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Duistermaat

[11] **3,904,912**

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[54] **CATHODE RAY TUBE DISPLAY SCREEN HAVING OVERLAPPING TRIAD ELEMENTS AND SEPARATED TRIADS**

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[51] **Int. Cl.**[2] **H01J 29/32;** H01J 31/20

[58] **Field of Search** .... 313/92 B

[56] **References Cited**

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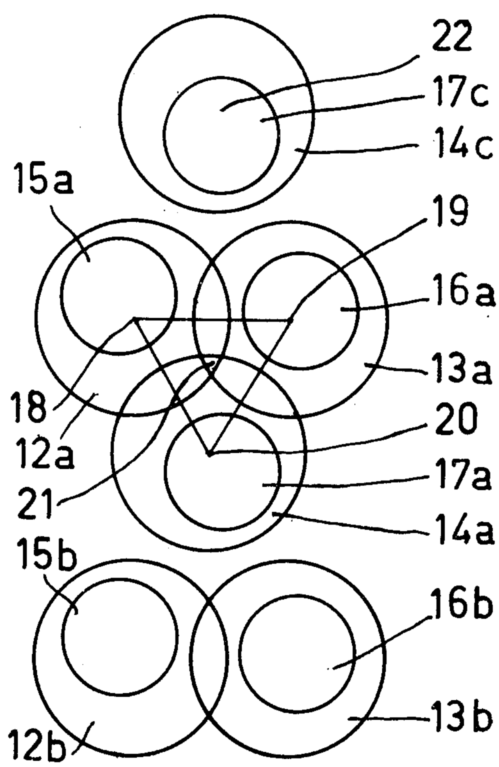
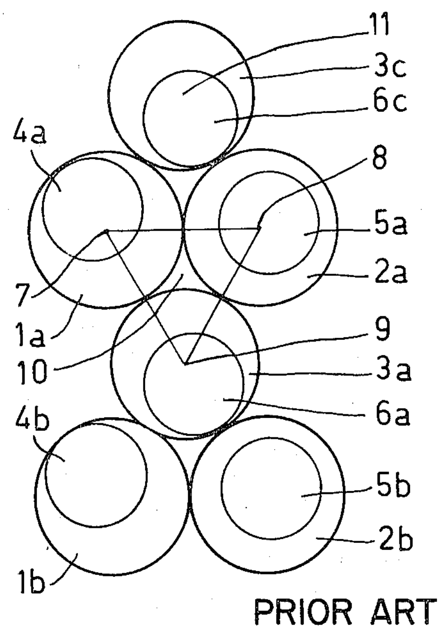
[57] **ABSTRACT**

A shadow mask tube having such a distance between the shadow mask and the screen, that at least at the edge of the screen the average of the three distances from the centers of the phosphor dots associated with one mask aperture to the center of gravity of the triangle formed by said centers is at least 10% smaller than one third of the distance between two nearest phosphor dots of the same color.

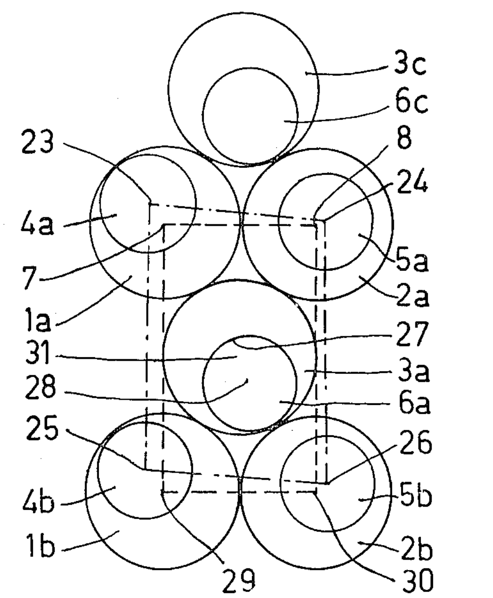
3 Claims, 6 Drawing Figures





PRIOR ART

Fig.1



PRIOR ART

Fig.3

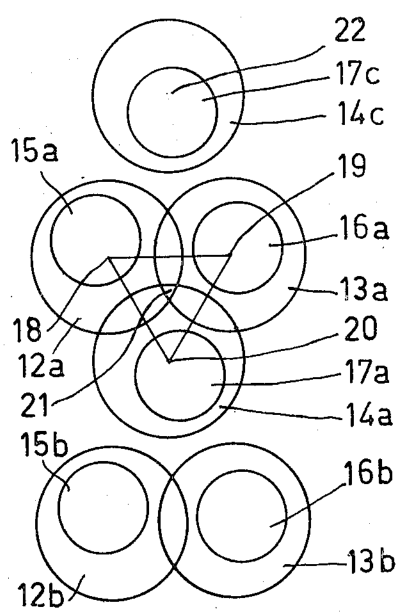


Fig.2

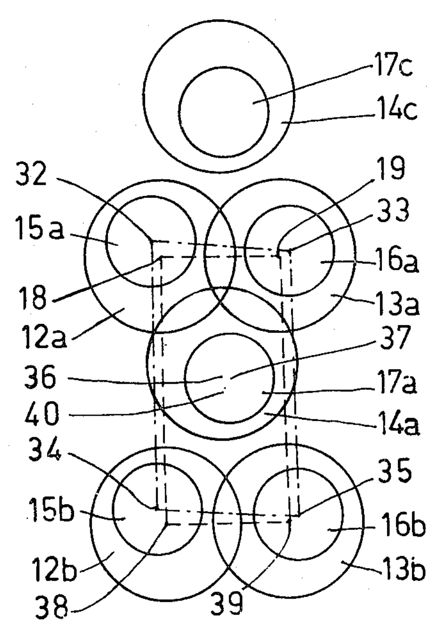
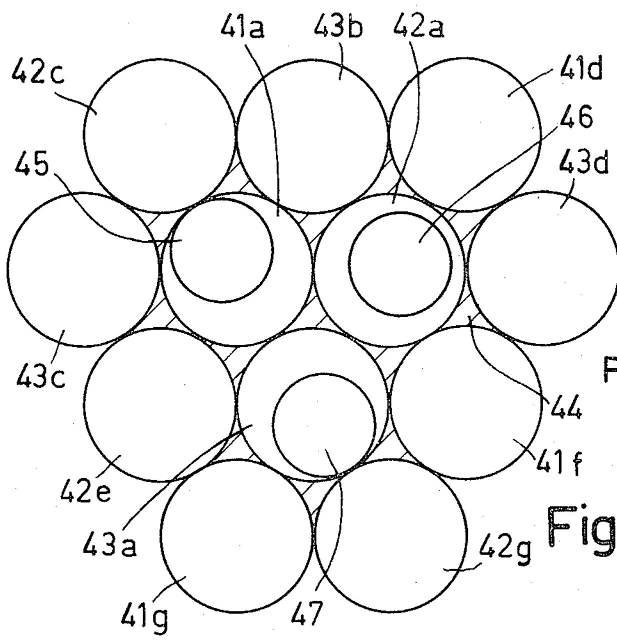


Fig.4



PRIOR ART

Fig.5

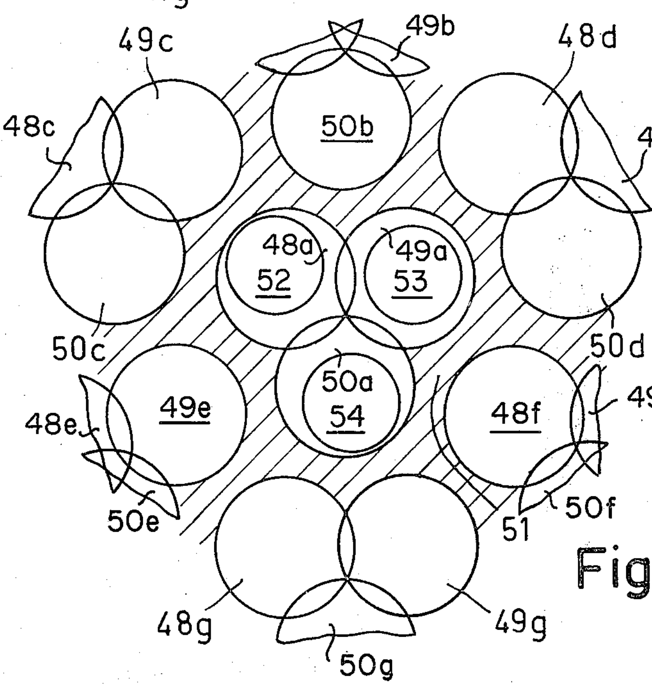


Fig.6

CATHODE RAY TUBE DISPLAY SCREEN HAVING OVERLAPPING TRIAD ELEMENTS AND SEPARATED TRIADS

The invention relates to a cathode ray tube for displaying colour pictures, comprising a shadow mask having substantially circular apertures and a picture display screen present on the window of the tube and comprising substantially circular surfaces of three materials which luminesce in different colours upon excitation by electrons.

Such a three-colour television display tube comprises an electrode system which supplies three electron beams the electrons of which move towards the screen via the apertures in the mask in different angular relationships relative to each other for producing the various colours. The phosphor dots on the screen should be present in such manner that the electrons of one electron beam impinge only upon phosphor dots of one colour, that is to say that the electron spots formed by one electron beam coincide fully or partly with phosphor dots of only one colour. The place of the electron spots is determined by the movement of the electrons, inter alia under the influence of a deflection coil system. As a result of this, the centre of deflection experiences a movement in the direction of the axis of the tube when the angle of deflection increases, while in addition it experiences a movement at right angles to the axis of the tube as a result of the dynamic convergence used of the electron beams. The phosphor dots are provided by hardening parts of a radiation-sensitive layer by means of light, so that the place of the phosphor dots is determined by an optic projection of the mask. Certain measures are taken to cause the virtual light source to coincide as readily as possible with the centre of deflection of the electron beam. In principle, however, it is impossible to take such measures that the phosphor dots and the electron spots are exactly concentric throughout the picture display screen. The measures consist inter alia in the use of certain systems of lenses. In addition, as is mentioned in the U.S. Pat. No. 3,109,116, the distance between the shadow mask and the picture display screen is taken smaller at the edges than in the centre so as to achieve that the phosphor dots touch each other. Since the virtual light source to be realized by means of the system of lenses is not capable of keeping the trio of dots associated with one mask aperture equal to the relevant trio of spots, the practical result of the said distance is that the electron spots which are smaller than the phosphor dots are present very eccentrically within the phosphor dots, namely against the edge thereof at the edges of the picture display screen. Since the phosphor dots touch each other, an electron spot, in the case of uncorrect control, can easily land partly on an adjacent undesired phosphor dot. The invention mitigates this drawback.

According to the invention, the distance between the shadow mask and the display screen is such that, at least at the edge of the picture display screen, the average of the three distances between the centres of the phosphor dots associated with one mask aperture and the centre of gravity of the triangle formed by said centres is at least 10% smaller than the third part of the distance between two adjacent phosphor dots of the same colour. The phosphor dots associated with one mask aperture are to be understood to mean the three phosphor dots upon which electrons of the three electron beams which pass through said mask aperture impinge. Said phosphor dots will be indicated as the phosphor dots associated with one trio. The above means that the distance between the shadow mask and the picture display screen is smaller there than for the case in which the phosphor dots touch each other, or in other words, are present in hexagonal densest stack of circular dots as is described above. The result of this is that at that area the phosphor dots associated with one trio overlap each other partly. However, this is no objection because the smaller electron spots lie outside the overlapping regions of the phosphor dots. In itself the place of the phosphor dots with said distance between the shadow mask and the picture display screen is just more favourable because the electron spots do not touch the edge of the phosphor dots. The position of a given electron spot actually is such that its centre is present more closely to the point of intersection of the diagonals of the square formed by the centres of the four surrounding electron spots and also more closely to the point of intersection of the diagonals of the square formed by the centres of the four surrounding phosphor dots. When the centre of a given electron spot coincides with the point of intersection of the diagonals of the square formed by the centres of the four surrounding electron spots, the electron spots are present in hexagonal densest stack of circular spots.

In particular, the distance between the shadow ma[illegible] and the picture display screen is such that substantially throughout the picture display screen, the distance between an electron spot and the two other electron spots associated with the same mask aperture is substantially equal to the distance between the first-mentioned electron spot and the two adjacent electron spots associated with another mask aperture. The position of the centres of the electron spots then corresponds substantially to the points of intersection of the diagonals of the said squares.

The said distance between the shadow mask and the picture display screen is also of advantage for the case in which the picture display screen comprises a light-absorbing material between the substantially circular surfaces of the luminescent materials. As is known, in such a picture display screen the tinting of the window glass may be less with the contrast remaining the same, as a result of which the observed brightness of the picture increases. The extent to which the tinting of the window glass may be less increases according as a larger part of the window is covered with light-absorbing material. If a sufficient part of the window is covered with light-absorbing material, the tinting of the window glass may even be omitted. Two different cases present themselves.

In one case, the substantially circular surfaces of the luminescent materials are smaller than the substantially circular apertures in the shadow mask, which means that the phosphor dots are smaller than the electron spots. The result of the distance between the shadow mask and the picture display screen according to the invention is that at the edge of the screen the position of the electron spots relative to the phosphor dots is more favourable. The size of the phosphor dots and the size of the electron spots is not principally different from that in the case in which the invention is not used.

In the other case, the substantially circular surfaces of the luminescent materials are larger than the substantially circular apertures in the shadow mask, which means that the phosphor dots are larger than the electron spots. Upon comparing a picture display screen according to the invention with one not according to the invention and having the same size of phosphor dots, it is obvious that as a result of the partial overlapping of the phosphor dots at the edge of the picture display screen, a larger part of the window is covered with light-absorbing material at that area. Since in addition the location of the electron spots within the phosphor dots is more favourable, smaller phosphor dots will do without this detrimentally influencing the quality of the picture so that an even larger part of the window may be covered with light-absorbing material. In the centre of the picture display screen, the electron spots and the phosphor dots are in principle more concentric relative to each other so that the phosphor dots can be made smaller without further measures. Therefore, the picture display screen more in particular comprises for the remaining part a light-absorbing material, while the substantially circular surfaces of the luminescent material are larger than the substantially circular apertures in the shadow mask.

In a concrete case, in a shadow mask tube of the last-mentioned type having maximum deflection of 90° (which means that the diagonals enclose an angle of 90°) the distance between the shadow mask and the window up to deflection angles relative to the axis of the tube of 30° is such that the phosphor dots on the window substantially touch each other. For larger angles of deflection said distance gradually decreases and that in such manner that with an angle of deflection of 45°; said distance is 25% smaller than was calculated at the area for phosphor dots substantially touching each other and the phosphor dots thus partly overlap each other at that area.

In another case, in a shadow mask tube having a maximum deflection of 110° (which means that the diagonals enclose an angle of 110°) the distance between the shadow mask and the window up to deflection angles relative to the axis of the tube of 38° is such that the phosphor dots on the window substantially touch each other. For larger angles of deflection said distance gradually decreases and that in such manner that with a deflection angle of 55°, said distance is 25% smaller than was calculated at that area for phosphor dots substantially touching each other and the phosphor dots thus partly overlap each other at that area.

It has been found that in these cases a quarter part of the window may be covered with a light-absorbing material.

The invention will be described in greater detail, by way of example, with reference to the drawing, in which

FIGS. **1**, **2**, **3**, **4**, **5** and **6** are schematic views showing on an enlarged scale, from the outside of several tubes, the arrangement of groups of phosphor dots in the right-hand top corner of the screen; in the case of FIGS. **1**, **3** and **5**, the phosphor dots touch each other as in the prior art; FIGS. **2**, **4** and **6** relate to the invention.

FIG. **1** is a schematic view on an enlarged scale, from the outside of a tube, of phosphor dots in the right-hand top corner of the screen, namely green phosphor dots **1***a* and **1***b*, red phosphor dots **2***a* and **2***b* and blue phosphor dots **3***a* and **3***c*. In this known tube the distance between the shadow mask and the picture display screen is such that the phosphor dots touch each other or, in other words, that the phosphor dots are present in hexagonal densest stack of circular dots. Furthermore, the electron spots **4***a*, 4*b*, 5*a*, 5*b*, 6*a* and **6***c* are shown. The electron spots **4***a*, 5*a* and 6*a* are formed by the three electron beams which pass through one mask aperture. In this manner the phosphor dots **1***a*, 2*a* and **3***a* are associated with one mask aperture. **7** denotes the centre of phosphor dot **1***a*, 8 that of phosphor dot 2*a* and **9** that of phosphor dot 3*a*. 10 is the centre of gravity of the equilateral triangle formed by the points 7, 8 and 9. 11 is the centre of phosphor dot 3*c*. The distance from the centre **9** of the blue phosphor dot **3***a* to the centre of gravity **10** is equal to one third of the distance from the centre **9** of the blue phosphor dot **3***a* to the centre **11** of the adjacent blue phosphor dot **3***c*. In case of the green and blue phosphor dots, the electron spots lie against the edge of the phosphor dots.

FIG. **2** is a schematic view on an enlarged scale, from the outside of a tube, of phosphor dots in the right-hand top corner of the screen, namely green phosphor dots **12***a* and **12***b*, red phosphor dots **13***a* and **13***b* and blue phosphor dots **14***a* and **14***c*. The position of the phosphor dots is according to the invention, as will be described in detail. Furthermore, the electron spots **15***a*, 15*b*, 16*a*, 16*b*, 17*a* and **17***c* are shown. The electron spots **15***a*, 16*a* and **17***a* are formed by the three electron beams which pass through one mask aperture. In this manner the phosphor dots **12***a*, 13*a* and **14***a* are associated with one mask aperture. **18** is the centre of phosphor dot **12***a*, 19 that of the phosphor dot 13*a* and **20** that of phosphor dot **14***a*. 21 is the centre of gravity of the equilateral triangle formed by the points 18, 19 and 20. 22 is the centre of phosphor dot 14*c*. The distance from the centre **20** of the blue phosphor dot **14***a* to the centre of gravity **21** is 20% smaller than one third of the distance from the centre **20** of the blue phosphor dot **14***a* to the centre **22** of the nearest blue phosphor dot **14***c*. None of the electron spots lies against the edge of a phosphor dot and they all lie outside the overlapping regions of the phosphor dots.

FIG. **3** shows the same phosphor dot configuration as FIG. **1** with phosphor dots **1***a*, 1*b*, 2*a*, 2*b*, 3*a* and **3***c* and electron spots **4***a*, 4*b*, 5*a*, 5*b*, 6*a* and **6***c*.

23 is the centre of electron spot **4***a*, 24 that of electron spot 5*a*, 25 that of electron spot 4*b* and **26** that of electron spot **5***b*. 27 is the point of intersection of the diagonals of the square formed by the points 23, 24, 25 and 26. 28 is the centre of the electron spot 6*a*. The centre **28** of electron spot **6***a* does not coincide with the point of intersection **27** of the diagonals of the square formed by the centres of the four surrounding electron spots **4***a*, 5*a*, 4*b* and **5***b*.

7 is the centre of phosphor dot **1***a*, 8 that of phosphor dot 2*a*, 29 that of phosphor dot 1*b* and **30** that of phosphor dot **2***b*. 31 is the point of intersection of the diagonals of the square formed by the points 7, 8, 29 and 30. The centre 28 of electron spot 6*a* does not coincide with the point of intersection **31** of the diagonals of the square formed by the centres of the four surrounding phosphor dots **1***a*, 2*a*, 1*b* and **2***b*.

FIG. **4** shows the same phosphor dot configuration as FIG. **2** with phosphor dots **12***a*, 12*b*, 13*a*, 13*b*, 14*a* and **14***c* and electron spots **15***a*, 15*b*, 16*a*, 16*b*, 17*a* and **17***c*.

32 is the centre of electron spot **15***a*, 33 that of electron spot 16*a*, 34 that of electron spot 15*b* and **35** that of electron spot **16***b*. 36 is the point of intersection of the diagonals of the square formed by the points 32, 33, 34 and 35. 37 is the centre of electron spot 17*a*. The centre **37** of electron spot **17***a* coincides substantially with the point of intersection **36** of the diagonals of the square formed by the centres of the four surrounding electron spots **15***a*, 16*a*, 15*b* and **16***b*. This means that the distance from the electron spot **17***a* to the two other electron spots **15***a* and **16***a* associated with the same mask aperture is substantially equal to the distance from the electron spot **17***a* to the two adjacent electron spots **15***b* and **16***b* associated with another mask aperture, or in other words, that the electron spots are present in a hexagonal densest stack of circular spots.

18 is the centre of phosphor dot **12***a*, 19 that of phosphor dot 13*a* 38 that of phosphor dot 12*b* and **39** that of phosphor dot **13***b*. 40 is the point of intersection of the diagonals of the square formed by the points 18, 19, 38 and 39. The centre 37 of electron spot 17*a* coincides substantially with the point of intersection **40** of the diagonals of the square formed by the centres of the four surrounding phosphor dots **12***a*, 13*a*, **12***b* and **13***b*.

FIG. **5** is an enlarged schematic view from the outside of a tube of phosphor dots in the right-hand top corner of the screen, namely green phosphor dots **41***a*, 41*d*, 41*f* and **41***g*, red phosphor dots **42***a*, 42*c*, 42*e* and **42***g*, and blue phosphor dots **43***a*, 43*b*, 43*c* and **43***d*. In this tube the distance between the shadow mask and the picture display screen is such that the phosphor dots touch each other, or in other words that the phosphor dots are present in a hexagonal stack of circular dots. In the spaces between the phosphor dots the picture display screen comprises a light-absorbing material. Furthermore, the electron spots **45, 46** and **47** are shown. Only a small part of the picture display screen, namely 9%, comprises light-absorbing material.

FIG. **6** is a schematic cutaway view on an enlarged scale from the outside of a tube of separate triplets of phosphor dots in the right-hand top corner of the screen, namely green phosphor dots **48***a*, 48*b*, 48*c*, 48*d*, 48*e*, **48***f*, and **48***g*, red phosphor dots **49***a*, 49*b*, 49*c*, 49*d*, 49*e*, 49*f*, and **49***g* and blue phosphor dots **50***a*, 50*b*, 50*c*, 50*d*. The position of the phosphor dots is according to the invention. In the spaces between the triplets of overlapping phosphor dots, the picture display screen comprises a light-absorbing material **51.** Shown furthermore are the electron spots **52, 53** and **54.** Since the electron spots in a tube according to the invention are present farther from the edge of the phosphor dots, smaller phosphor dots will do in a tube according to the invention. The phosphor dots in FIG. **6** are therefore smaller than the phosphor dots in FIG. **5.** Both due to the fact that the phosphor dots in FIG. **6** are smaller than in FIG. **5** and due to the fact that the phosphor dots in FIG. **6** overlap each other slightly, the picture display screen of FIG. **6** comprises much more light-absorbing material than the picture display screen shown in FIG. **5,** namely approximately 25%.

What is claimed is:

1. A cathode ray tube for displaying color pictures, comprising an electrode system for producing three electron beams, a shadow mask with a plurality of substantially circular apertures, a picture display screen provided on the window of the tube at a distance from the mask and including a plurality of triplets of substantially uniform circular surfaces of luminescent materials, each surface in a triplet luminescing in a different color upon excitation by an assigned electron beam passing through an associated aperture in said mask partially overlapping each other surface of said triplet, the distance between the mask and the area near the edge of the display screen being reduced and said triplets — at least in the area near the edge of the display screen — being separated from each other the average of the three distances between the centers of the luminescent surfaces and the center of gravity of the triangle formed by the three centers being smaller than one-third the distance between the centers of two nearest luminescent surfaces of the same color.

2. A cathode ray tube as claimed in claim **1,** characterized in that the distance between the shadow mask and the picture display screen is such that substantially throughout the picture display screen the distance between an electron spot and the two other electron spots associated with the same mask aperture is substantially equal to the distance between the first-mentioned electron spot and the two nearest electron spots associated with another mask aperture.

3. A cathode ray tube as claimed in claim **1,** characterized in that the picture display screen otherwise comprises a light-absorbing material, while the substantially circular surfaces of the luminescent materials are larger than the substantially circular apertures in the shadow mask.

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