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PHOTOELECTRIC DEVICE

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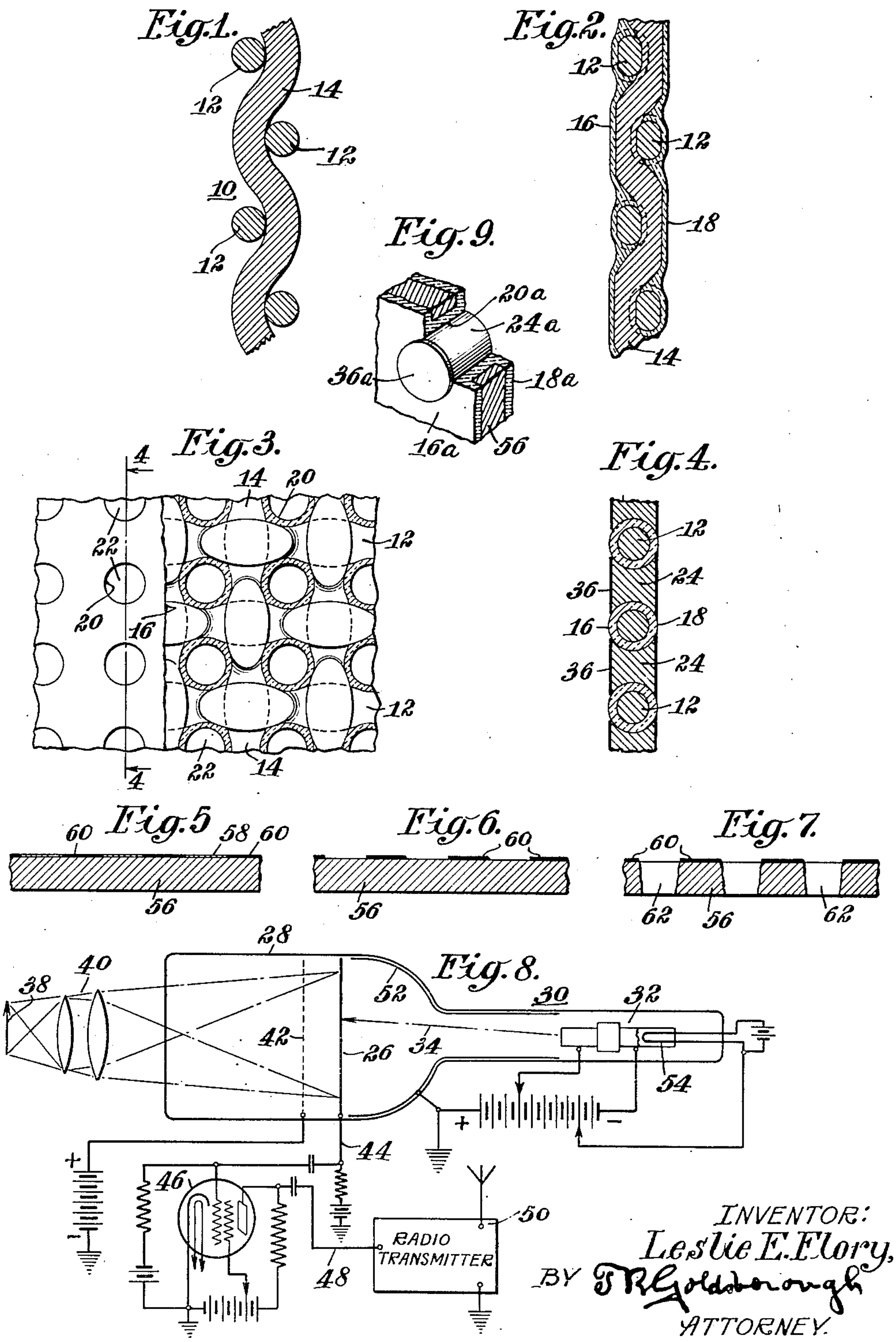

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PHOTOELECTRIC DEVICE

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My invention relates to photo-electric devices and more particularly to cathode ray tubes of the type utilized in television transmitting systems.

During the early development of cathode ray tubes for generating picture-signals in a television transmitting station, it was recognized that there would be advantages in projecting an image of the object for transmission onto one side of the photosensitive screen of the tube, and scanning the opposite side of the screen with the cathode ray. A tube of this general type is disclosed in Patent No. 1,660,886 issued February 28, 1928, to Karl C. Randall. Such a tube includes a photosensitive electrode of the mosaic type and an electron gun for directing a stream of electrons thereagainst during the operation of transmitting a view which is focused onto the photosensitive surface. In this particular tube, the electrode referred to is constituted by a relatively thin sheet of aluminum provided with an insulating layer of aluminum oxide, over the surface of which there are a great number of minute globules of photosensitive material, insulated from each other and from the aluminum sheet by the layer of aluminum oxide. In operation, projection of an optical image of the object onto the photosensitive surface causes emission of the electrons therefrom in such manner and amount that electrostatic charges are stored by the individual globules, each charge corresponding in amount to the light intensity to which the respective globules are exposed. As the cathode ray scans the aluminum sheet, the electrons penetrate the aluminum layer and the aluminum oxide layer, or are otherwise effective to neutralize the charges on the globules, whereupon picture-signals are developed and applied from the screen to the input circuit of suitable amplifying and transmitting apparatus.

While this type of tube is effective to develop and transmit picture-signals which can be intercepted at a distant station and utilized to reproduce a recognizable image of the object, it is obvious that the efficiency of the device may be increased if the electrons are not required to penetrate a metallic screen before becoming effective to neutralize the electrostatic charges.

With the foregoing in mind, it is one of the objects of my invention to provide an improved screen structure for television transmitting tubes which, when embodied in the same, operates in such manner that the various conditions for most efficient operation can be realized, which is disposed between the electron gun and the lens system in a plane perpendicular to the axes of the gun and the lens system, which are aligned, and which is effective as a shield to prevent interference between the effects of photo-electric emission from the lens side of the screen and secondary emission from the opposite side of the screen.

Another object of my invention is the provision of an improved screen construction for television transmitting tubes which not only has the advantages referred to, but which can be made in a practical way to obtain the required number, size and distribution of the individual elements comprising the mosaic surface, in order not only to obtain the necessary detail for faithful reproduction, but to also obtain a value of capacity between the individual elements and the supporting base structure which is sufficiently large to insure storing up of the electrostatic charges linearly.

Another object of my invention resides in the provision of an improved photosensitive screen for television transmitting tubes which can be made without difficulty, comparatively speaking, and which has the advantages of the hypothetical, ideal screen, but none of the disadvantages of the various screen constructions proposed heretofore.

In accordance with my invention, I employ a supporting, metallic base member in the form of a wire screen or a perforated sheet, the wire screen being of the proper mesh, or the perforated sheet having the proper number and distribution of apertures to obtain the required number of individual elements per square inch for the mosaic surface. The supporting base member is enamelled or otherwise treated to give the same an insulating coating, and the openings or apertures are filled with silver or other suitable material to provide the correct number of minute metallic elements, each insulated from each other and from the metallic base member. The screen is embodied in the tube, in a plane perpendicular to the axis of the electron gun, with either surface facing the same, and with its edges in close proximity to the wall structure of the tube so that the same is effective as a shield to prevent undesirable interference between the respective effects due to secondary emission from the surface of the screen facing the electron gun and photo-electric emission from the opposite surface of the screen. The exposed ends of the individual silver elements, on that side of the screen on which the image of the object is projected by the lens system, are then photo-sensitized.

My invention resides in the improved screen construction of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

Figure 1 is an enlarged, fragmentary, sectional view of wire mesh used in constructing my improved screen;

Figure 2 is a view similar to Figure 1, illustrative of the construction after the enamelling step;

Figure 3 is a plan view, partly broken away and looking toward the right in Figure 2;

Figure 4 is a sectional view, the section being taken on the line 4—4 in Figure 3;

Figures 5, 6 and 7 are enlarged fragmentary views, illustrative of a method of making a perforated metallic sheet to serve the same purpose as the wire mesh in Figure 1;

Figure 8 is a simplified diagrammatic view, showing the manner in which my improved screen construction is embodied in a television transmitting tube, and illustrative of the manner of operation; and

Figure 9 is an enlarged, fragmentary, perspective view, partly broken away, illustrative of a complete construction embodying my invention.

In making my improved screen, I employ a metallic base member 10, in the form of a wire screen of 150 to 200 mesh, for example, and which is comprised of the shute wires 12 and the warp wires 14. A 150-mesh screen will have 22,500 openings or apertures per square inch, while a 200-mesh screen will have 40,000 openings to the square inch. While a finer mesh screen may be used, if required, it has been found that for present requirements screens of at least 150 to 200 mesh give satisfactory detail.

For the purpose of making the screen as nearly as possible the equivalent of a flat metal sheet provided with the same number of apertures per square inch, the screen is first passed through rollers and thereby flattened out, as represented in Figure 2. Both surfaces of the screen will then be flat, for all practical purposes.

The next step in the construction consists in applying an enamel or other insulating coating over the entire surface of the screen, but without closing the openings or apertures. In this connection, satisfactory results have been obtained by using vitreous enamel having a specific resistance of at least 10^{12} ohms per cm^3. The enamel frit is first ground very fine and then applied to the surfaces of the metal base member by spraying, dusting, settling from liquid suspension, or by any other method effective to coat the surfaces uniformly without clogging the apertures. The screen is then heated to fuse the enamel, the temperature and duration of the heating period depending upon the characteristics of the enamel used. In this way, a continuous and uniform insulating coating of enamel, the thickness of which is of the order of .0005″, is formed over all the surfaces.

On one side of the member 10 there will be an insulating layer 16, and on the other side there will be an insulating layer 18, with insulating bushings 20 lining the openings 22 and extending through the base member and merging with the layers 16 and 18.

In Figure 3, which is a view looking toward the right in Figure 2, part of the insulating layer 16 has been removed to illustrate more clearly the insulating bushings 20.

The next step in the construction consists in filling the apertures 22 with metal material so that there are, in effect, metallic inserts or elements 24 disposed in and substantially filling the respective insulating bushings 20. These elements are therefore insulated from the metallic base member 10 and also from each other, and the capacity between any particular element and the base member 10 is relatively great as compared with the capacity between adjacent elements. Furthermore, the opposite ends of each of the elements 24 are exposed on the respective opposite sides of the screen structure, as more clearly shown in Figure 4. It is proposed to fill the openings 22 with the metal by pressing the metal, in powder or paste form, into these openings, after which the opposite surfaces of the screen are cleaned to remove any excess metallic material which might have adhered to the insulating layers 16 and 18. As an alternative, the apertures 22 might be filled with the metal by an electrolytic process by electro-plating through the apertures 22 onto a continuous conductor on one side of the screen, after which such conductor is removed by grinding, for example.

The completed screen, designated generally in Figure 8 by the reference numeral 26, is then sealed in the highly evacuated tube 28 of the cathode ray device 30, and is disposed as shown in a plane perpendicular to the axis of the gun 32 which operates to develop and direct a ray 34 of electrons at that side of the screen provided with the insulating layer 18. The ends of the minute metallic elements 24 which project through to the opposite side of the screen are then photosensitized in a well known manner whereby the proper amount of photosensitive material 36 is deposited over those ends of the elements 24.

In operation, an image of the object 38 is projected onto the photosensitized surface by a suitable lens system 40 whose axis is perpendicular to the screen 26 and in alignment with the axis of the gun 32. There will then be photo-electric emission from any particular element 24, 36 in an amount corresponding to the light intensity on such element at the instant, and this element will accordingly store up an electrostatic charge in an amount corresponding to the light intensity. In this way, during any framing period, individual electrostatic charges are stored over the surface of the screen, the value of the charge at any particular elemental area corresponding to the light intensity at the instant on such area. The electrons emitted from the lefthand surface of the screen 26, due to photo-electric action, are withdrawn or removed by an electrode 42 which is maintained at a relatively high positive potential, as indicated in Figure 8. The electrode 42 may be in the form of a few fine wires stretched across a suitable frame, so as not to interfere with projection of the light image onto the screen 26.

The picture-signals are developed as the ray 34 is caused to scan the righthand surface of the screen 26, for which purpose the ray is deflected horizontally at a relatively high rate and is simultaneously deflected vertically at a relatively low rate by suitable means such as coils or plates (not shown). The ray 34 is focused on the screen 26, and as the electrons of the ray strike the exposed righthand ends of the metallic elements 24, the electrostatic charges previously stored are neutralized, whereupon electrical impulses, corresponding in amplitude to the respective values of the charges, appear in a connection 44 which is connected to the metallic base member 10, and are applied as shown to the grid circuit of an amplifier tube **46**. The amplified picture signals are then supplied by a connection **48** to a suitable radio transmitter **50** and are utilized to modulate a carrier-wave.

During the scanning action, the electrons of secondary emission which are emitted from the righthand surface of the screen **26**, are collected by an anode **52** which is maintained at a relatively high positive potential with respect to the cathode **54** of the electron gun, as represented in Figure 8. The electrode **52** may be in the form of a silver coating on the inner surface of the tube **28**, and serves not only to collect the electrons of secondary emission as explained, but to focus the ray on the screen **26** and impart a relatively high velocity to the electrons so that they strike the elements **24** at a high rate of speed.

As indicated in Figure 8, the dimension of the screen **26** is only slightly less than the inside diameter of the large end of the tube **28**, so that the edges of the screen are in close proximity to the wall structure of the tube. The screen is therefore effective as a shield to prevent any appreciable interference between the electrons due to secondary emission and the electrons due to photo-electric emission. In this connection, it is important that the screen **26** be impervious to the flow of electrons in the ray **34**. There is, therefore, no interference of these electrons with respect to the electrons of photo-electric emission on the opposite or lefthand side of the screen.

From the foregoing it will be seen that the positive potential on the collector electrode **42** may be as high as desired for most efficient operation, without interfering with the operating effects taking place at the same time on the opposite side of the screen where the electron gun is located. The important advantage in this resides in the fact that all of the photo-electrons can be drawn off, the condition of relatively high positive potential on the electrode **42** for this purpose being independent of the other potentials on the respective electrodes. The polarities and relative values of potential on the various electrodes are as indicated in Figure 8.

In lieu of using a fine mesh screen for the base member **10**, as in Figure 1, I propose to make this member from a thin sheet of metal by the photo-engraving process. The steps in this process are illustrated in Figures 5, 6 and 7. A relatively thin metal sheet **56** is first provided on the surface thereof with a photographic emulsion **58**, after which a pattern of the minute apertures required is photographed on this layer and the layer subsequently treated to form a protective coating over the surface, except at the minute spots where the apertures are to be. An acid or other suitable etching substance is then applied to the photographed surface. The material of the layer **60** is resistive to the action of the etching substance, but the metal at the unprotected spots is not. The etching substance is therefore effective to eat through the material at these spots to form the minute apertures **62** which correspond in size, number and arrangement to the apertures **22** in Figure 3. The sheet is cleaned, and then enamelled in the same manner explained above, to provide the insulating layers **16a** and **18a** in Figure 9, corresponding respectively to the layers **16** and **18** in Figure 2, and to also provide an insulating bushing **20a** in each of the apertures, and which corresponds to the bushings **20** in Figures 3 and 4. Metallic elements **24a**, corresponding to the elements **24** in Figure 4, are then inserted into the respective bushings **20a**, and are photosensitized as before explained to apply photosensitive material **36** over the ends of the elements on one side only of the screen.

From the foregoing it will be seen that I have provided improved screen construction for television transmitting tubes which can be made in a practical way to have the required number of minute, individual elements to make up the mosaic structure, which is impervious to the flow of electrons, and which is effective as a shield, and can be so placed in the tube to attain the highest efficiency of photo-electric emission without interfering action due to the effect of secondary emission or to the electron bombardment by the cathode ray.

I claim as my invention:

1. Screen structure comprising a metallic base member honeycombed with metallic elements each of which is confined within the body of said base member and has its opposite ends exposed on the respective opposite sides of said member and each of which is insulated from the other elements and from said base member, the ends of said elements on the same side of said base member being photosensitized.

2. Screen structure comprising a metallic base having an insulating layer over a side thereof and insulating bushings merging with and extending from said layer into and through said base to the other side thereof, and metallic inserts disposed in and substantially filling the respective insulating bushings whereby said inserts are insulated from said base and from each other and whereby the capacity between any particular insert and said base is relatively great as compared with the capacity between adjacent inserts and whereby the opposite ends of each insert are exposed on the respective opposite sides of said screen structure, the ends of said inserts on said other side of said base being photosensitized.

3. An article of manufacture comprising a screen structure impervious to the passage of electrons through the same at every elemental area, of its entire effective operating area, said operating area being in the form of a mosaic comprising individual operating elements insulated from each other and distributed over said operating area and being in number at least twenty thousand of said elements over each square inch of said operating area; said structure comprising a metallic base having an insulating layer over a side thereof and insulating bushings merging with and extending from said layer into and through said base to the other side thereof, and metallic inserts disposed in and substantially filling the respective insulating bushings whereby said elements are insulated from said base and from each other and whereby the capacity between any particular insert and said base is relatively great as compared with the capacity between adjacent inserts and whereby the opposite ends of each insert are exposed on the respective opposite sides of said screen structure, the ends of said inserts on said other side of said base being photosensitized.

4. An electrode comprising a reticular base constituted by a plurality of interwoven insulated metallic filaments and electrically conductive material in the interstices between the filaments and extending through the reticular base from one surface to the other surface thereof, the portions of said material exposed at at least one of said surfaces being photosensitive.

5. The process of fabricating mosaic electrodes from a wire mesh screen which comprises coating the screen structure with an electrically insu-

lating substance and filling the interstitial spaces with an electrically conductive material.

6. The process claimed in the preceding claim comprising in addition, the step of photo-sensitizing one side of the electrically conductive material suppofted within the interstitial spaces of the mesh.

7. The process of fabricating mosaic electrodes from a wire mesh screen which comprises rolling the said wire mesh screen to imbed the wires of the warp with the wires of the weft at their intersections, coating the screen structure with an electrically insulating substance, and filling the interstitial spaces with an electrically conductive material.

8. The process claimed in the preceding claim comprising in addition, the step of photosensitizing one side of the electrically conductive material supported within the interstitial spaces of the mesh.

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