

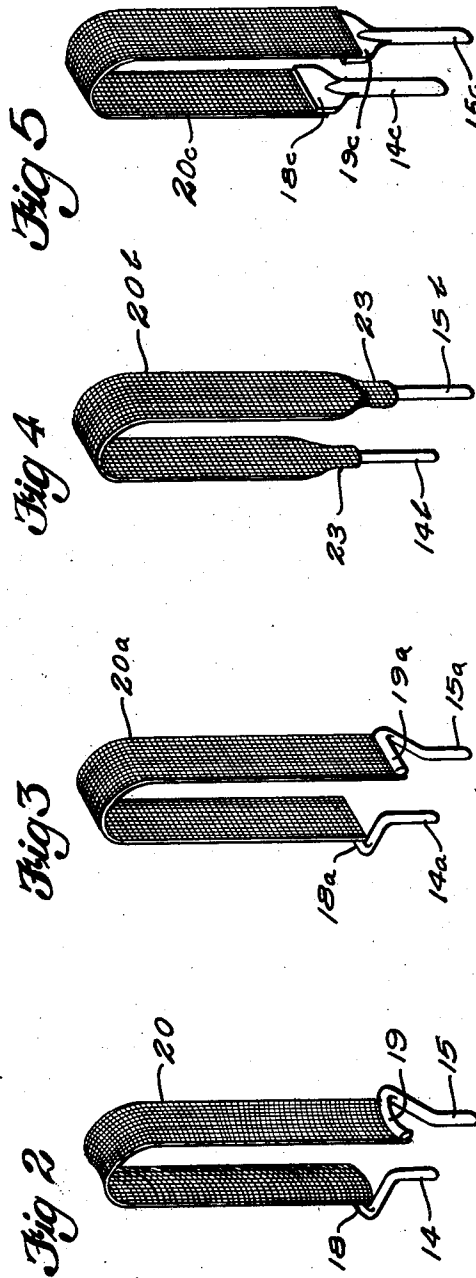
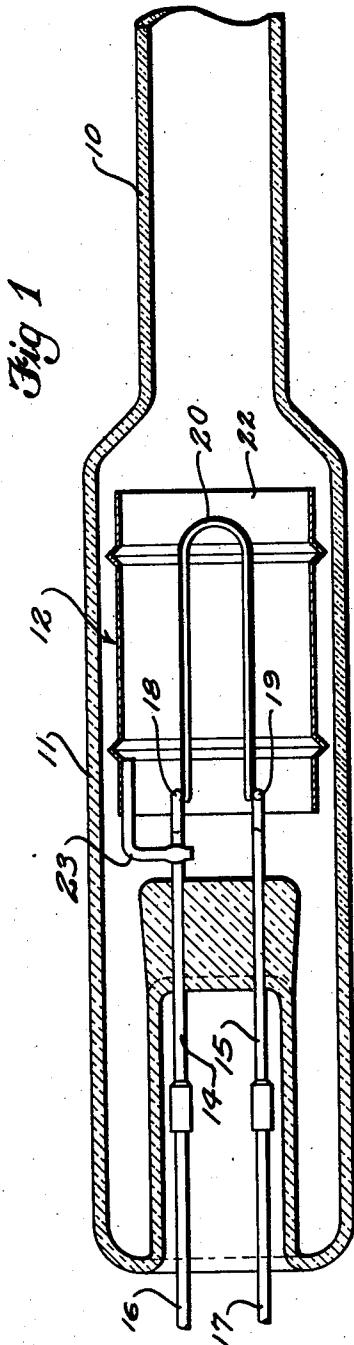
March 4, 1941.

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2,233,741

CATHODE ELECTRODE

Filed Nov. 21, 1938



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2,233,741

CATHODE ELECTRODE

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Application November 21, 1938, Serial No. 241,617

1 Claim. (Cl. 176—126)

This invention relates to improvements in electrodes for vacuum tubes, luminous arc tubes and the like, and it has reference more particularly to what are known in the art as "directly heated" cathode electrodes, which are especially designed for use in connection with vacuum tubes as employed in the radio field and in luminous tubes as now extensively used for signs, displays and illumination.

It is the principal object of this invention to provide a cathode electrode of the metallic-oxide coated type that is substantially instantaneous in starting, and which will have an exceedingly long period of life.

It is a further object of this invention to provide a cathode electrode, as stated above, that will be heated, directly, to a heat of maximum efficiency with the minimum consumption of electrical energy and in the minimum time, and which will operate satisfactorily by the automatic formation of a cathode spot when the heat supply of the cathode is cut off; this cathode spot having sufficient emission to prevent the destruction of the cathode by the impact of the ionic bombardment.

It is a still further object of this invention to provide a cathode electrode presenting the maximum surface to carry the metallic oxide thereon and to be heated thereby, thus yielding maximum electronic emission therefrom.

More specifically, it is the object of this invention to provide a cathode electrode, of the metallic-oxide coated type, wherein the oxide is carried on a fine wire screen which, for a given weight of material, has a maximum of surface. Furthermore, the invention resides in the use of a fine wire screen as a carrier of heating current, thereby resulting in a minimum heat consumption for maximum effectiveness in the heating of the oxide coating, thus creating maximum emission for minimum energy applied to the cathode.

It is a further object of this invention to provide an electrode of the above character on which a cathode spot will be formed from the arc current itself without necessarily requiring a separate heating service from the cathode.

Other objects of the invention reside in the details of construction, the combination of parts, and their mode of operation, as will hereinafter be fully described.

In accomplishing these objects, I have provided the improved details, the preferred forms of which are illustrated in the accompanying drawing, wherein—

Fig. 1 is a longitudinal sectional view through the end portion of a luminous arc tube, showing a cathode embodying the present invention as applied thereto.

Fig. 2 is a perspective view of the present cathode, particularly illustrating the manner in which it is formed and mounted.

Fig. 3 is a perspective view of the present cathode, particularly illustrating an alternate form of construction.

Fig. 4 is a perspective view of the present cathode particularly illustrating an alternate manner in which it may be mounted.

Fig. 5 is a perspective view of the present cathode, particularly illustrating still another manner in which it may be mounted.

Briefly described, the present invention resides in a cathode electrode, contained within the ends of a gaseous arc tube or vacuum tube, comprising a U-shaped strip of finely woven nickel wire mesh, mounted at its ends by electrical conductors that extend through the tube and are adapted to be connected to a source of electrical energy for the heating of the electrode and for the electrical arc discharge.

Explanatory to the present invention, it will here be stated that the electrode has been conceived and designed as an improvement upon the various forms of heated cathodes of the prior art now in general use and which may be grouped in three classes as follows:

Class 1.—The indirectly heated cathode, which consists of a tubular shell, usually made of thin nickel metal, within which is mounted a heating coil, usually of tungsten wire; the heating coil being insulated from the shell by a thin refractory tube. The nickel shell carries, on its outside surface, an oxide coating which emits electrons in great profusion when the oxide is brought to an orange red heat. In this class of cathode, the heating is accomplished indirectly by conduction and radiation from the tungsten heating coil, and from 10 to 60 seconds lapse upon closing the heating coil circuit, before the oxide coating glows at red heat. Therefore, in use of this electrode in a lamp or tube, a time delay relay or other thermostatic device is necessary to delay the closing of the arc circuit until full emission of the electrode is attained. Should the arc circuit and electrode heating circuit be closed at the same time, the ionized gas particles would impinge upon the initially cold electrode with such force as to peel off minute particles of the oxide layer, or coating, thus resulting in a substantially short period in the complete mechanical destruction of the cathode. However, if the electrode has reached full electron emission before the arc circuit is closed, the negative electrons will meet the positive ions at some distance from the electrode and the resulting neutralized ion loses its kinetic energy. Thus, the electrode will be protected by a cushion of electrons which will prevent such mechanical destruction.

The disadvantages of the indirectly heated cathode reside in the necessity of introducing into the electrical circuits, which provide for flow of current in a vacuum tube, or in a luminous arc tube, a time delay device. The costly maintenance and unreliability of these time delay devices, as well as the generally recognized undesirability of delayed action of the arc circuit after the switch is closed, have led to the use of the directly heated cathode.

Class 2.—Cathodes of the directly heated class usually consist of a thin nickel ribbon wound in a spiral form for maximum compactness. This ribbon, which is also covered with a metallic oxide, is directly heated by an electrical current and becomes red hot in less than ten seconds. Thus, the arc ions have considerable time for their destructive action on the oxide layer. However, cathodes of this class do not necessarily require use of a time delay relay device in connection therewith, but will suffer a small amount of destruction during every starting operation. Approximately one thousand starting operations for a directly heated ribbon cathode may be imposed upon it before it is completely destroyed. Therefore, the ribbon type, directly heated cathode may be considered to have a rather short life if used without time delay devices.

Class 3.—The tungsten-nickel electrode is the third type and most recently introduced upon the market. This electrode was designed primarily with the view of lengthening the life of the ribbon type electrode by greatly increasing the surface of the oxide layer for the same amount of heated nickel. This was accomplished by winding a very fine nickel wire, approximately 0.002" in diameter, upon a tungsten wire, leaving a space equal to the thickness of the nickel wire between adjacent turns. This tungsten wire with its nickel cover is then again coiled so as to bring the whole assembly into a compact grouping. Thus the nickel carrier for the oxide is again indirectly heated, but without the intervention of a refractory insulator. The tungsten carrier for the nickel forms the heating circuit and both metals reach incandescence a few seconds after the heating circuit is closed. The life of this electrode promises to be greater than that of the ribbon type, but the advantages of increased area of the oxide coating is offset by the increase in time required for full emission after the heating circuit is closed.

The electrode of the present invention is designed with the object in mind of overcoming the defects of the three classes or types of electrodes above described.

Referring more in detail to the drawing—

In Fig. 1 is illustrated one end of a sealed transparent glass tube, designated in its entirety by the reference numeral 10, which may be curved or angularly formed in different shapes, and within which is contained a suitable gas, such as neon, a mixture of rare gases, or metallic vapors. At the ends of this tube, of which only one end is herein illustrated, to simplify the drawing, there is provided the usual terminal enlargements 11 within which the electrodes, embodying the present invention, are located, designated in entirety by the reference numeral 12.

Within the ends of the tube are two sealed in rods 14 and 15, which extend into the tube to mount the electrode, and, externally of the tube, are connected to the lead wires 16 and 17, which are connected in the usual manner to a source of electrical current, not shown.

Mounted on the forward ends 18 and 19 of the rods 14 and 15, is the cathode strip, designated by the reference numeral 20, which is formed in a substantially U-shaped loop, disposed parallel to the arc path. A cylindrical reflecting shield 22 is mounted by a support 23 that is fixed to one of the sealed in rods, and this shield coaxially surrounds the cathode 20.

The cathode 20 comprises a metallic ribbon or mesh of closely woven fine nickel wire, forming a screen, and, in the present instance, comprises approximately 150 mesh per inch. It will be here stated that the smaller the wire used in this screen, the greater the mesh per inch will be, and the more efficient will be the operation of the electrode.

It will be noted that the ends of the cathode strip 20 are mounted upon the formed ends 18 and 19 of the sealed in conductor rods 14 and 15 by the entire end portion of the strip, so as to provide an even and equal flow of electrical current through all parts of the ribbon. Furthermore, as will be noted by reference to Figs. 1 and 2, these end portions 18 and 19 of rods 14 and 15, are curvedly formed, as is the entire ribbon 20, to give an increased rigidity to the strip 20.

It will be understood that in many uses or applications of the tube, it will not be subjected to any violent jarring or vibrating forces, and as an alternate form of construction, a cathode strip 20a may be mounted on the straight formed portions 18a and 19a of the rods 14a and 15a, as shown in Fig. 3. This will constitute an economy in the construction or manufacture of such electrodes, in that one forming operation will be eliminated.

As a further alternate form of construction, supports 14b and 15b may be coextensive and disposed in parallel relation, and the ends of a cathode strip 20b merely folded or wrapped around the ends thereof, as at 33, and fixed thereto, as illustrated in Fig. 4.

As a still further alternate form, the supports 14c and 15c may be forged to form flattened ends as at 18c and 19c, for the easy mounting of the cathode strip 20c as illustrated in Fig. 5.

It is to be understood, of course, that the cathode strips 20, 20a, 20b and 20c are coated or treated with the usual metallic oxide, in the usual manner. This metallic-oxide coating usually comprises a barium-strontium oxide, and the usual method of application is to apply a mixture of barium and strontium carbonate in a suitable carrier, to the cathode strip, and then heat it to a temperature whereby the barium and strontium carbonates are completely oxidized to their respective oxides, and the carrier driven off. Such an oxide coating emits electrons profusely when heated again to incandescence, as is well known.

Assuming the device to be so constructed, and also assuming that the tube electrodes are connected to a source of electrical current, in the usual manner, to heat the electrodes and to cause the electrodes to emit a luminous arc or discharge from one to the other, its operation would be as follows:

When the electrical circuit is closed, the cathode strip is heated instantly to a temperature of maximum efficiency, specifically to a temperature of incandescence, with a minimum consumption of electrical energy. This is due to the fact that each one of the small wires that comprise the electrode strip acts as a conductor for the electrical current, and because of its size, it is

heated by the passing therethrough of the electrical current.

As a further explanation of the theoretical and physical operation of this cathode, it will here be stated that each one of the long wires of screen 20 that extends from mounting end 18 of the supporting rod 14 to the mounting 19 of the supporting rod 15, in reality comprises a separate and distinct cathode strip. It is obvious that such a small cathode strip, as compared to one solid cathode strip the size of the entire screen, will take much less current to heat it to incandescence. However, by use of a plurality of these small cathode strips in the form of the long wires of the screen, a slight increase in current accordingly is necessary to accomplish the necessary heating thereof, but even then, it is considerably less than the current needed to heat a solid cathode strip of the old type, because of the heat generated by the resistance offered to the electrical current in the fine wire. In reality, this electrode comprises a plurality of cathode strips, which are the long wires of the screen, held together or strengthened by the short cross wires that are interwoven in the screen. These cross wires not only hold together and strengthen the plurality of cathode strips, but also provide added area for the carrying of the oxide coating used.

Upon the cathode strip reaching this temperature of incandescence, electrons are emitted therefrom in great profusion. Furthermore, upon the closing of the electrical circuit, as stated, the gas included in the sealed tube becomes ionized, and, in this ionic state, each ion of the gas moves toward the cathode.

The emission of electrons from the cathode serves as a protective cushion for the oxide coating on the cathode, in that the negative electrons collide with the positive ions of the gas at a substantial distance from the cathode, resulting in electrically neutralizing the gas ion, whereby it is caused to lose its kinetic energy, and emit a characteristic visible light.

However, should a positive ion of the gas strike or impinge upon the cathode strip before the electronic emission has reached its maximum, heat will be generated by the impact, and this heat will be localized, because of the screen construction; the heat not being dissipated or conducted away as rapidly as in cathodes of solid metallic construction. In reality, such impacts of ions on the cathode itself are very few, but the heat of such an impact, being localized, will form what may be termed a "cathode spot" on the strip, in that the heat of the impact will be sufficient to cause or start electronic emission.

A further advantage in the use of such a cathode is that because of its efficiency as above stated, it can be made much smaller in actual size than cathodes constructed of solid metal, and still operate considerably more effectively.

It will here be explained that by the use of such a woven wire screen cathode strip, the surface area presented thereby is many times greater than is possible with a solid metal cathode strip for a given weight of metal. This greater area provides greater electronic emission, as is obvious.

The electrode of the present invention is designed with the object in mind of overcoming all of the defects of electrodes heretofore in use, as enumerated above. The present electrode combines the advantages of Classes 2 and 3, as described, and avoids all of their disadvantages.

It reaches incandescence in a very small fraction of one second, and has such a greater area of metallic oxide that its life is much greater than that of any of the electrodes of the prior art. Also, as a contributing factor to its long life is the fact that the oxide coating will not be chipped off by ionic bombardment, in view of the fact that a very few of such impacts will occur, and these few will cause the cathode to be heated, and the heat localized, thereby setting up electronic emission. It should be stated here that when the cathode is not heated to incandescence and ionic emission is not at its maximum, the actual number of ionic impacts that take place in one second of time constitute a countless number. Furthermore, each individual impact forms a cathode spot instantly under ionic bombardment, so that full emission is obtained without the heating of the entire cathode by a special heating circuit. This phenomenon may be explained by the fact that a screen conducts or dissipates heat at a much lesser rate of speed than a metal plate of the same thickness as the wire of the screen. Hence, the power required to overcome cathode drop is greatly localized on the screen, whereas it is quickly spread by conduction in a metal plate. Therefore, an incandescent spot will form on the present screen with much less power concentration than on a metal plate.

It also has been found by experiment that a metal screen cathode can be operated without supply of heat energy from an outside source. It instantly forms a cathode spot and operates satisfactorily with the arc forming its own emission.

It has also been found that the finer the wire of the screen cathode, the smaller is the arc current required to form a cathode spot.

There are many other advantages inherent in the cathode of my invention; namely, first, the screen ribbon is far more compact than the other cathodes for the same cathode energy; second, by forming the cathode in a single loop, as illustrated, no mechanical stresses appear when it expands from cold to extreme heat, such mechanical stresses, as in other types of cathodes tend to loosen the oxide coating, allowing it to fall off; third, the cathode can be constructed for any desired emission by merely adjusting the width of the ribbon. The same construction methods prevail for all sizes of cathodes.

Such a cathode is applicable to all vacuum tubes, gaseous arc lamps, and the like, and may be made in various modifications. Therefore, it is desired that the appended claim be not limited to the disclosures herein made, but that they be given an interpretation commensurate with the spirit and scope of the invention.

Having thus described my invention, what I claim as new therein and desire to secure by Letters Patent is:

In a lamp of the character described, a cathode electrode of the metallic oxide coated type, comprising a ribbon strip of fine mesh wire screening, formed into a U-shaped loop and supported at its ends by means for supplying current thereto and extending in the direction of the arc path to the opposite electrode; said strip comprising a multiplicity of continuous longitudinal strands from end to end, each having electrical connection at its ends with the supports, transverse strands in close relationship across the longitudinal strands, and said supports being shaped to transversely cup the ribbon strip.

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