May 19, 1942. R. J. CASHMAN 2,283,413

PHOTOTUBE AND METHOD OF MANUFACTURE

Filed Aug. 3, 1940

Fig. 1

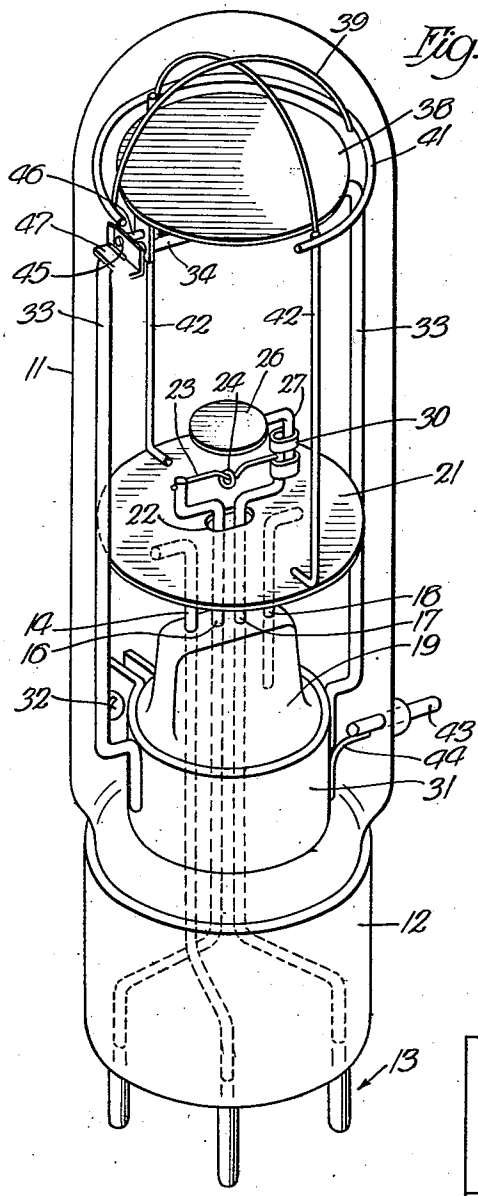


Fig. 2

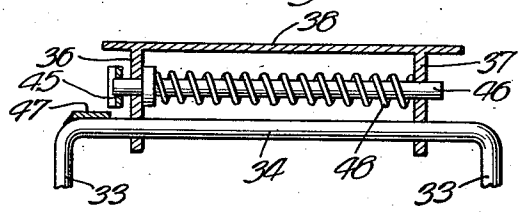


Fig. 3

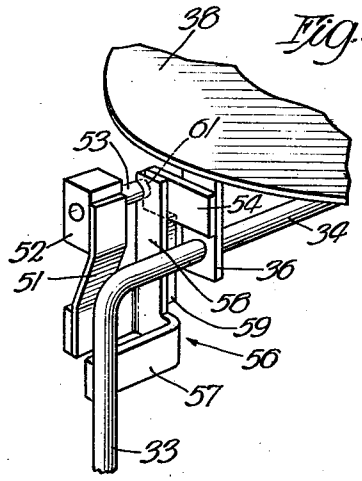
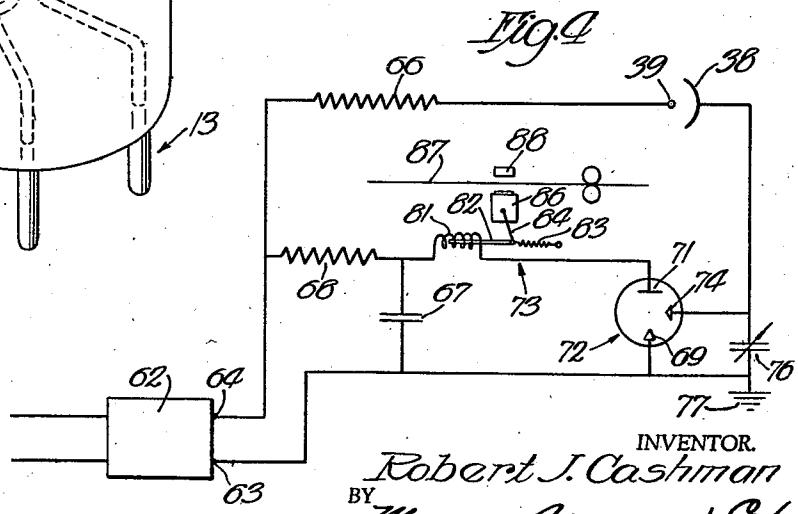


Fig. 4



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PHOTOTUBE AND METHOD OF MANUFACTURE

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18 Claims. (Cl. 250—165)

It is known that ultraviolet radiations having wave lengths shorter than 3200 Å. have the valuable effect of curing rickets and are believed to have some prophylactic value in heliotherapy. These radiations have also proved valuable in sterilization and in certain photo-chemical processes. The accurate quantative determination of the intensity of these radiations has, however, been difficult if not impossible due to the lack of means capable of measuring only these radiations. Several forms of meters have been devised but these have been objectionable for various reasons, one of the common shortcomings being the limited field from which radiations may be received, and another being their inability to respond only to biologically effective radiations.

An object of my invention therefore, is to provide an apparatus and a method of making such apparatus to accurately measure all biologically significant ultraviolet radiations incident upon a horizontal plane.

Another object is to provide a method of making phototubes which substantially eliminates variation in characteristics between similarly constructed phototubes.

Another object of my invention is to provide a phototube having a negligible response to changes in temperature.

These and other objects, which will become apparent from the following description, are accomplished in general by providing a phototube having a metal cathode disc covered on at least one face by a gas-free coating of condensed magnesium. The phototube consists broadly of an envelope capable of transmitting ultraviolet radiations and within which the cathode disc is rotatably mounted. The anode is preferably formed of thin wire and is located above the cathode plate.

In making the tube a quantity of pure magnesium is placed near the cathode plate and is associated with heating means. Initially the flat cathode plate is moved upon its supports until the surface to be activated faces the magnesium and a small occulting disc is interposed between the magnesium and the cathode. Gases within the tube are removed insofar as possible by an efficient vacuum pump and heat is applied to the magnesium during the pumping process, causing a portion, or fraction, of the magnesium to vaporize and condense principally upon the occulting disc. After a portion of the magnesium has been vaporized the tube is sealed. The vaporization process is continued after sealing, as it effectively "getters" or removes after the remaining active gases from the tube, which would otherwise harmfully effect its characteristics. When the active gases have been completely removed by the action of the magnesium, the occulting disc is withdrawn from its position between the magnesium and the cathode, allowing the middle fraction of the magnesium to condense upon the surface of the cathode disc. When the desired amount of magnesium has been collected the cathode disc is moved upon its supports by external means and secured in its operative position. A tube formed in this manner will have a threshold of substantially 3200 Å.; that is, it will be unresponsive to radiations having wave lengths greater than substantially 3200 Å. but will respond to radiations below 3200 Å., the lower limit being determined by the envelope material and its thickness. The response of my tube to such radiations is directly proportional to their intensity, in other words the characteristics of my phototube are substantially linear. Because of the novel construction of my tube practically all of the biologically effective ultraviolet radiations from a single source or combination of sources incident upon a horizontal plane will act upon the tube when the cathode is horizontal and the intensity of these radiations may be measured and integrated by a suitable recording device operating in conjunction with my tube Furthermore, the response of my tube is substantially unaffected by changes in temperature. However, it is to be understood that the basic principles of my method of manufacturing, hereinafter described in detail, are applicable to phototubes formed of other materials and adapted for use in other relations such as phototubes for use in conjunction with television or motion picture sound apparatus.

As the threshold of a phototube is controlled largely by the material forming the cathode or cathode coating I may form a tube by my process having a threshold other than 3200 Å. by substituting other metals for magnesium, or if a combination of more than one metal is desired I may employ an alloy or mixture of two or more metals. It is not essential that the material chosen have the property of adsorbing active gases for magnesium, or some similar material, may also be vaporized in the tube without coating the cathode by providing an auxiliary vaporizing unit.

The threshold of a tube formed by my process may be varied by the admission of active gases

under controlled conditions regardless of the type of metal or mixture of metals used to form the cathode or cathode coating. For example the threshold of 3200 Å. which is characteristic of a tube having a gas-free magnesium coating on the cathode may be raised to 5100 Å. by admitting small quantities of hydrogen and this threshold may be reduced to approximately 4700 Å. by re-exhausting the tube. The admission of gases of this nature has also been found to greatly increase the sensitivity of a tube.

In the accompanying drawing Fig. 1 is a perspective view of one form of my invention showing the relative disposition of the parts.

Fig. 2 is a sectional view of one form of mechanism employed to hold the cathode in operative position.

Fig. 3 is a perspective view illustrating another form of mechanism employed to hold the cathode in operative position, and

Fig. 4 is a diagrammatic illustration of a circuit and recording apparatus suitable for use in conjunction with my tube.

Referring to Fig. 1 an envelope 11 formed of fused quartz or of glass such as Corex D, Corning #972 or Corning 791, capable of transmitting ultraviolet radiations having wave lengths of less than approximately 3200 Å., is attached to a standard tube base 12 in a manner well known in the art. Four metallic prongs, designated 13, extend through the base 12 and are connected to four electrodes 14, 16, 17 and 18. Connection of electrode 18 to one of the prongs 13 is, however, optional and is shown as disconnected in Fig. 1 for clarity. The electrodes are disposed substantially parallel to the longer axis of the tube and sealed into a glass base 19 which is attached to the envelope 11. The lower portion of the glass base 19 is preferably cylindrical in form, tapering at the top to a pinch seal or press of approximately rectangular cross-section.

All of the electrodes extend upwardly beyond the glass base, 19 the two outer electrodes 14 and 18 being attached to the under side of a transverse metallic disc 21. The two central electrodes 16 and 17 extend through an opening 22 in the central portion of the transverse disc 21, the ends of these electrodes being spread apart after passing through the disc 21 and connected together by a high resistance wire 23.

A small quantity of pure magnesium 24 is placed around the resistance wire 23 and is held in place by deforming the wire. A horizontal occulting disc 26 is attached to a vertical shaft 27 which is rotatably mounted in a vertical position by bands 30 attached to the upper portion of the electrode 17. The dimensions of the occulting disc 26 are such that it may be swung into and out of position directly over the magnesium 24.

A metal collar 31 is clamped around the cylindrical portion of the glass base 19 by a bolt 32 and supports two upright members designated 33, which extend upwardly parallel to the axis of the tube beyond but not in contact with the disc 21. The upper ends of these uprights 33 are joined together by a horizontal bar or axle 34 upon which two similar arms 36 and 37 are journaled. A flat metallic cathode disc 38, preferably of nickel, is attached to the free ends of the arms 36 and 37, the plane of the cathode disc being at all times parallel to the horizontal bar 34 so that when the cathode is held in a horizontal position its plane will be at right angles to the major axis of the tube.

The anode comprises two fine curved wires, 39 extending above and diametrically across the cathode 38 at right angles to each other. The ends of the anode wires 39 are attached to an open ring 41 which may extend around but not in contact with the cathode disc 38. The ring 41 is attached to two diametrically opposed supports 42, the lower ends of which are attached to the disc 21. A metal prong 43 is sealed through the wall of the envelope 11 and is connected with the collar 31 by a wire 44.

Potential may be applied to the cathode 38 through the wire prong 43, the wire 44, the collar 31, the uprights 33, the horizontal bar 34, and the arms 36 and 37, and to the anode 39, through the electrode 14, the metal disc 21, the supports 42, and the ring 41. The electrode 18 serves primarily as a support for the disc 21 and its connection with one of the prongs 13 is therefore optional.

As the method of manufacturing employed contemplates coating the surface of the cathode with condensed magnesium vapors after sealing the envelope and subsequently rotating the cathode into its normal operative position, it is necessary to provide a latch device to hold the cathode in position after rotation. A device suitable for this purpose is shown in Fig. 2 and includes a bar 46 extending through aligned openings in the arms 36 and 37. An L shaped member 47 is attached to the horizontal bar 34 with the plane of vertical portion of the member adjacent and parallel to the outer side of arm 36, and an opening 45 is provided in this portion to receive one end of the bar 46 when the cathode assumes its operative position. A coiled spring 48 acts upon the bar 46 urging it outwardly towards member 47. One end of the vertical section of member 47 is bent outwardly and serves to force the bar 46 inwardly against the pressure of the spring 48 when the protruding end of the bar 46 is brought in contact with the vertical section of member 47 by rotation of the cathode 38. The spring 48 forces the bar 46 into the opening 45 the moment the bar and opening are aligned and so holds the cathode firmly in the desired position.

Fig. 3 illustrates another form of latch mechanism adapted to hold the cathode in operative position. This form comprises a flat spring 51 attached at its lower end to vertical member 33 and carrying an armature 52 on its upper end. A pin 53 extends through the armature 52 substantially parallel to the horizontal bar 34, the projecting end of the pin engaging a notch in the end of a bar 54 when the cathode is in operative position. The bar 54 is attached to the arm 36 and extends laterally therefrom. A stop, generally designated 56, is provided to prevent rotation of the cathode beyond the desired position and comprises a horizontal bar 57 attached at one end to the vertical member 33 slightly below the end of the spring 51. The unattached end of the bar 57 is joined to a leg 58 which extends laterally and vertically with respect to the leg 57 in a plane parallel and adjacent to the plane of the bar 54. A flat section of metal 59 is attached to the inner portion of the vertical leg 58. The parts of the stop 56 are positioned in such manner that as the cathode is rotated the arm 54 will move in a plane parallel and adjacent to the plane of the vertical leg 58 until it comes in contact with the upper end of the flat

section 59 at which time the free end of the arm 54 will be immediately adjacent to the vertical leg 58 of the stop 56. A small notch 61 is provided in the outer edge of the vertical leg 58 positioned to register with the notch in the end of the arm 54 when the cathode has reached operative position. The pin 53 on the armature 52 is urged into engagement with these notches by the action of the spring 51 and may be disengaged at will by applying magnetic force to the armature 52. I prefer to use this form of holding device, as it is possible to move the cathode into or out of operative position at will, whereas the device illustrated in Fig. 2 will not permit movement of the cathode once it has been placed in operative condition.

A phototube having the construction above described is particularly adapted to the measurement of biologically effective solar radiations, and is intended to illustrate a novel and acceptable form of phototube for this purpose without limiting my invention solely to the use of this type of construction. The construction of the anode and cathode, however, imparts certain novel and highly desirable characteristics to my tube. For example, the shadow of the anode upon the cathode is negligible, thereby practically eliminating a source of error in measurements. The flat metallic cathode, in addition to broadening the field of the phototube, also eliminates the variations found in tubes having curved cathodes caused by variations in the incident angle of the radiations, which affect the response of the tube.

In the following description of the process of manufacturing and in the claims, fractional distillation is to be understood as meaning a process in which the volatilization of the metal is substantially continuous, but in which only selected portions of the vapor are used as a coating for the cathode, as distinguished from double distillation in which the metal is vaporized, condensed, subsequently re-vaporized and re-condensed upon the cathode. The term "middle fraction" is to be understood as meaning any portion of metal vapor other than the gas contaminated vapors first evolved. It may be applied to the last portion, if there are only two, or to all but the first portion, if there are more than two.

In the manufacture of the tube the parts are formed substantially as shown and prior to their final assembly are heated under suitable conditions to remove all possible occluded gases and other foreign material. The parts are then assembled as previously described with the magnesium located approximately in the center of the resistance wire 23, and with the occulting disc 26 swung into position over the magnesium. The cathode disc 38 is initially placed in its inverted position with the face to be coated adjacent to and facing the occulting disc 26. The tube is then connected to an efficient vacuum pump, not shown, in any desired manner and is exhausted by pumping. The pumping process is continued until the maximum degree of vacuum is obtained, at which time the vaporization process is begun by passing current through the electrodes 16 and 17, and the resistance wire 23. The heat developed by the resistance wire 23 is sufficient to cause a slow vaporization of the magnesium 24.

It is essential that the first fraction of magnesium vapor evolved be prevented from condensing on the surface of the cathode, as this portion of the vapor will be contaminated with active gases unavoidably remaining in the tube. The first fraction of vapor evolved by the magnesium is, therefore, deposited upon the occulting disc 26, the function of which is to prevent the deposition of this fraction upon the surface of the cathode. Portions of this initial fraction of magnesium vapor will also deposit upon the adjacent walls of the tube, exposing, in conjunction with the occulting disc 26, a relatively large surface to the gases within the envelope. This initial step effectively "getters" or removes the active gases from within the tube as magnesium has the property of readily trapping such gases.

When a suitable portion of the magnesium has been vaporized the tube is sealed and the vaporization is preferably continued for a few moments to remove the gases formed in the tube by the sealing process. At this stage of the procedure all active gases remaining within the now sealed tube will have been adsorbed by the magnesium condensed on the lower surface of the occulting disc 26, and on the walls of the envelope 11.

The occulting disc 26 is now swung out of its original position by a sharp movement of the tube and the vapors are allowed to condense upon the surface of the cathode 38. As the vaporization appears to take place in practically straight lines, the uppermost portion of the envelope 11 will not be coated with magnesium as it is protected from such deposits by the inverted cathode plate 38. When sufficient of the magnesium has been condensed upon the surface of the cathode plate, the current through the resistance wire 23 is cut off and the cathode swung around the bar 34 into its operative position by a sharp movement of the tube.

The coating so formed upon the surface of the cathode will be substantially free of any active gases and I have found that a coating formed in the manner described has a photo-electric threshold of substantially 3200 Å., which is approximately the longest wave length of biologically effective ultraviolet radiations. Radiant energy striking the cathode, having wave lengths or more than substantially 3200 Å, will not energize the tube.

The range of responsiveness of my tube to radiations having wave lengths of less than 3200 Å., is largely determined by the thickness and material used as an envelope. If the envelope is of thin quartz my tube will respond to radiations having wave lengths as short as 1850 Å., or if of Corex D, 0.3 to 0.5 mm. thick is used, it will respond to radiations having wave lengths as short as 2200 Å. As the biologically effective ultraviolet radiations have minimum wave lengths of about 2000 Å., an envelope of Corex D is usually satisfactory, for the most important of these radiations have wave lengths in excess of 2200 Å. Filters may, of course, be used to cut out certain bands of radiations if desired.

The effect of changes in temperature upon the characteristics of my tube is negligible, due at least in part to the fact that the cathode surface is gas free, and has a negligible vapor pressure. This is in sharp contrast to tubes formed by ordinary methods, in which changes in temperature produce marked changes in characteristics.

If I connect the above described tube to a suitable recording and amplifying apparatus and place the tube in an exposed position, substantially all of the biologically effective ultraviolet radiations from a source, or combination of sources, such as from the sun and the entire sky,

will strike the flat surface of the cathode plate 38, energizing the tube and causing the recording apparatus to operate.

To obtain a continuous record of the intensity of the biologically effective ultraviolet radiations striking my tube I employ a circuit and apparatus similar to that shown diagrammatically in Fig. 4. Current may be supplied to the circuit through any suitable converter 62 capable of maintaining a constant voltage, and which may be any one of several well known types adapted to deliver 270 volts D. C. to a negative terminal 63, and a positive terminal 64. The positive terminal 64 is connected with the anode 39 of my phototube through a relatively high resistance 66 which may be approximately one megohm.

A condenser 67 having a capacity of approximately two microfarads is connected to the terminals of the converter 62 through a resistance 68 which controls the rate at which the condenser 67 will be charged and which may be suitably of about 150,000 ohms. The condenser 67 is connected to the cathode 69 of a relay tube generally designated 72, such as a Westinghouse "trigger" tube, WL 759. The coil of a recording device generally designated 73 is connected in series between the condenser 67 and the main anode 71 of the tube 72. The cathode 38 of the phototube is connected to the "trigger" anode 74 of the tube 72 and the "trigger" anode and the cathode 69 are connected through a variable condenser 76, this connection being grounded as shown at 77.

In the above described circuit it may be seen that the condenser 67 will be charged by the current imposed upon the terminals 63 and 64, the rate of charge being controlled by the resistance 68. Discharge of the condenser, however, must take place between the main anode 71 and the cathode 69 of the tube 72, and this discharge is normally prevented by the potential of the "trigger" anode 74. When radiations having wave lengths below 3200 Å. strike the cathode 38 of my phototube the variable condenser 76 is charged by the current developed, the time required varying with the setting of the condenser and the intensity of the radiations. When the condenser 76 is charged to a certain potential difference the gas in the tube 72 is ionized by a discharge between the cathode 69 and the "trigger" anode 74, which lowers the potential required to cause a discharge between the cathode 69 and the main anode 71. When the tube 72 assumes this condition, the condenser 67 will discharge through the main anode 71 and the cathode 69, completing the circuit. The passage of this current energizes the coil of the recorder 73 causing actuation of the recording device.

The intensity of the incident biologically effective ultraviolet rays may be recorded in two ways. First, the setting of the variable condenser 76 may be fixed and a record kept of the number of times the recorder 73 is actuated, or, if desired, the variable condenser may be provided with a graduated scale and set to allow a fixed number of discharges to occur in a unit length of time, the setting of the condenser then being a comparative measure of the intensity of the incident radiations. From the foregoing it may be seen that if desired the variable condenser 76 may be replaced with a fixed condenser of predetermined capacity, but due to the variations occurring in the intensity of the biologically effective ultraviolet rays I prefer to use the variable condenser as shown and to record the number of times the recorder 73 is actuated within a fixed time.

The recorder 73 may be any one of several types. One which I have found suitable for use consists of a solenoid 81 having a movable armature 82 held in its de-energized position by a spring 83. An arm 84, pivotally attached to the end of the armature 82, actuates a counter 86 which will automatically register each time the coil 81 is energized by the passage of current through the tube 72. The numerals of the counter are adapted to print upon a paper tape 87 whenever a platen 88 is caused to strike the face of the counter 86 through the action of an electric timing mechanism, not shown. Movement of the platen 88 also moves the paper tape 87. The electric clock mechanism and the counter are of standard types and need not be described in detail. It may be seen, however, that by means of this apparatus a direct comparison of the intensity of the ultraviolet rays incident upon my phototube throughout any selected period of time may be obtained.

It cannot be stated with absolute certainty that the coating of my cathode, formed by fractional distillation or sublimation of a photo-sensitive gas absorptive metal in a vacuum, is completely free of active gases, as there may be extremely small amounts of occluded gases retained by the metal after condensation. I have determined, however, that the variable threshold commonly experienced in the manufacture of photo-electric tubes is largely due to gas contamination of the photo-sensitive metal cathode coating, and that by my process sufficient quantities of these active gases are invariably removed to produce a photo-sensitive material having a constant threshold, although some minute amount of gas may remain in the material. For all practical intents and purposes my fractionally distilled photo-sensitive material is free of active gases, and the use of the term "gas free" in the appended claims is to be understood as meaning gas free to the extent that the active gases, if any, remaining in the photo-sensitive material are present in such minute quantities as to be incapable of influencing the photo-electric threshold of the material.

I have made the foregoing detailed description in compliance with the provisions of section 4888 of the Revised Statutes but I do not wish to be specifically limited to the details herein set forth, as obviously many modifications may be made in the process and apparatus without departing from the true spirit and scope of my invention. While the method of manufacture of the tube herein described has been confined to the use of magnesium I have successfully constructed phototubes having various photo-electric thresholds by the use of other metal such as barium, strontium, calcium, titanium, tungsten, silver, copper and platinum. Each of the tubes above mentioned is characterized by the reproducibility of characteristics. It is, of course, also possible to employ other amplifying and recording devices in connection with my phototube.

I claim as my invention:

1. A vacuum phototube comprising an envelope having a projecting transparent window portion, an anode and a cathode at the base of said window portion, the cathode comprising a flat metallic disc rotatable within the envelope about an axis parallel to the disc and closely adjacent thereto.

2. A phototube comprising an envelope having

a transparent window, an anode, a cathode structure including a plate coated with photo-sensitive material, means completely enclosed by said envelope and freely rotatably supporting said cathode structure for free rotation of said plate towards and away from said window, and latch means engaging said cathode structure for retaining said plate in a position facing said window.

3. A vacuum phototube comprising a sealed envelope transparent to light, an anode, a movable cathode within the envelope, means within the envelope for vaporizing a photo-sensitive metal, and means for depositing any selected portion of the metal upon the cathode said depositing means including an occulting disc interposable between the cathode and the vaporizing means.

4. A vacuum phototube comprising a sealed envelope transparent to light, an anode, a movable cathode within the envelope, means within the envelope for vaporizing a photo-sensitive metal, means for depositing any selected portion of the vaporized metal upon the cathode, and means for restraining the cathode in operative position said depositing means including an occulting disc interposable between the cathode and the vaporizing means.

5. A phototube comprising a gas-impervious envelope transparent to light, an anode, a movable cathode within the tube, a source of photo-sensitive metal within the tube, and a movable shield interposable between the metal vapor source and the cathode.

6. The method of manufacturing a phototube having a movable cathode comprising the steps of degassing the metal parts, exhausting the tube, positioning an occulting disc before the cathode, vaporizing a gas-adsorptive photo-sensitive metal within the tube, sealing the tube without discontinuing the vaporizing process, removing the occulting disc from before the cathode and depositing the middle fraction of the metal vapors upon the cathode, and subsequently moving the cathode into operative position.

7. A photo-electric tube comprising a shell having a transparent hemispherical window portion, a flat cathode within the shell having a photo-sensitive surface disposed to receive radiations through the window portion, anode supporting means adjacent said cathode and having no portion thereof projecting substantially above the plane of said cathode, and a fine wire anode fixed to the anode supporting means and projecting beyond the plane of said cathode between said photo-sensitive surface and said window portion whereby the response of the photo-electric tube is substantially directly proportional to the cosine of the angle of incidence of energizing radiations.

8. The method of manufacturing a photo-electric tube having a rotatable cathode including the successive steps of exposing a face of the cathode to a photo-sensitive metal, interposing a movable shield between the cathode and the photo-sensitive metal, exhausting the tube, vaporizing the photo-sensitive metal, sealing the tube, withdrawing the movable shield and coating the cathode with photo-sensitive metal, and rotating the cathode to operative position.

9. The method of manufacturing a photo-electric tube having a movable cathode and a source of vaporizable photo-sensitive metal including the steps of shielding a surface of the cathode from the metal vapor, exhausting the tube, initiating vaporization of the photo-sensitive metal while continuing to exhaust the tube, sealing the tube while continuing vaporization of the metal and subsequently exposing said surface of the cathode to the metal vapor whereby the metal disposed on said surface of the cathode is substantially gas free.

10. A phototube comprising a cathode, an envelope having a hemispherical transparent end, a cathode having a flat photo-sensitive surface lying substantially in the plane of the base of said hemispherical end, anode supporting means having no portion above the plane of said surface, and a fine anode wire extending from said supporting means to points above said surface.

11. A phototube comprising a cathode having a photo-sensitive surface whose periphery lies substantially in a single plane, an envelope having a transparent portion above and enclosing said cathode, anode supporting means adjacent said cathode and having no portion projecting substantially above said plane, and fine anode wires fixed to said supporting means and projecting beyond said plane between said photo-sensitive surface and said window.

12. A phototube comprising an envelope having a window, pivot means entirely within said envelope spaced from and extending across said window, a flat cathode mounted to swing on said pivot means and to present either face to said window, a wire anode extending between said cathode and said window, and means for vaporizing a photo-sensitive material on the face of said cathode remote from said window.

13. A phototube comprising an envelope having a window, means within said envelope defining an axis spaced from and extending across said window, a flat cathode mounted to swing on said axis and to present either face to said window, a latch mounted in said envelope adjacent to said cathode for holding said cathode facing said window, an anode wire extending between said cathode and said window, and means for vaporizing a photo-sensitive material at a point substantially in line with the centers of said window and said cathode and on the other side of said cathode from said window.

14. A phototube comprising an envelope having a window, pivot means within said envelope spaced from and extending across said window, a flat cathode mounted to swing on said pivot means and to present either face to said window, anode supporting means at the side of said cathode, a wire anode fixed to said supporting means and extending between said cathode and said window, every portion of said wire anode being far enough from said pivot means to permit free swinging of said cathode, and means for vaporizing a photo-sensitive material at a point substantially in line with the centers of said window and said cathode and on the face of said cathode remote from said window.

15. A phototube comprising an envelope having a window, means in said envelope opposite said window for vaporizing photo-sensitive material, an axle completely enclosed by said envelope and located between said window and said means, and a cathode rotatably carried by said axle, said cathode, vaporizing means and window being in alignment whereby said cathode shields said window from said vaporizing means.

16. A phototube comprising an envelope having a window, a supporting structure located in and completely enclosed by said envelope, a cathode structure carried by said supporting structure and rotatable thereon into a position

facing said window, a latch mechanism carried by said structures for positively retaining said cathode structure in said position, and means operable from the exterior of the envelope for releasing said latch mechanism.

17. A phototube comprising an envelope having a window, a supporting structure located in and completely enclosed by said envelope, a cathode structure carried by said supporting structure and rotatable thereon into a position facing said window, a latch mechanism carried by said structures for positively retaining said cathode structure in said position, and an armature connected to said latch mechanism for operation thereof.

18. A phototube including a gas impervious envelope containing an anode and a movable cathode, a rigid arm on said cathode, a cathode support adjacent to said cathode, a locking pin movably mounted on said cathode support and movable by magnetic force applied externally of the envelope, and a spring operatively connected to said locking pin and normally urging said locking pin into engagement with said rigid arm on said cathode.

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