July 25, 1944. A. N. GOLDSMITH 2,354,591

TELEVISION APPARATUS

Filed Nov. 29, 1941 2 Sheets-Sheet 1

Fig. 1.

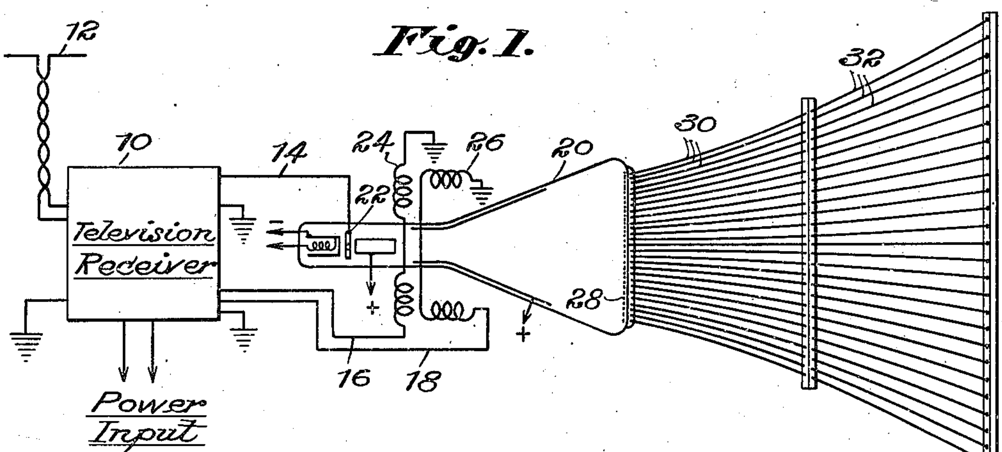

Fig. 2.

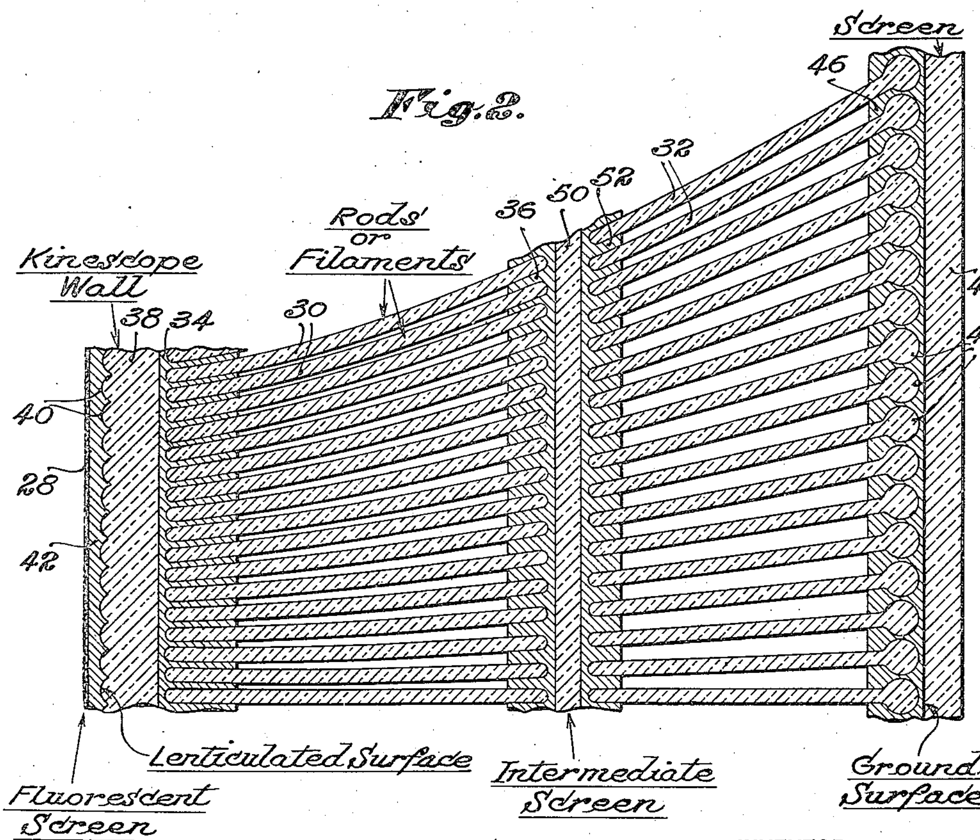

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Fig. 2a.

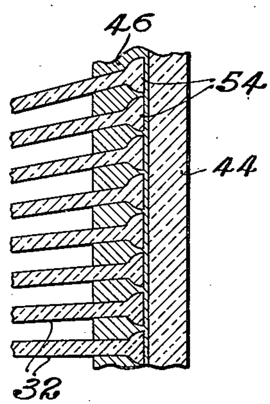
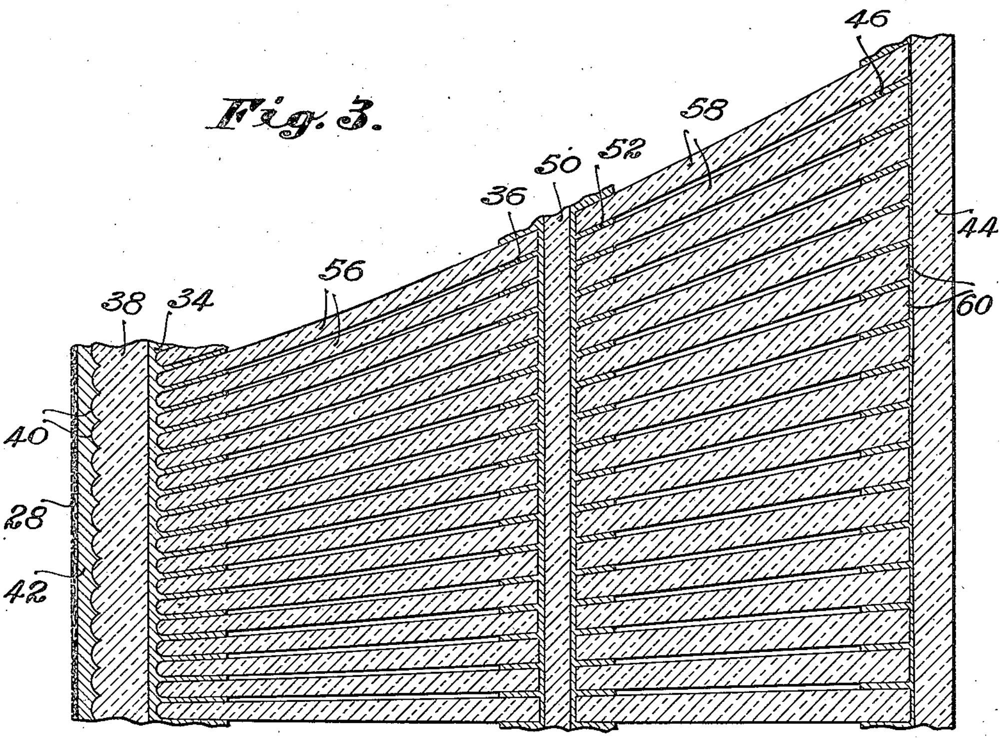


Fig. 3.



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TELEVISION APPARATUS

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Application November 29, 1941, Serial No. 420,914

24 Claims. (Cl. 178—7.5)

This invention relates to television systems and more particularly to systems used in a television receiver.

Broadly, the invention is concerned with a system for enlarging television images in order that relatively small television image producing cathode ray tubes may be used and yet relatively large images may be produced.

Normally, a television image is produced on the end of a television image producing tube as a result of electronic bombardment of a fluorescent, phosphorescent, luminescent or incandescent surface. The image produced at the end of the tube is generally viewed directly or indirectly without magnification. However, in some instances it is desirable to enlarge the image produced on the end of the image producing tube in order that a larger final image may be produced. For enlarging television images, lens systems have been employed to some extent. Optical systems of this type are inherently expensive and necessitate the use of highly corrected lenses if a desired distortion-free enlarged image is to be produced. Furthermore, the use of lenses generally requires the availability of considerable space particularly where the image producing tube has a diameter of more than about four inches since the focal length of the lenses which may be used for the requisite magnification is a function of the diameter of the original television image, particularly when highly corrected projection images are desired.

In the present system no lenses are used yet any usual degree of enlargement of the television image for most applications is possible by appropriately proportioning the size and dimensions of the apparatus employed. The present invention and method for enlarging the television image is in the form of a filamentary enlarger in which each image element of the original television image is expanded or caused to occupy an enlarged area. Basically, the enlargement is accomplished through the use of a plurality of light-conducting rods or filaments which have a statistical average of parallelism and which are arranged in a superficially frustroconical or pyramidal manner in order that the original television image may be presented in enlarged form at one end of the filaments. No lenses are in fact used so that distortion normally attending the use of lenses is avoided. Furthermore, through the use of the filamentary enlarger considerable space may be conserved and, in addition, the cost of producing the enlarger may be materially reduced.

The plurality of light-conducting rods or filaments are arranged in a bundle and the original television image is produced as near one end of the bundle as is practically possible. The light from the original image is then transmitted lengthwise through the filaments and is made visible at the opposite end of the bundle of filaments. Accordingly, the image aspect ratio as well as the distribution of the image elements can be maintained and a maximum of the original light available is utilized in the production of the final enlarged image.

It is therefore one purpose of the present invention to provide means in a television receiver for enlarging the produced television image in order that a magnified television image may be made available.

Another purpose of the present invention is the provision of an image enlarging means without the use of the usual lenses.

Still another purpose of the present invention resides in the provision of a filamentary enlarger in which a plurality of light-conducting rods or filaments are employed.

A still further purpose of the present invention resides in the provision of means whereby the original television image may be effectively reproduced at one end of each of the light transmitting rods.

A further purpose of the present invention resides in the provision of means intermediate the ends of the filamentary enlarger for providing a secondary image source in order that a certain amount of light diffusion may be there produced.

A still further purpose of the present invention resides in the use of tapered light-conducting rods or filaments, the taper or variation in cross-sectional area of each rod corresponding to the taper or variation in cross-sectional area of the entire filamentary enlarger.

Another purpose of the present invention is the optical transference of an image from one surface of origin thereof to another surface of reproduction thereof, but without the use of the conventional optical image-transfer means of lenses, mirrors, or combinations thereof.

Still other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following description, particularly when considered in connection with the drawings wherein:

Figure 1 indicates broadly a preferred form of the present invention.

Figure 2 shows detailed enlargements of portions of the enlarging system shown in Figure 1.

Figure 2a shows a modification of the enlarger shown in Figure 2 and,

Figure 3 shows a still further modification of the filamentary enlarger.

Referring now to the drawings, and particularly to Figure 1, there is shown in schematic form a television receiver 10. This receiver is supplied with received energy from the dipole antenna 12. After the received signals have been appropriately amplified and demodulated the received picture signals are then present on conductor 14. The television receiver also includes appropriate beam deflecting circuits which respond to received synchronizing signals and which produce the necessary deflection voltage variations which are available from conductors 16 and 18.

A cathode ray tube 20 is also provided which includes a gun structure for generating a focused cathode ray beam. The intensity of the produced cathode ray beam is controlled by the received signal energy applied to charge the voltage of the control electrode 22 relative to the cathode, whereas the position of the cathode ray beam is controlled by means of the horizontal and vertical deflecting coils 24 and 26, respectively. The beam intensity control electrode 22 is connected to the conductor 14 in order that image or video signals may be applied thereto and in order that the intensity of the cathode ray beam may be varied in accordance with the received signals, while the horizontal and vertical deflecting coils 24 and 26 are connected respectively to conductors 16 and 18 in order that the produced cathode ray beam may be caused to scan a target area in the end of the cathode ray tube.

The inside surface of the enlarged end of the cathode ray tube is provided with a layer of fluorescent or luminescent salts or other materials 28 which produce light when bombarded by electrons. Accordingly, when the fluorescent coating 28 is scanned by the cathode ray beam and the beam is modulated in accordance with received image signals, a television image is produced on the end of the tube.

For enlarging the original television image, a plurality of light transmitting rods 30 and 32 are employed. These rods or filaments are preferably made of quartz or of a similar color-free light transmitting medium. In place of quartz, glass commonly referred to by the trade names of "Pyrex" and "Nonex" may be used, or clear glass as, for example, the boro-silicate type may also be used. It is desirable also that the index of refraction of the rods or filaments be maintained relatively high in order to preclude loss of light along the rods. The rods 30 are arranged relatively adjacent each other at one end whereas the opposite ends of the rods are displaced by a uniform amount with respect to each other. The bundle of rods 30, therefore, are in the form of a truncated pyramid or cone and any light which is admitted to one end of the rods will be visible at the opposite end. This is due to the well-known phenomenon of internal total reflection.

In order that the rods or filaments may be maintained in their proper relative positions, the ends of the rods or, in fact, the entire bundle of rods from one end to the other may be supplied with a transparent cement. Preferably, but not necessarily, the ends of the rods should terminate in substantially parallel planes.

The cement that is shown at 34 and 36 will maintain the ends of the rods or filaments in proper position. It should preferably be transparent or clear and for this purpose a cement such as gelatin, Canada balsam, waterglass or the highly polymerized synthetic resins may be used. The index of refraction of the cement used should be selected with care and particularly the index of refraction of the cement 34, which is used at the receiving tube end of the rods or filaments, may have an index of refraction corresponding substantially to the index of refraction of the rods or filaments per se, in which case the thickness of the cement layer along the length of the rods should be kept small. Alternatively, a transparent cement of low refractive index may be used; or an opaque cement can be used primarily for structural supporting purposes. If a cement is used along the lengths of the filaments, it should be either of a low refractive index or opaque.

When the plurality of rods are applied to the end wall 38 of the television image producing tube 20 the original television image produced thereon will be visible at the opposite end of the rods or filaments, the area of the television image being increased in proportion to the relative displacement or "spread" of the rods from a true parallel relationship.

In order that the best final television image may be produced, it is desirable that the plane of the original television image be as near the ends of the rods as possible in order to prevent halation or spreading of the picture elements with an apparent comatic effect. In order to prevent such undesired conditions, certain additional provisions can be made in order effectively to place the produced television image in a plane coinciding with the plane of the ends of the rods or filaments. This is accomplished by forming or embossing on the inside surface of the receiving tube wall 38 a plurality of spherical lenses 40. These small lenses may be formed in the end of the tube wall through the use of a die which is applied to the glass after the glass has been heated to a temperature such that it becomes plastic. When the glass hardens the small embossed lenses 40 remain in the surface of the glass which forms the end wall 38 of the television image producing tube 20. The fluorescent coating 28 is preferably not applied directly to the lenticulated inner surface of the tube end wall 38 although such direct application may in some instances be desirable. In Figure 2 the fluorescent coating 28 is shown deposited on a binder 42 which is located between the fluorescent coating 28 and the lenticulated surface of the end wall 38. This binder or cement may be optically clear or may have a slight gray pallor in order to prevent a certain amount of halation, and the binder layer should be as thin as practicable.

The curvature of the individual lens elements 40 is chosen in accordance with the thickness of the tube end wall 38 and in accordance with the index of refraction of the glass of which the end wall is made. The purpose of the lenticulated surface is effectively to focus the original television image in a plane coinciding with the plane of the outside surface of the end wall of the tube. When this is done and when the ends of the rods or filaments are brought substantially into contact with the outside surface of the tube wall 38, halation and other undesirable objectional optical effects are reduced to a minimum.

The light from the television image is then transmitted through the rods or filaments and is visible at the opposite ends of the rods.

In place of the use of the cement 34 for securing the ends of the rods or filaments that are brought in contact with the end of the tube wall, the ends of the rods may actually be fused by heat so as to form a thin glass sheet. When this is done the line of fusion should not extend appreciably beyond the terminating ends of the rods.

For best results and in order that none of the image detail may be lost, it is desirable that the number of individual lens elements that are embossed or otherwise formed on the inside wall of the end of the receiving tube shall exceed or at least correspond to the number of individual image elements. The number of image elements is determined by the number of lines scanned and by other constants of the system. Also, the number of rods or filaments 30 that are used should at least equal the number of image elements and, in most instances, it is desirable to select rods or filaments having a diameter less than the size of each individual image element. Since glass or quartz rods having a diameter of one or two mils are quite flexible, and considerably more flexible than rods having a diameter say of 10 mils, there is a distinct advantage in using relatively fine rods or filaments. When the matter of flexibility is of no consequence, then rods having a diameter of from five to ten mils may well be used.

Figure 2 also shows, as stated above, a plurality of rods 32. These rods should approximately correspond in number to the rods 30 and are used to relay or further direct the light from the original television image to the final viewing screen 44. The viewing screen may be made of clear glass or, in some instances, may be made of ground or opalescent glass depending upon the desired degree of light diffusion. The outer ends of the rods or filaments 32 that are adjacent the viewing screen 44 are embedded in a thin layer of cement 46 for maintaining proper relative position between the ends of the rods. This cement may be transparent and may, for example, be similar to the cement 34 used at the ends of the inner rods 30.

If the rods 30 and 32, as shown in Figure 2, are of substantially the same diameter and are cylindrical, then naturally the outer ends of the rods 32 that are adjacent the viewing screen 44 will be displaced with respect to each other by an amount considerably greater than the displacement of the inner ends of the rods 30 that are adjacent the tube end wall 38. The degree of displacement of the outer ends of the rods 32 is naturally a function of the desired amount of optical enlargement to which the original television image is subjected. Since the outer ends of the rods 32 are displaced with respect to each other, it is desirable that the ends of these rods be beaded in order that their effective diameter will be increased, particularly in the region of the ends of the rods adjacent the screen. This fusion for beading may be accomplished by the application of heat, in which case the end of each of the rods 32 terminates in a small sphere. If the ends of the rods are beaded in like amount and to the proper extent, then the spherical portions 48 at the ends of the rods 32 may actually become tangential or be nearly in contact with each other. By so beading the ends of the rods or filaments, their effective diameter is increased and the light emitted from each individual rod or filament is distributed or averaged over a larger area. This area corresponds naturally to an enlargement of the area occupied by the inner end of each of the rods 30.

In order to reduce halation and in order that as much light intensity may be utilized as is possible, the viewing screen should be positioned adjacent the beaded ends 48 of the rods 32. By closely spacing the viewing screen and the ends 48 of the rods 32, distortion of light from each of the rods is reduced to a minimum. Furthermore, the viewing screen should be relatively thin if the diffusing surface thereof is on the side away from the terminations of the rods. The viewing screen may be made of clear glass or may be made of ground or opalescent glass as stated above. Where ground glass is used it is preferable to place the ground side of the glass adjacent the ends 48 of the rods 32.

Intermediate the rods 30 and 32 is an intermediate screen or subdivision which affords a certain amount of diffusion. This element includes a plate 50 which is interposed between the cooperating ends of rods 30 and 32. The plate 50 may be made of clear glass or, in some instances where a high degree of diffusion is desired, an opalescent glass plate may be used. The degree of diffusion is naturally a function of the thickness of the plate 50 and, since an excessive amount of diffusion is not desirable, the plate 50 is preferably made quite thin and, in some instances, may be entirely dispensed with in which case the rods 30 and 32 will be made contiguous. In cases where the intermediate screen 50 is used then naturally the adjacent cooperating ends of the rods 30 and 32 may be maintained in proper special relationship by means of cement 36 and 52.

For supporting the glass rods 30 and 32 intermediate their ends when such supporting is found necessary, it is possible to use a cement similar to the cement 34 and 46 or an opaque cement such as wax or some similar low temperature melting medium may be used. If interaction between the rods and loss of light along their lengths is to be reduced to a minimum then, as stated above, the rods should have a relatively high index of refraction and should have a relatively small diameter such as 1 or 2 mils and the plastic medium for maintaining the rods in proper relationship and for supporting the rods should be made of an opaque or a light absorbing material, or of a material of low refractive index.

From the above it may be seen that when a television image is produced at the fluorescent screen 28 the elements of this fluorescent image may be brought to focus at the plane of the outside surface of the wall 38 of the tube by reason of the lenticulated surface 40. The reconstituted image present at this plane is then transmitted through the glass rods 30 and 32 and is accordingly made visible at the viewing screen 44 in enlarged form.

In Figure 2*a* is shown a modification of the apparatus shown in Figure 2 and the modification differs from Figure 2 in regard to the shape of the ends of the rods 32. In Figure 2*a* the rods terminate in a plane substantially parallel to the plane of the viewing screen and the flat surface or plane 54 at the end of each tube 32 may be produced by beading the ends of the rods as in Figure 2 and subsequent to such beading operation, the rods may then be subjected to a grinding process in order to grind off a portion of the spherical end of the rods. This results in the formation of a flat surface 54 and since all of the rods are ground after assembly, the rods then terminate in a single plane. Such a structure is in some respects better than the structure shown in Figure 2 since it results in less diffusion and distortion of the image at the viewing screen since the light from the plane surfaces 54 of the rods 32 is directed against the viewing screen more nearly normal to the surface of the screen with the result that there is less diffusion from the end of each of the individual filaments or rods.

A still further modification of the invention is shown in Figure 3 in which rods or filaments 56 and 58 are used. These rods or filaments correspond respectively to the rods 30 and 32 in Figure 2 and differ from the rods in Figure 2 in that they are not cylindrical and do not have a constant diameter. The rods 56 and 58 are tapered as may be seen from Figure 3, the degree of taper depending upon the amount of enlargement that is desired. If the rods are tapered as shown in Figure 3, and if the taper corresponds to the taper of the entire filamentary enlarger then the spacing between the individual adjacent rods is uniform throughout the entire enlarger assembly. The ends 60 of the rods 58 that are positioned adjacent the viewing screen are also flattened and the ends of all these rods preferably lie in a common plane. Rods that are tapered as shown in Figure 3 are in some instances difficult to manufacture. However, by reason of the taper of the rods the filamentary enlarger is more readily assembled.

When rods of a constant diameter are used such as is the case in Figures 2 and 2*a*, dispersion and proper distribution of the rods at the viewing screen end may be accomplished by electrostatic or other means in order that proper relative positioning of the rods may be assured. Furthermore, if electrostatic means are used for spreading or dispersing the rods the desired amount, a substantially uniform statistical average of parallelism may be readily maintained. A statistical average of parallelism exists when, near any cross section of the bundle approximately perpendicular to its central filament, the filaments on the average closely approach parallelism. That is, short lengths of the filaments in the immediate neighborhood of any cross section of the bundle deviate little on the average from parallelism. The deviations from parallelism are small compared with the lengths of the filaments.

When the inside surface of the end wall 38 of the receiving tube 20 is lenticulated as indicated at 40 in Figure 2, it is generally necessary to emboss or otherwise lenticulate the end wall of the tube before it is installed in the tube proper. Such a process requires that the end wall be made separately and after the lenticulation embossing operation the end wall is then installed in the tube sleeve. In some cases it is not desirable to place the lenticulations directly on the inside surface of the end of the tube in which case a thin pliable sheet of moldable or plastic material may be used, one or both surfaces of the material being lenticulated or embossed in the desired manner. Such a sheet should be quite thin and would be placed in intimate contact with the inside surface of the end wall of the tube. When such a sheet is used it may be maintained in proper position by means of a thin layer of clear cement.

As an alternative, in place of using a lenticulated end wall for the tube 20, the end wall 38 may be fabricated of a plurality of short cylindrical or rectangular segments of glass or other light-conducting rods. When this is done it will assure transmission of light through the end wall or the tube in a direction normal to the plane of the end wall without the use of the lenticulated surface 40. Inasmuch as the construction of such an end wall may be somewhat difficult, the formation of the lenticulated surface is regarded as preferable.

Although the filamentary enlarger as shown and described above has a linear axis of symmetry which is to be positioned co-axially with the axis of the image producing tube 20, it is entirely conceivable that such an enlarger could be made to have a curved "axis" of symmetry in order that the receiving tube could be mounted vertically with the end wall 38 of the tube 20 occupying a horizontal plane whereas elements of the filamentary enlarger could be bent through 90 degrees or other appropriate angle in order that the terminating ends 48, 54 or 60 of the filaments could lie in a vertical plane. In this case, the screen can be positioned in a plane parallel to the front of a television receiver cabinet whereas the tube can be positioned vertically within the cabinet.

Various other alterations and modifications of the present invention may become apparent to those skilled in the art and it is desirable that any and all such modifications and alterations be considered within the purview of the present invention except as limited by the hereinafter appended claims.

I claim:

1. A television receiver wherein a complete light image is produced on a television image producing tube including a filamentary image enlarger comprising a multiplicity of stationary light transmitting filaments, said multiplicity of filaments being arranged in a group, the group having the form of a truncated solid and having at each cross section a statistical average of parallelism, and means for positioning the small end of the truncated group of filaments near the source of the produced light image, whereby an enlarged complete light image will be visible at the other end of the group of filaments.

2. A television receiver wherein a complete light image is produced on a television image producing tube including a filamentary image transfer device comprising a multiplicity of stationary light transmitting filaments, each filament having a cross-sectional area equal to or less than the area of each image element of the produced image, said multiplicity of filaments being arranged in the form of a bundle with the filaments approximately maintained in their relative positions so that a statistical average of parallelism exists, and means for positioning one end of the bundle of filaments near the source of the produced light image, whereby substantially the entire produced light image will be visible at the other end of the bundle of filaments.

3. A television receiver wherein received picture and synchronizing signals are used to produce a complete light image on a television image producing tube including a filamentary image enlarger comprising a plurality of light transmitting filaments, each filament having a cross-sectional area equal to or less than the area of each image element of the produced image, said

plurality of filaments being arranged in the form of a truncated pyramid with the individual filaments approximately maintained in their relative positions so that a statistical average of parallelism results, and means for positioning the small end of the truncated group of filaments near the source of the produced light image, whereby the complete light image will be visible at the other end of the group of filaments in enlarged form.

4. A television receiver wherein a light image is produced at a fluorescent screen in a television image producing tube, said receiving tube having an end wall of a predetermined thickness, the inside surface of the end wall of said tube having formed thereon a plurality of individual lens elements, whereby the fluorescent light image which is produced at the fluorescent screen on the inside of the tube will be imaged at a plane substantially coinciding with the outside surface of the tube, a filamentary image transfer device comprising a plurality of light conducting filaments arranged such that the individual filaments are approximately maintained in their relative positions, the size of the individual lenses of the lenticulated surface and the cross-sectional area of each filament of the image transfer device being equal to or less than the area of each image element of the produced light image, and means for positioning one end of the filamentary transfer device substantially in contact with the outside surface of the image producing tube, whereby the produced light image is visible at the other end of the device.

5. A television receiver wherein a light image is produced at a fluorescent screen in a television image producing tube including a filamentary image enlarger comprising a plurality of light conducting filaments arranged such that the individual filaments are approximately maintained in their relative positions throughout their entire lengths, said filaments being arranged in the form of a truncated solid having substantially parallel end surfaces, the relative spacing between the individual filaments at one end of the filamentary enlarger being less than the relative spacing at the other end of the enlarger, said image producing tube having an end wall of a predetermined thickness, the inside surface of the end wall of said tube being provided with a plurality of individual lens elements, whereby the fluorescent light image which is produced at the fluorescent coating on the inside of the tube will be imaged at a plane adjacent the outside surface of the tube, the size of the individual lens elements and the cross-sectional area of each filament of the enlarger being equal to or less than the area of each image element of the produced light image, and means for positioning said one end of the filamentary enlarger substantially in contact with the outside surface of the end wall of the image producing tube, whereby the produced image will be visible at the other end of the enlarger.

6. A television receiver wherein received image or video and synchronizing signals are used to produce a light image at a fluorescent screen in a television image producing tube, said tube having an end wall of a predetermined thickness, a plurality of individual lens elements positioned near the inside surface of the end wall of said tube whereby the produced light image will be focused on a surface adjacent the outside surface of the tube, a filamentary image enlarger comprising a plurality of statistically parallel light conducting filaments, said filaments being arranged in the form of a truncated pyramid having substantially parallel end surfaces and the relative positions of the separate filaments being substantially fixed throughout the length of the enlarger, the relative spacing between the individual filaments at one end of the filamentary enlarger being less than the relative spacing at the other end of the enlarger, the size of the individual lens elements and the cross-sectional area of each filament of the enlarger being of the order of the area of each image element of the produced light image, and means for positioning one end of the filamentary enlarger adjacent the outside surface of the image producing tube, whereby an enlarged image is visible at the other end of the enlarger.

7. In combination with a television receiver wherein a light image is produced in a television image producing tube, a filamentary image enlarger comprising a multiplicity of outwardly fanning closely adjacent transparent filaments arranged in the form of a bundle, the smaller end of the enlarger constituting the luminous entry to said filaments and the expanded larger end of the enlarger constituting the luminous exit from said filaments, the relative positions of the filaments being substantially fixed, and means for positioning the smaller end adjacent the produced light image whereby substantially the entire image is visible at the larger end of the enlarger in enlarged form.

8. A filamentary image enlarger for use in combination with a television receiver wherein a complete light image is produced in a television image producing tube, said filamentary image enlarger comprising a multiplicity of stationary outwardly fanning closely adjacent transparent filaments arranged in the form of a bundle, the smaller end of the enlarger constituting the luminous entry to said filaments and the expanded larger end of the enlarger constituting the luminous exit from said filaments, the relative positions of the filaments being substantially fixed, said smaller end being positioned approximately normal to and adjacent the produced light image, whereby a complete enlarged image is visible at the larger end of the enlarger.

9. In combination with a television receiver wherein received image and synchronizing signals are used to produce a complete light image in a television image producing tube, a filamentary image enlarger comprising a multiplicity of stationary outwardly fanning closely adjacent transparent filaments arranged in the form of a bundle with the relative positions of the filaments substantially fixed throughout the length of the bundle, the smaller end of the enlarger constituting the luminous entry to said filaments and the expanded larger end of the enlarger constituting the luminous exit from said filaments, said smaller end being positioned approximately normal to and adjacent the produced light image, a viewing screen, and means for positioning the viewing screen near the expanded larger end of the enlarger, whereby a second and enlarged complete image is produced at the viewing screen.

10. In combination with a television receiver wherein a complete light image is produced at a radiant energy responsive screen positioned in a television image producing tube, a filamentary image enlarger comprising a plurality of individual light transmitting filaments, the plurality

of filaments being arranged to have a statistical average of parallelism with one end of each of the plurality of filaments positioned substantially in contact with each other and the other end of each of the filaments being displaced with respect to each other by a predetermined amount, the relative positions of the filaments intermediate their ends being approximately fixed and means for positioning the small end of the enlarger adjacent the produced light image, whereby an enlarged complete light image is visible at the opposite end of the enlarger.

11. In combination with a television receiver wherein received image and synchronizing signals are used to produce a light image at a radiant energy responsive screen positioned in a television image producing tube, a filamentary image enlarger comprising a plurality of individual light transmitting filaments, each filament having a cross-sectional area equal to or less than the area of each image element of the produced light image, the plurality of filaments being approximately maintained in their relative positions throughout their lengths so as to have a statistical average of parallelism with the end portions of the plurality of filaments at one end of the enlarger positioned substantially in contact with each other and with the end portions of each of the filaments at the other end of the enlarger being displaced with respect to each other by a predetermined amount, and means for positioning the small end of the enlarger substantially normal to and adjacent the produced light image, whereby an enlargement of the produced light image is visible at the opposite end of the enlarger.

12. In combination with a television receiver wherein a light image is produced at a radiant energy responsive screen on the inside of a television image producing tube, a filamentary image enlarger comprising a multiplicity of outwardly fanning closely adjacent light transparent filaments of substantially uniform cross-sectional area, the ends of each of the filaments at the larger end of the enlarger being shaped substantially in the form of a sphere having a cross-sectional area greater than the cross-sectional area of the filaments, and means for positioning the smaller end of the enlarger adjacent the produced light image, whereby an enlarged image is visible at the larger end of the enlarger.

13. In combination with a television receiver wherein a light image is produced at a radiant energy responsive screen on the inside of a television image producing tube, a filamentary image enlarger comprising a multiplicity of outwardly fanning closely adjacent light transparent filaments of substantially uniform cross-sectional area, the cross-sectional area of each filament being equal to or less than the area of each image element of the produced light image, the ends of each of the filaments at the larger end of the enlarger being shaped substantially in the form of a sphere having a cross-sectional area greater than the cross-sectional area of the filaments, and means for positioning the smaller end of the enlarger adjacent the produced light image, whereby an enlarged image is visible at the larger end of the enlarger.

14. In combination with a television receiver wherein received image and synchronizing signals are used to produce a complete light image on a radiant energy responsive target area on the inside surface of the end wall of a television image image producing tube, a filamentary image enlarger comprising a multiplicity of closely adjacent light transparent filaments of substantially uniform cross-sectional area, said filaments being arranged in the form of a truncated solid the cross-sectional area of each filament being equal to or less than the area of each image element of the produced light image, the ends of each of the filaments at the larger end of the enlarger being beaded and having a cross-sectional area greater than the cross-sectional area of the filaments, a viewing target area, means for placing the viewing target area substantially in contact with the larger end of the enlarger, and means for positioning the smaller end of the enlarger substantially normal to and adjacent the produced light image, whereby an enlarged complete image may be produced at said viewing target area.

15. A filamentary enlarger for an optical image comprising a plurality of individual light conducting filaments, means for arranging the filaments in a bundle in the form of a truncated pyramid, the end of each of the filaments at the larger end of the bundle being provided with an enlarged portion terminating in a flat surface, whereby when an optical image is projected upon the small end of the enlarger, an enlargement of the image is visible at the larger end of the enlarger.

16. A filamentary enlarger for an optical image comprising a plurality of individual light conducting filaments, means for arranging the filaments in a bundle in the form of a truncated pyramid the cross-sectional areas of which, along its axis of symmetry, vary according to a predetermined function, the end of each of the filaments at the larger end of the bundle being provided with an enlarged portion terminating in substantially coplanar flat surfaces, whereby, when an optical image is projected upon the small end of the enlarger, an enlargement of the image is visible at the larger end of the enlarger.

17. A filamentary enlarger for an optical image comprising a plurality of individual light conducting filaments, means for arranging the filaments in a bundle in the form of a truncated solid figure, in which cross-sectional areas along its axis of symmetry vary in size according to a predetermined function, the end of each of the filaments at the larger end of the bundle being provided with an enlarged portion terminating in substantially coplanar flat surfaces, and a viewing screen positioned substantially in contact with the flat ends of the larger end of the enlarger, whereby when an optical image is projected upon the small end of the enlarger, an enlarged image is produced at the larger end of the enlarger.

18. In a television receiver for producing a light image of a subject, wherein is included a television image producing tube, a plurality of tapered light conducting filaments, the filaments being arranged in the form of a bundle and with the taper of each filament extending in the same direction whereby a statistical average of parallelism is maintained and whereby the filaments may be maintained in their relative positions throughout the length of the bundle, and means for positioning the smaller end of the filaments adjacent the produced light image, whereby an enlarged light image is visible at the larger end of the bundle of filaments.

19. In combination with a television receiver wherein received image and synchronizing signals are used to produce a light image in a tele-

vision image producing tube, a plurality of tapered light conducting filaments, the filaments being arranged in the form of a bundle with the taper of each filament extending in the same direction, means for positioning the smaller end of the bundle of filaments adjacent the produced light image, a viewing screen, and means for positioning the viewing screen adjacent the larger end of the bundle of filaments, whereby an enlargement of substantially the entire light image is produced at the viewing screen.

20. A television receiver wherein a light image is produced at a radiant energy responsive means in a television image producing tube, said tube including an end wall the inside surface of which is provided with a plurality of lenses, a thin layer of gray material positioned on the lenticulated surface, a radiant energy responsive screen positioned on the gray material, the focal lengths of the lenses being such as to image the produced image on the outside surface of the end wall of the tube, a filamentary image enlarger comprising a plurality of light conducting filaments, said filaments being arranged in a bundle, the relative displacement between the ends of the filaments at one end of the bundle being greater than the relative displacement between the ends of the filaments at the other end of the bundle, and means for positioning the smaller end of the bundle of filaments adjacent the outside surface of said television image producing tube, whereby an enlargement of the produced light image is made visible at the larger end of the bundle of filaments.

21. A television receiver wherein a light image is produced at a radiant energy responsive means in a television image producing tube, said tube including an end wall the inside surface of which is provided with a plurality of lenses, a thin layer of gray material positioned on the lenticulated surface, a radiant energy responsive screen positioned on the gray material, the focal lengths of the lenses being such as to image the produced image on the outside surface of the end wall of the tube, a filamentary image enlarger comprising a plurality of light conducting filaments, said filaments being arranged in a bundle, the relative displacement between the ends of the filaments at one end of the bundle being greater than the relative displacement between the ends of the filaments at the other end of the bundle, the cross-sectional area of the individual filaments and the area of the individual lenses being equal to or less than the area of each picture element of the produced light image, and means for positioning the smaller end of the bundle of filaments adjacent to the outside surface of said television image producing tube, whereby an enlarged image is made visible at the larger end of the bundle of filaments.

22. In combination with a television receiver wherein a complete light image is adapted to be produced on a television image producing tube, a filamentary image enlarger comprising a plurality of light transmitting filaments, said plurality of filaments being arranged in the form of a truncated solid with the relative positions of the filaments maintained substantially fixed and having a statistical average of parallelism, and means for positioning the small end of the truncated group of filaments near the source of the produced light image, whereby an enlarged complete light image will be visible at the other end of the group of filaments, said filamentary image enlarger being constructed in two sections with a light diffusing screen positioned intermediate the ends of the enlarger.

23. In a television receiver wherein a complete light image is produced in a television image producing tube, the combination which comprises a filamentary image enlarger comprising a multiplicity of outwardly fanning closely adjacent transparent filaments arranged in the form of a bundle, the smaller end of the enlarger constituting the luminous entry to said filaments and the expanded larger end of the enlarger constituting the luminous exit from said filaments, and means for positioning the smaller end adjacent the produced light image whereby the complete image is visible at the larger end of the enlarger in enlarged form, said filamentary image enlarger being constructed in two sections with a light diffusing screen positioned intermediate the ends of the enlarger.

24. A filamentary enlarger for an optical image comprising a plurality of individual light conducting filaments, means for arranging the filaments in a bundle in the form of a truncated pyramid, the end of each of the filaments at the larger end of the bundle being provided with an enlarged portion terminating in a substantially flat surface, whereby when an optical image is projected upon the small end of the enlarger, an enlarged image is visible at the larger end of the enlarger, said filamentary image enlarger being constructed in two sections with a light diffusing screen positioned intermediate the ends of the enlarger.

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