May 6, 1969 R. D. THOMPSON 3,443,139

COLOR CATHODE RAY TUBE WITH RADIATION-EMITTING STRIP-LIKE INDEXING AREAS HAVING SERRATED EDGES

Filed April 19, 1968 Sheet 1 of 3

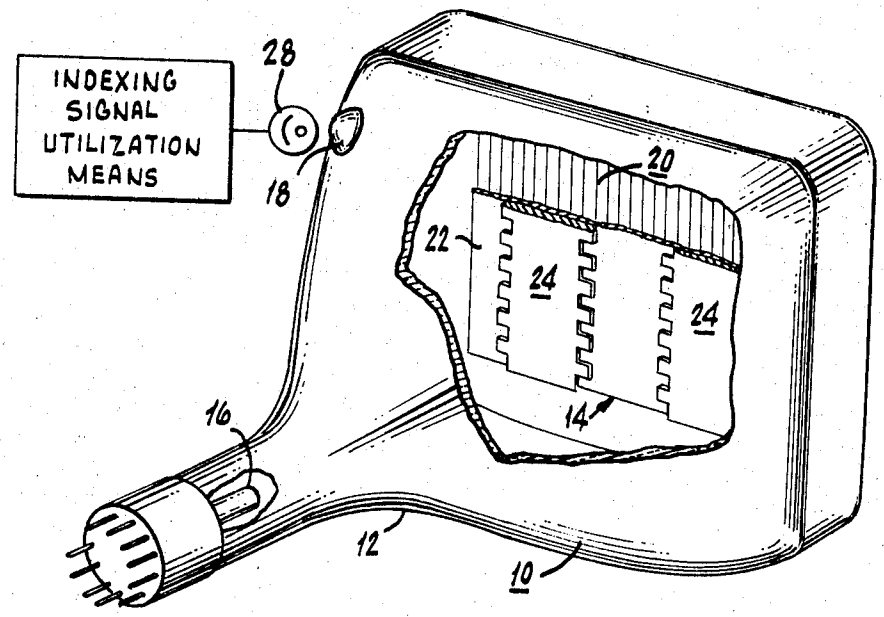
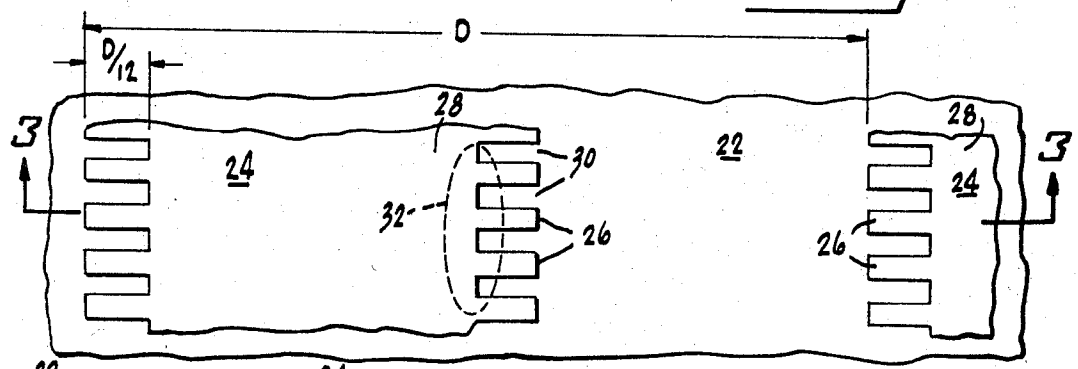


Fig. 1.

Fig. 2.



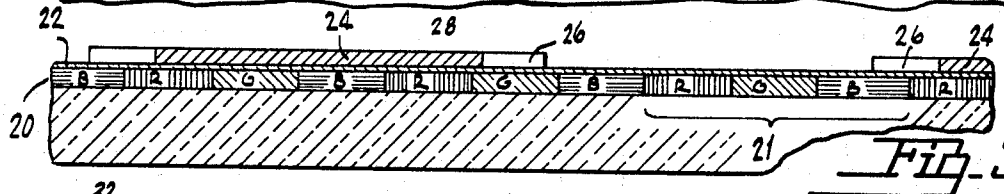


Fig. 3.

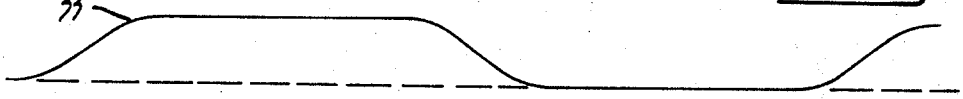


Fig. 4.

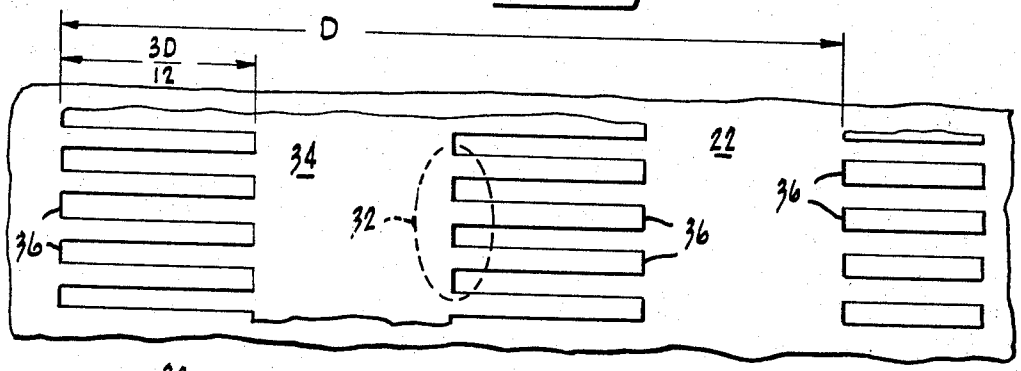
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Fig. 5.



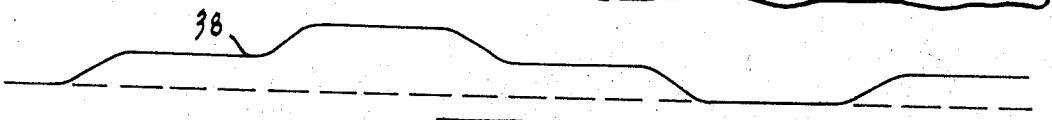
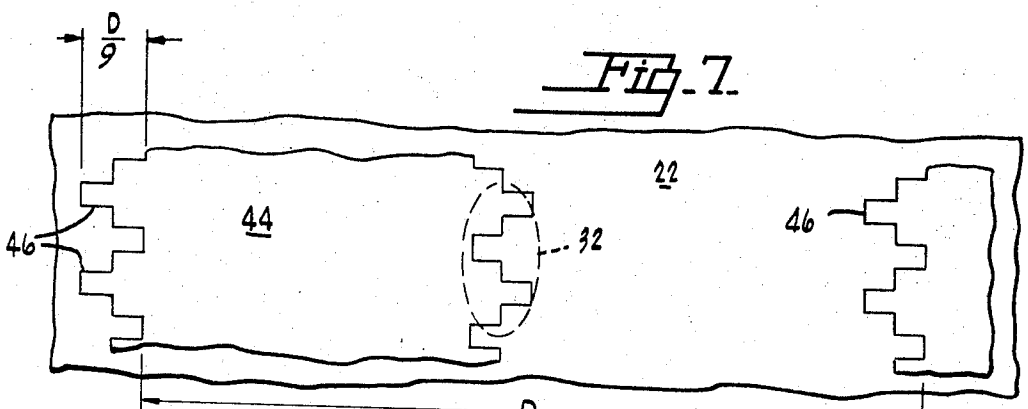


Fig. 6.

Fig. 7.



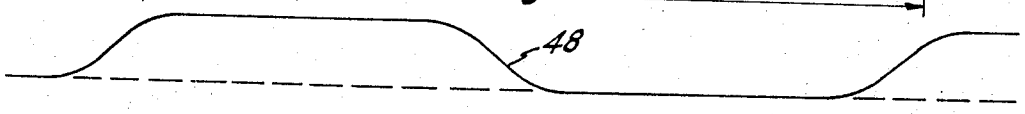


Fig. 8.

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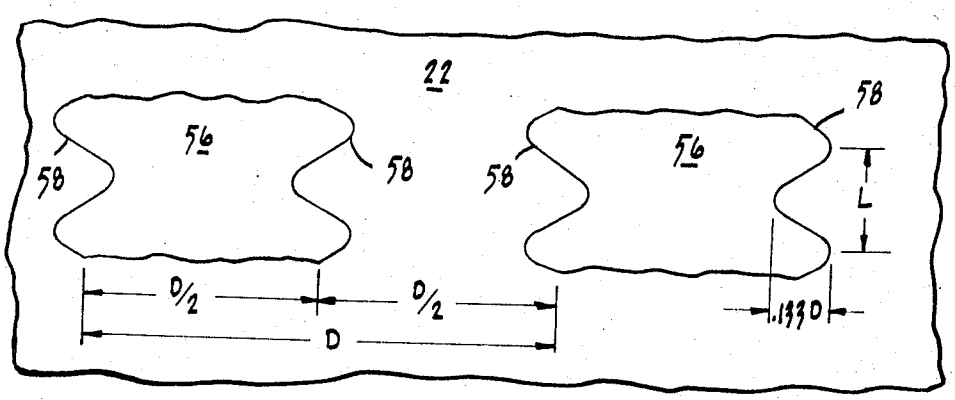
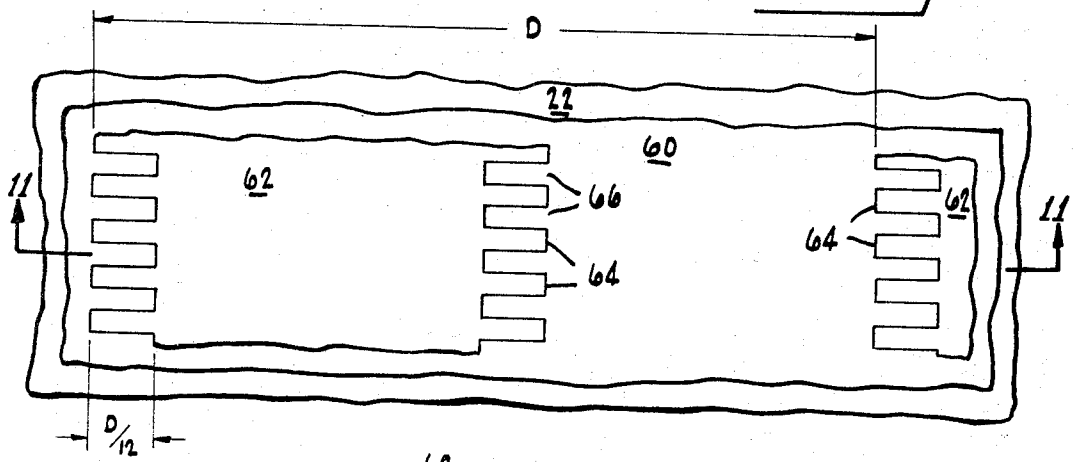


Fig. 9

Fig. 10



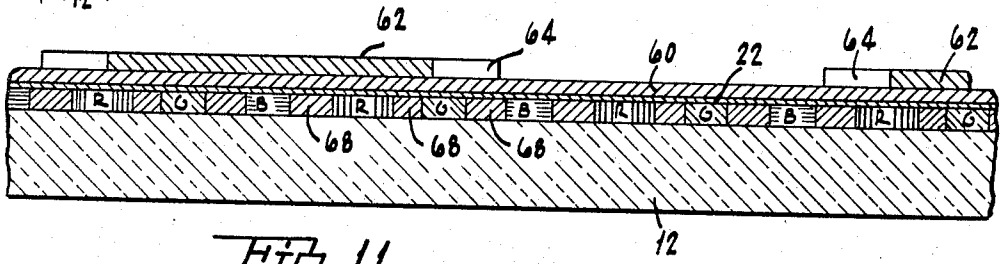


Fig. 11

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COLOR CATHODE RAY TUBE WITH RADIATION-EMITTING STRIP-LIKE INDEXING AREAS HAVING SERRATED EDGES

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Int. Cl. H01j 29/18

U.S. Cl. 313—92 10 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed a color picture tube of the feedback or sensing type wherein the electron sensitive screen comprises a series of groups of different color emitting phosphor strips and a series of serrated-edge indexing strips or exposed strip-like areas extending parallel to the color phosphor strips and perpendicular to the direction of beam scan. Beam-produced radiation from the indexing strips is utilized to synchronize the application of color signals to the beam with the instantaneous position of the beam on the screen. The serrated edges of the indexing strips may be simple rectangular teeth of suitable length, stepped teeth, or sinusoidal teeth.

Background of the invention

This invention relates to image reproducing devices for producing color images and particularly to cathode ray tubes having a luminescent screen which includes means for generating indexing signals for the purpose of synchronizing the scan and color modulation of an electron beam with each other. Such tubes are sometimes known as feedback or sensing tubes. One such tube disclosed by the prior art includes a mosaic luminescent screen comprising an array of color phosphor groups, each of which includes a plurality of different color-emitting phosphor strips parallel to each other and perpendicular to the direction of beam scan. A plurality of spaced-apart short-persistence phosphor strips is disposed adjacent to the back of and parallel to the color phosphor strips. For example, the short persistence phosphor may be ultraviolet emitting. The tube envelope is provided with a UV transmitting window positioned behind the luminescent screen, whereby a UV-sensitive phototube outside the cathode ray tube can pick up UV indexing signals which are generated when the electron beam scans across the spaced-apart UV phosphor strips. The indexing signal derived from the indexing strips provides information regarding the actual instantaneous positon of the electron beam on the screen with relation to the color of light being produced. The indexing signal is employed in a servo system to insure the application of the proper electrical color signal to the electron beam at all times.

Alternatively, the material of the indexing strips could be secondary emissive, and means could be provided within the tube for collecting the radiation from the strips.

In my Patent No. 2,962,546 I disclosed that "video pulling," that is, distortion of the indexing signal by the color modulation applied to the beam, could be minimized by making the frequency of the indexing strips (and the signal produced thereby) different from the color group frequency of the phosphor strips, and by constructing the indexing strips with a sine wave distribution in thickness or phosphor efficiency so that the indexing signal is a sine wave free of harmonics. However, it is difficult to make variable thickness indexing strips with the ideal sine wave distribution. A plural-step approximation thereof is shown in FIG. 4 of the patent. With the proportions shown in FIG. 4, the video pulling of that approximation would be about 10 degrees.

Summary of the invention

An object of the present invention is to provide an improved screen structure for a sensing type cathode ray tube.

In accordance with the invention, the luminescent screen of the sensing type cathode ray tube is provided with UV emitting indexing strips or exposed strip-like indexing areas of variable width. For example, serrated-edge strips may be deposited on the mosaic of color phosphor strips, or on a thin light reflective coating on the mosaic. Alternately, a continuous layer of UV indexing phosphor material may be deposited on the color phosphor mosaic (or the aluminum coating), and spaced-apart serrated strips of inactive material, such as graphite, may be deposited on the UV layer to mask off all but the desired serrated strip-like areas thereof. The inactive material must be opaque to UV radiation. While the serrations on the edges of the indexing strips or areas may have a simple rectangular shape for easy manufacture, lowest video pulling is produced by a sinusoidal serrated edge having a width of about 0.133 times the width of the indexing cycle.

Brief description of the drawing

FIG. 1 is a perspective view, with parts broken away and the interior greatly enlarged, of a sensing-type color cathode ray tube embodying the invention;

FIG. 2 is an enlarged view of a portion of the luminescent screen shown in FIG. 1;

FIG. 3 is a section view taken on the lines 3—3 of FIG. 2;

FIG. 4 is a graph showing approximately the indexing signal produced by an elliptical beam spot shape in FIG. 2;

FIG. 5 is a view similar to FIG. 2 of a modification thereof;

FIG. 6 is a graph showing approximately the indexing signal produced by an elliptical beam spot in FIG. 5;

FIG. 7 is a view similar to FIG. 2 of another modification thereof;

FIG. 8 is a graph showing approximately the indexing signal produced by an elliptical beam spot in FIG. 7;

FIG. 9 is a view similar to FIG. 2 of a further modification thereof;

FIG. 10 is a view similar to FIG. 2 of still another modification; and

FIG. 11 is a section view taken on the line 11—11 of FIG. 10.

Description of the preferred embodiments

In FIG. 1 is shown a cathode ray tube **10** comprising an envelope **12** having a luminescent screen **14** disposed on an internal end surface thereof. An electron gun **16** disposed in the envelope is adapted to project an electron beam onto the screen **14**. A window **18** is provided in the envelope **12** rearwardly of the screen **14** for a purpose hereinafter described.

The luminescent screen **14** includes a mosaic **20** of different color emitting phosphor strips. The color strips may for example comprise successive strips of red-emitting, green-emitting and blue-emitting phosphor, designated in the drawing as R, G and B, respectively. The mosaic **20** is made up of a plurality of recurring groups **21**, each of which includes one each of the R, G and B strips. The specific character of the color phosphor groups **21**, for example, the width of the color strips, the color emission thereof, the number of strips for each group, and the color arrangement within each group, may be chosen in accordance with known practice.

Preferably, a light reflective layer **22** is superimposed on the back of the mosaic **20**, i.e. on the side facing towards the electron gun **16**. If included, the layer **22** may, for example, comprise a thin electron-transparent layer of

aluminum which is disposed on the color mosaic **20** in accordance with known practice.

Superimposed on the light reflective layer **22** is an array of spaced-apart strips **24** of indexing material. The indexing strips **24** are preferably made of a phosphor which emits very short-persistence ultraviolet luminescence when excited by an electron beam. For example, a cesium-lithium activated calcium-magnesium-silicate phosphor known as P–16 may be used.

In accordance with the present invention, each of the indexing strips is formed with serrations in each side or edge thereof, for reducing video pulling. In the embodiment shown in FIGS. 1–3, the serrations are formed by longitudinally-spaced rectangular teeth **26** extending outwardly from a continuous middle portion **28** of the indexing strip **24**.

Preferably, the width of the teeth **26** and the rectangular spaces **30** therebetween should be small compared to the height of the beam spot, that is the beam dimension parallel to the color strips **21**, and the spaces **30** between the teeth should have a width substantially equal to the width of the teeth **26**, as shown in FIG. 2. The cycle width D of the indexing strips **24**, as measured between corresponding points on adjacent strips, is preferably equal to the width of three groups **21** of the color phosphor strips, as also shown in FIG. 2. The average width of each strip **24** is equal to one-half the cycle width D.

The beam is preferably shaped, by suitable beam forming and focusing means, to produce a vertically-elongated spot having rounded corners, e.g. an elliptical spot, as shown by the dotted ellipse **32** in FIG. 2. The curve **33** in FIG. 4 shows approximately the shape of the indexing signal wave produced by scanning the indexing strips **24** of FIG. 2 by an unmodulated elliptical beam spot **32**.

It can be shown theoretically, and it has been demonstrated experimentally, that the lowest video pulling is produced with the type of serrations shown in FIG. 2 when the width of the serrated edge of each strip **24** is approximately $n/12$ of the cycle width D of the strips, where n is 1, 3 or 5. In FIG. 2, where $n=1$, the amount of video pulling is no more than about 2 degrees when the tube is operated to produce a saturated color.

In the modification shown in FIG. 5, the indexing strips **34** have teeth **36** that are three times as long as the teeth **26** in FIG. 2. Thus, $n=3$, and the width of the serrated edge is $3/12$ of the cycle width D. The approximate shape of the three-level indexing signal produced by an elliptical beam spot **32** in FIG. 5 is shown by the curve **38** in FIG. 6.

FIG. 7 shows a modification of FIG. 2 wherein the simple rectangular teeth **26** are replaced by stepped teeth **46** on indexing strips **44**. The width of each step should be about $1/18$ of the cycle width D. FIG. 8 shows a curve **48** of the approximate indexing signal produced by an elliptical beam spot **32** in FIG. 7. It can be seen that the signal **48** in FIG. 8 is very similar to the signal **33** in FIG. 4.

FIG. 9 shows a modification of the screen of FIG. 2 wherein the indexing strips **24** are replaced by spaced indexing strips **56** the edges of which are formed with sinusoidal-shaped serrations **58**. The optimum width of the sinusoidal serrated edge for minimum pulling is about .133D, in which case the video pulling is less than 1°.

FIGS. 10 and 11 show a modification of FIG. 2 in which a continuous layer **60** of indexing material is deposited on the reflective layer **22** and the desired serrated edge strip-like areas of exposed indexing material are formed by masking off portions of the indexing layer **60** by means of serrated edge masking strips **62** of inactive material, as described in my Patent No. 3,280,358 for masking strips of uniform width. In the particular case shown, wherein the average width of the indexing strips is equal to one half the cycle width D, the shape of the serrated masking strips **62** may be identical with the shape of the serrated indexing strips **64** in FIG. 2. That is, the masking strips **62** may be formed with rectangular teeth **64** and intermediate spaces **66** which are identical in shape to the teeth **26** and spaces **30** in FIG. 2. The masking strips **62** may be made of graphite, for example.

FIG. 11 also shows a modified color phosphor strip arrangement wherein the individual color phosphor strips of different colors, e.g. R, G and B, are separated or spaced apart by inactive guard band strips **68**, to permit the production of saturated colors with a larger beam spot.

The mosaic **20** of different color emitting phosphor strips in FIG. 3 can be produced by known methods, such as by a sequence in which each set of strips of the same color is obtained by application to the envelope **12** of a photosensitive suspension of phosphor particles capable of luminescing in a particular color, exposure to active light through a photographic pattern composed of elongated clear and opaque areas, and development to remove phosphor particles in areas not exposed. The light reflecting layer **22** can be applied in known manner by evaporation. The serrated indexing phosphor strips **24** can be applied by a photographic printing method like the color phosphor strips. The continuous indexing phosphor layer **60** of FIG. 11 can be applied to the layer **22** by spreading through rotational forces a suspension of phosphor particles in a viscous vehicle, a portion of which evaporates and another portion of which remains as a binder to permit subsequent application of a serrated edge indexing pattern of opaque material forming the masking strips **62**. A suitable process is one in which a layer of polyvinyl alcohol (PVA) sensitized by potassium dichromate is applied to the layer **60** and exposed to light through an appropriate photographic pattern of opaque and transparent areas, and unexposed areas are removed by solution in water. Graphite particles are then applied in a uniform layer by settling or spinning. A water spray then removes graphite particles from the bare areas but not from the tacky surface of the PVA pattern. This method can also be used to produce the guard band strips **68** in FIG. 11.

I claim:

1. An image reproducing device comprising an image screen and electron gun means to project an electron beam towards said screen, said screen including a plurality of light emitting strips arranged to be energized by said beam, and indexing means disposed to be energized by said beam to thereby produce an indexing signal, said indexing means comprising a plurality of strip-like areas of indexing material extending parallel to said light emitting strips and disposed to be energized by said beam, each of said strip-like areas having serrated edges.

2. A device as in claim **1**, wherein said screen includes an electron transparent light reflective layer interposed between said indexing means and said light emitting strips.

3. A device as in claim **1**, wherein each of said serrated edges is made up of substantially rectangular indexing areas separated by substantially rectangular inactive areas of substantially the same dimensions.

4. A device as in claim **3**, wherein the dimension of said rectangular areas normal to said edges is approximately $n/12$ of the distance between corresponding points on adjacent strip-like areas, where n is 1, 3 or 5.

5. A device as in claim **1**, wherein each of said serrated edges is made up of stepped areas each having a dimension normal to said edges approximately equal to $n/12$ of the distance between corresponding points on adjacent strip-like areas, where n is 1, 3 or 5.

6. A device as in claim **1**, wherein said indexing means comprises a continuous layer of indexing material on said screen and spaced serrated-edge strips of opaque material disposed on said indexing layer and masking said layer except for said serrated-edge strip-like areas of indexing material.

7. A device as in claim **1**, wherein said strip-like areas consist of spaced serrated-edge strips of indexing material.

8. A device as in claim 1, wherein said serrated edges have a substantially sinusoidal shape.

9. A device as in claim 8, wherein the width of each serrated edge is approximately .133 times the distance between corresponding points on adjacent strip-like areas.

10. A color image reproducing device comprising an image screen and electron gun means to project an electron beam towards said screen, said screen including strips of a plurality of different colored light emitting materials arranged in repeating color groups to be energized at a given color group frequency by said beam, and indexing means disposed to be energized by said beam and to thereby produce an indexing signal, said indexing means being constructed so that said indexing signal has an indexing frequency different from said color group frequency and harmonics thereof, said indexing means comprising a plurality of strip-like areas of indexing material

disposed to be energized by said beam and extending parallel to said light emitting strips, each of said strip-like areas having serrated edges.

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U.S. Cl. X.R.

315—10; 178—5.4