Feb. 27, 1962 R. H. COLBORNE ET AL 3,023,137

CATHODE RAY TUBES

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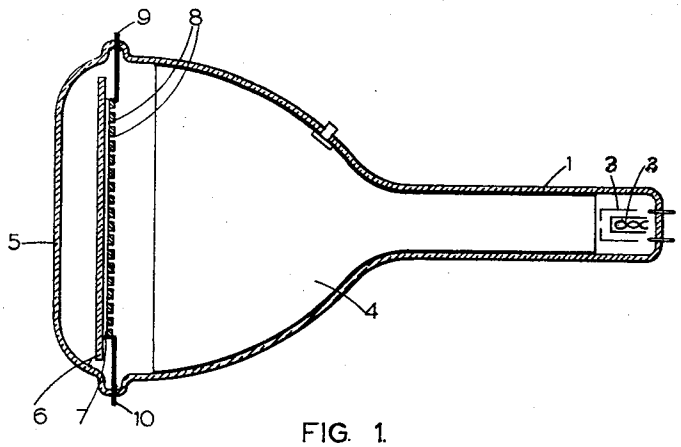


FIG. 1.

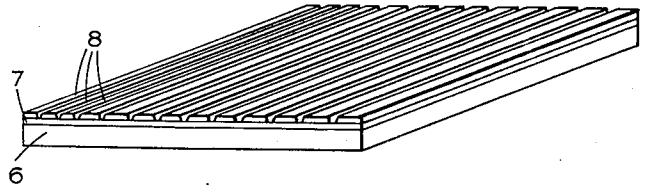


FIG. 2.

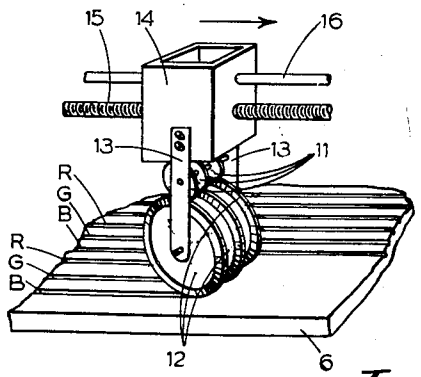


FIG. 3.

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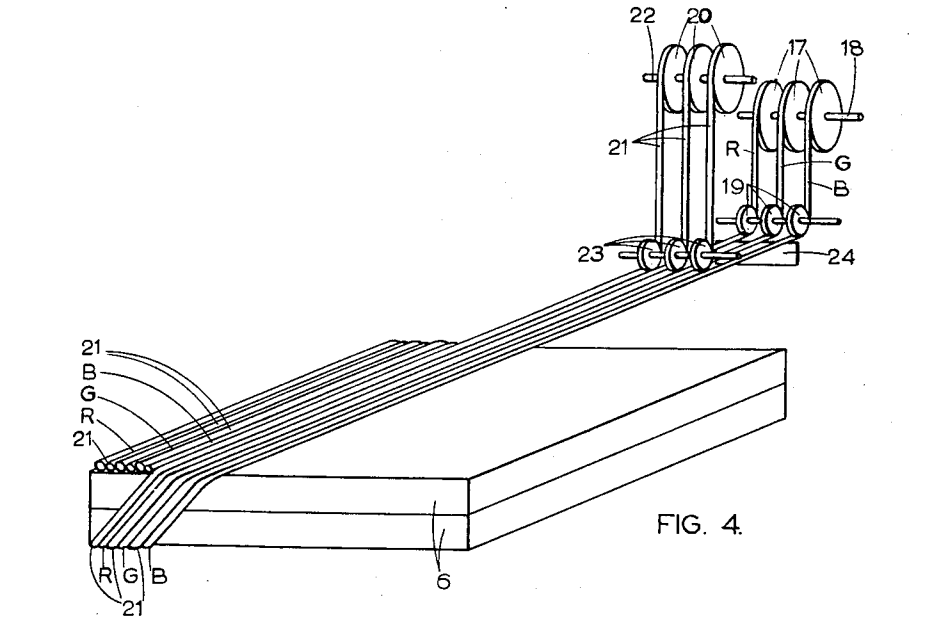


FIG. 4.

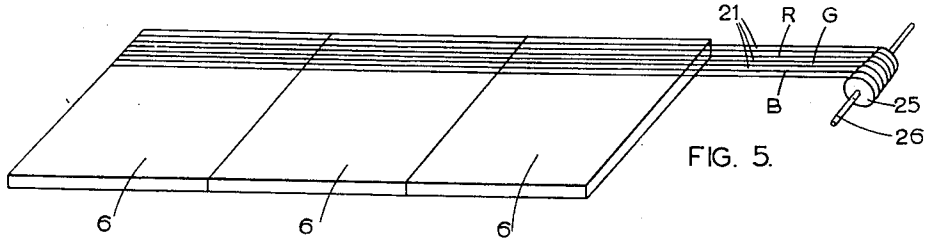


FIG. 5.

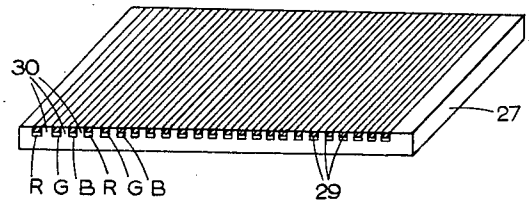


FIG. 6.

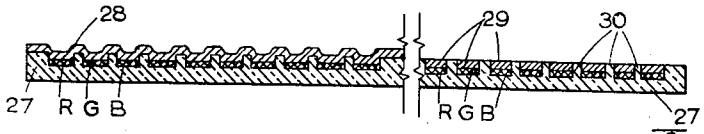


FIG. 7

FIG. 8.

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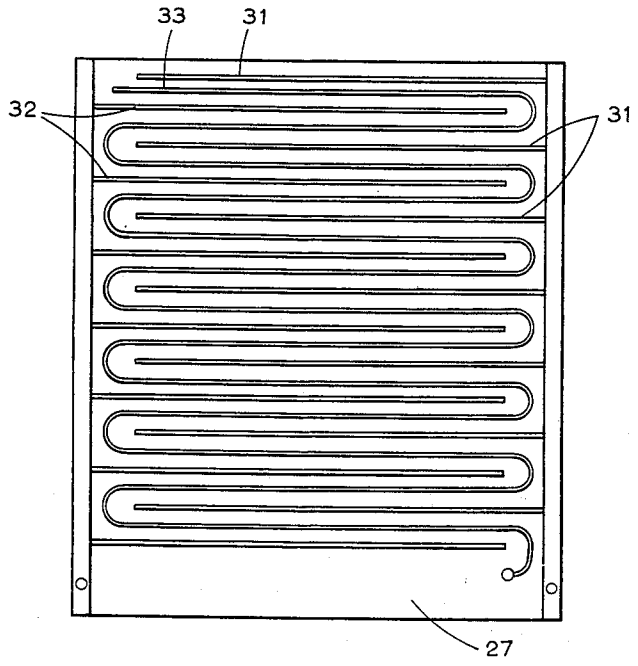


FIG. 9

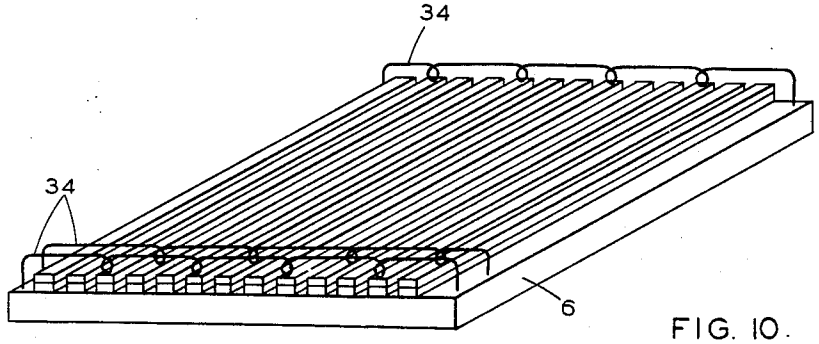


FIG. 10.

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3,023,137
CATHODE RAY TUBES

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12 Claims. (Cl. 156—67)

The present invention relates to cathode ray tubes and in particular to luminescent screens therefor.

With cathode ray tubes such as those employed for television reception it is often desirable to provide a conductor in close proximity to the phosphor surface, for example, over areas of line length and width. Such an arrangement is required in tubes for color television where the screen is deposited in line form, the adjacent lines being of different phosphors which when struck by electrons give off light of different colours, e.g. red, green and blue. A screen of this kind will therefore comprise a large number of phosphor lines having widths corresponding substantially to beam spot diameter and each consecutive line providing a different colour. In the operation of the tube this electron beam is arranged to scan the screen in a line by line manner and during this scanning it is essential that accurate registration with the various phosphor lines are maintained otherwise a true colour rendering will not be obtained.

It has already been proposed to obtain registration of a line phosphor screen of this kind by providing the different phosphor materials on line conductors which are electrically separated from each other, these conductors being arranged so that consecutive conductors correspond to different colours, and all the conductors of each colour group are connected together.

By applying a high positive potential to the conductors of one group and zero or negative potentials to the other conductors the beam is directed so that it is only able to reach the phosphors on the high potential conductor during the scanning cycle. Tubes constructed in this manner have the disadvantage that it is necessary to view the image from the side of the screen which is struck by the electron beam.

It is therefore an object of the present invention to provide a cathode ray tube having a luminescent screen which is capable of being viewed from the side thereof which is opposite to that struck by the electron beam and which is also provided with electrical conductors to enable accurate positioning of the electron beam striking said screen.

According to one feature of the invention there is provided a cathode ray tube including a luminescent screen mounted on a translucent support, the phosphor surface of said screen which faces the electron beam having thereon a series of electron permeable metal strips which are formed by mechanically dividing a coherent continuous layer of electrically conducting material deposited on said screen.

According to a second feature of the invention there is provided a method of forming electrical conductors on a luminescent screen comprising, coating said screen with a coherent continuous layer of electrically conducting material of a thickness such that said layer is permeable by electrons and thereafter mechanically removing selected portions of said layer to divide it into a plurality of separated individual conductors of strip form extending over said screen.

The luminescent screen may comprise different phosphor materials deposited in line sequence on the support, said conductive layer being divided at a position between

each line so that each line of phosphor is covered by an individual conductor. Preferably the conductors covering phosphor lines of the same material are connected together as a group.

In order that the invention may be more fully understood various embodiments of same which are suitable for the production of cathode ray tubes for television purposes will now be described with reference to the accompanying drawings, in which:

FIGURE 1 illustrates a cathode ray tube including a luminescent screen having metal strips according to the invention,

FIGURE 2 shows in greater detail the screen of FIGURE 1,

FIGURE 3 illustrates means for depositing phosphor materials on a screen support for a colour tube,

FIGURES 4 and 5 illustrate alternative ways of forming a colour screen according to the invention,

FIGURE 6 shows a colour screen in which phosphors and metal strips are formed in grooves in a support plate,

FIGURE 7 is a section of part of a screen of the kind illustrated in FIGURE 6 in an early stage of manufacture,

FIGURE 8 a section of part of the completed screen of FIGURE 6,

FIGURE 9 shows an alternative form of grooved colour screen, and

FIGURE 10 one way of electrically connecting the individual metal strips into groups.

Referring to FIGURE 1 there is shown a cathode ray tube comprising within an evacuated glass envelope 1 a thermionic cathode 2, cathode screen 3 and wall anode 4 the front end 5 of the envelope being constructed as a plain glass window. The luminescent screen comprises a translucent supporting member 6 such as a sheet glass plate of rectangular shape which is coated on one of its major surfaces with a layer of phosphor particles 7. The deposition of the phosphor layer may be carried out in any of the manners now well known in the art, for example, by first coating the surface of the glass 6 with an adhesive such as potassium silicate and then dusting or spraying the phosphor particles thereon, by suspending the particles in a suitable vehicle such as potassium silicate and applying it in the manner of paint, or by allowing the particles to settle on to the surface from an aqueous suspension.

The screen so formed is then further treated so as to provide it with a coherent layer of electrically conductive electron permeable material such as aluminium, beryllium or magnesium. The surface of the phosphor screen 7 on which the conductive layer is to be deposited is of irregular form and since it is preferable that this conducting layer should also be highly reflecting, a technique which is now well established in the production of cathode ray tube screens is employed for putting down the conducting layer. In these known methods the irregularities in the surface of the screen are smoothed out by means of a suitable filling material or by stretching across the peaks of the phosphor crystals a film of a heat removable material such as nitrocellulose, the metal being deposited on this intermediate layer by evaporating in vacuo.

In accordance with the invention the metal layer on the screen is mechanically divided, as more clearly shown in FIGURE 2, by any suitable dividing means such as by a reciprocating cutter so as to provide a number of individual strip conductors 8, each covering an area of the screen 7 of line length and having a width of the electron scanning beam. If the tube is required for use with a picture transmission comprising 405 lines with interlaced frames the sub-division may be such as to provide 405 conductor strips 8 covering the picture area,

the alternate conductors being joined together to form two interleaving groups. The glass plate 6 with the screen 7 and conductors 8 thereon is assembled within the tube envelope 1, with the uncoated side facing the translucent window 5 its opposite side having the conductors 8 facing the cathode 2, lead conductors 9, 10 being provided for applying potentials to each group of strip conductors 8. In operation, during one frame of the interlaced transmission, a high positive potential is applied to one group of strip conductors and a zero or negative potential to the other group so that on scanning the strips with an electron beam only the line of phosphor covered by the high potential strip in proximity to the beam will be excited to luminescence, the low potential strips on each side thereof will also assist in directing the electrons on to the high potential strip. By switching the potentials applied to the respective groups of strips so that they are reversed in sequence with each interlace frame period, accurate registration of the beam on the respective strips can be maintained throughout the scanning cycle.

Although accurate registration of the electron scanning beam in a tube providing a monochrome picture as above described is very desirable, the effects of mis-registration are less noticeable than with tubes designed for colour television having different coloured phosphor strips arranged in line sequence where any mis-registration during scanning may provide an improper colour rendering.

In applying the invention to the construction of tubes for colour purposes, the various different phosphor materials are deposited on a translucent support as stripes of line length so that each consecutive stripe will fluoresce in a different colour, i.e. for a three colour system the stripes may be arranged to fluoresce red (R) green (G) and blue (B) R, G, B, R, G.

One convenient way in which phosphor stripes may be applied to the support 6 is shown in FIGURE 3. The various phosphor materials which produce the different colours when excited by electrons are made up with a suitable binder to a consistency such as that of printing ink and each different colour is applied by means of a series of rollers 11 to a series of printing wheels 12 of line width and constructed for example of fairly hard rubber. The rollers 11 and wheels 12 are mounted in contacting engagement with each other by means of arms 13 attached to a carriage 14 caused to move across the screen support 6 by a screw 15 and guide rod 16 so as to deposit the phosphor materials in lines thereon. Instead of employing a series of three printing wheels 12 each having a different colour phosphor a number of wheels corresponding to a number of lines and each adapted to print the same colour may be employed. In such an arrangement the wheels are all mounted on a common spindle, but each of them is spaced apart by a distance equal to double the width of a colour stripe. Alternatively, the support may be coated with a suitable adhesive and phosphor particles sprayed thereon through a series of suitable stencil masks. The irregular surface of the phosphor screen is rendered smooth, and provided with a continuous conducting layer by evaporating a metal thereon in the manner previously described. The metal layer is then sub-divided in the manner previously described so as to provide an individual conductor over each phosphor line, the various conductors covering each of the phosphor strips corresponding to a particular colour are connected together in a manner to be described later, so as to provide three groups of conductors corresponding with R, G, and B phosphor colour stripes.

With a three colour system having a definition equivalent to the 405 line monochrome transmission it will be necessary to provide a total of about 1200 lines of phosphor and the same number of conducting strips backing same. To minimise colour fringing with an interlaced transmission the phosphor line sequence may be R, B, G, R, B, G, . . . , the scanning sequence for the first interlace frame being R, G, B, . . . and for the second interlace frame B, R, G, ... In operating the tube with a sequential system the potentials applied to the various groups of conductors are switched at colour frame frequency so that a high positive potential with respect to the cathode of the tube is applied to the conductors of the group representing the required colour for that particular frame, i.e. red, the other two groups, i.e. G, B, being maintained at a potential nearer to that of the cathode or negative with respect thereto.

In an alternative manner of constructing screen plates for colour tubes a pair of plates may be made simultaneously as illustrated in FIGURE 4.

Two translucent supporting plates 6 formed, for example, of glass are placed together with their major surfaces abutting and are then coated except for their edges with an adhesive such as phosphoric acid or sodium silicate. Continuous lengths of colour strips are formed by drag-coating woven glass threads with appropriate different coloured phosphors the phosphor coating finally being protected with a coating of varnish such as nitrocellulose, and wound for storage onto spools.

Three of the spools 17 having threads coated with phosphors in this manner are mounted on an axle 18 so that they pass over guide rollers 19. A further series of three spools 20 having thereon uncoated spacer threads 21 of slightly larger diameter than the color threads R, G, B are mounted on an axle 22 and pass over guide rollers 23 so that they interlace with the colour threads. The spacer threads 21 may also be of glass but alternatively they may be formed of an organic material which can be removed by heat. The series of six threads are then wound around the two plates 6 until the required number of phosphor lines are provided. If desired during winding of the threads onto the plate the coated threads R, G, B may be arranged to pass over a scraper 24 which removes the phosphor coating from those portions of the threads which will be positioned immediately adjacent the surface of the plates 6. The plates 6 are then thoroughly dried so as to set the adhesive bonding the threads 21 and R, G, B thereto and are then provided with a continuous film in the above described manner and thereafter a continuous conducting layer is evaporated on both of the major sides following the methods previously described. To provide independent conducting strips over each line of phosphor the conducting layer is removed along the lines provided by the spacing threads either by cutting or by a light buffing. The two plates 6 are now separated by cutting the threads wound over the edges, the individual conductors provided over phosphors having the same colour being connected together and the plate mounted within the envelope of the tube. Instead of winding the phosphor coated threads R, G, B and the spaced threads 21 around a pair of glass plates the threads R, G, B and 21 may be stretched across a single glass plate or, as shown in FIGURE 5, over a series of such plates 6 each coated on one surface with an adhesive. When forming screen plates in this manner the number of coated and spacer threads which are stretched across at any instant will be determined by the convenience of handling but by way of example six such threads are shown in FIGURE 5 taken from spools 25 mounted on an axle 26.

As an example it may be mentioned that the coated threads R, G, B may have a diameter of 0.004 inch and the spacer threads 21 0.006 inch so that with a screen comprising 1215 colour lines having a 4 by 3 aspect ratio the picture size of the screen will be 16 x 12 inches.

In a yet further method of producing colour screens illustrated in FIGURES 6, 7 and 8, the plate glass supporting member 27 is first rolled whilst plastic to form a pattern of grooves on one major surface, each groove being of line width and the number of grooves corresponding with the required number of lines, i.e. 1215.

Different phosphor materials R, G, B are deposited in the grooves, such as by a printing wheel previously de-

scribed, so that the grooves are provided with red, green and blue light emitting phosphors in repeated line sequence. The surface of the screen plate having the phosphor coated grooves in them filmed and coated with a continuous conducting layer 28, see FIGURE 7, in the manner previously described and the conducting layer on the tops of the ridges between the grooves is removed by cutting or by a light buffing operation leaving individual conductors 29 in the grooves, see FIGURE 8, and clear insulating land portions 30 therebetween. The conductors 29 covering phosphor strips having the same colour are electrically connected together so as to form three groups of conductors.

When employing the construction using a grooved plate 27 the grooves may be molded into a pattern such that, as illustrated in FIGURE 9, all grooves 31 destined to take one colour phosphor, e.g. red, extend beyond the picture area and terminate at one edge of the plate 27, the grooves 32 which are to take a second colour, e.g. green, extending in a similar manner but terminating at the opposite edge of the plate. The third colour, blue, is provided in a continuous groove 33 of zig-zag form passing between the series of grooves 31, 32 containing the other colours but out of contact with the terminations thereof. After filming and depositing of the continuous conducting layer thereover the coating is removed from the ridges between the grooves 31, 32, 33 so that the conductor extending over the blue phosphor is a continuous strip throughout its length and can be directly connected at either of its ends to a lead out conductor, the conductors covering the red and green phosphor grooves being connected into groups by bus-bars 34, 35 provided at opposite sides of the picture area.

Electrical connection of the various conductors into colour groups in any of the above described constructions of screen plates such as the colour plate 6 formed in the manner described in connection with FIGURE 3 will now be described with reference to FIGURE 10. In this figure there is shown three tungsten wire elements 34 each wound into a helix so as to have a pitch corresponding to the distance between the centres of the conducting strips covering the adjacent phosphors of any particular colour group, i.e. the distance between the centres of the 1st and 4th and 7th etc. conductors. The helices 34 formed in this manner are then positioned so that the turns make contact with each of the conductors of the group which are to be connected together and the helices fixed in position by sealing them at their ends to the glass plate 6. Alternatively and particularly in the example where the metal is removed by a cutting operation a short wire or pin of, for example, chrome-iron may be sealed into the glass plate at the position which will be occupied by a conductor and after deposition of the conductor and the removal of portions of the metal thereof, the pins contacting the respective colour conductors are electrically connected together.

The translucent screen supporting members 6 or 27 described above may be constructed so that they can themselves form the end wall of the tube in which case it will need to be sealed to the conical portion of the envelope by some low temperature sealing compound such as a glass frit or enamel. When the screen is a plate which is to be mounted within the envelope as shown in FIGURE 1, some form of low temperature sealing of the envelope parts, i.e. 1 and 5, is again desirable in order to prevent damage to the phosphors 7 and the conducting strips 8. For example, the glass window forming the end wall of the tube may be provided at its peripheral edge with chrome-iron rings heat sealed thereto which engage with a similar ring provided on the conical portion of a glass or metal envelope. The screen plate is mounted in the envelope with the conductors facing the electron gun and the envelope completed by seam welding the rings on the window and the cone together. Alternatively, when the cone portion of the envelope is also made from glass, the peripheral edges of the windows and mating edge of the cone may be optically polished and the two members joined together by heat and pressure using a glass frit or enamel which softens at a low temperature, i.e. about 350° C. In this latter construction lead connections for the various groups of conductors may be taken out at this sealed junction by using platinum paste strips burnt into the glass.

Although as mentioned it is possible to obtain registration of the beam on the various conductors by applying a high positive potential to one conductor and a zero or negative potential to the adjacent conductors there are other ways in which said conductors may be employed to obtain registration of the scanning beam. In an alternative way of operating such a tube the conductor adjacent the high potential conductor are maintained at a relatively low positive potential such that in the event that the beam strikes one or other of the conductors signals are generated which are fed to the scanning means to cause shift of the beam in the appropriate direction.

What we claim is:

1. A method of forming electrical conductors on a luminescent phosphor screen comprising depositing phosphor material on a translucent support, coating said phosphor with an imperforate continuous adherent layer of electrically conducting material of a thickness such that said layer is permeable by electrons and thereafter cutting away selected portions of said layer to divide it into a plurality of separated individual conductors of strip form extending over said phosphor screen.

2. A method of forming a luminescent phosphor screen comprising depositing phosphor material on a translucent support as a series of individual strips, depositing a thin, imperforate continuous adherent electron permeable layer of electrically conducting material so as to cover said strips and the spaces therebetween and thereafter cutting away portions of said layer lying between adjacent phosphor strips to divide said conducting layer into a plurality of individual conductors of strip form covering in a coextensive manner said individual phosphor strips.

3. A method according to claim 2 wherein said individual stripes of phosphor material are deposited on said support by printing by means of wheels.

4. A method according to claim 2 wherein said layer is divided into individual conductors by operating thereon with the cutting tool of a ruling machine.

5. A method of forming a luminescent screen on a translucent support as an array of phosphor stripes comprising providing grooves in said support at positions where said stripes are to be provided with lands separating said grooves, depositing phosphor material in said grooves, depositing a thin imperforate continuous adherent electron permeable layer of electrically conducting material so as to cover said phosphor and said lands and cutting away portions of said layer on said lands so as to divide said layer into a plurality of individual conductors of strip form covering said phosphor stripes.

6. A method of forming a luminescent screen according to claim 5 wherein said phosphor material is deposited to an extent which is insufficient to fill said grooves.

7. A method according to claim 5 wherein said grooves are formed as a first series of grooves extending partially across a surface of said support so as to terminate at one edge thereof, a second series of grooves extending partially across said surface so as to terminate at the opposite edge thereof, said first and second series of grooves being arranged in interlaced relationship and a further groove of zig-zag form formed in said support and arranged to pass in a continuous manner between adjacent grooves of said first and second series of grooves.

8. A method according to claim 5 wherein the portions of the conducting layer deposited on said lands is cut away therefrom by buffing.

9. A method of forming a luminescent screen on a translucent support comprising coating threads with phos-

phor material, interleaving said coated threads with other threads of larger thickness to provide spacer threads, securing all said threads on a major surface of said support so as to provide phosphor coated linear threads in a recurring sequence with spacer threads said spacer threads because of their greater thickness projecting beyond and forming lands between said coated threads, depositing a thin coherent electron permeable layer of electrically conducting material so as to cover all said threads and mechanically removing said electrically conducting material covering said lands formed by said spacer threads so as to divide said layer into a plurality of individual conductors of strip form extending over said phosphor coated threads.

10. A method according to claim 9 wherein the conducting layer deposited on said lands is removed therefrom by buffing.

11. A method according to claim 9 wherein all said threads are made of glass.

12. A method according to claim 9 including the step of providing a pair of supports each of plate form placing said supports together with major surfaces thereof

abutting, winding said coated threads with said spacer threads interleaved therewith around said supports so as to cover exposed major surfaces of both said supports with said threads, securing said threads to said exposed surfaces and cutting said threads at the edges of said plates to enable said plates to be separated.

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