistivity, dimensions and physical characteristics of the material to be employed in interconnecting said junction points, the calculation to be made according to the well known electrical laws governing current flow in electrical circuits.

By providing a plurality of paths it is possible to multiply the number of paths in a single or in several networks to produce candle powers as high as 50,000 candle power without encountering the difficulties heretofore attendant upon attempts to utilize a single filament for such a lamp. With a network filament the break down of any one current path does not render the lamp useless as when the single filament in common use is ruptured.

A plurality of networks may be connected in parallel or by a polyphase connection. The network filaments are preferably supported by the electrical conductors supplying energy thereto. This construction produces a new flexibility to such incandescent lamps, as a three wire 220/110 volt circuit is capable of supplying a lamp of three network filaments; a three wire three phase circuit can supply a lamp of three network filaments. These features of application give my lamp a wide range of brightness.

The broad concept of this novel invention is the use of incandescible electrical networks as filaments for an incandescent lamp, and the combination of such primary networks with branching tree-conductor systems so intermeshed with the primary incandescible networks as to form compound incandescible networks of larger extent. Likewise compound incandescible network systems may be designed with conductive and resistive members for parallel or series connection on a monophase system or the several compound incandescible networks may in similar manner be assembled on different phases of a polyphase lamp. One unique application occurs in designing a lamp for a three-wire circuit, either single phase or of the direct-current type, as illustrated in the drawing. Lamps of Figures 2 and 3 are mere detailed species of the broader invention of Figure 1, rather than independent and separate inventions.

In the application of network filaments to form a lamp of high candle power, it is necessary to divide and further divide, by branching and further sub-branching of the conductor systems to bring a uniform luminosity to each elemental resistive unit of an incandescible network.

Beginning with the smallest group of resistors that receives the full impressed lamp voltage or some fractional part of it, is the filament element. By a spatial assembly of filament elements into rows and columns there is created a network filament made operable by conducting frameworks severally united at selected junction points of the resistor assembly. Such construction, forms by assembly of filament elements, a wider network of a compound type.

If there be joined into the resistive network, frameworks of conductive systems, there is formed a wider network which, in relation to the primary resistive network, may be properly defined as a compound network.

The filament element is a group of incandescible wires or resistors and functions as a unit, each such unit functioning like every other filament element. The compound electrical network may, therefore, be viewed as an ordered assembly of filament elements brought to incandescence by the cooperating frameworks of conductors.

As the primary network is extended, the conductor framework is further branched, thus dividing the initial current input to the lamp.

In Figure 4 is shown the combination of a compound incandescible network with a transformer winding for producing the large amperage, to be divided and subdivided down to the quantity required to bring the elemental resistive unit to incandescence.

The combination of the two (2) elements in one structure, shows in Figure 4 the old element a transformer winding, and the new element the compound incandescible network. In one lamp they produce a result not hitherto attained in the art of electrical illumination.

The accompanying drawing illustrates several present preferred embodiments of the invention, in which

Figure 1 illustrates an incandescent lamp having a single network filament;

Fig. 2 illustrates a lamp having three networks transverse to the major axis of the lamp connected in a polyphase circuit;

Fig. 3 illustrates a lamp having three networks parallel to the major axis of the lamp connected in a polyphase circuit;

Fig. 4 is a diagrammatic view of one of the network filaments and its connection to an auto-transformer;

Fig. 5 is an enlarged view of the resistors in a unit of the network;

Fig. 6 is a view of a lamp having a plurality of network filaments in parallel circuit.

Fig. 7 is a view of a lamp having incandescible network filaments curved to control the intensity of light radiated from an incandescible sheet composed of filament elements.

Fig. 8 is a diagrammatic sketch showing an assembly of network filaments in parallel arrangement for a type of three-wire polyphase lamp.

Referring to Fig. 1, an incandescent lamp **1** is provided with a globe **2** of quartz glass or some other suitable transparent material, to the top of which there is attached a threaded ferrule **3** and a terminal button **4** of usual construction. A diaphragm **5** may be provided in the lamp for preventing heat and currents of gases from rising upwardly toward the end of the lamp. The filament element **6** of the lamp is constituted by a network of electrical resistors **7** which are spaced between conductors **8** of better current conducting characteristics. The conductors **8** of opposite polarity are spaced from each other so that a plurality of paths are provided between the different conductors of the network filament. The conductors **8** are branched in somewhat the manner of a tree to provide a substantially uniform voltage drop across all areas of the electrical network. The assemblage of filament element **6** is supported by conductors **9** and **10**. The conductor **9** is shown as connected to the ferrule **3** while the conductor **10** is connected to the terminal **4** in the usual manner.

The filament element **6** provides a large number of current paths each of which is maintained at incandescence. The rupture of any one path does not destroy the lamp as many other paths are available. The total available cross sectional area of resistors is very large, although the cross sectional area of any single resistor is maintained fairly small. The large number of current paths provided makes possible a lamp of large candle power rating without the necessity of carefully adjusting and connecting any large single resistor element, as is necessary in incandescent lamps now in common use.

The filament elements are united in one network filament obviously capable of large spatial extension into what is practically a luminous sheet.

Referring again to Fig. 2, I have illustrated a modified form of lamp in which three network filaments **11**, **12** and **13** are supported and connected in a polyphase circuit by conductors **14**, **15**, and **16**. The top of the lamp is provided with two threaded ferrules **17** and **18** which are spaced apart. A terminal button **19** is also provided. The conductor **14** is connected to the ferrule **17**, the conductor **15** to the terminal **19**, and the conductor **16** to the ferrule **18**, respectively. Each of the network filaments **11**, **12** and **13** is supported at diagonal corners so that it is held in a rigid position. In Fig. 3 I have illustrated the filament networks **21**, **22** and **23** supported in a position substantially parallel to the major axis of the lamp as compared with the transverse position had in Fig. 2. In Fig. 4, I have illustrated an application of a single network filament to a transformer lamp, **24** being the network filament cooperating with the transformer winding **25**.

Fig. 5 illustrates an enlarged resistor unit or filament element of the larger network designated as a filament network. This unit is the resistor which is confined between branch conductors **8** of opposite polarity. In Fig. 4 I have illustrated the manner of connecting a single network filament **24** to an auto-transformer **25** so that the voltage drop across the resistor may be reduced to as low as 10 volts per inch of resistor path as compared to a potential gradient of 50 to 100 volts per inch, such as is common in single filament lamps. My network does not require as close soldering adjustments as are required in single filament lamps.

In Fig. 6 I have shown a lamp in which network filaments **36**, **37**, **38**, **39**, **40**, **41**, **42**, **43**, eight in all, are connected in parallel circuit for a three-wire 220/110 volt circuit constituting a network lamp in which eight network filaments alternately (**36**, **38**, **40**, **42** and **37**, **39**, **41**, **43**) are grouped in multiple filament networks in parallel circuit from one outside leg **45** of the circuit across **44**, the neutral, to **46** the other outside leg. This arrangement constitutes a multiple three-wire lamp.

In a similar manner to Fig. 2, showing a polyphase network filament lamp, each phase may be paralleled by selecting from a group of nine network filaments as **36**, **37**, **38**, **39**, **40**, **41**, **42**, **43** and one other, every third network as **36**, **39**, **42**, for one phase, **37**, **40**, **43**, for the second phase, and **38**, **41**, and the last one of the group, for the third phase, each of the said groups having said three filament networks as **36**, **39**, **42** in parallel. These network filaments would be supported from the conductors supplying them as in Fig. 2. In Fig. 7 is shown a polyphase lamp in which two

incandescible sheets of network filaments 47 and 48 are curved in cylindrical form so as to present a substantially uniform horizontal distribution of light. Incandescible sheet 49 is in plate or plane form in the illustration. Obviously other curved forms may be employed to control the intensity of light distribution.

Referring to Figure 7, a curved network filament is shown at 47 and another at 48, both of them being outer network filaments in a three filament lamp in which the third element 49 remains planar. The purpose of curving filaments is to control the intensity of illumination in any direction from the assembly. It is patent that curvature may be placed in different directions and the network filament may be designed to lie in a warped surface.

While I have shown and described certain present preferred embodiments of my invention, it is to be understood that it may be otherwise embodied within the spirit of the invention and the scope of the appended claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. An incandescent lamp having for an incandescible body an "electrical network" of electrical conductors some of which have good current conducting characteristics and terminate within the network and some of which have resistive and incandescent characteristics and are arranged between the first named conductors so that they are supplied with electrical energy by group parrallel feeding to provide uniform voltage in the resistive part of said network for the uniform generation of light.

2. An incandescent lamp having for a luminous filament an "electrical network" of electrically interconnected conductors.

3. An incandescent lamp having a plurality of network filaments each of which comprises an "electrical network" of electrical conductors some of which have good current conducting characteristics and terminate within the "electrical network" and some of which have resistive and incandescent characteristics and are arranged between the first named conductors so that they are supplied with electrical energy by group parallel feeding to provide uniform voltage in the electrical resistive network for the uniform generation of light.

4. An incandescent lamp comprising a plurality of incandescible elements in the form of electrical resistive networks and electrical conductors for supporting said incandescible elements and conducting electrical energy thereto.

5. An incandescent lamp comprising a plurality of "electrical network" filaments, and branching electrical conductors for supporting said network filaments, said conductors being arranged in polyphase connection to said network filaments.

6. An incandescent lamp comprising a plurality of resistive filament elements in the form of electrical networks, and electrical conductors for supporting said filaments within the "electrical network", said conductors constituting a parallel connection for said filament elements.

7. An incandescent lamp comprising a globe of transparent material, a plurality of "electrical networks" therein constituting filaments, a plurality of conductors for supporting and supplying electrical energy to said "electrical networks", and a plurality of electrical terminals carried externally of said lamp and connected to said conductors whereby a polyphase current may be supplied to said "electrical networks."

8. An incandescent lamp having for filaments a plurality of "electrical networks" extending transversely to the major axis of said lamp.

9. An incandescent lamp having for a filament a plurality of "electrical networks" extending in substantial parallelism to the major axis of said lamp.

10. An incandescent lamp having for a filament a plurality of "electrical networks" extending in substantial parallelism to the major axis of said lamp, at least one of the outer networks being curved to control the intensity of light radiated therefrom.

11. An incandescent lamp having for an incandescible body an "electrical network" of bare electrical wires comprising a plurality of interconnected branching electrical conductors and supplemental light generating resistors joined thereto at a plurality of points internal of the "electrical network."

12. An incandescent lamp having for an incandescible body an "electrical network" of electrical conductors, said network comprising a plurality of electrical resistors each of which is in electrical circuit immediately with a plurality of other resistors and electrical conductors for feeding said resistors at a plurality of points internal of the "electrical network."

13. In an electrical polyphase network distribution system the combination with an "electrical network" to generate light of a light transmitting globe, enclosing said network.

14. An incandescent lamp, having an incandescible element having two branching couplings, one for current entry and one for current exit, said couplings having selected branches of the one come closely to selected branches of the other, said couplings contacting at their end points with an electrical network filament structure of light producing resistors interconnected electrically at said end points of the coupling, and at spaced points along the branching couplings so that full lamp voltage is impressed upon each resistor network filament.

15. An incandescent lamp having for its incandescible element an electrical network of conductors having main conductor and branching conductors which have good current conducting characteristics and terminate within the said network and of resistors having incandescent characteristics arranged between the first named conductors so that they are supplied with electrical energy by group parallel feeding from the main conductors to provide uniform voltage distribution in the network filament for the uniform generation of light.

16. An incandescent lamp having for its incandescible element a branching electrical network of conductors each member of which is in electrical contact at a plurality of internal points of its extent with one or more of the other conductors, some of said conductors serving primarily to transmit electrical energy and others serving primarily as resistors having incandescent properties, said resistors forming an electrical network in themselves.

17. A group of incandescible filaments made up of elemental units of resistors arranged in columns and rows and connected at a plurality of points into a space distribution to form a resistor network without the interposition of any conductor members, all resistors forming an electrical network in themselves within an incandescent

lamp, and a framework of branching conducting and supporting wires, which form a compound network by uniting with the resistor network, serving to carry at points intermediate the said networks, full impressed lamp voltage to each elemental resistor unit.

18. An incandescent lamp having for an incandescible body an electrical network comprising a plurality of electrical resistors each of which is in electrical circuit immediately with a plurality of other resistors and interlinked with said incandescible network a group of supply conductors each comprising a main trunk conductor, branch conductors and sub-branch conductors resembling the branching pattern of a tree, for completing a plurality of conducting paths through the incandescible network.

19. In an incandescent lamp, the combination of a group of incandescible filaments made up of element units of resistors arranged in columns and rows and connected at a plurality of points into a space distribution to form a resistor network without the interposition of any conductor members, all resistors forming an "electrical network" in themselves within an incandescent lamp, and of a framework of branching conducting and supporting wires, the combination forming a compound "electrical network" by uniting with the resistor network, and serving to carry at points intermediate the said networks, full impressed lamp voltage to each elemental resistor unit.

20. A three-wire system consisting of a lead-in and a second lead-in, with a neutral lead-in, and network filaments lying across from neutral to each outside leg of the circuits so completed through an incandescent lamp; said network filaments consisting of a group of such filaments in which alternate filaments are united at one terminal to one lead-in wire and the other filaments are united to the other lead-in wire by the like terminal, with all opposite terminals of the filaments connected to the neutral lead-in wire.

21. In an incandescent lamp, an "electrical network" having internal of the said network a plurality of sending points within the network and a plurality of other receiving points, the difference of potential between the sending points and the receiving points being substantially equal to the impressed electromotive force upon the lamp terminals.

22. A polyphase system consisting of phase lead-in wires with network filaments lying across phase wires, in parallel connection, to complete circuits through an incandescent lamp, said network filaments consisting of a group of such filaments in which selected filaments are united by one terminal to one phase wire with the other terminal united to a different phase wire, for all phase connections.

23. In an incandescent lamp, in combination a transparent bulb member having reentrant seal portions, refractory metal lead and support wires sealed therein, and a luminable network attached thereto comprising a network frame of conductors attached to said lead wires, and a network mesh of refractory metal incandescible members attached thereto.

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