

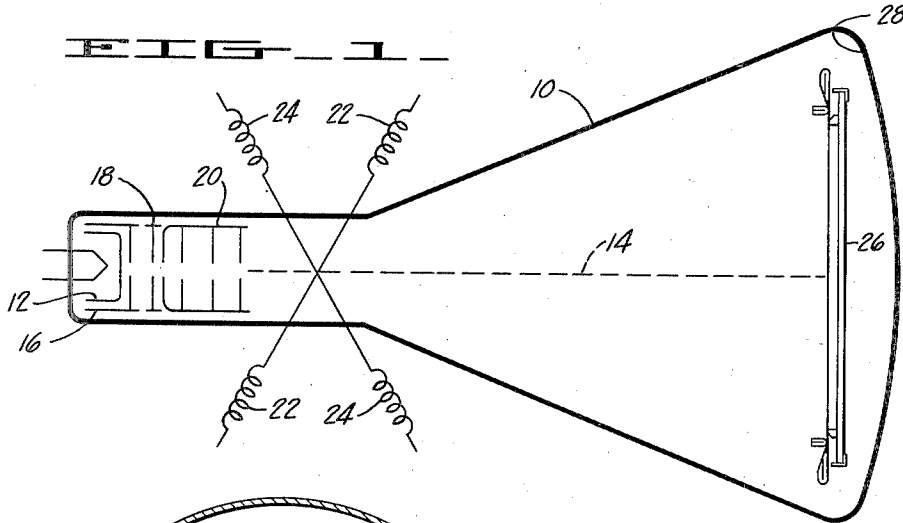
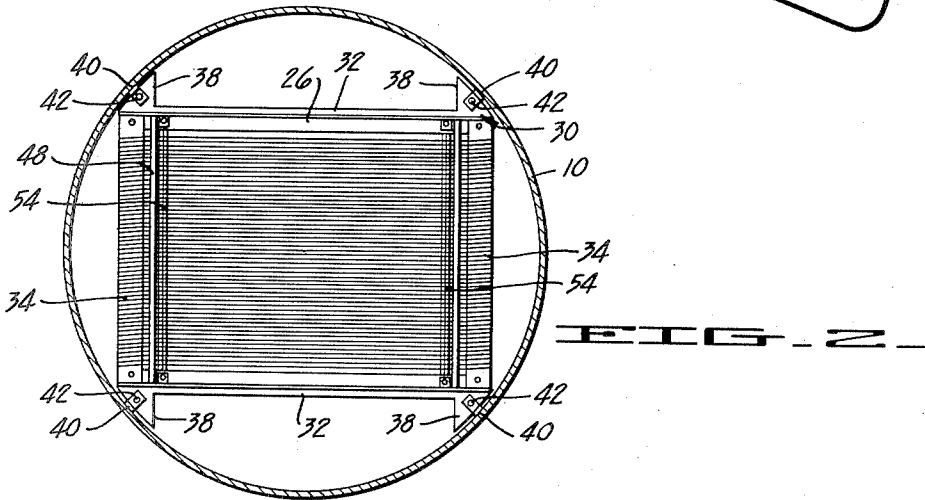
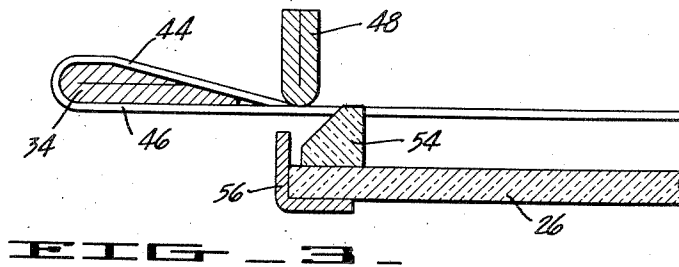
Nov. 27, 1956

L. J. COOK ET AL
GRID STRUCTURE FOR CATHODE-RAY TUBES DESIGNED
FOR POLYCHROME IMAGE REPRODUCTION

2,772,376

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2 Sheets-Sheet 1



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FIG. 4

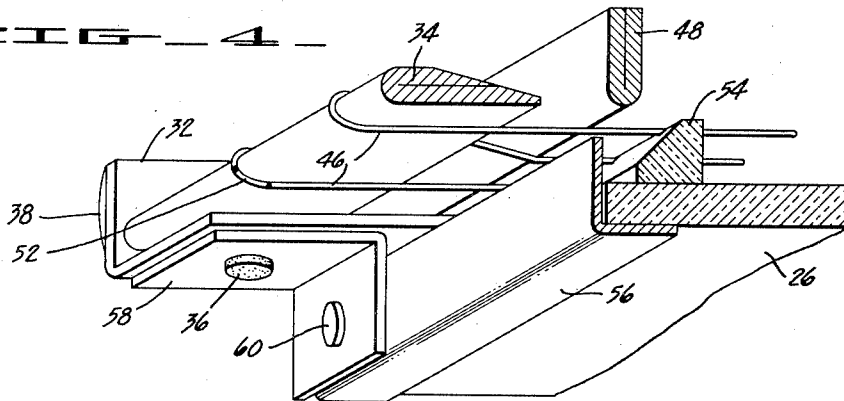


FIG. 5

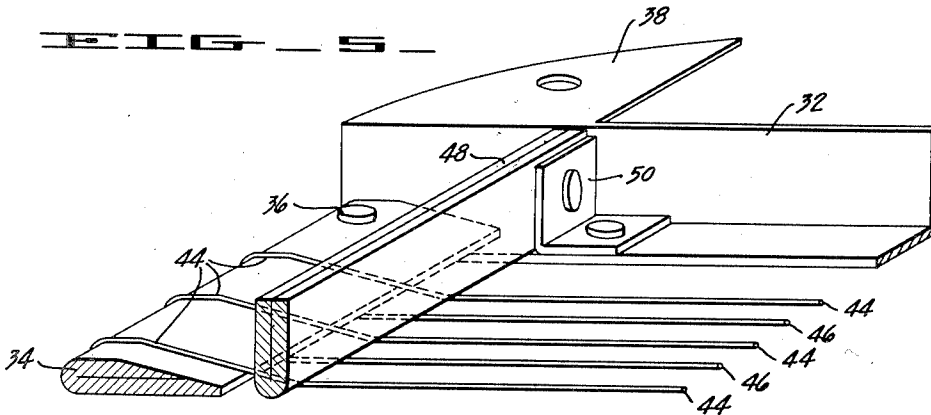
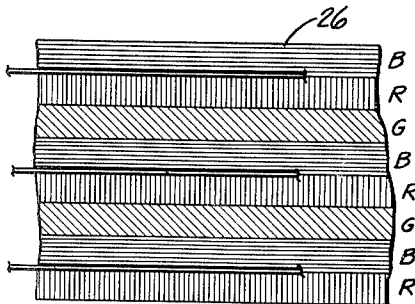


FIG. 7

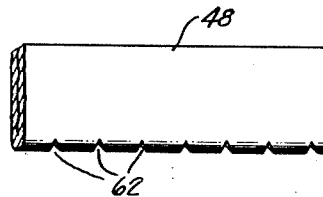


FIG. 6

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GRID STRUCTURE FOR CATHODE-RAY TUBES DESIGNED FOR POLYCHROME IMAGE REPRODUCTION

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Application January 14, 1954, Serial No. 404,038

11 Claims. (Cl. 313—78)

The present invention relates to cathode-ray tubes of the type adapted to effect the reconstitution of polychrome images. More particularly, the invention relates to a grid structure for such cathode-ray tubes which is characterized by its adaptability to mass production techniques and also by its simplicity of design.

Cathode-ray tubes having a grid of essentially parallel wires located adjacent to a striped phosphor screen are now known in the art. Such a tube structure may in some cases serve to focus the beam electrons into a pattern of thin lines nominally registered with discrete phosphor areas of the screen, as heretofore disclosed by Ernest O. Lawrence as, for instance by his copending United States patent application Serial No. 234,190 filed June 29, 1951 and his United States Patent No. 2,692,532, granted October 26, 1954.

One type of cathode-ray tube incorporating the above principle (which may be termed "post-deflection-focusing") is designed with a relatively large number of narrow component-color phosphor strips laid down in a predetermined sequence to form a screen, or target electrode. These phosphor strips luminesce, when impacted by the cathode-ray beam, in various component colors of the image to be synthesized. Purely as an example, the order in which the phosphor strips are laid down may be red, green, blue, red, green, blue, etc., bearing in mind that the color of a phosphor as used herein refers to the color of the light emitted therefrom which is seen by an observer. An electrically-conductive coating overlies the phosphor strips, and is produced in some preferred manner such as by aluminization.

A grid assembly is located adjacent to the phosphor screen, and, with the latter, comprises a structure of the type to which the present invention is particularly applicable. This grid is formed of a large number of wires, or linear conductors, extending in the same direction as the phosphor strips and lying in the path of electrons directed to the target electrode from the electron gun of the cathode-ray tube. The wires of the grid assembly are electron-optically related to the phosphor strips so that, in this electron-optical sense, there is a wire aligned with the boundary between each color group, or "cell," consisting of at least a portion of a phosphor area representative of each of the component colors. It should be borne in mind that this electron-optical alignment incorporates whatever corrections are necessary to compensate for variations in tube operation, such as by changes in the instantaneous angle of impingement of the cathode-ray beam as it scans the target. However, the above forms no part of the present invention, and is mentioned merely as an aid in understanding a tube of the nature set forth.

Between the actual or nominal plane of the wire grid assembly and the conductive coating on the phosphor strips a difference of potential is established. By properly choosing the magnitude and polarity of this potential difference, a series of converging electrostatic fields for the beam electrons is created. These con-

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verging fields (which may be likened in an optical sense to cylindrical lenses) cause the beam electrons arriving at the wire grid from the electron gun of the tube to form a fine line structure on the phosphor target. It will be appreciated that the particular scanning operation by means of which the beam electrons are caused to trace a raster at the plane of the grid wires has no direct geometrical relationship to the actual line structure developed on the target electrode, the latter being determined solely by the configuration of the wires of the grid assembly.

In designing one grid structure of the above type, the wires are maintained in position relative to the phosphor strips of the target by means of spacer elements. The spacing between the plane of the grid wires and the phosphor-coated surface of the target is critical in many respects and must remain substantially unchanged during operation of the cathode-ray tube. One preferred construction in which the grid wires and the phosphor screen are formed as a unit is illustrated and described in a copending United States patent application of Renn Zaphiropoulos, Serial No. 307,435, filed September 2, 1952.

In the Zaphiropoulos assembly, a light-transmissive base plate (which may be of glass) is employed as a target backing. This base plate is secured to a grid frame by the strand conductors, or wires, of the grid. A pair of spacer bars is affixed to one surface of the base plate, and defines a window, or target area, therebetween which may be coated with phosphor strips having the desired color characteristics. Means are provided for securing the electrically-conducting wires to the frame so that these wires extend across the window, or target area, of the base plate and are positioned therefrom by the spacer bars. Inasmuch as the grid structure being described is designed for color switching, or micro-deflection, of the beam in the vicinity of the target electrode, the wires, or linear conductors are divided into two sets of alternate strands, and suitable means are provided for applying potentials to each set of strands. To carry this out, the frame is divided into two sections, with each section serving a separate set of strands and also being electrically insulated from the other. Consequently, in this form of construction, the glass plate is "sandwiched" between the wires of the grid, on one hand, and the two frame sections on the other. These two frame portions are pressed together by the tension of the wires associated with the outer frame portion, and this pressure acts to hold the frames, base plate and wires in a unitary assembly.

A structure such as described in the above-mentioned Zaphiropoulos patent application is designed for use with a single-gun color-reproducing cathode-ray tube in which the grid assembly acts as a control means for changing the color of the light emitted from the tube in accordance with particular values of potentials applied to the different parts of the grid. The grid structure of the present invention, however, is intended to be utilized in conjunction with a multiple-gun cathode-ray tube of the type set forth in above-mentioned Lawrence application Serial No. 234,190. Although there are many similarities between the two types of structures, nevertheless the principle of operation of the one described in the Lawrence application calls for a color-reproducing cycle in which the particular color displayed is dependent upon the angle of incidence of the cathode-ray beam at the plane of the grid wires. There is no auxiliary, or micro-deflection, produced by the grid assembly, and all of the wires of the grid are maintained at the same potential relative to that of the conductive coating on the phosphor screen. As a result of this potential difference, and with proper spacing between the grid assembly and

the screen, all of the electrons passing between any adjacent pair of wires are brought to a focus area of much smaller width than the wire spacing. Since there is no necessity for dividing the grid into electrically-insulated sections, it has been found possible by means of the present invention to simplify to a considerable degree the construction of the grid unit over that set forth by Zaphiropoulos, especially in the sense of making it more applicable to mass production.

Although the color grid structure set forth by Zaphiropoulos in his above-mentioned patent application is completely satisfactory insofar as operation is concerned, and produces an image in which there is substantially no color contamination, nevertheless it is somewhat time-consuming to manufacture due to the techniques which must be employed. As presently constructed, each set of grid wires is attached to its associated frame section by hooking the wire over a projection on the frame, laying down the wire across the raster area of the base plate, hooking it over a projection on the opposite side of the same frame, bringing it back across the raster area of the base plate, and so on. A winding operation is thus carried out which, while producing a grid of satisfactory operating characteristics, nonetheless requires a considerable amount of time to complete and hence materially reduces the number of units that may be manufactured within a given time period.

In an attempt to shorten the time required for fabricating such color grid structures, an alternative method was devised. This is set forth both in the above-mentioned application of Renn Zaphiropoulos, Serial No. 307,435, as well as in his further application Serial No. 307,436 filed concurrently therewith. This consists in winding the grid continuously around the base plate to eliminate the back-and-forth motion previously employed. Inasmuch as this left a set of wires on the rear, or viewing, side of the base plate which had to be removed prior to operation of the tube, it was necessary to anchor the wires near the two extremities of the base plate, and this was done by cementing them in position so that the portion of each turn of wire which was unnecessary to tube operation might be cut out and discarded. While eliminating one objectionable feature of previous methods of construction, this last-mentioned technique added a step of cementing the wires in position and then a further step of cutting out one portion of the continuously-wound assembly. This used up a considerable percentage of the time saved by eliminating the back-and-forth winding operation. Furthermore, all the tension of the wires in such a construction is exerted through these cementitious bindings, and there is always a possibility present that the latter will not be sufficiently strong to hold the tensioned wires in position. Nevertheless, the structure just described was a step in the right direction toward developing a grid assembly which could readily be mass produced.

According to a feature of the present invention, a substantially rectangular grid frame is employed around which a continuous conductor is wound in an uninterrupted fashion. This results in two sets or groups of parallel wires which lie in different planes. However, means are further provided for applying pressure to the strand conductors of one of these sets relative to the other to cause each strand to assume a position wherein both sets of wires are essentially coplanar. Inasmuch as the above design does not comprehend a physical connection between the wire strands and the glass base plate upon which the colored phosphor strips are deposited, these two members are brought into juxtaposition so that the coplanar wire strands are indexed in notches in a pair of spacer bars carried by the glass plate. When the plate (and its support) are secured to the grid frame, a unitary structure results. All of the operations mentioned above may be carried out by simple mechanical means, thus permitting a relatively low cost of manufacture.

One object of the present invention, therefore, is to provide an improved type of cathode-ray tube designed for the reconstitution of polychrome images.

A further object of the present invention is to provide a grid structure, for cathode-ray tubes designed especially but not exclusively for polychrome image reproduction, in which the various portions of the grid may be readily fabricated and then these portions assembled into a unitary structure.

A still further object of the present invention is to provide a grid structure for cathode-ray tubes designed especially but not exclusively for polychrome image reproduction in which the strand conductors of the grid are wound in a continuous uninterrupted fashion.

An additional object of the invention is to provide a method of manufacturing a grid structure of the above nature.

Other objects and advantages of the present invention will be apparent from the following description and from the drawings, in which:

Figure 1 is a semi-diagrammatic view of a cathode-ray tube showing in cross section a color grid structure in accordance with the present invention;

Figure 2 is a plan view of the color grid structure of Fig. 1 as seen from the electron gun end of the cathode-ray tube;

Figure 3 is a detailed view of a portion of Fig. 1;

Figure 4 is a perspective view of Fig. 3, showing in addition one manner of securing the base plate assembly to the wire grid unit;

Figure 5 is a perspective view of a portion of Fig. 3, showing in further detail the manner in which the two sets of grid wires are brought into substantially coplanar relationship;

Figure 6 is a modification of a portion of the assembly shown in Figs. 1, 2, 3, 4 and 5; and

Figure 7 is a plan view of a portion of the target area of Fig. 2, showing one preferred relationship between the grid wires and phosphor strips.

Referring now to the drawing, there is shown in Fig. 1 a cathode-ray tube certain parts of which are conventional. For example, in the neck end of the tube, and within the envelope 10, there is an indirectly-heated cathode 12 which acts as a source of electrons for development into a scanning beam. The latter is indicated schematically by the trace 14. Adjacent to, and partially surrounding, the cathode 12 is a control grid #1, or electrode, 16 suitably apertured to permit the passage of electrons which are subsequently formed into the beam 14. The control grid 16 functions in the usual manner to modulate the emitted stream of electrons in accordance with the potential applied thereto relative to the cathode 12. Also in the neck of the tube there is provided a first anode or grid #2 (identified by the reference numeral 18) to which suitable potentials may be applied so as to result in an initial acceleration of the electrons emitted from the cathode 12. Adjacent to grid #2 there is positioned a second anode or grid #3 (reference numeral 20) for supplying an additional acceleration to the electrons.

Deflecting coils, comprising a horizontal pair 22 and a vertical pair 24, are provided for the usual scanning purposes. Obviously, the terms "horizontal" and "vertical" are used herein in a descriptive sense only. Thus, the electron beam 14 is caused to scan a phosphor-coated target, or light-transmissive base plate 26, to produce light which is visible through the end wall 28 of the envelope 10.

Shown in Fig. 2 is a substantially rectangular support, or frame, 30 adapted to fit within the envelope of the cathode-ray tube. This frame 30 is made up of a pair of oppositely-disposed L-shaped channel members 32, which form two sides of the frame, and a pair of grooved side members 34, which form the remaining two sides. The L-shaped members 32 are respectively secured to the

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side members 34 by rivets 36 one of which is shown in each of Fig. 4 and 5. Each side member 34 is of generally flat configuration, and may be fabricated, for example, from 0.062" thick type 430 stainless steel sheet bent double as indicated in the drawing. However, the particular manner of fabricating the frame 30 forms no part of the present invention, and any indication that it may be formed by bending and riveting operations is merely for the purpose of explanation.

The frame 30 is provided at each corner with a lug or tab 38 which is shown in Fig. 2 as having a contour generally similar to the internal periphery of the envelope 10. In the case of a metal envelope 10, small angles 40 may be welded to the inside surface of the envelope at positions where it is desired to attach the lugs 38. The lugs are joined to the angles by means of bolts or rivets 42 which preferably pass through ceramic bushings (not shown) which are provided with insulating discs on each end to isolate electrically the frame 30 from the envelope 10. Other means of attachment may be employed, especially when glass instead of metal envelopes are used. However, since these constructional features form no part of the present invention, and furthermore are mentioned in the above-referred-to Zaphiropoulos applications, no further details in regard thereto will be set forth herein.

A continuous filamentary conductor (such as #302 stainless steel of 6 mil. thickness) is wound around the oppositely-disposed frame side members 34 in coil-like fashion so as to form two sets of strands. One such set of strands (indicated in the drawing by the reference numeral 44) is composed of those which pass over the upper surface of each grooved side member 34 (as best shown in Fig. 5) and the other set of strands (identified as 46) is composed of those passing above the under surface of the side member. It will be apparent from a consideration of the drawing, and especially from Figs. 3, 4 and 5, that these two sets of strand conductors would normally lie in separate planes one above the other, the distance between the planes being determined by the thickness of the grooved side member 34.

As has been previously brought out, it is highly desirable that all of the strand conductors of the wire grid assembly be essentially coplanar, so that the beam electrons passing between the strands can be properly focused upon desired areas of the base plate 26. In order to establish such a coplanar relationship of the wires, those strand conductors which constitute one set (such as 44) are compressed, or forced into a position in which they are not only coplanar with the other set of conducting strands but also so that they are interleaved with the latter. Thus, the wires of one set alternate with the wires of the other.

The manner of bringing this about is illustrated especially in Figs. 3, 4, and 5, and comprises in part a wire-aligning bar 48 which is secured to and carried by the two oppositely-disposed L-shaped channel members 32 of the frame 30. This wire-aligning bar 48 may be composed of the same material as the frame 30, and is so designed that, when it is secured to each of the channel members 32 by an angle 50 (Fig. 5) riveted both to the wire-aligning bar 48 and to each frame member 32, the lower edge of the wire-aligning bar is substantially co-extensive with the strand conductors 46 (note especially Fig. 3). In other words, when this wire-aligning bar 48 is properly positioned following the formation of the two sets of conducting strands, such a positioning operation forces the upper set of strands (44) into coplanar relationship with the lower set of strands (46). When the bar 48 is riveted to the members 32 through the angles 50, this coplanar relationship of all of the strand conductors will normally be maintained throughout the life of the cathode-ray tube of which the grid assembly forms a part.

In order that the strand conductors shall be substan-

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tially equally spaced apart (as best shown in Fig. 5) when the wire-aligning bar 48 is in position, it is necessary that the wires of one set be offset with respect to the conductors of the other set, so that application of pressure to one such group will cause the individual wires of the groups to be interleaved with respect to one another when the coplanar relationship of all of the conductors is established. One method of accomplishing this is by forming a series of grooves 52 in the outer edge of each of the side members 34. Obviously, if these grooves 52 are so aligned to be perpendicular, or normal, to the respective planes of the strand conductors 44 and 46 which extend between the members 34 and across the window area of the frame 30, then the corresponding wires of the two sets of conductors would be positioned one above the other, and pressure upon one set (when the wire-aligning bar 48 is placed in position) would cause a physical contact between the two sets of conductors which would not be satisfactory for the purpose of the present invention. Consequently, the strand conductors of the two groups 44 and 46 are caused to be offset by means of a properly chosen directional alignment of the grooves cut into the side members 34. This alignment is so selected that, when a particular "arriving" wire strand is looped around the outer edge of one of the side members 34, this looping operation results in the "returning" strand lying midway between two adjacent wires of the upper set, considered in a direction normal to the plane of the wires. Expressed differently, these grooves are cut into the outer edge of each of the side members 34 in a predetermined direction which is other than normal to the plane of the grid wires. The particular angle at which the grooves 52 are cut will depend at least in part upon the thickness of the frame member 34, but in any event will be so chosen that the "returning" wires, following their looping around the edge of the member 34, will respectively lie midway between the "approaching" wires of the grid. Consequently, a grid structure of coplanar wires is formed in which all of these coplanar wires are substantially evenly spaced from one another, and in which all of the wires are maintained under a selected degree of tension determined by the winding operation.

The backing area, or base plate, 26 carries on one of its surfaces a series of phosphor strips laid down in a manner such as will be described in connection with Fig. 7. That is, the sequence of these phosphor strips may be, for example, red, green, blue, red, green, blue, and so on. For proper operation of the tube being described, it is desirable that each of the strand conductors (which have been brought into coplanar relationship in the manner previously set forth) be electron-optically aligned with the junction between adjacent groups of color strips. To bring this about, a pair of insulating spacer elements or bars 54 are securely affixed to one surface of the base plate 26 in the manner best shown in Figs. 2, 3 and 4. These spacing bars, as well as the translucent base plate 26, may comprise boro-silicate glass, but in any event should have the same coefficient of expansion. These spacer bars perform the dual function of aligning the coplanar wire strands with the phosphor strips and also maintaining the wire strands at a uniform distance from the surface of the base plate 26.

The base plate 26, with its pair of spacer bars 54, is mounted in a pair of L-shaped support members 56, one of which is shown in Figs. 3 and 4. The plate 26 is cradled in each L-shaped member 56 in the manner shown, the latter members being preferably composed of the same material as the frame sections 32 and 34.

There have now been described two units, or sub-assemblies, one of which may be designated as the grid wire sub-assembly, as shown in Fig. 5, for example, and the remaining one constituting the base plate sub-assembly, which includes the phosphor-coated glass plate 26, the spacer bars 54 secured to one surface of this plate, and the support members 56. These two sub-assem-

blies are now brought together so that the coplanar wire conductors of the unit shown in Fig. 5 respectively fall within grooves in the upper surface of the spacer bars 54. In other words, these two units are brought into the position best shown in Figs. 3 and 4, with the upper edge of the spacer bars 54 contacting the coplanar wires of the assembly of Fig. 5 with just enough pressure to maintain the conductors of the grid wire assembly properly indexed within the grooves or notches cut into the upper surface of the spacer bars 54. In this position, the two units are secured together by means such as the angles 58, one of which is shown in Fig. 4. The rivet 36 which secures together one of the L-shaped channel members 32 and one of the grooved side members 34 may also pass through this angle 58 as best shown in Fig. 4, while another rivet 60 secures this angle 58 to the L-shaped support member 56. Obviously, four such securing means are employed, one on each corner of the frame 30.

While there has been described above an embodiment of the invention wherein the side members 34 of the frame 30 are provided with a series of grooves into which the individual wire strands are respectively receivable, nevertheless it may be desirable to index the wires in position by means of V-shaped notches 62 formed in the aligning bar 48, as shown in Fig. 6. These notches 62, equal in number to the strand conductors 44, are preferably wide enough at the base to allow for some misalignment of the wires following the winding operation. When the bar 48 is brought into contact with the conductors 44, therefore, each of the wire strands will be seated at the apex of its respective notch. If now the bar 48 is given a lateral displacement equal to one-half the distance between the center of the wires 46, then securing of the bar 48 to the frame members 32 by means of the angles 50 will cause each wire 44 to lie midway between adjacent conductors 46, and the desired equally-spaced coplanar relationship is brought about. Obviously, under such conditions, there is normally no need for grooving the side members 34.

The relative position of the conducting strands, or grid wires, and the red, green and blue phosphor strips which are applied to that surface of the base plate 26 impacted by the electron scanning beam, is shown in Fig. 7. Although the particular arrangement of the phosphor strips forms no part of the present invention, nevertheless a desirable arrangement has been shown to consist of repeating groups of red, green and blue strips. The strip widths are chosen in accordance with tube design so as to provide electro-optical rather than physical relationships between the grid wires and the phosphor strips. Each adjacent pair of grid wires accordingly is designed to subtend (in an electro-optical sense) a portion of the target electrode surface which includes phosphor areas of each of the component colors. Generally speaking, however, it may be said that the distance between adjacent grid wires is substantially resolved by the cathode-ray tube.

Having thus described the invention, what is claimed is:

1. In a grid structure designed for incorporation into a cathode-ray tube adapted to reconstitute images in a plurality of colors, the combination of a frame having a window area, a continuous conductor wound in coil-like fashion around said frame so as to form across said window area two sets of substantially parallel strands respectively lying in separate parallel planes and a bar of rigid material positioned substantially adjacent to the conductor support frame to compress one of the sets of parallel strands into coplanar relationship with the other.

2. In a grid structure designed for incorporation into a cathode-ray tube adapted to reconstitute images in a plurality of colors, the combination of a frame having a window area, a continuous conductor wound in coil-like fashion around opposed edges of said frame so as to form across said window area two sets of substan-

tially parallel strands respectively lying in separate parallel lanes and pressure bar means supported from the frame and located substantially adjacent to the conductor support for bringing one of the said sets so that all of the coplanar strands are substantially equally spaced apart.

3. The combination of claim 2, in which said last-mentioned means comprises a notched bar of rigid material, the individual strands of each set being respectively receivable in such notches.

4. In a grid structure designed for incorporation into a cathode-ray tube adapted to reconstitute images in a plurality of colors, the combination of two pairs of oppositely-disposed frame members together defining a substantially rectangular window area therebetween, each member of one of said pairs being provided with a series of parallel grooves on its outer edge, a continuous conductor wound in coil-like fashion around the frame members of said one pair so that successive turns of said coil lie within adjacent grooves in each such frame member to form across said window area two sets of substantially parallel strands respectively lying in separate parallel planes and means for bringing one of the said sets of parallel strands into coplanar relationship with the other of said sets.

5. The combination of claim 4, in which the parallel grooves on the outer edge of each of the two oppositely-disposed frame members are aligned in a direction other than perpendicular to the plane of each of the said sets of strand conductors.

6. The combination of claim 4, in which the parallel grooves on the outer edge of each of the two oppositely-disposed frame members are so aligned that the strand conductors of one group are offset from the strand conductors of the other group.

7. A grid structure comprising a frame having a window area, a continuous conductor wound around said frame in coil-like fashion so as to form across said window area two groups of strand conductors lying in separate parallel planes, means for causing the strand conductors of one group to be offset with respect to the strand conductors of the other group, means for applying pressure on the conductors in a direction substantially normal thereto, as well as normal to the conductor length for bringing all of the said strand conductors into a common plane which all of the coplanar conductors are substantially equally spaced apart and means for anchoring the conductor displacing means in a position permanently to maintain the coplanar conductor arrangement.

8. A grid structure according to claim 7, further comprising a transparent base secured to said frame, and so as to lie substantially equidistant from the said coplanar conductors.

9. The combination of claim 8, comprising, in addition, a plurality of phosphor strips coated upon the base plate in nominal registry with the coplanar strand conductors.

10. A grid structure comprising a frame having a window area, a continuous conductor wound around said frame in coil-like fashion so as to form across said window area two groups of strand conductors lying in planes which are separate yet parallel to one another, means for causing the strand conductors of one group to be offset with respect to the strand conductors of the other group, means for bringing all of the said strand conductors into a coplanar relationship in which all of the coplanar conductors are substantially equidistant from one another, a transparent base plate, a pair of spacer bars carried by said base plate, and means for securing said base plate to said frame so that said spacer bars act to contact said strand conductors and thereby maintain said strand conductors substantially evenly spaced from said base plate across that portion of the said window area lying between said spacer bars.

11. The combination of claim 10, in which each of the said spacer bars is provided with a plurality of notches respectively adapted to receive the said strand conductors.

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