May 7, 1957 R. DRESSLER 2,791,710

GRID STRUCTURE FOR TELEVISION TUBE

Filed March 23, 1953

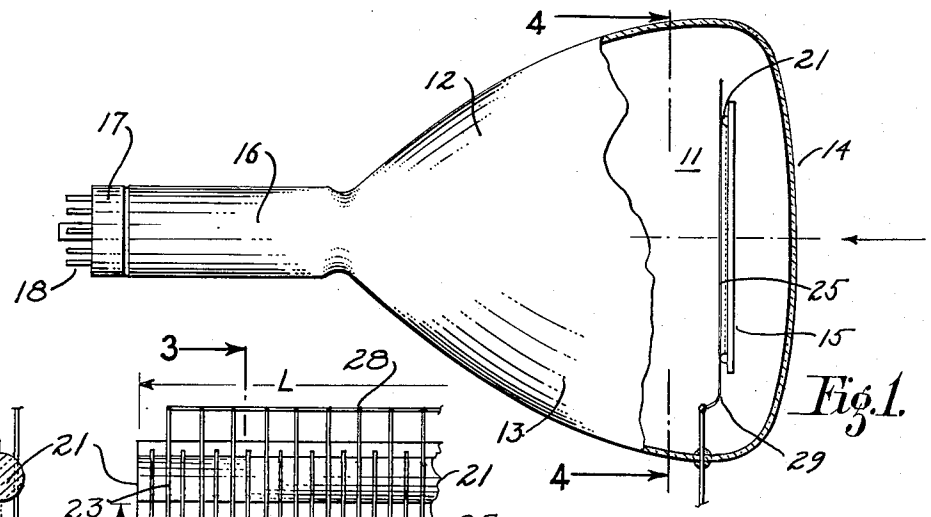

Fig. 1.

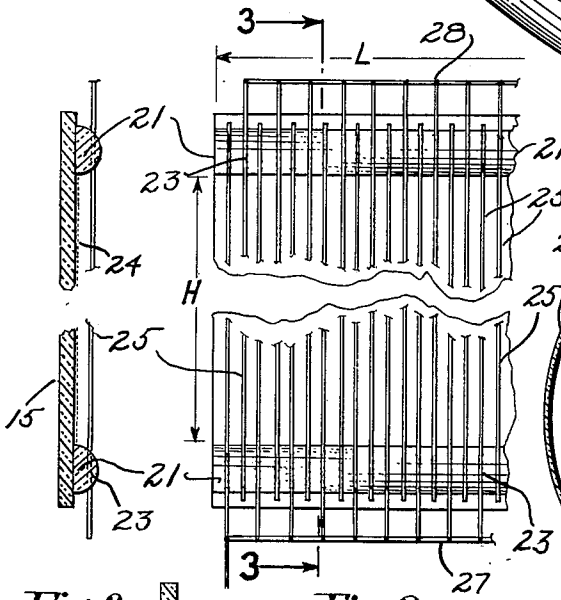

Fig. 3.

Fig. 2.

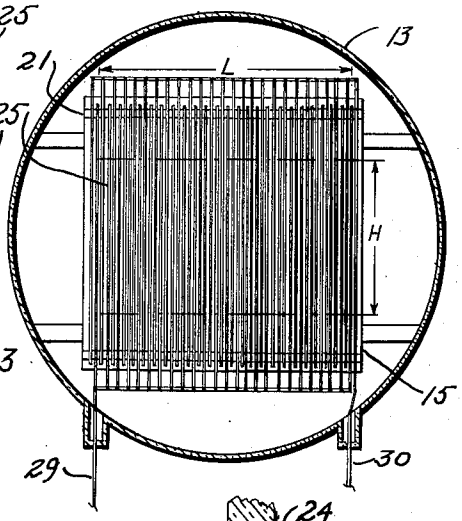

Fig. 4.

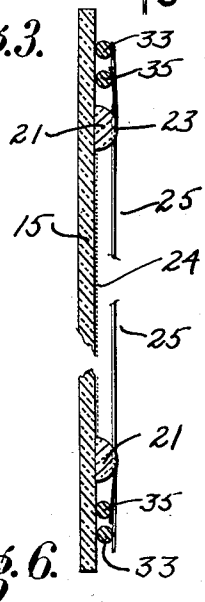

Fig. 6.

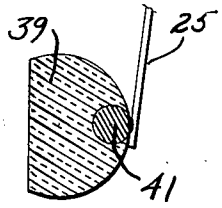

Fig. 7.

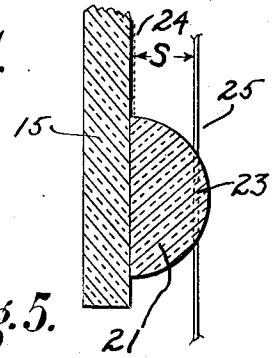

Fig. 5.

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United States Patent Office 2,791,710 Patented May 7, 1957

2,791,710

GRID STRUCTURE FOR TELEVISION TUBE

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Application March 23, 1953, Serial No. 343,834

1 Claim. (Cl. 313—78)

This invention relates to cathode ray tubes of a type usable to produce and display images in either substantially natural color or monochrome. The images which are to be created for display upon the tube target are developed as the result of one or more electron beams impacting a phosphor coated target area thereon to develop electro-optical effects which become observable as light images. The impacting electron flow toward the target area from any suitable source is adapted to be signal controlled by any desired form of modulation mechanism and bidimensionally deflected relative to the impacted target area so that a raster is traced according to well known patterns.

While the invention is applicable to electronic tubes designed for image production in either substantially natural color or monochrome consideration will be given in this description primarily to the tube as used in a color operation. As such, a tricolor additive system of creating the images which, when viewed, evoke in the mind of the observer the effect of an image in substantially its true and natural color will herein be considered. Such images are obtained by arranging coatings of phosphors to respond under electron beam impact to produce light observable in each of the primary or component colors red, green or blue of a tricolor adding to produce when observed in equal intensity the effect of white light from the target surface.

There has already been set forth in the prior art a proposal to form a phosphor coated target upon which the electro-optical images are created of a series of strips, each of a width representing a fraction only of that width which at any point in the finally traced raster is developed. The strip lengths usually may be considered, for illustrative purposes, as corresponding to one dimension of the raster to be developed, although it will be understood that in practice and in the fabrication of the coated target surface, with which target construction this invention is, per se, not concerned, practical considerations usually require that the phosphor strip length exceed slightly one dimension of the raster.

In tubes wherein a target surface is formed in such fashion proposals have been made whereby the separate strips of the target coating may be scanned or traced by the electron flow concentrated into a suitable scanning cathode ray beam so deflected that the tracing path follows the length of the target strips or in such fashion that the rapid tracing path is transverse to the target strips. This particular invention is adapted to either form of operation, although, for reference purposes where any mention is made of the type of scanning operation it will be explained, illustratively, as being transverse to the long dimension of the phosphor coated strips.

Various proposals have been made by Ernest O. Lawrence and James T. Vale, as exemplified by their Letters Patent of the United States identified as Nos. 2,692,532; 2,711,493; 2,695,072; 2,669,675, and 2,721,288, granted respectively on October 26, 1954; June 21, 1955; November 23, 1954; February 16, 1954, and October 18, 1955, with respect to various ways to support and locate a grid electrode adjacent to a phosphor coated target of the type above described. Complete theoretical description of the functioning of a grid of this character is consequently considered unnecessary in this application except to state that the so-constructed grid is intended to function either as a component of an electron lens arrangement of the general character described by the above named Lawrence applications, and also by U. S. Letters Patent No. 2,532,511, granted to Ferenc Okolicsanyi, or the grid structure may also act as a color control electrode, or it may have a dual function to accomplish both objectives last named.

The present invention, despite such utility of the grid structure, is concerned, however, with the formation of the grid itself and with the positioning of such a grid relative to the tube target. In this connection it is particularly important and essential to high fidelity operation of a cathode ray tube adapted for the production of images in either their substantially natural color or in monochrome that precise relative alinement of the conducting strands (usually in the form of wires) of which the grid electrode is formed be established relative to the phosphor target strips. As such, the grid conductors are arranged to extend parallel to one edge of the phosphor strips and for a length usually, from practical standpoint, slightly in excess of the phosphor strip length, the excess length being used to provide for supporting the grid conductors and for connecting them to operating electrical circuitry through suitable connections made to the tube. Further than this, the present invention is particularly concerned with providing a mechanism for supporting and anchoring the conductors forming the grid in such a way that precise parallelism will be maintained between adjacent grid conductors and, at the same time, the conductors when drawn taut relative to the supporting components may readily be alined in coplanar fashion and spaced at any desired optimum operating distance from the target.

In the form of construction to be considered in this disclosure the grid is placed and supported in fixed fashion substantially adjacent to the target area which is coated with the already discussed phosphor strips. In this connection, as the grid will be described herein and set forth in the claims, it will be understood that the grid element is located relative to the phosphor coated target at such a distance therefrom that the effect of its field in the plane of the target is substantially uniform. In preferred forms of tubes it is spaced apart from the plane of the target surface by a distance which is only an extremely small fraction of the length of the electron path from the source to the final target plane and it is closer to the target than any other active elements of the tube. As such, it will be understood in the description to follow that reference to positioning mechanisms for supporting the grid relative to the target will be defined in this sense as positioning the grid "adjacent" to the target.

As cathode ray tubes are usually constructed the phosphor coating is applied to a transparent vitreous window surface within the tube so that when the developed electron flow within the tube impacts the target and the energy of the electrons is converted into electro-optical effects those effects are visible through the target surface. Alternatively, in some tubes a target of this character is positioned internally of the tube end wall for convenience of manufacturing and the developed electro-optical effects created upon the target surface are then viewed through a transparent window constituting the end wall of the tube, as contrasted with both the target surface and the tube

end wall being identical. Either form of construction falls within the scope of this invention, but for purposes of illustration and in order to describe this invention in one of its simpler adaptations it will be assumed that the target surface is a planar vitreous element supported within the tube envelope just slightly within the confines of a transparent tube end wall.

According to the invention, as it will be herein described, suitable grid conductors or wires for a structure which will serve as an accelerating, focusing and color control grid of the general type already mentioned are strung or tightly stretched over suitable support rods located generally to border two opposite edges of what will be formed as the raster area in the tube in its operation. Considering the target surface to be adapted for tricolor operations the separate phosphor strips having such characteristics as to fluoresce in different colors upon excitation may be arranged on the target surface according to a repeating color cycle. Such a color cyle, by way of example, may follow a pattern to produce light in the colors red, green, blue, green, red, green, blue, green, and so on. A pattern of this character is generally one where the width of the phosphor coated strip area to produce each of the red and blue light is one-third of the width of one elemental area into which it is assumed the image division takes place.

Since the suggested color cycle provides twice as many phosphor coated strip areas to produce green light as those used to produce the red and blue light, it is usually desirable for the obtainment of a proper balance of color to form the green-light-producing strips to approximately one-half the width of those used to produce red or blue light. Here again, however, the explanation is purely illustrative and per se forms no part of the present invention except insofar as it aids in the general understanding and relates the type of grid support and structure herein to be set forth to a tube of the character mentioned so that the strips to produce green light may for some tubes equal the width of the other strips. So considered, the grid conductors or wires will be observed, when supported, to be electron-optically centered over each of the phosphor coated strips which produce the red and the blue light. When so centered, if different potentials be applied to the grid conductors centered relative to the phosphor strips and if an electron flow in the form of one or more cathode ray scanning beams be directed toward the tube target through the grid, it can be appreciated that, depending upon which of the grid conductors is the more positive relative to some equilibrium point or element, establishes the path of the electron beam toward the target and thus, the light color which becomes observable. If, on the other hand, the grid conductors are maintained at such state that no electrical potential difference exists between them any electron flow toward the target will be centered generally midway between the conductors. For the example assumed in what has heretofore been stated this would result in the production of green light. To this end the various conductors of the grid may be considered, for the example illustrated, to be spaced from each other by spacings of between one-half and an entire elemental area to be resolved upon the target surface in the creation of the image.

To illustrate the operation to a further extent, if the image be assumed of a character such as to be created upon a tube having a viewing window of the 20" size, it will be appreciated that the grid wire spacing between centers is of the general order of 15 mils. A wire size of the order of approximately 2 to 3 mils' diameter is satisfactory. Wire sizes of such diameter are extremely light. They are, however, reasonably strong in tension so that with suitable stretching as initially positioned, the tautness of the relationship between the wires may be maintained and the wires will be prevented from sagging and swaying with respect to each other and the target surface if adequate anchoring is provided.

In the construction herein proposed grid conductors or wires arranged in the pattern above suggested are adapted to be held in suitable vitreous anchoring members in which suitable conductor passing and embedding slots are formed in any suitable manner. Various forms of construction to achieve this end result will be explained in the description to follow. Included in such description will be the formation of slots spaced equidistant from each other and cut preferably to the same depth for holding the grid conductors. The anchoring rods are preferably secured to the surface of the target outside the raster area by refusing the two components together or by any other suitable form of fastening desired, all of which will be set forth in the description to follow.

It, accordingly, becomes an object of the invention to simplify the constructional arrangement of the overall assembly of a tube adapted particularly for tricolor operation by making possible the rapid fabrication of the grid structure and the assembly of such structure with the tube target.

A further object of the invention is that of providing an improved arrangement whereby connections may be made from the conductors of the grid to external supports so that the conductors of the grid may be formed into sets which are interleaved with respect to each other and adapted for connection to terminal points in the tube wall, to which terminal points conections may be made to external circuits.

A further object of the invention is that of providing a grid structure for a cathode day tube in which the various grid conductors may be permanently secured to suitable supports, which supports, in turn, may be appropriately located in fixed relationship relative to a target area with which they are to be used.

A further object of the invention is that of providing a grid structure for a cathode ray tube in which uniformity of spacing of the grid conductors is insured both with respect to adjacent conductors and with respect to the target area upon which the images are to be developed.

Still a further object of the invention is that of providing a grid structure for cathode ray tubes adapted to produce images in either color or monochrome which is of such a character as to insure carrying out of efficient production methods including rapid assembly, production line operation and reduced manufacturing costs.

Other and further objects of this invention will become apparent and suggest themselves to those familiar with the art to which the invention is directed when the following description and claim are considered in connection with the accompanying drawings in which:

Fig. 1 represents an elevation, partly in section and in extremely schematic form, of a cathode ray image producing tube in which the invention is utilized;

Fig. 2 is a plan view, partly broken away, of a section of the grid structure of the present invention looking at the grid structure as depicted by Fig. 1 from the direction of the tube base;

Fig. 3 is an elevational sectional view of the grid structure of Fig. 2 taken along the line 3—3 thereof;

Fig. 4 is a view, partially in section, taken along the line 4—4 of Fig. 1 looking in the direction of the arrows to illustrate illustratively the positioning of the grid structure within the tube envelope;

Fig. 5 is a greatly enlarged sectional view to illustrate the relative relationship of the target surface, the grid conductors or wires positioned relative thereto and the grid support component for locating the grid conductors relative to each other and to the target surface and for supporting the grid components relative to the target;

Fig. 6 is a sectional view patterned generally to follow the arrangement of Fig. 3 and showing particularly one form of connection of the grid conductors for attachment to contact points on the tube in order to connect to an external support; and

Fig. 7 illustrates, partly in section and on enlarged

scale, a modified manner of connecting the grid conductors to a common connector, this view representing a modification of the connecting forms represented in Figs. 2 and 6.

Considering now the drawing for a further understanding of the invention, a grid structure, generally designated at **11**, is arranged for positioning in the enlarged bulbous end of a highly evacuated cathode ray tube envelope, generally designated at **12**. The form of tube envelope here depicted is purely schematic, and without departing from its scope it may be either of the well known metal or vitreous type. In either event, the tube embodies a substantially frusto-conical shaped bulbous portion **13** terminating in a substantially flat viewing window **14** which is viewed from the direction shown by the arrow to the right thereof in Fig. 1.

This viewing window **14** is usually formed of glass so as to become transparent to the viewing of an image which may be created upon a phosphor coating contained within the tube envelope. In many forms of tube construction the phosphor coating is applied directly to the inner surface of the viewing window **14**. In an alternative construction (which is herein particularly shown) the coating may be formed upon a transparent target surface generally designated at **15** which is appropriately supported within the tube envelope and is close to the viewing window as is conveniently possible for ready mounting and simplified tube construction. The construction herein shown is one which offers some advantages from the standpoint of simplified tube manufacture although it is to be understood that where the tube is formed with a generally flat window **14** the phosphor coating may be applied thereto, as above suggested, so that the showing herein made is to be regarded as illustrative rather than limiting.

At the opposite end of the tube the frusto-conical section **13** merges into a neck portion **16** to the end of which, at substantially the end of the completion of the manufacturing processes, there is supplied a base **17**. Suitable contact prongs or pins **18** are fastened to the base for attachment to a tube holder or for connection to an external circuit. There is contained within the tube neck **16** one or more suitable electron guns from which electrons are adapted to emerge to be directed toward the target for impacting it.

The electron gun, as is well known, comprises the usual cathode, together with its heater, and selected accelerating or anode electrodes in combination with various grids or modulating electrodes. In some tubes there is a second anode component which serves to accelerate the developed electron flow as it is formed into an electron beam of concentrated cross-section adapted to focus at the target plane. With such a construction the electron beam moves toward the target at a relatively high velocity.

In the tube with which this invention is diseclosed, however, it will be assumed that the electron gun forms the emitted electron flow into a single beam of electrons which is directed toward the target surface through the major portions of the distance between the gun and target under the influence of an accelerating voltage somewhere in the region of about one-quarter that which will be acquired at the instant of target impact. Likewise, since electron beam deflecting components are well known in the art no illustration thereof has been made in the showing of Fig. 1. Suffice to say, therefore, that the developed electron beam may be deflected in its path toward the target **15** bidimensionally under the influence of developed electromagnetic or electrostatic fields, or a combination of both, acting in directions normal to each other and normal to the direction of flow of electrons from the electron gun toward the target.

A tube of the character herein described is one wherein a grid structure, conventionally shown at **11**, is adapted for positioning adjacent to the phosphor coated tube target **15**. Such a grid electrode is adapted to operate (subject to changes to provide different color effects later to be described) at a potential relative to the electron source which is approximately that of the anode of the electron gun.

As is now generally common practice in the industry there is applied to the phosphor coating on the transparent target **15** (the character of which phosphor coating has already been described) a metallic film on the side of the phosphor coating faced toward the grid structure **11**. Such a metallic film is of an electron permeable character to permit electrons to pass therethrough to excite the phosphor coating on the target but the film forms a barrier against ions reaching the target to produce thereon the well known and objectionable ion spot. At the same time the metallic film coating being conducting in character permits the application of a relatively high voltage measured relative to the grid structure to the target. This operating voltage difference may be in the general neighborhood of 2 to 4 times that voltage difference existing between the electron source and the final accelerator of the electron gun which has already been described as adapted to operate at substantially the same potential as the grid.

Consequently, in the region between the grid structure as a whole and the target an accelerating field is developed which brings the electrons moving from the source to the target to a relatively high velocity as the target is impacted. At the same time by reason of the adjacent relationship of the grid structure and the target, the applied potential provides converging electrical fields to produce a further focusing of the electron beam as it reaches the target. With the conductors of the grid arranged, as above explained, a multiplicity of cylindrical electron lenses of a number corresponding to the number of conductors in the grid are formed in the region between the grid conductors and the target so that any electron beam entering is promptly focused to a considerably reduced cross-sectional state. It may be worth repeating at this point that because of the small diameter of the grid wire relative to the cross-section of the scanning beam directed therethrough toward the phosphor coated target, a negligible portion only of the scanning beam is intercepted by the grid wires so that a major portion of the electrons released are focused upon the phosphor coated target.

Considering now the foregoing in the light of the arrangement of the grid and assuming that the target area **15** is a vitreous material there may be supported adjacent to opposite edges of the raster area suitable grid wire support rods **21**. For conditions where the scanning by the developed electron beam is assumed to take place in a direction transverse to the phosphor coating strips on the target these support rods are positioned to extend parallel to the long dimension of the raster, conventionally represented particularly by the dimension "L" in Fig. 4. Such rods in their preferred form are cross-sectionally of any desired form but it has been found that a rod of circular cross-section cut generally through its center to provide a flattened face to be secured to the target proper is particularly suitable. This gives a generally semicircular rod cross-section for securement to the target base.

In the preferred construction the grid support rods **21** are secured to the vitreous target element **15** to extend in directions parallel to each other. Spacing is provided between the rods corresponding to the span desired for the grid wires across the raster to be traced. On the curved outer side of the support rods **21** suitable grooves or recesses **23** are formed in any suitable manner so as to receive and locate the grid conductors or wires represented at **25**. While various constructional methods may be adapted to form the slots or grooves it is essen-

tial that there be a high degree of precision in the spacing if extremely high fidelity operation is to result in the final tube.

In one constructional form the grooves or recesses are cut by spacing the rod **23**, prior to its assembly within the tube, adjacent to a multiplicity of cutting heads or grinding edges in the form of a rotating spindle or mandrel. The rod is then moved into contact with the rotary cutting or grinding edge and the grooves are formed to the desired depth. A cutting or grinding edge so-formed is of an extremely hard cutting or grinding material so that the relatively soft glass may be cut with the grooves spaced precisely uniformly from each other to coincide with the spacing or grinding edges of the machined cutter. This manner of constructing the rods is not illustrated but is mentioned merely as one manner of fabricating the rods.

In an alternative constructional form, the rods may be of a type which is photosensitively opacifiable. A glass of such character is frequently known as photosensitive opal glass. The Corning Glass Works, of Corning, New York is a manufacturer of one type of this glass. The characteristics of the glass having heretofore been described in an article entitled "Photosensitive glass" by S. D. Stookey, appearing on pages 856 to 861 of the April, 1949, issue of "Industrial and Engineering Chemistry." Additional types of the type of glass are also described in abstract form on page 3951 of the September 24, 1951, issue of "Chemical and Engineering News."

Summarizing very briefly, the glass is of a type which may be exposed to ultraviolet radiations through an appropriate and extremely accurately formed photographic negative. The negative has the desired image or pattern of the desired slots or grooves thereon, so that when the glass is exposed the exposure which takes place is one whereon there has been photographed extremely accurately an image of the recesses or slots in which it is desired to locate and hold the grid wire **25**. The spacing of such slots coincides with that already explained.

Little need be said about the process of forming the slot after exposure, other than to point out that the glass rod is subjected to controlled heat treatment which effects the development of an image within the glass. This occurs generally by the formation of crystals of a lithium silicate in the exposed areas. The image proper is developed by exposing the glass to heat to approximately 1200° F. for an established time period, usually of the order of about two hours. With this heat exposure there appears a milk-white image in the otherwise transparent glass. If the glass is then immersed in a solution of hydrofluoric acid, there is a selective dissolving of the devitrified glass from the so-called opal heat-developed image. As was the case with the cutting or grinding operation of the slots in the glass rods already explained, the depth of the image created is controllable with equal ease by varying the duration and intensity of the exposure of the glass to the ultraviolet radiation through the negative. Usually the time selected is determined experimentally. When it is known that the depth of the slots in the rods **21** is to be made just sufficient accurately to locate the wire the exposure time may be set accordingly.

In the form in which the construction is shown by Fig. 5, for example, the slot has been made deeper than the diameter of the conducting element used to form the grid, while in the arrangement shown by Fig. 6 the slot in the rod **21** is made to a depth substantially corresponding to the diameter of the conductor forming the grid. This is a matter of choice.

After the glass rods **21** have been cut, ground, photographically slotted or otherwise formed in such a way that the desired number of slots has been produced, and with all of these slots accurately spaced from each other, the vitreous rod member must be attached to the transparent target plate **15**. In the majority of tubes prior to this time the phophor-coating in the form of the strips already explained has been applied, with such coating generally designated at **24** (see, particularly, Fig. 3). While not within the scope of this disclosure, methods to deposit the phosphor-coatings after the rods **21** have been secured to the target are available and the defined construction is thus purely illustrative. The coating has applied to it the conducting metallic film deposited in any suitable manner customarily used in tube manufacturing processes. The vitreous rods **21** are chosen of such diameter or thicknes that with the rods in place the bottom of the slot into which the conducting elements of the grid are to be placed is at such distance from the plane of the target as to provide a separation between the metallic film on the target and the grid wires which corresponds to the desired spacing between the grid and the target. In most tube types this distance is only a fraction of an inch (generally about five times the width of a sequence of phosphor-coated strips forming one complete color cycle).

In order that there shall be a minimum amount of loss in the manufacturing process due to the breakage of rods or the like, when the finally prepared tube is baked out it is desirable that the glass from which the rods **21** are formed shall have a coefficient of expansion which is either identical or substantially identical to that of the transparent target plate **15**, so that there may not be any difference in expansion which would cause the rod to crack due to heat to which the tube is subjected in the bake-out process. If these conditions be met, the glass rods **21**, when positioned at the proper spacing from one another and parallelly alined in such a way that conducting members **25** of the grid when stretched between the rods and located in the formed slots which extend precisely parallel to the edges of the phosphor strips, it is possible to fuse the glass rods **21** and the target plate **15** into a unitary mass. Other methods of attachment, such as K-sil (potassium silicate) or solder glass, to mention but two, are also available.

For some conditions of operation, and especially where the so-called photographic type of glass is used, the coefficients of expansion of the glass rods **21** and the transparent target plate **15** may not precisely correspond. Under these circumstances it is desirable that a so-called graded seal be provided by the two components, in order to distribute stresses and prevent breakage due to difference in expansion of the two components. Graded seals are too well known in the art to require detailed description, but it must be borne in mind that in making such a graded seal and providing the grading between the rod component per se and the transparent support base, allowance must be made for the seal to occupy a finite space in order that the separation between the two grid conductors and the metallic film coating the phosphor on the target plate shall be that desired. This is a manufacturing technique, however, which need not be explained at this time in any further detail.

As an alternative to using graded seals it will, of course, be appreciated that the coefficient of expansion of the vitreous target surface **15** may be matched to correspond to that of the grid support rods, such as the so-called photographic glass rods. Changes in the coefficient of expansion of the vitreous material of which the target is formed may readily be introduced in the glass making process, although it is generally the more difficult to change the coefficient of expansion of the rods to correspond to that of the target. In any event, the problem of different coefficients of expansion of the rods and the target surface is not critical.

For the purpose of designating the space between the conductors of the grid and the phosphor coated target surface **24**, Fig. 5 shows the dimension "S" which is to be maintained accurately throughout the lenght of the grid conductors. To this end, the conducting strands or wire **25** from which the grid is formed are positioned to bridge and fit into the slots **23** and then stretched tightly there-

in, so that any sagging of the grid conductors or wires in the space between the two insulating rods 21 is eliminated. The wires or conductors when held in such location are then securely anchored.

Various forms of constructions may be adopted for this purpose, but with the arrangement shown, illustratively, by the constructions depicted in Figs. 2 and 3, when the conductors or wires are so stretched and held in a taut position to preserve the spacing "S" between the grid member of the target surface throughout a suitable glass-to-metal sealing process is instituted permanently to secure the strung conductors or wires within the recesses. The ease of stretching can be made evident when it is noted that the wire size is only of the order of about 3 mils, so that its weight is almost insignificant, with a result that, generally speaking, sealing of the wires in the grooves 23 is sufficient to position them and adequate to prevent sagging. In order not to complicate this description, it will be appreciated that the method of securement stated is purely illustrative. It is also feasible to secure the grid wires within the notches by various forms of cement, of which one known as "Sauereisen" is quite suitable.

When the wires or conductors 25 are then so sealed in the spacing rods 21, and where it is desired to operate the grid in such a way that it may be used either with a tube to produce color images or to produce images in monochrome, alternate wires are connected together. One set of wires is secured to a header conductor 27 with the other set secured to a similar header conductor 28, at opposite ends of the wires. Wires of the different sets at the ends not connected to the headers may then be trimmed at points close to the spacing rods as indicated particularly by Fig. 2. Suitable connections from each of the headers 27 and 28 to lead exteriorly of the tube envelope may then be provided, as conventionally shown at 29, with the connection leading out through the seal in the tube wall in any desired fashion, or alternatively, leading to a button connection within the tube to the opposite side of which a cap may be secured to provide connection to external circuitry 29 and 30.

While it has not been shown in Figs. 2, 3 or 4, for convenience of illustration, that the headers 27 and 28 may be supported from the target member itself, a construction of such type is usually preferable. The construction is generally such that the wires or conductors from which the grid is formed are of themselves not sufficiently rigid to support the headers so that, generally speaking, such headers may be fastened in any desired fashion to the plane of the target in a manner similar to that shown by Fig. 6. For this type of construction various forms of connectors to hold the two elements together may be used, but one which is suitable would be a form where sufficient movement was permitted in the bake-out process to compensate for the difference in expansion of the glass and the header. This construction per se is not a part of the invention and, therefore, is not illustrated in further detail.

Various types of supports for securing the complete framework of the transparent phosphor coated target and the thereby-carried grid wire support rods and the grid wires themselves may then be provided. This particular construction, per se, forms no part of the present invention, and therefore is indicated purely conventionally by the bracket members 31, 32, which may be in the form of ribs. Where the bracket members are metal and the frusto-conical portion 13 of the bulb 12 is also metal, they may be suitably welded to the interior wall of the tube and then secured to the transparent target plate, by any conventional or convenient glass-to-metal seal permitting the proper and desired expansion. In another form of construction the glass target may be surrounded with a metal frame and the connection then made to the frame. Where the tube is formed completely of vitreous material, the support rods or ribs 31 and 32 are usually also formed of vitreous material having a like or approximately like coefficient of expansion to that of the target. The assembly then can be fused to bond the tube wall and the target plate.

In a modified form of the arrangement, it frequently becomes desirable to use the spacer rods 21 with the grooves or notches cut therein merely as a cradle or saddle into which the grid conductors are positioned and located. Then there is preferably attached by fusing or otherwise securing to the surface of the base plate a rod to which conductive connection may be established. These rods are indicated particularly at Fig. 6 as the metal rods 33, 35, which are secured to the outer edges of the transparent target plate 15 by any suitable glass-to-metal seal. Such metal rods may be held in brackets or in any other manner to permit expansion and contraction where they are of a different expansion characteristic than the base. To use such rods, the grid wires are then arranged so that alternate wires overlap the conductor 33, and other alternate wires overlap the conductor 35, in which position the wires are suitably welded or otherwise permanently connected. This type of permanent connection insures, first, good electrical contact between the wires of the grid and the conductor, and, second, a permanent positioning of the grid wires in a stretched and taut state relative to the plane of the target.

In the form in which the conductors or wires 25 attach to the header elements, as in Fig. 6, it will be appreciated that the two conducting members 33 and 35, which are outside the support rods 21, are so located that the conductors or wires 25 when bending to contact them form slightly different angles relative to the plane of the conductors in the region between the support rods 21. So that there may be no chance that the conductors or wires 25, which are secured to the outer-most of the headers touching that header 35 which is closer to the support rods, it frequently may be desirable to make the inner header 35 of a cross-sectional diameter which is slightly less than that of the outer member 33. In this way those conductors in the grid which extend to the outer member may be held above the header nearer to the vitreous support rods 21.

By connecting alternate wires of the grid to the separate conductors 33 and 35 it will be appreciated that arrangements may be made whereby different potentials relative to the target may be applied to alternate conductors of the grid in order to bring about a color change of the character already explained, within the tube when the tube is in operation.

In a modified form of construction, as shown particularly by Fig. 7, the conducting rods 33 and 35 may be replaced by an insulating rod such as that shown in Fig. 7, where, the insulating rod 39, preferably in the form of a vitreous member, is fused or otherwise appropriately secured to the target plate 15. The vitreous rod 39 has extending through it and appropriately held therein a conducting cord or connector 41 extending throughout the length thereof. The conducting member at one point on the surface of the vitreous rod 39 extends just slightly outwardly from the periphery, in order to permit the establishment of a suitable welded or brazed connection 43 between the conducting wire 25 of the grid and the conductor 41. A connection of this form is well known, and detailed description relative thereto need not be added; suffice it to say that by such an arrangement the conducting portion 41 may connect in any desired fashion to an external circuit wherefrom the results attained by the heretofore-described arrangements may be achieved.

Other modifications, of course, are fully within the scope of this description and what is claimed and desired to be secured by Letters Patent is the following:

A grid structure for a cathode ray tube wherein there is included within the tube envelope an electron source for developing a beam of cathode rays and a transparent target area having on one side thereof a coating adapted

to receive the electrons of the source and to become luminescent with impact of said electrons thereon, comprising a plurality of insulating support rods parallelly positioned and secured to the target in spaced relationship with respect to each other and each faced toward the electron source, the rod spacing corresponding approximately to one dimension of a raster adapted to be traced upon the target area, each rod having formed therein a plurality of slots formed to substantially uniform depth and extending with generally regular separation from one end of the rod to the other, a plurality of wire strands uniformly spaced relative to each other bridging said support rods and resting thereupon inwardly to the slot depth, means provided by each rod for locating each wire relative to the rod and the target to form a plurality of parallelly located wires spaced from each other by distances related to the size of each elemental area adapted to be resolved upon the transparent target, means to space the plurality of wire strands in a plane parallel to the target and all substantially equi-distant therefrom, means to fuse the wires in the slots, a pair of conducting members

located external to the raster area and adjacent to the support ends, and means for establishing electrical connections of adjacent wire strands to alternate ones of the conducting members.

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