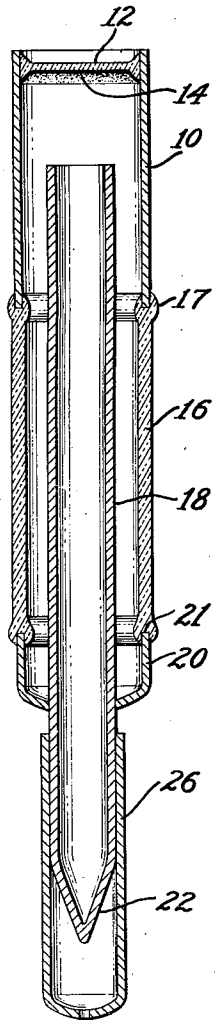
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END-ON PHOTOTUBE

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END-ON PHOTOTUBE

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Our invention relates to photoelectric tubes, and in particular to a photoelectric tube of miniature proportions and to its method of manufacture.

Photoelectric tubes of very small overall dimensions have great utility in many types of applications, as, for example, in card indexing machines. In many instances when a large number of phototubes are incorporated in a single machine the size of each tube will determine in a large part the overall size and bulkiness of the machine. Also, there are many uses of phototubes in which the minimum tube size is desirable. In cases in which the size of the photoelectric tube is a major consideration, an ideal design would be that in which the surface area of the tube presented to a small activating light beam is no larger than the cross-sectional area of the light beam. Conventional photoelectric tubes which may be constructed with dimensions approaching this ideal design would be difficult and expensive to manufacture. Such a tube having a small enclosing glass envelope of the order of the cross-sectional area of a small beam of light and which would enclose a still smaller photosensitive electrode, would be limited by its structure to a relatively small output current. This would necessitate additional means for amplification of the output current.

It is, therefore, an object of our invention to provide a photoelectric tube having a minimum surface area presented to a small activating light beam. It is also an object of our invention to provide a photoelectric tube having a maximum photoelectric cathode surface area relative to the tube dimension perpendicular to an activating light beam. It is also an object of our invention to provide a photoelectric tube which incorporates an anode of novel design and arrangement to provide for greater current collection and a better and simpler method of tube construction.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing, in which the figure is a longitudinal sectional view of a photoelectric tube, according to our invention.

The figure discloses the principal structure of the phototube, according to our invention. The tube principally consists of a cathode cylinder 10 and an anode tube electrode 18 fixed so as to coaxially extend up into the cathode cylinder 10. Part of the cathode 10 is a glass window or transparent disc 12 which is sealed in the upper end of the cylinder 10. Upon the inner surface of the window 12 is a photosensitive film 14. The film 14 extends over the inner surface of the window 12 and into electrical contact with the metal cathode cylinder 10. The photosensitive film 14 may be of any well known material but in our particular tube it consists, preferably of a layer of antimony which has been activated by caesium. The window 12 may be formed by a glass disc sealed to the inner surface of cylinder 10, or the cylinder 10 may be first sealed to a larger piece of glass sheeting after which the edges extending beyond the end of cylinder 10 may be broken off. Insulating the anode tube 18 from the cathode cylinder 10 is a glass tubular section 16 sealed at 17 to the cathode cylinder 10. To permit a lasting seal at 17 the metal cathode cylinder 10 is, preferably, of a chrome iron alloy, having thermal expansion characteristics satisfactorily matched with that of the glass of section 16. The other end of the glass tube 16 is joined to the anode tube 18 through a metal cup structure 20. The cup-like portion 20 is also of a chrome iron alloy and has its lip portion sealed to the glass tube 16 as shown at 21. The bottom of the cup-like portion then is sealed or brazed to the anode tube 18.

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It is easily seen from this figure that the anode tube 18 is comparatively large and extends upwardly through the glass portion 16 and the metal portion 10. The end of anode 18, enclosed by the cathode cylinder 10, is mounted close to the photosensitive coating 14 so as to provide a good collector of the photoelectric current. The glass tubular section 16 together with the metal cathode cylinder 10 and the sensitized disc 12, comprises the main portion of the tube envelope. The anode collector tube 18 is used as an exhaust tubulation for the phototube envelope and is pinched off at 22 after tube exhaust to form a hermetical seal. This end of the anode 18 which extends outside of the envelope is covered by a metal cap 26 welded or brazed to tube 18. Cap 26 forms a terminal for connecting the anode 18 in an electrical circuit. Tubes of this type, shown in this figure, may be slipped into a receiving socket in which one terminal of the socket is of such shape to receive the cap 26, while the other terminal of the socket may be of any design such as spring figures, for example, to receive in electrical contact the metal cylinder 10. However, the cathode terminal may consist of a metal cylinder mounted in the receiving socket so as to be coaxial to the anode cap 26.

The particular phototube, which we have disclosed, is of the transmission type photoelectric surface. That is, the design of the tube is such that light passes through the window 12 and film 14 to effect a photoelectric discharge. When a difference of potential is established between the cathode 10 and anode 18, the photoemission passes to the anode 18 from the photosensitive cathode surface 14. The phototube may be connected into an appropriate circuit whereby the output current of the tube may be utilized as desired.

It is desirable to control the thickness of the photoelectric film 14 deposited upon the inside of the glass window 12. This is necessary, since, if the energy of the light falling upon the glass window 12 were completely absorbed by the photosensitive film, the photoelectrons emitted thereby would be released so deeply within the film that they could not escape into the inter-electrode space between the cathode 12 and the anode 18. On the other hand, if most of the light were allowed to pass through the photosensitive layer, very little, if any, light would be absorbed, to provide energy for photoelectric emission. We have found that from 20% to 50% of the light falling upon the window 12 should be transmitted by the photosensitive film 14.

In constructing our tube other materials may be used for the photoelectric surface. Instead of using an antimony layer, either arsenic or bismuth may be substituted, or if desired some other alkali metal may replace the caesium; nor should our invention be limited to this particular type of photosensitive material as it is obvious that other photosensitive films such as a silver-silver oxide-caesium surface may be used.

From the following description it is obvious that certain novel and advantageous features exist in this tube. The head of the tube which is the end closed by the glass window 12 is completely a photosensitive surface. That is, the head-on view of the tube is all photosurface which provides a large photocathode surface relative to the cross-sectional dimensions of the tube. Furthermore, by utilizing an envelope comprising the cathode cylinder 10, it is unnecessary to use an enclosing glass envelope. This permits a much smaller overall cross-sectional area of the tube and also allows the circuit leads to be connected directly to the cathode instead of requiring a conventional base structure. The copper anode tube 18 is used both as an electrode and as an exhaust tubulation 22. This provides a large electrode surface for collecting the photoelectric current and also eliminates additional structures which would be required in a conventional tube for tube exhaust. The large anode tube also provides easier glass-to-metal sealing.

The important dimension of the tube is obviously its cross-sectional dimension which in this case is determined by the size of the photosensitive cathode. This dimension of the cathode structure can be kept small relative to the corresponding dimension of conventional phototubes. Due to this small head-on dimension which is the part of the tube presented to an activating beam of light, greater utility of the tube is evident. Machines which would utilize a series or a bank of such tubes may be designed to much smaller overall dimensions than were formerly possible. Due to its small size this tube may be incorporated in instruments of small design where previously the use of phototubes greatly complicated the technical problems at hand.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What we claim as new is:

1. A photoelectric tube including an envelope, said envelope comprising an insulating tubular member, a metal tubular member coaxially sealed to one end of said insulating tubular member and a glass disc closing said metal tubular member, a photosensitive coating deposited on the inside surface of said disc and in electrical contact with the inside of said metal tubular member for providing within the tube a source of photoelectron emission, a collector electrode having a portion sealed within said tube for collecting the photoelectron emission from said cathode.

2. A photoelectric tube including an envelope, said envelope comprising a glass tubular member, a metal tubular member of the same cross-sectional area coaxially sealed at one end to one end of said glass tubular member and a transparent window closing the other end of said metal tubular member, a photosensitive coating adhering to the inside surface of said window and in electrical contact with said metal tubular member for providing within the tube a source of photoelectron emission, a collector electrode closing the other end of said glass tubular member for collecting the photoelectric emission from said cathode.

3. A photoelectric tube comprising a glass tubular member forming an envelope portion of the tube, a cathode including a metal tube sealed to one end of said glass tubular member and forming a second envelope portion of the tube, a transparent disc closing the other end of said metal tube and an electrically conducting photosensitive substance coated on the inner surface of said transparent disc, said photosensitive substance extending in electrical contact with the inner wall of said metal tube for providing within the tube a source of photoelectron emission, an anode electrode within said envelope having a portion sealing the other end of said glass tubular member.

4. A photoelectric tube comprising a cylindrical insulating member, a cathode electrode including a metal cylinder sealed to one end of said insulating cylinder and forming therewith a portion of the envelope of said tube, a glass window closing said metal cylinder and an electrically conducting photosensitive film deposited over the inner surface of said glass window, said photosensitive film extending in electrical contact with said metal cylinder for providing within the tube a source of photoelectron emission, and an anode electrode within said envelope having a portion sealing the other end of said cylindrical insulating member.

5. A photoelectric tube including an evacuated envelope, said envelope comprising a tubular member and a transparent photosensitive cathode electrode sealed across one end of said tubular member, an anode electrode assembly having a portion spaced within said envelope from said cathode electrode and a metal cup portion sealed across the other end of said tubular member.

6. A photoelectric tube including an evacuated envelope, said envelope comprising a hollow cylindrical member and a transparent photosensitive cathode electrode closing one end of said hollow cylindrical member, an anode electrode assembly having a conductive portion closely

spaced within said envelope from said cathode electrode and a metal cup portion sealed across the other end of said tubular member.

7. A photoelectric tube including an envelope, said envelope comprising a glass tubular member, a metal tubular member of the same cross-sectional area coaxially sealed at one end to one end of said glass tubular member and a transparent window closing the other end of said metal tubular member, a photosensitive coating deposited on the inside surface of said window and in electrical contact with the inside of said metal tubular member for providing within the tube a source of photoelectron emission, a collector electrode comprising a closed metal tube extending through the other end of said glass tubular member in spaced relationship to said photosensitive coating for collecting the photoelectrons emitted therefrom, and means closing and sealing said envelope between said glass tubular member and said closed metal tube.

8. A photoelectric tube comprising a cylindrical insulating member of uniform diameter, a cathode including a metal cylinder sealed at one end to an end of said cylindrical insulating member and forming therewith a portion of the envelope of said tube, a glass window sealed across to close the other end of said metal cylinder and an electrically conducting photosensitive substance deposited over the inner surface of said glass window, said photosensitive substance extending in electrical contact with the wall of said cylinder for providing within the tube a source of photoelectron emission, an anode including a closed copper tube extending through the other end of said cylindrical insulating member into said metal cathode cylinder and in spaced relationship to said photosensitive film for collecting the photoelectrons emitted therefrom and a metal cup fixed to said copper tube to said cylindrical insulating member to close said envelope between said cylindrical insulating member and said enclosed copper tube.

9. A photoelectric tube comprising an evacuated tubular envelope, a photosensitive cathode electrode closing one end of said tubular envelope and an anode electrode having one portion spaced within said envelope from said cathode electrode and a second portion sealed to and hermetically closing the other end of said tubular envelope.

10. A photoelectric tube comprising an evacuated tubular envelope, a photosensitive cathode electrode closing one end of said tubular envelope and an anode electrode including a cylindrical member extending coaxially into said tubular envelope and a portion closing the other end of said tubular envelope, said cylindrical anode member extending in spaced relationship to said photosensitive cathode electrode for collecting the photoelectron emission therefrom, said cylindrical anode member including a hollow exhaust tubulation for said tubular envelope.

11. A photoelectric tube comprising a tubular envelope, a transparent window closing one end of said tubular envelope, a transparent photosensitive film deposited on the inside surface of said window, said photosensitive film forming a photoelectron emitting cathode adapted to be activated by a beam of light passing through said window, a cylindrical anode electrode having one end enclosed in said tubular envelope, said cylindrical anode including a portion closing the other end of said tubular envelope, the enclosed end of said anode electrode extending in spaced relationship to said photoelectron emitting cathode for collecting the photoelectron emission therefrom, said cylindrical anode electrode formed of a hollow metal tube with said enclosed end open for exhausting said envelope and the other end thereof hermetically sealed after tube exhaust.

12. A photoelectric tube including an envelope, said envelope comprising a tubular insulating member and a tubular photosensitive cathode electrode coaxially sealed to one end of said tubular insulating member, an anode electrode formed of a hollow metal tube enclosed within said tubular insulating member, one end of said anode tube extending into said tubular photosensitive cathode for collecting the photoelectron emission therefrom, the other end of said anode tube extending through the other end of said tubular insulating member, means hermetically closing said envelope between said other end of said tubular insulating member and said anode tube, whereby said anode tube forms an exhaust tubulation for said photoelectric tube, said other end of said anode tube hermetically closed after tube exhaust.

13 A photoelectric tube including an envelope, said envelope comprising a tubular insulating member and a photosensitive cathode electrode, said photosensitive cathode including a metal cylinder coaxially sealed at one end to an end of said tubular insulating member and a transparent window hermetically closing the other end thereof, an anode electrode formed of a hollow copper tube enclosed within said tubular insulating member, one end of said anode tube extending into said photosensitive cathode cylinder for collecting the photoelectron emission therefrom, the other end of said anode tube extending through the other end of said tubular insulating member, cup means hermetically closing said envelope between said other end of said tubular insulating member and said anode tube, whereby said anode tube forms an exhaust tubulation for said photoelectric tube, said other end of said anode tube hermetically closed after tube exhaust, a conductor fixed to said other end of said anode tubulation for connecting said photoelectric tube in a circuit.

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