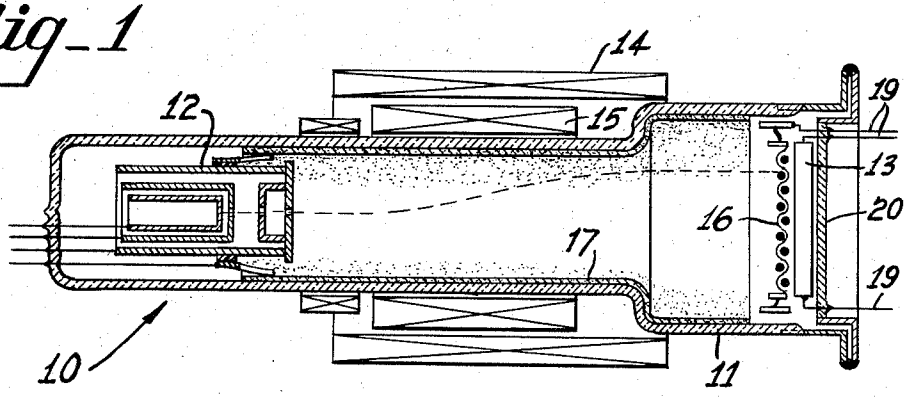
July 15, 1958 P. K. WEIMER 2,843,772

CATHODE RAY TUBE AND TARGET

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Fig_1



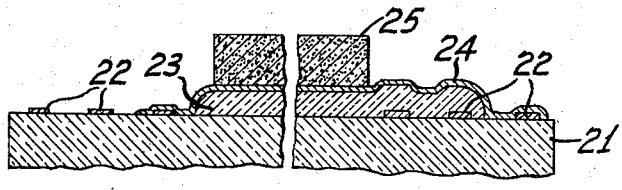
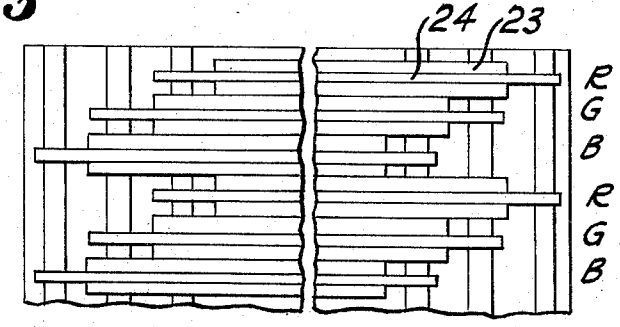


Fig_2

Fig_3



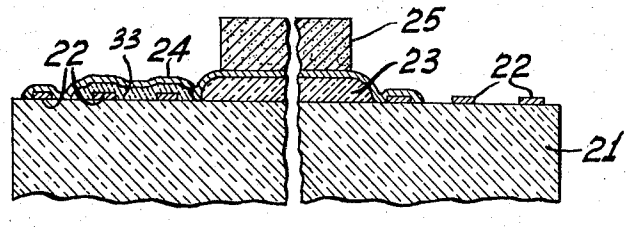


Fig_4

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CATHODE RAY TUBE AND TARGET

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Fig. 5

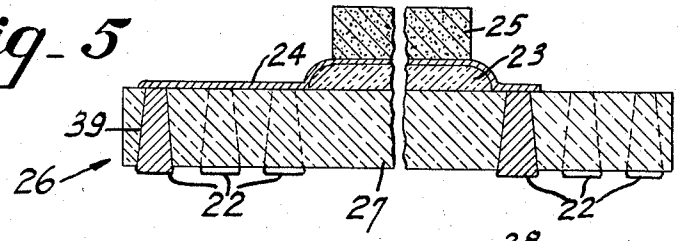


Fig. 6

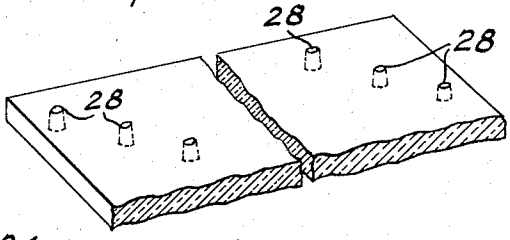


Fig. 7

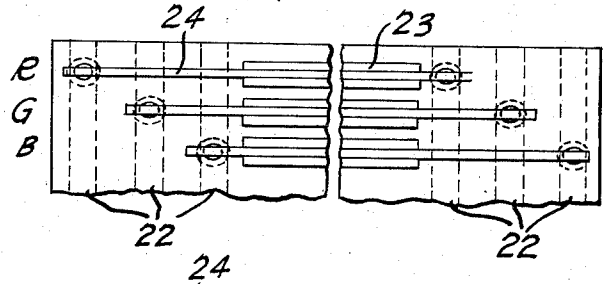


Fig. 8

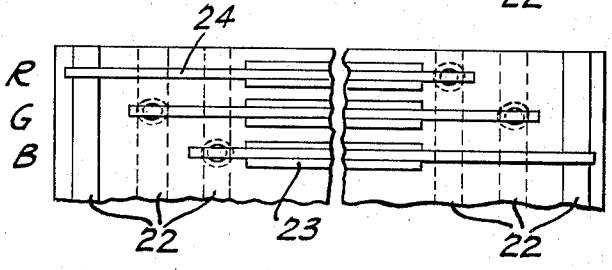
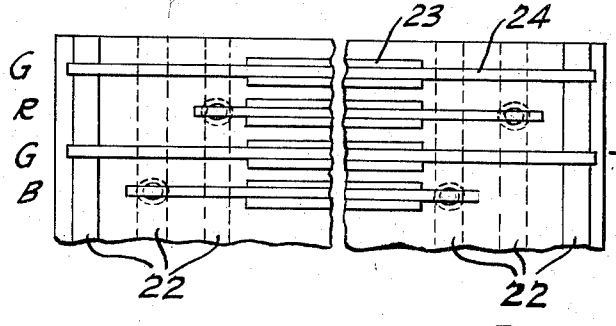


Fig. 9



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2,843,772

CATHODE RAY TUBE AND TARGET

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Application March 25, 1953, Serial No. 344,497

2 Claims. (Cl. 313—65)

This invention relates to cathode ray tubes and more particularly to cathode ray tubes having a ray sensitive target suitable for color television.

In various types of cathode ray tubes suitable for color television it has been proposed to provide a ray sensitive target which includes a plurality of fine closely spaced elements. It is often desirable to interconnect these elements in one relation or another as in the case of pickup tubes for producing simultaneous color video signals. One of such pickup tubes is capable of producing several video signals each corresponding to a color component of the object light. For example, three signals each corresponding to a different one of the primary colors of the object light are taken from the pickup tube to the utilization circuit. It has also been proposed to effect various improvements in such tubes by providing a structure in which the corresponding elements for producing each of the color signals are in a single plane. In such an arrangement the signal plate, which is capacitively coupled to the varying charge pattern or electron image formed on the surface scanned by the electron beam, is made up of a plurality of spaced parallel conductive strips or segments. The conductive strips are formed on the surface of an insulating support transparent sheet of glass. A coating of photo-sensitive material is also formed on the insulating support and is scanned by the electron beam. While the precise number of conductive strips is not at all critical it will be readily appreciated that they must be extremely narrow to avoid undue enlargement of the pickup tube and at the same time form a signal image elemental portions of which conform to elemental portions of the object image of a size acceptable to the observer at the receiver. In the three color type of pickup tube the conductive strips forming the signal plate are connected to form three separate but interlaced signal plates one for each color. The conductive strips are arranged with a strip for each color such as red, green and blue in a given sequence which is repeated over the target. The conductive strips for the red are connected as are also the strips for the green and blue.

In practice it has proven difficult to form such targets which are wholly satisfactory in operation. One of the faults noted is that the color image reproduced at the receiver from pickup tubes heretofore in use is streaky. That is to say, streaks appear in the picture in which the desired color is absent. Furthermore, it has been necessary to strike a balance between the desired transparency of the conductive strips and their resistivity. With increasing resistivity of the conductive strips there is an increasing loss in color fidelity due to increased leakage of signal between adjacent conductive strips.

It is, therefore, a principal object of this invention to provide an improved cathode ray tube suitable for color television in which a target has a plurality of discrete non-selfsupporting elements which are readily interconnected in a desired pattern.

Another object is the provision of such a cathode ray tube in which a plurality of extremely fine non-selfsupporting strips are arranged in a desired pattern and readily interconnected to form interlaced groups with each group independent of the others.

A further object is to provide such a tube having improved color filter strips arranged with signal strips in registration with each of the color filter strips.

Yet another object is to provide an improved pickup tube capable of producing electrical signals corresponding to the color components of the object light in which spurious signals are substantially reduced and virtually eliminated.

Another object is the provision of such a tube capable of improved color fidelity and in which coupling or cross-talk between the separate color signals is substantially reduced.

A more specific object is the provision of an improved target suitable for a color television pickup tube which substantially reduces the number of such tubes which have to be rejected because of unsatisfactory operation.

In accordance with one feature of my invention, spurious signals caused by a minute break in a conductive strip are eliminated by connecting both ends of each strip into the output circuit. In accordance with another feature of my invention, the conductive strips forming the segmented signal plate and the ray sensitive coating thereon are on one surface, i. e., the back surface, of the target which serves as the backing or support. Small holes are provided for at least some of the conductive strips and are in registration therewith. Conductive material in the holes electrically contacts the strip in registration therewith as well as conductive connecting lines or bus bars formed on the front surface of the target. The bus bars are arranged so as to interconnect the conductive strips associated with one color with one of the terminal pins of the pickup tube.

My invention as well as further objects and features thereof will be apparent from the following detailed description thereof taken in conjunction with the accompanying drawing in which—

Figure 1 is a sectional view of a photoconductive pickup tube constructed in accordance with my invention;

Figure 2 is a sectional view on an exaggerated scale of the target of such a tube;

Figure 3 is a plan view of a portion of the target of Figure 2 with the photoconductive material removed for convenience;

Figure 4 is a sectional view of another form of target constructed in accordance with my invention;

Figure 5 is a sectional view of yet another target;

Figure 6 is a perspective view, broken away for convenience, of the supporting member shown in Figure 5;

Figure 7 is a plan view of the target shown in Figure 5; and

Figures 8 and 9 are plan views of still other targets.

I will now describe my invention in detail as used in a photoconductive pickup tube wherein my invention is particularly useful. However, I consider my invention to be useful also in other types of cathode ray tubes particularly those suited for use in color television.

Referring now to the drawings in detail and in particular to Figure 1, pickup tube **10** comprises a vacuum tight envelope **11** with an electron gun **12** mounted in one end thereof. The electrodes of the electron gun include the usual cathode, control electrode and one or more accelerating anodes which are connected to lead-in pins in the well known manner. An electron beam from the gun is directed upon target **13** at the other end portion of tube **10**. Means are provided for focusing the electron beam and scanning the beam over target **13** to form a raster and may include focus coil **14** and deflection yoke **15** as

well as an alinement coil as shown. An electrode **16** permeable to the electron beam is positioned adjacent target **13** and in operation, together with focus coil **14**, functions to insure that the beam in its final approach to the surface of target **13** is normal thereto. Final accelerating electrode **17** is in the form of a conductive coating on the interior of envelope **11**. Fingers mounted on gun **12** but insulated therefrom serve to connect coating **17** to one of the lead-in pins.

Target **13** is conveniently supported adjacent transparent window **20** and three terminal pins **19** sealed through the envelope are connected thereto. As shown most clearly in Figures 2 and 3 target **13** comprises a support or backing **21** preferably of transparent glass. Conductive coating material in the form of strips or bus bars **22** are formed in the present instance on the back surface of backing **21**. As shown, two sets of bus bars **22** are provided; a set being located adjacent to opposite ends of backing **21**. Each set of bus bars **22** includes one bus bar for a color component of the object light for which a video signal is desired. In the present three color pickup tube there are three bus bars in each set. Three separate color filters, for example red, green and blue, are formed by laying down suitable coating material to form filter strips **23**. One type of filter which I have found suitable is a multi-layer interference type filter which can be made to have the desired pass bands for the primary colors. A sufficient number of alternate layers of a high and low index of refraction material having an optical thickness of desired wavelength are formed. The filter strips **23**, in the present instance are of insulating material and extend over the unwanted bus bars **22**. That is to say, the red filter strip "R" extends over the unwanted blue and green signal conducting bus bars and serves to insulate transparent conductive strips **24** from those bus bars at the crossover points as is most clearly shown in Figure 2.

Transparent conductive strips **24** are formed of suitable coating material. While the specific dimensions of transparent conductive strips **24** are not critical, the strips are extremely fine. At the present time, more than 200 such strips are formed per inch spaced approximately one half mil (.0005 inch) apart and approximately 100 angstrom units thick. Strips **24** are each laid down over the associated filter and are longer than the filter so as to make electrical contact with the proper bus bars **22**. In the form shown in Figure 3, the sequence of red, green and blue filters each with its associated transparent conducting strip is repeated over the target with adjacent ones offset as shown.

Thus, target **13** has an interlaced network of the several filters **23** and transparent conducting strips **24**; with the conducting strips **24** associated with the filters of the same color each connected at one end to one common bus bar **22** and at the other end thereof to another common bus bar **22**. Each set of conducting strips is connected to one of the terminal pins **19** by a suitable lead connected to both the bus bars **22** common to that set.

Photoconductive coating material is laid down over conductive strips **24** to form photoconductive coating **25**. Coating **25** is preferably of photoconductive material having a broad spectral response similar to that of the human eye though other materials may be used.

In operation target **13** may be oriented as desired in tube **10**. For example, filters **23** and strips **24** may be oriented parallel or perpendicular to the direction of scan. Pickup tube **10** may be operated in several ways and low or high velocity operation are both suitable.

While satisfactory operation of tube **10** is not dependent upon any particular materials it is of course necessary that suitable materials be utilized. Insulating red and blue filters of the type referred to above may be formed by evaporating successive layers of zinc sulfide and cryolite onto backing **21**. I have found eleven layers of zinc sulfide and cryolite formed in that sequence provide suitable filters. The optical thickness of each of the layers is one quarter wavelength of light having a wavelength of approximately 4,500 angstroms in the case of the red filters and of approximately 5,730 angstroms in the case of the blue. For forming the green filters zinc selenide and cryolite may be used and nine layers have been found to be suitable. Here, the zinc selenide is preferably laid down in layers having an optical thickness of three quarters of a wavelength of light of about 5,730 angstrom units wavelength.

Bus bars **22** and conductive strips **24** are formed of material having the desired conductivity. When formed by evaporation a suitable material is gold. Where, as in the present instance, conductive strips **24** need also to be transparent extremely thin strips are formed.

As described in detail in my application, Serial No. 344,498, now Patent No. 2,745,773, filed simultaneously herewith and assigned to the assignee of my present application, such a target may be formed by evaporating the various materials in proper sequence through suitable masks to form the fine closely spaced as well as superimposed strips. However, it may be well to point out that evaporation of the various materials is carried out in a suitable atmosphere. Bus bars **22**, filters **23** and conductive strips **24** are laid down in vacuum when the materials indicated above are used. Photoconductive material such as porous antimony sulfide is also evaporated in vacuum but under somewhat different conductions as pointed out in the Patent No. 2,744,837 of S. V. Forgue, assigned to the assignee of the present application.

Pickup tube **10** operates in a substantially improved manner. With bus bars **22** connected to both ends of each transparent conductive strip a single break in a strip no longer causes spurious color signals. Heretofore, a single break in a conductive strip left a portion of a strip unconnected to a bus bar. Signals generated along such an unconnected portion were then capacitively coupled to adjacent strips of the other colors resulting then in a spurious signal of a mixture of the adjacent colors. Furthermore, where, as in the present instance, the transparent conductive strip **24** is between the object light and the photoconductive material **25** then the maximum thickness thereof is limited by their transparency. Substantial transparency must be sacrified since the resistivity must not be so high as to unduly increase the ratio of the impedance along one strip measured from end to end to the impedance between adjacent strips. With connections to each conductive strip at both ends thereof the resistivity is substantially reduced so that thinner transparent strips may be used. Such a construction also avoids the introduction of high resistance in a strip which may be caused by a portion thereof being of reduced thickness as when a strip is almost but not completely broken through.

When filter strips **23** are not sufficiently insulating additional insulating layers may be formed at the cross-over points to insulate the signal strips from the unwanted bus bars. As shown in Figure 4, I may provide insulating layers **33** at the cross-over points. Such insulating layers may be formed from zinc sulfide or other suitable material which may be evaporated. Layers **33** may also be formed of superimposed layers of zinc sulphide and cryolite. Insulating layers **33** are also provided when the color filter strips are not included in the target structure.

Referring now to Figures 5, 6, and 7, target **26** is another target which may be used in pickup tube **10**. A transparent glass sheet **27** has a plurality of accurately located holes **28** formed therethrough adjacent opposite ends thereof. For this purpose, glass sold under the name Fotoform by the Corning Glass Works, Corning, New York is suitable. The holes are formed by exposing the glass sheet to ultra violet light to which it is sensitive through a template. The exposed areas under-

go a transformation to a form such that may then be etched away, leaving the desired holes. Suitable masks or templates are made by any convenient process, as for example, the processes wherein photographic film is exposed through a mask or template to light originating at substantially a point source.

As shown in Figures 5 and 6 holes **28** are conical in shape. Conductive material such as silver, copper, or gold is evaporated into the holes to form conductive coatings or plugs **29**. During the evaporation of plugs **29** a mask is utilized to cover all but the holes on the front surface of sheet **27** to avoid the deposition of conductive material elsewhere on the surface. During the evaporation, sheet **27** is rotated about its short axis to insure an even formation of plugs **29**. Conductive bus bars **22** are laid down as described above. Here bus bars **22** are all formed on the front surface of sheet **27** and each conductively contact one set of plugs **29**. Filter strips **23**, conductive strips **24** and photoconductive material **25** are applied as described in connection with target **13**. It is apparent, that on target **26** all cross-over points between conductive strips **24** and the unwanted bus bars 22 are eliminated. Double end connections between each conductive strip and the bus bars **22** common to the strip of a given color are readily effected through contact between strip **24** and the appropriate plugs **29**. Holes **28** and thus plugs **29** are formed in any pattern which is most convenient. Conductive strips **24** on each of the color filter strips are alined only with the plugs **29** to which they are conductively connected.

It is not necessary that holes be provided for each conductive strip **24** or that the same number be provided for each such strip. For example, as shown in Figure 8, two of the bus bars **22** are formed on the back surface and four on the front surface of transparent sheet **30**. One set of conductive strips **24**, such as the red, are each connected at one end to a bus bar on the back surface and to a bus bar on the front surface. Similarly, another set such as the blue are also thus connected. The set of conductive strips for the green are each connected by plugs **29** to bus bars on the front surface as shown in Figures 4 and 6.

As pointed out in connection with Figures 2 and 3 filters **23** are of insulating material. However, such filter may also be of conductive material. In the structure shown in Figure 4, insulation must be provided at the cross-over points with the bus bars of the other colors when the filters themselves are conductive. However, in the case of the targets shown in Figures 5, 7, 8 and 9 there is no necessity for providing such insulation where the filters are conducting since cross-overs are eliminated. Filter strips **23** are of necessity spaced one from the other, as in Figure 7, when they are of conducting material. As shown in Figure 3, insulating filters are preferably formed without spaces between adjacent filters to avoid unfiltered light affecting the photoconductive coating material.

As shown in Figure 9, the color filter strips of one color and its signal strips may be interlaced between the other color filter strips and their signal strips to provide additional electrical isolation. Thus, green filter strips **23** and green signal strips **24** are interposed between each of the red and blue strips. In such an arrangement there would then be twice as many green strips as red or blue. The signal strips themselves may be thus arranged when color filter strips are omitted. Similarly, the bus bars of one color, such as the green, may be interposed between the red and blue bus bars. Such arrangements are particularly advantageous where it is desired to operate two of the signal strips, such as the red and blue, with a relatively large potential difference between them. The green strips may be operated at some intermediate potential.

An important advantage accrues from the offset relationship of the strips. By offsetting signal strips **24** connections to desired bus bars may be readily made while at the same time insulation may readily be provided at the cross-over points with undesired bus bars. As shown in Figure 2, such insulating may be provided by similarly offsetting the color filter strips. It should be noted that the advantage accrues when connections are made to only one end portion of each of the signal strips as well as when connections are made to both ends.

It should be noted that, while for purposes of illustration, signal strips **24** are shown narrower than color filter strips **23** in Figures 7–9, they may here be of the same width as the filter strips.

The nature of the electrical connections between various parts may be most readily understood when considered in connection with the operation of such a device. In this regard, a consideration of one mode of operating pickup tube **10** will be advantageous. In the so called low velocity mode of operation, the electron beam which scans target **13** arrives with such low velocity that the ratio of the secondary electrons knocked out of the coating **25** to the number of electrons deposited by the beam is less than unity. In the absence of light, the electron beam keeps the scanned surface at substantially cathode potential. Signal strips **24** are biased to some moderate positive potential with respect to the cathode, as for example 50 volts. The frame time, or time for completing one scansion of target **13**, may be $\frac{1}{30}$ of a second while the element time, or the time the beam is on a given elemental surface portion, may be 1/4,000,000 of a second for a four megacycle per second signal. In the absence of light a slight substantially steady dark current flows indicative of some small number of electrons traveling from the beam to the signal strips. Consider now an elemental portion of the target with light falling thereon just after the beam has passed. Because of the effect of light on photoconductive material of this type, the scanned surface of this elemental portion charges positive during the next $\frac{1}{30}$ of a second. It is believed that in the case of porous antimony sulfide the photoconduction process involves the travel of electrons. Thus the elemental area, during the frame scansion time, loses negative charge as a consequence of the travel of electrons to the front surface. There the electrons are bound by the charge on the elemental area. During the element time when the electron beam is once again on the elemental area, the charge on the surface thereof is removed and the surface returned to its dark potential. At the same time, the bound electrons on the front surface, i. e., the surface presented toward the signal strips, are released. With such material as a photoconductor a back to front potential gradient necessarily must be maintained since in the absence of some direct current flow to the front surface it soon loses its necessary positive potential by reason of the repeated flow of negative charge from the back surface. In this respect, such material differs from others which do not require a direct current potenital gradient across them, such as secondary or photoemissive materials.

When, as in the present instance, photoconductive material is utilized, then the signal strips may be used to maintain the desired potential gradient across the material as well as to function as signal strips for the output signal. In view of the relatively long frame scansion time, and the small currents which flow, the connection between each of the signal strips and its bus bar may have resistance so long as the voltage drop across the contact does not become so large as to represent an objectionable loss in bias. On the other hand, for the output signal, which is in the form of a current pulse, it is believed sufficient that there be enough capacitance between the signal strip and its bus bar so as to present a low impedance path as compared to the impedance between adjacent signal strips. Such capacitance may be introduced by the scattering of some of the materials, as may

occur during the evaporation process referred to hereinabove, to form a thin film at the junctions. For example, the cross capacitance between adjacent signal strips may be approximately four micro-microfarads while that between a strip and its bus bar about ten times that. In some respects the connection of a signal strip to a bus bar may be similar to a condenser shunted by a resistance.

It is apparent from the foregoing that I have provided an improved pickup tube and target particularly suitable for full color television capable of enhanced color fidelity and improved operation. While I have described my invention in detail with respect to the forms thereof shown by way of illustration it is believed obvious that changes and deviations therefrom may be made without departing from my invention. It is therefore intended that all such changes and deviations as come within the appended claims be included within my invention.

What is claimed is:

1. A ray sensitive target for a color television pickup tube comprising a transparent insulating support member, a plurality of electrically insulating color filter strips extending across said support member and arranged in groups with the filter strips that pass each color of light interlaced with the filter strips that pass other colors of light, a pair of sets of bus bars in the form of electrically conductive strips deposited on said support member and one set adjacent to each end of said color filter strips, a plurality of transparent conducting signal strips each on a different one of said color filter strips and each contacting one of said bus bars in each of said sets by means of deposited conductive strips, and each of said color filters being positioned between at least one of said bus bars in at least one of said sets and the signal strips on that color filter strip, whereby each of said signal strips is insulated from at least one of said bus bars by means of its insulating color filter strip.

2. A ray sensitive target for a color television pickup tube, comprising a light transparent electrically insulating support member, a pair of sets of bus bars in the form of electrically conductive strips evaporated on a surface of said support member, each of said sets being arranged adjacent to an opposite side of said support member, a plurality of electrically insulating light color filters on said support member and extending between said sets of bus bars, each of said color filters being on at least one of said bus bars in at least one of said sets, a plurality of light transparent electrically conductive signal strips each on a different one of said color filters and each connected to one of the bus bars in both of said sets by means of evaporated conductive strips, and the portion of each of said color filters on said at least one bus bar forming the electrical insulation between said at least one bus bar and the signal strip on said color filter.

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