United States Patent [19]

Tsuneta et al.

SUBSTITUTE FOR MISSING XR

[11] 3,736,848

[45] June 5, 1973

[54] METHOD OF PREPARING THE SCREEN OF A COLOUR TELEVISION PICTURE TUBE AND DEVICE PERFORMING THE METHOD

[75] Inventors: Asahide Tsuneta, Kawasaki; Makoto Ikegaki, Fukaya, both of Japan

[73] Assignee: Tokyo Shibaura Electric Co., Ltd., Kawasaki-shi, Japan

[22] Filed: Oct. 15, 1971

[21] Appl. No.: 189,723

[30] Foreign Application Priority Data

Oct. 20, 1970 Japan 45/91623

[52] U.S. Cl. ..... 95/1 R, 313/92 B

[51] Int. Cl. G03b 27/00

[58] Field of Search ..... 95/1 R; 313/92 B, 313/853

[56] References Cited

UNITED STATES PATENTS

3,358,175 12/1967 Morrell et al. ..... 313/92 B

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard M. Sheer
Attorney—Solon B. Kemon, Carroll Palmer and William T. Estabrook

[57] ABSTRACT

A method of preparing the screen of a colour television image pickup tube by photographic printing which consists in disposing a prism tapered to a prescribed angle between a screen being prepared and a source of light so fixed as to face the screen and projecting light on the screen while causing the prism to revolve, thereby forming on the screen light-exposed portions having a smaller area than the light-permeable portions of a shadow mask and a device for performing the method.

5 Claims, 7 Drawing Figures

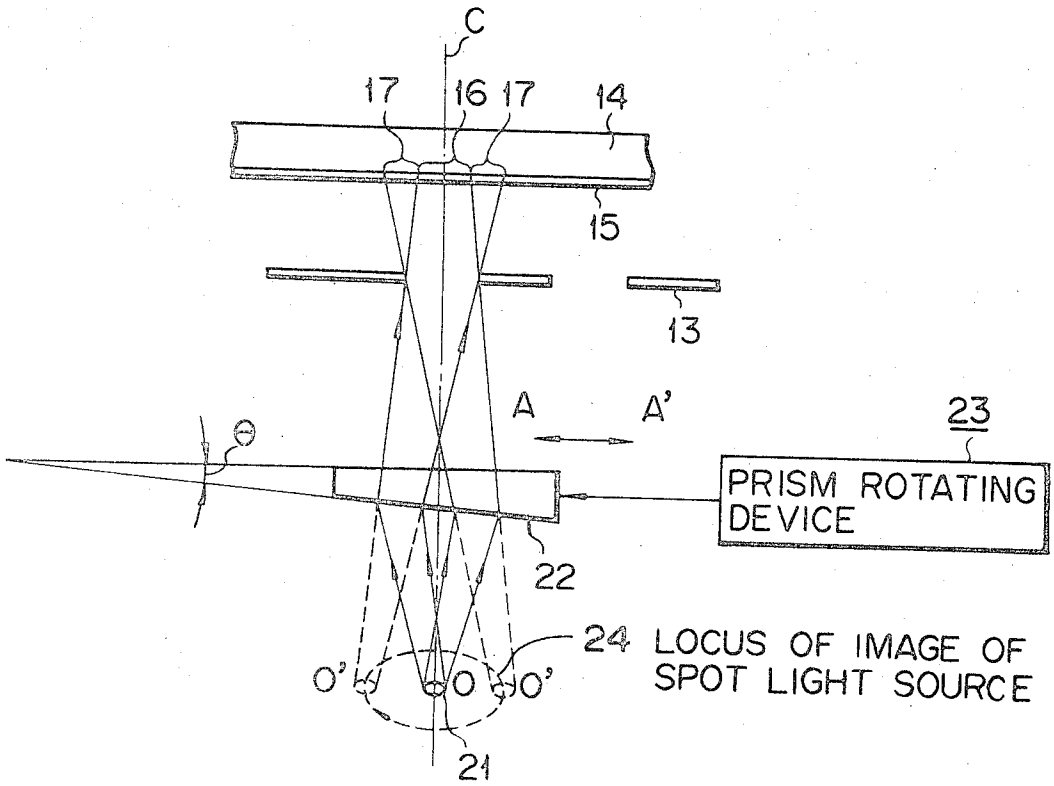


FIG. 1

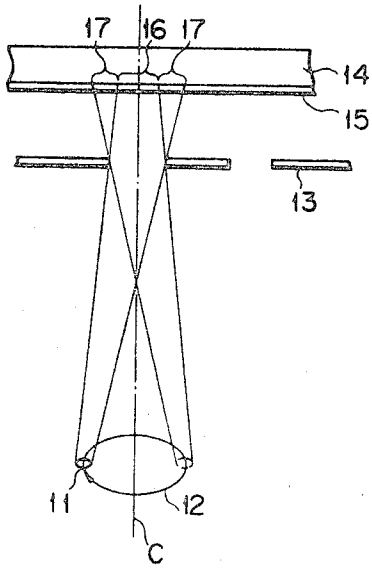


FIG. 2A

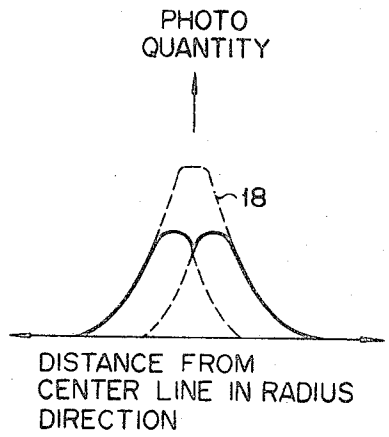


FIG. 2B

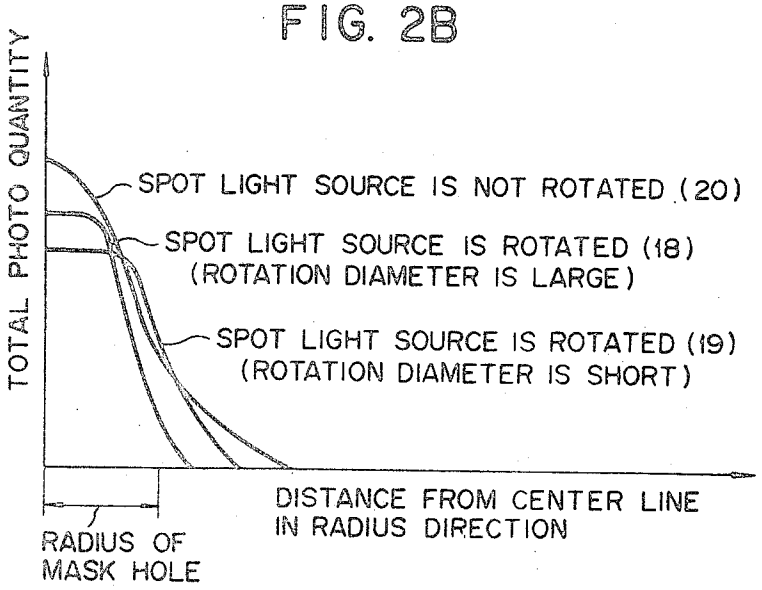


FIG. 3

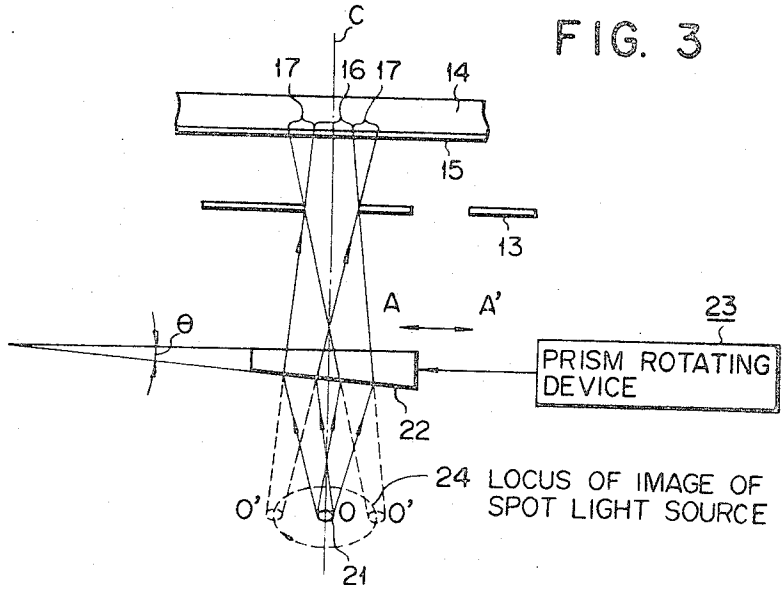

C
17
16
17
14
15
13
A
A'
23
θ
PRISM ROTATING DEVICE
22
24
LOCUS OF IMAGE OF SPOT LIGHT SOURCE
O'
O
O'
21

FIG. 5

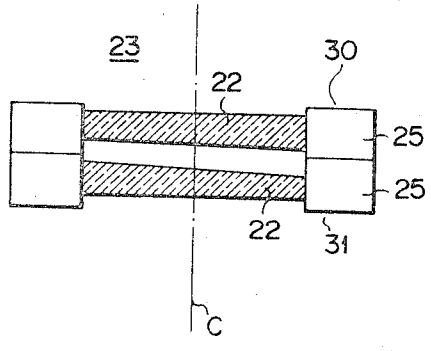

23
30
22
25
25
22
31
C

FIG. 4A

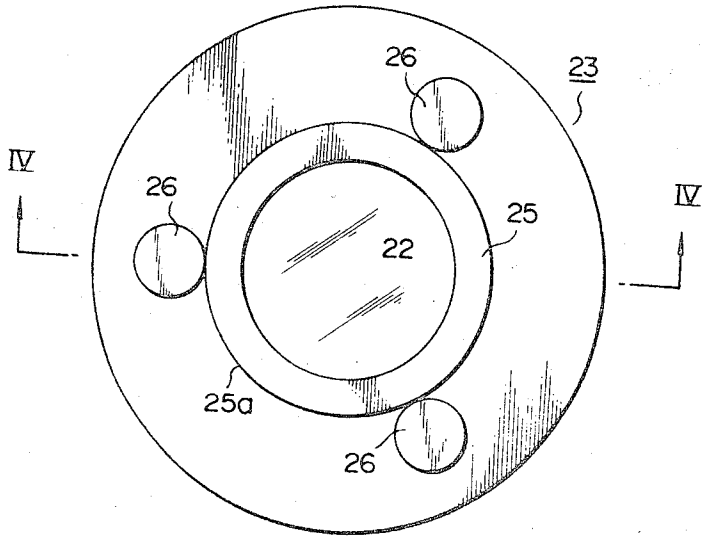
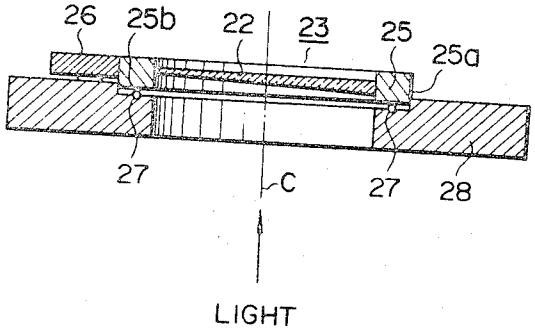


FIG. 4B



METHOD OF PREPARING THE SCREEN OF A COLOUR TELEVISION PICTURE TUBE AND DEVICE PERFORMING THE METHOD

This invention relates to a method of preparing the screen of a colour television picture tube provided with fluorescent dots having a smaller diameter than shadow mask holes, for example, a black matrix type screen and more particularly to improvements in the method of projecting light on the screen when it is prepared by photographic printing and a device for performing the method.

There will first be described in a general way a black matrix type colour television picture tube. The screen of such type of picture tube consists of a black light-absorbing layer such as that of graphite, a matrix layer perforated with matrix holes corresponding to red, blue and green colours and fluorescent dots embedded in said holes so as to produce red, blue and green lights. About 10 mm apart from the screen is disposed a shadow mask. It is considered necessary for the shadow mask holes to have a larger diameter than the fluorescent dots in order effectively to expose said dots to light. To this end, the matrix holes should be formed with a smaller diameter than the shadow mask holes. For formation of such matrix holes, there have heretofore been contemplated the following two methods:

1. The shadow mask holes are first formed with substantially the same diameter as the matrix holes which should be finally obtained. After light is projected on the screen through the shadow mask holes, the shadow mask is etched again to broaden its holes.

2. The shadow mask holes are so formed from the outset as to have a larger diameter than the matrix holes which should be finally obtained. Under such condition, there are baked to the screen a large number of minute areas corresponding to the matrix holes.

According to the method of (1), there has to be additionally applied a complicated step of etching the shadow mask a second time, said etching causing the shadow mask to be reduced in thickness and consequently in mechanical strength. Though the latter method of (2) is preferable, the conventional procedure associated therewith had serious drawbacks as described later. Eventually, therefore, the method of (1) has generally been adapted.

The present invention can be more fully understood from the following detailed description when taken with reference to the accompanying drawings, in which:

FIG. 1 is a schematic diagram of a device for projecting light on the screen, illustrating the method of (2) as conventionally practised;

FIGS. 2A and 2B are curve diagrams showing the distribution of light quantity on the screen;

FIG. 3 is a schematic diagram of a device for projecting light on the screen according to an embodiment of this invention;

FIG. 4A is a plan view of a prism-revolving mechanism to be used in FIG. 3;

FIG. 4B is a sectional view on line IV—IV of FIG. 4A as viewed in the direction of the arrows; and

FIG. 5 is a sectional view of a modified prism device of this invention.

Among the conventional procedures associated with the method of (2) is one using such a light-projecting device as illustrated in FIG. 1. Said device includes an

extremely minute source of light 11 about 1.0 to 0.3 mm in diameter. While said source of light 11 is rotated with a rotation diameter of about 1 to 3 mm along a locus 12, there is projected light through the holes of a shadow mask 13 on a layer 15 made of photosensitive polyvinyl alcohol resin (PVA) coated on a panel 14 constituting a screen.

When such a minute spot light source 11 is rotated, there are produced on the PVA layer 15 that portion 16 which is always exposed to light, as illustrated in FIG. 1, during said rotation, namely, the portion corresponding to the central area of the shadow mask hole and those portions 17—17 which are not always exposed to light, namely, those areas lying outside of the first mentioned portion 16. As a result, the distribution of an integrated quantity of light projected on said PVA layer 15 presents a uniform pattern in a region corresponding to the aforementioned portion 16 exposed to light. Thus, as indicated by the curves 18 and 19 of FIGS. 2A and 2B, those portions of said curves which represent the aforementioned region are made flat. The region where the integrated quantity of light becomes uniform is always a smaller area than the holes of the shadow mask. Projection of light, therefore, on said region enables screen holes to be formed with a smaller diameter than shadow mask holes. The curve 20 of FIG. 2B denotes the integrated quantity of light where, the light source 11 is fixed on a central line C (FIG. 1) of a hole of the shadow mask instead of being rotated.

Experiments show that when there was projected light through shadow mask holes 0.23 mm in diameter by rotating a spot light source 0.5 mm in diameter with a rotation diameter of 2.0 mm, then there were obtained PVA dots 0.13 mm in diameter and when said light source was rotated with a rotation diameter of 1.0 mm there were produced PVA dots 0.22 mm in diameter. As apparent from these experiments, the relationship of the rotation diameter and the diameter of the resulting PVA dots presents an appreciably sharp pattern. To produce PVA dots with an accurate diameter, therefore, the rotation diameter should be controlled with considerable precision. The spot light source consists of a super high pressure mercury lamp which gives forth extremely high temperature in projecting light therefrom, thus requiring a forced cooling device using, for example, cooling water or a compressed air device. Further there has to be provided a source of power. Accordingly, a light source system of the aforementioned arrangement unavoidably becomes bulky, so that the conventional method of preparing a screen by rotating such a bulky light source system presents extreme difficulties in elevating the precision more than one-tenth with which the rotation diameter should be controlled. Since the tolerance to errors in the rotation diameter is of the order of one-handredth, the prior art method of preparing a screen based on the rotation of a light source failed to be put to practical application.

It is accordingly the object of this invention to draw upon the advantage offered by the screen-preparing method based on the rotating light source which eliminates the necessity of etching the shadow mask a second time and also to resolve the problems associated with said method which failed to be generally accepted due to the difficulty of manufacturing a device by rotating the light source with the aforementioned high precision.

According to this invention, there is provided a method of preparing the screen of colour television picture tube by photographic printing which consists in providing an optical system between a screen being prepared and a light source so fixed as to face said screen, causing the optical system to be rotated in order to form on said screen light-baked portions having a smaller area than the light-permeable shadow mask holes and a device for performing the method.

With a general black matrix type colour television picture tube, the beam of electrons has a larger diameter than the fluorescent dots, and the area occupied by the matrix section normally accounts for 40 to 50 per cent of the effective area of the screen. Accordingly, this type of picture tube prevents the intrusion of light reflected from the outside, suppresses the appearance of scattered light and reproduces colour television images in distinct contrast, thus attracting great attention in recent years.

There is shown below the concrete measurement of a 20-inch picture tube.

Pitch between shadow mask holes = 0.60 mm

Trio pitch of matrix holes = 0.62 mm

Diameter of matrix holes = { 0.25 mm. (at center of screen) / 0.21 mm. (at periphery of screen) }

Diameter of shadow mask holes = 0.33 mm (at both center and periphery of screen)

Diameter of electron beam passing through shadow mask holes = 0.34 to 0.36 mm (at both center and periphery of screen)

Trio pitch of matrix holes/ $\sqrt{3}$ = 0.36 mm

The black matrix screen is prepared through the following steps.

1. A layer of PVA is coated on a screen panel.

2. There are baked on the screen panel red, blue and green dots by projecting light through the holes or light permeable section of the shadow mask by means of a spot light source and a device for projecting light on the screen which is provided with a correction lens so as to cause light from said spot light source to travel along a locus approximating that of a beam of electrons.

3. The light-exposed screen panel is developed to wash away the PVA coated on the other regions of said panel than those which were exposed to light through the shadow mask holes.

4. There is coated graphite on the panel thus processed.

5. The graphite deposited on the PVA is washed away with hydrogen peroxide (H_2O_2).

6. There are formed fluorescent dots on the matrix screen by the customary process.

This invention is intended to provide a method of preparing a screen by improving a device for projecting light thereon. There will now be described by reference to the appended drawings an embodiment of this invention. The same parts of FIG. 3 as those of FIG. **1** are denoted by the same numerals and description thereof is omitted. Referring to FIG. **3**, there is provided between a spot light source **21** and a shadow mask **13** a device with a round periphery for causing a prism **22** to revolve horizontally in a prescribed direction with said spot light source **21** fixed. The prism **22** tapered at an angle θ is so disposed as to cause the axis thereof to be aligned with the center line C of the shadow mask hole. The aforementioned correction lens is not indicated.

Light projected from point O of the spot light source **21** is deflected by the prism **22** and brought to the PVA layer **15** deposited on the screen panel **14** through such a route as would appear if it was emitted straight from point O'. When the prism is made to revolve in a plane perpendicular to the center line C, then point O' is revolved along a locus **24** to provide light-exposed portions having a smaller diameter than the shadow mask holes by the same principle as that by which there is revolved the light source of FIG. **1**, thus enabling PVA dots smaller than the shadow mask holes to be baked to the screen. The diameter of a circular locus along which point O' rotates may be defined as desired by selecting the angle θ at which the prism used is tapered.

With the method of this invention which consists in revolving the image O' of the light source by the rotation of the prism **22**, the angle of incidence of light to the plane of the prism **22** and in consequence the smoothness of its surface have a great bearing. However, said smoothness can be easily attained with high precision. The angle of incidence of light to the plane of the prism **22** does not vary with the displacement of said prism **22** in a direction perpendicular to the axis of the picture tube, namely, the center line C (the direction indicated by A—A' in FIG. 3). Therefore, the displacement of the image O' of the light source caused by such lateral shift of the prism **22** is so extremely small that it can be considered negligible.

One embodiment of a device **23** for causing the prism **22** to rotate consists of the type illustrated in FIGS. **4A** and **4B**. The prism **22** is supported on an annular metal frame **25** which is made to rotate by rollers **26** abutting against its periphery **25***a*, thus leading to the rotation of the prism **22**. To ensure the flat position of the surface of the prism **22** during its rotation, that side **25***b* of the prism-supporting metal frame **25** which faces the light source **21** is machined to attain the highest possible precision of smoothness and the base plate **28** of said supporting metal frame **25** is fitted with bearing **27** in at least three places. That side of the base plate **28** which faces the prism **22** is hollowed out in the annular form to conduct light to the prism **22**. The prism **22** may be caused to be revolved by using a fluid pressure. As compared with the conventional complicated device for rotating the light source which is provided with a source of power, cooling means and means for supplying compressed air, the device **23** of this invention arranged as described above for revolution of the prism **22** has only to be designed for said revolution, prominently simplifying the arrangement. Accordingly, the method of this invention enabes errors in the diameter of a circular locus along which the image of the light source is shifted to be reduced to below one-hundredth. Therefore, this invention has rendered the prior art screen-manufacturing method based on the rotation of a light source fully available for practical application simply by causing the image of a light source to be rotated with the light source itself fixed.

Referring to FIG. **5** illustrating a device according to another embodiment of this invention for causing a prism to revolve itself, there are superposed two prism means **30** and **31**, each consisting of a prism **22** and the corresponding annular metal frame **25**. Variation of the angle at which both prisms are combined enables the displacement of the image O' of a light source from said source O, that is, the radius of a circular locus along which said image O' is rotated to be easily

changed. With the prior art screen-preparing method based on the rotation of a light source, it was difficult to design a rotation device so as to cause the light source to travel along a circular locus whose diameter could be made variable. However, the embodiment of FIG. 5 enables the radius of a circular locus along which the image of a light source travels to be easily changed by varying the angle at which there are combined two prism means 30 and 31.

The foregoing description refers to a circular hole type shadow mask, but this invention may be appplicable not only to, for example, a slitted shadow mask, but also to a mosaic screen used with a general cathode ray tube.

As mentioned above, the method of this invention consists in using a spot light source and optical system, for example, a prism to produce an image of said light source at a point displaced a prescribed distance therefrom, causing the optical system to revolve, and projecting light on a screen while rotating said image, thereby baking to the screen fluorescent dots having a smaller diameter than the shadow mask holes.

What we claim is:

1. In the method of preparing the screen of a color television picture tube provided with fluorescent dots having a smaller area than the area of holes of the shadow mask of the tube wherein light from a spot light source is projected through a hole of the shadow mask onto a panel bearing a photosensitive layer in such manner that an integrated quantity of light projected on the photosensitive layer produces a developable image of a dot having an area smaller than the hole of the shadow mask, the improvement in forming such developable image which comprises:

using a stationary light source for projection of light through a hole of the shadow mask onto the panel on which there is to be formed the screen for the picture tube,

interposing a tapered prism in the path of the projected light between the light source and the shadow mask, and

rotating the prism in its longitudinal plane eccentrically to revolve the light image projected upon the panel through the hole in the shadow mask.

2. The method of claim 1 wherein the panel is coated with a layer of photosensitive polyvinyl alcohol resin and the panel after being subjected to the light projection is developed to wash away that portion of the layer in which developable images are not formed by the light projection.

3. In a device for preparing the screen of a color television picture tube provided with fluorescent dots having a smaller area than the area of holes of the shadow mask of the tube provided with an optical system for projecting light from a spot light source onto a panel bearing a photosensitive layer in such manner that an integrated quantity of light projected on the photosensitive layer produces a developable image of a dot having an area smaller than the hole of the shadow mask, the improvement which comprises:

a stationary spot light source for projecting light through a hole of the shadow mask onto the panel on which there is to be formed the screen of the picture tube,

a tapered prism interposed between said spot light source and the hole of the shadow mask to intercept the path of light from said source to the hole, and

means for rotating said tapered prism in its longitudinal plane eccentrically to revolve the light image projected upon the panel through the hole in the shadow mask.

4. The device of claim 3 wherein the optical system comprises a second tapered prism adjacent said tapered prism and means to adjust the angle between said prisms.

5. The device of claim 3 wherein said means to rotate said tapered prism comprises a metal frame for supporting at least one prism, a plurality of rollers abutting against the perifery of said frame to impart rotating motion to the prism, a base plate upon which said rollers are fitted, said plate having an opening therethrough at the portion of the plate that faces said prism and bearings carried by said base plate upon which the prism is supported for rotation.

* * * * *