July 28, 1959 D. M. GOODMAN 2,897,388

DIRECTED RAY TUBE AND THE LIKE

Filed July 18, 1955 2 Sheets-Sheet 1

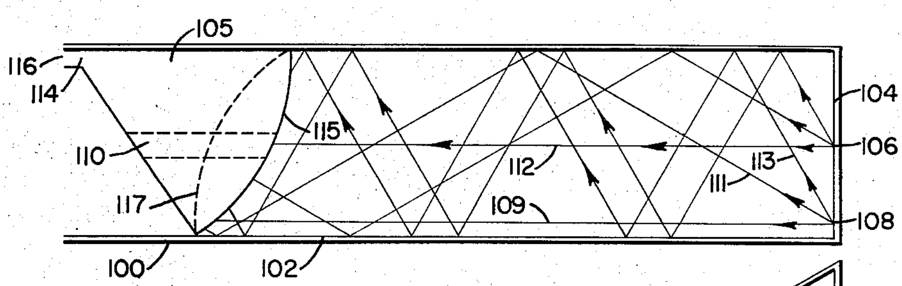

Figure 1

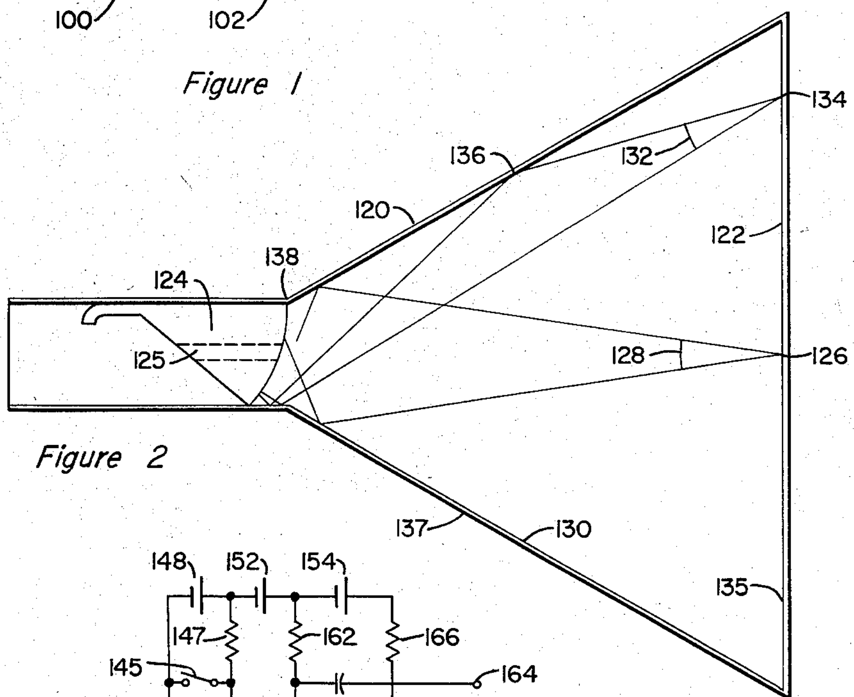

Figure 2

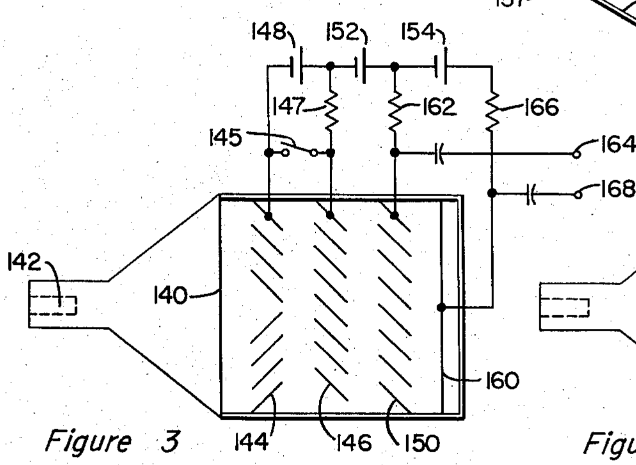

Figure 3

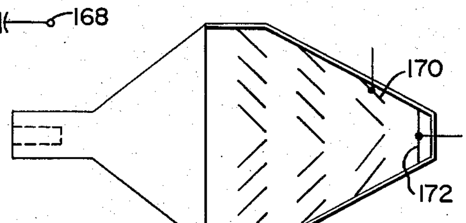

Figure 4

INVENTOR.
david m. goodman
BY Hane & Nydick

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DIRECTED RAY TUBE AND THE LIKE

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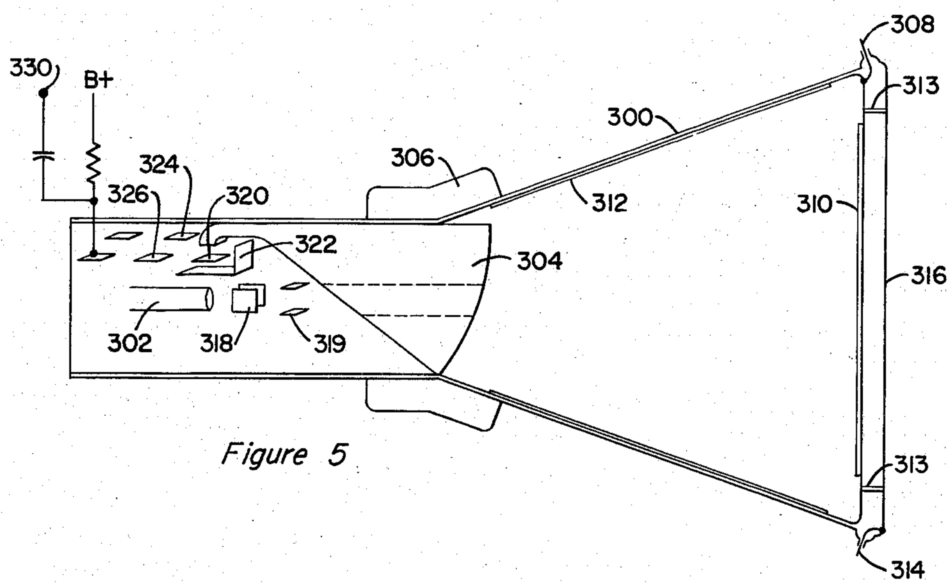

Figure 5

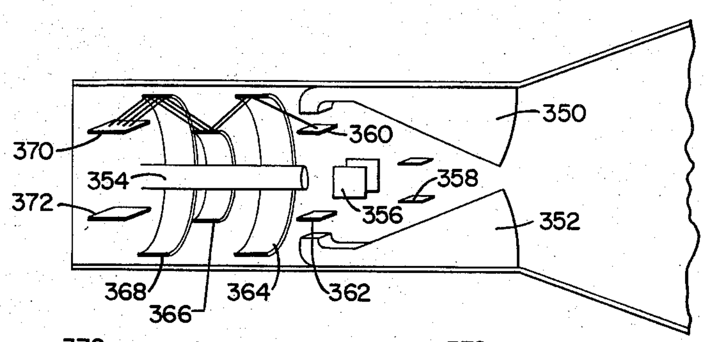

Figure 6

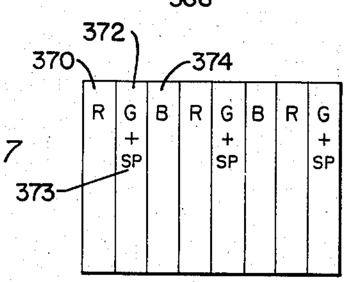

Figure 7

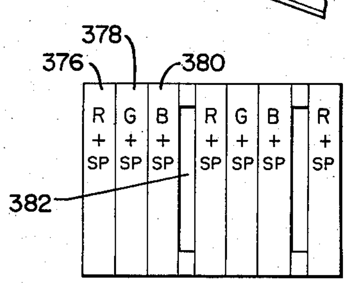

Figure 8

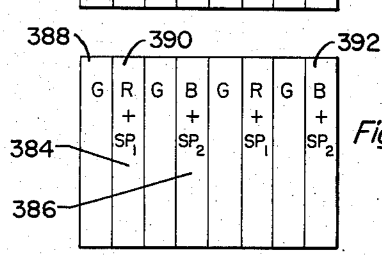

Figure 9

INVENTOR.
david m. goodman
BY Hane & Nydick

United States Patent Office

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DIRECTED RAY TUBE AND THE LIKE

David M. Goodman, Wantagh, N.Y.

Application July 18, 1955, Serial No. 522,609

9 Claims. (Cl. 313—65)

This invention relates to the manipulation of radiation generated by controlled excitation of radiation emissive materials or structures; devices operated in accordance with the foregoing principles; and electrical systems embodying the aforesaid.

In particular, it is directed to the aforesaid manipulation and devices in the form of directed ray tubes, synchros, resolvers, multipliers, dividers, analyzers, coders, pulse generators, strain gages, etc.

This invention also relates to signal producing, reproducing, coding and decoding, and the transmission, reception, display, analysis and storage of information.

Such a system may be used in color television.

In one of its fundamental aspects, and accordingly among one of its fundamental objects, this invention provides a system for selected transmission, storage, display, coding and decoding of information by combination of a cathode ray tube or directed ray tube or plurality of said tubes, or combination thereof, containing or having, for example, a special phosphor or phosphors or other radiation emitting materials or structures with appropriate pick-up means responsive to the developed radiation whereby said radiation is manipulated and controlled either internally or externally of the tube.

In another of its fundamental aspects and objects, this invention provides a system, as aforesaid, for selected transmission, storage, display, analysis, coding and decoding of information by combination of a cathode ray tube or directed ray tube or a combination thereof, or a plurality thereof having, for example, a special phosphor or plurality of special phosphors or other radiation emitting materials with appropriate pick-up means responsive to the developed radiation whereby said radiation is manipulated and controlled either internally or externally of the tube and whereby said radiation and its buildup and decay characteristics are utilized for control, regulation, measurement and other purposes.

Another object of this invention is to provide means and methods to control the electro-magnetic radiation that is emitted within a directed ray tube as a result of excitation by the directed rays. This control may be exercised with respect to:

(1) The magnitude of the emitted radiation

(2) The frequency, or wavelength, of the emitted radiation

(3) The geometry of the area which is activated by the rays, or particles, in such manner that

(4) Substantially the entire amount, or a lesser controlled amount, of the aforesaid electro-magnetic radiation is transmitted to a location within, or outside of, the structure housing or holding the radiation emissive substructure.

(5) Substantially the entire amount, or a lesser controlled amount, of the aforesaid electro-magnetic radiation within a limited frequency range or ranges is transmitted to a location within, or outside of, the structure housing or holding the radiation emissive sub-structure.

(6) Substantially constant, or equal, proportions of

the generated electro-magnetic radiation is transmitted, within or outside the structure, independently of the location of the source of radiation.

Another object of this invention is to provide means, within or outside the structure, to convert the aforesaid transmitted radiation into electrical signals; and to amplify these signals; and to provide these signals with a push-pull output; and suitably to interrupt, switch, or modulate these signals.

The fundamental concept of this invention resides in providing on one face of a ray tube as aforesaid, one, or a plurality of radiation emitting materials, and structures, that are activated by the focused rays of a gun within the tube, or elsewhere, which materials and structures generate radiation that is directed, manipulated, and controlled to impinge on one or more pick-up devices or detectors, positioned within and/or outside the tube.

A fuller understanding of this invention whereby the primary objects and advantages as well as other objects and advantages may be achieved, will become more evident from the following description thereof taken in connection with the accompanying drawing wherein:

Fig. 1 is a cross sectional view of a structure containing an emitter of radiation upon activation and an internally disposed gatherer of such radiation and distributor.

Fig. 2 is a cross sectional view of a structure, fundamentally akin to Fig. 1, that is tapered-in towards a narrow section.

Fig. 3 is a cross sectional view of a radiation exciter, radiation emitter, radiation detector and an electrical secondary emission amplifier positioned in an in-line arrangement, whereby substantially all the radiation emitted may, on excitation, be utilized.

Fig. 4 is a cross sectional view of a structure akin to Fig. 3 wherein electrical focusing is utilized to reduce the dimensions of the output circuits.

Fig. 5 is a cross sectional view of a structure akin to that of Fig. 2 that may be used for color television.

Fig. 6 is a cross sectional view of the neck of a cathode ray tube in which two different internally disposed radiation gatherers are located, with two photon sensitive surfaces, two secondary emission amplifiers, and two pairs of auxiliary deflection plates.

Fig. 7 illustrates, on an enlarged scale, a section of radiation emitter that may be used with the structure of Fig. 5 for use in color television.

Fig. 8 illustrates a radiation emitter akin to that of Fig. 7 wherein "quiet" signals are utilized for synchronizing purposes.

Fig. 9 illustrates, on an enlarged scale, a section of radiation emitter that may be used with the structure of Fig. 6 for use in color television.

In Fig. 1, tube **100** is provided with inside surface **102** that is substantially completely reflective. The surface **102** may be formed of a reflective coating produced by painting, vapor deposition, sputtering or otherwise depositing a suitable material such as aluminum on **100**. It may also consist of the body material of **100** suitably molded, shaped or polished to act as a photon reflector. Surface **104** comprises a radiation emitter that emits photons upon excitation. Photon bundler and transmitter **105** gathers photons that emanate from surface **104**. By way of example, two point sources thereon are shown as **106** and **108**. The rays emanating from source **108** are shown as traveling directly to the bundler **105** as by ray **109** and by multiple reflection paths **111** and **113** so as ultimately to impinge on bundler **105**. Since the surface **102** is highly reflective, and since the angle of incidence is equal to the angle of reflection, practically all of the radiation "fired" back from **104** strikes bundler **105**. Two possible exceptions to this generalization are:

The rays generated by 104 and whose paths are in the line of channel 110, as shown by ray 112, will pass through the bundler, and the rays generated perpendicular to the longitudinal axis, or parallel to surface 104, will undergo multiple reflections but will not travel down the structure 100 to bundler 105.

Channel 110, which is used when a conventional electron gun is disposed to the left of bundler 105, permits a free path for electron flow to 104. The opening of 110 may be quite small in cross-sectional area. When necessary channel 110 and the electron beam therein may be inclined to a slight extent. It is also possible to flare the tubular structure 100 into conical form outwardly from 104 so that even the rays emanating parallel to surface 104 (and which surface may be curved slightly) will travel from the smaller end of the conical structure to the larger end wherein may be located a bundler akin to 105.

Bundler 105, preferably consists of material with a high index of refraction (for the incident wavelength involved) which gathers and transmits the radiation from surface 104 to section 114 of 105. The thus-concentrated radiation may be piped, as by cylindrical extension 116 to any convenient location within or outside structure 100. Crown glass, flint glass, quartz, fused silica, etc., are typical examples of high index optical materials which may be used. The material chosen should be transparent for the incident wave-length involved; must be stable in vacuum when so located; must be stable under electron and particle bombardment; etc. These properties are well known for the glasses listed, and for other glasses and materials and are described in references hereinafter cited.

Although described for tubular section 100, this photon gatherer operates similarly when positioned in square, rectangular or otherwise shaped structures. The dimensions of 105 are important but not critical in the sense that an image forming lens is required. The configuration or geometry of collector 105 is calculated in consequence of the configuration of structure 100 and the radiation transmitting properties of the material of which 105 is constituted. Data contained in Bulletin 175, entitled, "Plexiglass—Design, Fabrication and Molding Data," issued by the Plastics Department of the Rohm and Haas Company with respect to the optical characteristics of Plexiglas, a material having the optical characteristics of materials useful in carrying out this invention, will be helpful. I also refer to Jenkins and White, "Fundamentals of Physical Optics," McGraw-Hill, 1937, p. 393. Bundler 105 may be constructed in spherical form, the center of the sphere being in the vicinity of 114, the solid angle therefrom being determined by the intersection of the sphere with the housing 100. As an alternative, a simple double convex converging lens shown in phantom at 117 may be used. When 117 is used it likewise need not be image forming and is preferably placed so that the convergent rays assume a minimum diameter in the vicinity of 114, which diameter approximately outlines the area of the distributor 116 at the region 114. I refer to Hardy and Perrin, "Principles of Optics," McGraw-Hill, 1932, for further information relating to "lens" design. Two precautions are to be observed in the utilization of bundler 105. First, the molding operation, or other means, by which the collector is formed should leave smooth surfaces so that the radiation is not unnecessarily lost. Second, when plastics are used, high vacuum not being required, the ambient temperature must not be excessive. It is also to be noted that the particular form illustrated for bundler 105 in Figure 1 will serve most efficiently to collect rays which arrive nearly perpendicular to the incident surface 115 of bundler 105. If it be more desirable to gather, rather than to converge that radiation which is gathered, then section 114 may be increased in area. It should also be noted that the bundler may be "colored," or filters positioned, fore or aft, or individual color reflectors may be placed along the bundler to allow for wavelength discrimination. These aspects of this invention will be described infra. It is also apparent that many types of lenses, or a plurality thereof, may actually be a part of the internal structure of 100.

Figure 2 illustrates a conically shaped envelope 120 which transmits substantially equal proportions of the radiation generated at any point on the screen or surface 122, to the bundler 124, akin to 105. Bundler 124 may have a channel 125 akin to 110. For illustration the angle 128 subtended from source point 126 contains all the "light" rays or photons that are emitted by point 126 and that strike 124. Those rays generated at 126 that lie outside angle 128 undergo multiple reflections on the inside surfaces 130 and 122. For the dimensions chosen for illustration the angle 128 is approximately 17 degrees. Similarly, angle 132 subtended from source point 134 contains all the photon rays that are emitted by 134 and that reach collector 124. Likewise those rays generated at 134 that lie outside angle 132 undergo multiple reflections on the inside surfaces 130 and 122. For the dimensions chosen for illustration the angle 132 is approximately 16 degrees.

Surfaces 130 and 122 and envelope 120 may be prepared to enhance the transmission or the absorption or the reflection of these rays as desired. For example, when the useful radiation from screen 122 is geometrically limited to point 134, with a corresponding symmetrically located lower point 135, then as is seen in Figure 2, the inner coating 130 need only be reflective from the collector 124, to the circumference defined by points 136 and 137. If the multiple reflections need not be absorbed, then the area from points 136, 137 outwards toward and including sections of 122 may likewise be reflective. This will actually cause a slight increase in total gathered radiation but may be undesirable due to the effects of this radiation on part of the surface 122. For example, assume that the radiation emitted from point 134 is at a frequency of 3700 Angstrom units, and in such case, aluminum deposited smoothly on the surface 130 will serve as an efficient reflector. It may simultaneously replace the conventional colloidal graphite used for establishing the high voltage field in many conventional cathode ray tubes. If part or all of the radiation emissive material of surface 122 is sensitive to 3700 A., as well as to the primary source of excitation, then a spurious radiation pattern may be generated. When it is desired to inhibit or suppress such spurious radiation (many phosphors being sensitive to ultra-violet radiation) the surface 130 may be prepared from a copper deposit which is much less efficient a reflector than aluminum at the wavelength being considered in this example. To reduce further these reflections, the absorptive coating may be extended from the line of 136 and 137 back towards the neck. The last coating may reduce the effective angle 132 to a small extent. It should be noted that for purposes of explanation Figure 2 indicates a sharp angle at 138. In general this section is smoothly faired or curved thereby slightly modifying the specific angles mentioned. The use of other than conical sections clearly follows from the above description, and although explained with reference to the conical section for ease in representation, this obviously is not a restriction as to use. This explanation of the illustrations and descriptions applies to that which follows as well as to Figure 1 and Figure 2 and should be so understood.

In comparing the results with regards to the radiation transmitted to the bundler, it should be noted that, although the angle of 17 or 18 degrees of Figure 2 is considerably less than that of 180 degrees of Figure 1, with an approximate cosine distribution of the point source of radiation, the energy contained in the 18 degrees is an appreciable percentage of the total, certainly more than 10% as might be inferred from a rapid glance at the angles involved.

Bundler **105** is shown with a cylindrical "light" pipe **116** in Fig. 1. Bundler **124** of Fig. 2 shows the pipe conducting the radiation inward. It is also possible to pipe the radiation outward through the side-wall of the envelope, through a special port, or through a section of the header much akin to the fashion in which the voltages and currents are introduced in conventional cathode ray tubes.

Figure 3 illustrates an embodiment which optimizes the "light" gathering properties and which may be used when the radiation structure or surface **140** is not "viewed" from the gun side. When **140** radiates on impingement of electrons from a conventional electron gun **142**, or is otherwise activated, as by a source of focussed beta rays located on a member moving with respect to **140**, close fitting structure **144** is so arranged as to receive substantially all of the photons from **140**. Structure **144** is of "Venetian blind" construction so that only those rays parallel to the slats will pass unabsorbed. By curving the slats of **144** even this radiation may be absorbed. Reflective coatings may be placed on **140** to further enhance this "light" gathering process. This coating may consist of the conventional, electron penetrable, light-reflecting surface, used on the gun side of **140** or it may consist of reflection reduction coatings when placed on the other side of **140** as may be especially useful when **140** is of substantial thickness.

The radiation from **140** impinges upon the photo-emissive surfaces of structure **144**. The electrons thereby released from **144** are accelerated to Venetian blind structure **146**, the potential required being designated by voltage source **148**. Due to secondary emission from structure **146**, a number of electrons will be emitted for each incident electron. The electrons released from structure **146** are accelerated to Venetian blind structure **150** by means of accelerating potential **152**. This process may be repeated many times and is further described, as is the structure and other structures further defined, in the literature. I refer for example to "Recent Applications of Electron Multiplier Tubes," by James S. Allen in the Proceedings of the Institute of Radio Engineers, April 1950, pp. 346–358, including references contained therein. For a given excitation, by gun **142**, for example, on a particular portion of **140**, let there be "*n*" electrons released by structure **146**. After being accelerated to structure **150** these "*n*" electrons will strike structure **150** causing "*m*" electrons to be released for each incident electron. Due to accelerating potential **154**, the electrons released by **150** will be attracted to collector plate **160** which is constructed to reduce or eliminate secondary emission. Suitable choices of collector potential screening grids, etc. are well known and available to insure efficient collection. Since "*n*" electrons arrive at structure **150** and since "*n*" times "m" electrons leave structure **150** there is a net deficiency of $(m-1)$ times "*n*" electrons. As these electrons are replenished, a signal is developed across resistor **162** which is available as a positive going signal at **164**. The "*n*" times "*m*" electrons that leave structure **150** are collected by **160** and in flowing to potential **154** cause a signal to be developed across resistor **166** which is available as a negative going signal at **168**. Hence a push-pull signal is derived at points **164** and **168** which differ in magnitude by the ratio $m-1$ to m, but which magnitudes may be adjusted by selecting different values of resistors **162** or **166**.

In controlling the transit time between collector **160** and structure **150**, as by varying the spacing between **150** and **160**, the delay between the positive going and negative going signals may be adjusted when desired. It may be desirable to place a filter or filters between **140** and photo emissive surface **144** to control the extent and area of signal transfer.

Switch means **145** may also be used when it is desired to interrupt the signal transfer. Switch **145** may be mechanical or electronic. Protective resistance **147** is used to reduce the current flow when the switch is closed. Instead of low resistance switch **145**, an equally common high resistance switch may replace **147** to achieve the same interruption. In any case this interruption of signal transfer may be used to modulate the information being carried by the signal. The advantage of this arrangement lies in the elimination of switching pulses in the output of the device, for when electrons are not emitted by **144**, the presence (or lack) of suitable accelerating potential at **146** will not be detectable at the outputs **164** or **168**.

Figure 4 illustrates a modification of the combination described in Figure 3 wherein the low velocity electrons emitted by the secondary emissive surfaces are focused on their travel to collectors **170** and **172** so that structures **170** and **172** may be reduced in size thereby, to reduce associated capacities and to increase the potential frequency response of the output signals.

Although not illustrated in Fig. 4 it is clear that operating potentials akin to these illustrated and described in Figure 3 are necessary. The use of delay networks, "optical" filters, and switch means are likewise applicable to the embodiment of Figure 4.

In Figure 5, envelope **300** contains a conventional gun **302**, a bundler **304**, deflection means **306**, a high voltage anode connection **308**, and a layer of a phosphor or phosphors **30**. On the inside surface of envelope **300** is deposited a conductive coating **312** which may be divided into regions of high reflection, absorption, or transmission as previously explained. Insulating spacers **313** support the phosphor screen **310**. Auxiliary high voltage is introduced at **314**. By use of electrically conducting glass or transparent metallic deposits, the inside surface **316** of the face of envelope **300** is maintained at the approximate potential introduced at **314**. Alternative construction is outlined in my co-pending application, Serial No. 514,973, filed June 13, 1955. Auxiliary deflection pairs of plates **318** and **319** are positioned between gun **302** and **304**. They may also be placed within **304** or between **304** and screen **310**, but preferably in the low voltage region of the cathode ray tube. Bundler **304** lies, at least partially within the field of deflection means **306** in Fig. 5. For the magnetic deflection means used in conjunction with television kinescopes the horizontal line scanning frequency (approximately 15 kc.) and the useful harmonics thereof are sufficiently low in frequency so that the presence of high quality glass, when used for the collector, positioned as illustrated in the field of the deflection coils, will not materially affect the operation. However, in other applications, **304** may, if desired, be moved or shielded from the electro-magnetic fields. Bundle **304** transmits an appreciable percentage of the desired radiation, received at its front surface, to surface **320**. Said surface **320** is sensitive to this transmitted radiation and upon excitation yields a supply of electrons. If surface **320** is sensitive to other radiations, then suitable filtering may be employed. If the illustration of Figure 5, a shield of **322** of lead or other suitable material, is shown to surround sensitive surface **320** so that only the radiation piped through **304** may excite surface **320** to any appreciable extent.

For soft X-rays, **304** itself may serve this latter purpose. The electrons issuing from surface **320** are attracted by the higher potential of dynode **324** with sufficient energy to release secondary electrons. These electrons in turn are attracted to dynode **326**, etc., in such manner as ultimately to yield an appreciable signal output at **330**. Means for mounting all the components in Fig. 5 and the operating potentials are not illustrated in order to allow for a clearer presentation of the pertinent facets of this invention. It should be noted that shield **322** may be placed to protect sensitive surface **320** from positive ion bombardment in addition to its use as an

X-ray shield. Shield **322** is maintained at a suitable potential to attract the positive ions. The electron focusing required in traversing the dynodes may be accomplished by electrostatic or by combined electrostatic and magnetic fields. Gun **302** may include conventional electron beam focusing and ion spot eliminating means.

In Figure 6, two bundlers **350** and **352**, each akin in general construction and mode of functioning to **304**, are located in the neck of a cathode ray tube. Auxiliary pairs of deflection plates **356** and **358** are akin to **318** and **319**. Gun **354** is akin to **302**. Primary deflection means (not illustrated) are generally used. Bundler **350** gathers and transmits specific radiation from the conical section of the tube to photo-sensitive surface **360**. Collector **352** gathers and transmits another specific radiation from the excited front surface of the tube to photosensitive surface **362**. The collector and its associated sensitive surface, e.g., **350** in combination with **360** respond only to a single band of frequencies. In addition to peaking the response of **360**, by choice of suitable material and processing thereof, to the desired incident radiation and in addition to optimizing the transmitting, the gathering, and the converging processes of the collector **350** to the desired wavelength of the incident radiation, a filter or series of filters, dyed or of the interference type, may be interposed between **350** and **360** or may be placed at suitable other positions to allow the passage of one and only one band of signals radiated from the energized end of the tube. Collector **352** in combination with sensitive surface **362** will likewise respond only to selected radiation, which radiation in general will have a different frequency (or wavelength) from that passed in the combination of **350** and **360**. Shielding means typified by shield **322**, may also be used. Likewise, it is apparent that the configuration of the envelope and internal components of Figure 6 may be extended as hereinbefore and hereinafter set forth.

The electrons released by **360** are attracted to the inside surface of dynode **364**. By the multiplicative processes of secondary emission the electron flow or signal, is augmented at the outside surface of **366**; again at the inside surface of **368**; thence the signal is collected at **370** for utilization. The electron released by **362** follow a correlative path but preserve their identity in space and are collected at **372** for utilization. It should be emphasized that in utilizing a set of dynodes for the transmission and amplification of a plurality of signals as described, the number of connections required is considerably reduced. This advantage in reducing the number of lead connections, components, filters, etc. increases with total number of emitter collector combinations akin to **360**, **370**, and **362**, **372**. Since the secondary emission process is confined to the area hit by the incident electrons, it is only necessary to bypass the dynodes electrically in order that channel isolation is maintained.

A typical phosphor pattern that may be utilized is illustrated in Fig. 7. For application to a color kinescope there are located on the viewed end of a cathode ray tube a red emitting phosphor **370**, a green emitting phosphor **372**, and a blue emitting phosphor **374**. These phosphors are utilized in such fashion to present a colored image to the viewer. One of the phosphors in this case **372**, has associated a special phosphor **373** which also radiates when energized by cathode rays which is not used for visual display but which is used to signal the location of the electron beam. A typical phosphor that may be used for this purpose is Hex ZnO, suitably prepared, and which phosphor may be deposited on either side of **372**, or mixed with it. The signalling radiation is of such frequency that it is readily filtered from the remainder of the radiations generated by electron bombardment (and other radiation sources) so that the information containing the position information of the electron beam is properly distinguishable. Since the screen is adapted to radiate in the red, green and blue respectively, and in different amounts, as a function of picture content, it is extremely advantageous to select the invisible, or in this case, the ultra-violet output of the special phosphor to indicate beam position. The zinc oxide phosphor may be prepared to decay rapidly, and to emit efficiently in the ultra-violet region. If this special phosphor should radiate in that portion of the spectrum covered by the red, green and blue phosphors, then special provisions would be required to distinguish between the picture content radiation and the position indicating signals. In the case of an aluminum backed screen, with thin special phosphor strips located parallel to the viewed phosphor strips and on the gun side of the aluminum coating, this problem would be reduced but spurious radiation would still enter the tube unless special provisions were made to shield the cathode ray tube from external sources. "Optical" filtering would still be required without special preparation of the phosphor.

In Fig. 8, red phosphor **376**, green phosphor **378**, and blue phosphor **380** are associated with a special phosphor akin to **373** of Fig. 7. In this phosphor pattern, a region **382** is provided without the special phosphor. Region **382** is shown between phosphors as would be required when the special phosphor is mixed with the main prosphors. However, when the special phosphor is independently deposited the extra space of region **382** may be eliminated. The position where the thin strip of special phosphor is missing may be chosen to lie in line with one, or part of, or more than one of the main phosphors. Alternatively, instead of using a special phosphor, an X-ray emitting material may be utilized. In this case, the X-ray production normally encountered may be augmented by depositing finely divided tungsten particles in place of the special phosphor. To further distinguish region **382** from other areas, the pattern of Fig. 8 may be incorporated as **310** in the dual voltage construction of Fig. 5. In this case the red, green and blue phosphors (including additional X-ray producing particles) are connected with high voltage terminal **308**. Hence, when the electron beam strikes this portion of the screen many X-rays will be produced. When the electron beam travels through region **382**, which region is now removed from the screen of Fig. 8 the beam will slow down due to the low voltage of face **316**. These electrons will be collected by potential **314** but due to this deceleration the radiation produced will be substantially different from all other radiations. The interruption or change in X-ray radiation may be detected by coating bundler **304** with a material, such as zinc oxide which will radiate near or in the visible spectrum. Alternatively, collector **304** may be replaced with a material, such as bismuth, which will convert the X-radiation directly into electrons with subsequent multiplication of said electrons. Another alternative is to introduce a voltage at **316** substantially higher than that at **310** so that region **382** may be identified by an increase in the X-ray radiation. With suitably high voltages, radiation characteristic of the emitting material may be produced thereby lending said radiation to appropriate filtering. Especially when the beam position indicating signals consist primarily of X-rays, the dimensions of region **382** in the direction of beam travel will affect the time duration of the said indicating signals, and therefore may be used to control same signals duration.

In Fig. 9 a pattern is illustrated which may be used in conjunction with the structure of Fig. 6. Special phosphor **384** of Fig. 9 and collector **350**, and photosensitive surface **360** of Fig. 6 operate in combination to furnish a signal only when the electron beam excites special phosphor **384**. A suitable combination that may be utilized consists of zinc oxide for **384**, treated to radiate in the ultra-violet, nickel oxide glass for **350**, or for part of **350**, to transmit this ultra-violet radiation, and to absorb the remaining spectrum, and an antimony-caesium or antimony lithium surface for **360**. Likewise special emitter **386** operates in conjunction with collector **352** and surface **362** to furnish a signal only when the electron beam excites special phosphor **386**; special emitter **386** may be the finely divided particles operating as previously described. Green phosphor **388**, red phosphor **390**, and blue phosphor **392** are conventional.

The radiation emitting screens of Figs. 7 and 8 may be utilized directly in my co-pending application, Serial No. 448,039, filed August 5, 1954. Likewise, Fig. 5 as well as other figures and descriptions of the instant invention may be directly applied to my aforesaid co-pending application of August 5, 1954. It is therefore to be noted that the ZnO, special phosphor may be mixed with other than the green-emitting phosphors in order to improve the overall efficiency of operation.

The screen of Fig. 9 may be utilized in my aforesaid co-pending application of August 5, 1954 with appropriate changes in the "delay-switching triggering" arrangement of that invention.

Deflection plates **318** and **319** of Fig. 5 and **356**, **358** of Fig. 6 may be incorporated and utilized when it is desired to vary the shape and position of the electron beam in the cathode ray tube. For example, the horizontal scanning velocity in a color television system using substantially vertical strips of phosphorescent materals may be regulated so that the effective time during which the electron beam impinges on a particular strip or strips is considerably longer than would be permissible with a uniform, horizontal scanning velocity. The set of plates orthogonal, or nearly so, to those imparting the variations in horizontal velocity may be incorporated and utilized when it is desired to elongate the electron beam in a direction substantially parallel to the aforementioned strips. For equal horizontal and vertical resolution in a color kinescope, of the type considered, it is possible to increase the length of the electron beam transversely of its horizontal travel, or parallel to the "vertical" phosphor strips, by a factor of the order of 3:1 without adversely affecting the ultimate resolution. Further due to the anticipated correlation in the picture-bright areas it is possible to increase this ratio still further without suffering an undue loss of resolution. These last set of deflecting plates may be utilized so that the spot stretch is controlled by the picture content at the point, or area, in question.

Although the invention has been described with horizontal and vertical electron-beam, it will be appreciated that the invention is not limited thereto, to be applicable as well to any two-dimensional scanning patterns, as for example, concentric circles, a spiral and many other scanning configurations.

It will be understood that the foregoing description of the invention and the embodiments illustrated are merely illustrative of the principles thereof. Accordingly, the appended claims are to be construed as defining the invention within the full spirit and scope thereof.

I claim:

1. A structure comprising: a housing containing a member which emits electro-magnetic radiation with a frequency in the range extending from the infra-red to that of ultra-violet upon excitation by a scanning beam of energy, said member comprising discrete elements extending over a substantial area which provide said radiation means comprising a lens within said housing and separated therefrom for collecting and transmitting at least a portion of the emitted electro-magnetic radiation, said lens being positioned symmetrically with respect to the radiation producing elements to the extent that it picks up substantially equal amounts of the emitted radiation independent of the location of the discrete elements which produce said radiation.

2. A cathode ray tube comprising an electron gun, a member which emits electro-magnetic radiation with a frequency in the range from infra-red to that of X-rays upon excitation by a scanning beam of electrons from said gun, said member comprising a plurality of discrete elements extending over a substantial area which provide said radiation, filtering means within the tube for transmitting and controlling at least a portion of said electro-magnetic radition, and converting means within the tube to convert the transmitted radiation into electrical signals, wherein said electron gun, said member, said filtering means and said converting means are arranged in-line with the said member adjacent the said filtering means.

3. A cathode ray tube comprising an electron gun, a member which emits electro-magnetic radiation with a frequency in the range from infra-red to that of X-rays upon excitation by a scanning beam of electrons from said gun, said member comprising a plurality of discrete elements extending over a substantial area which provide said radiation, filtering means within the tube for transmitting and controlling at least a portion of said electro-magnetic radiation, and converting means within the tube to convert the transmitted radiation into electrical signals, wherein said electron gun, said member, said filtering means and said converting means are arranged in-line with the said member adjacent the said filtering means, and wherein said converting means comprises a photon-sensitive electron-emitter and secondary emission means.

4. A cathode ray tube comprising an envelope and an electron gun adapted to emit a beam of electrons, said beam being capable of scanning electron-sensitive means that emit electro-magnetic radiation with a frequency in the range from infra-red to that of ultra-violet upon excitation by said electrons, means comprising a lens within the cathode ray tube separated from the envelope thereof and positioned to face said electron-sensitive means, that bundles a portion of said electro-magnetic radiation into a concentration thereof.

5. A cathode ray tube comprising an envelope and an electron gun adapted to emit a beam of electrons, said beam being capable of scanning electron-sensitive means that emit electro-magnetic radiation with a frequency in the range from infra-red to that of ultra-violet upon excitation by said electrons, means comprising a lens within the cathode ray tube separated from the envelope thereof and positioned to face said electron-sensitive means, that bundles a portion of said electro-magnetic radiation into a concentration thereof, and means to transmit said concentrated radiation.

6. A cathode ray tube comprising an envelope and an electron gun adapted to emit a beam of electrons, said beam being capable of scanning electron-sensitive means that emit electro-magnetic radiation with a frequency in the range from infra-red to that of ultra-violet upon excitation by said electrons, means comprising a lens within the cathode ray tube separated from the envelope thereof and positioned to face said electron-sensitive means, that bundles a portion of said electro-magnetic radiation into a concentration thereof, and converting means inside the tube that converts at least a portion of said concentrated radiation into electrical signals.

7. A cathode ray tube comprising an envelope and an electron gun adapted to emit a beam of electrons, said beam being capable of scanning electron-sensitive means that emit electro-magnetic radiation with a frequency in the range from infra-red to that of ultra-violet upon excitation by said electrons, means comprising a lens within the cathode ray tube separated from the envelope thereof and positioned to face said electron-sensitive means, that bundles a portion of said electro-magnetic radiation into a concentration thereof, and means to transmit said concentrated radiation and converting means inside the tube that converts at least a portion of said concentrated radiation into electrical signals, and wherein

said converting means comprises a photon-sensitive electron-emitter and secondary emission means.

8. A cathode ray tube comprising an electron gun adapted to emit a beam of electrons, said beam being capable of scanning an electron-sensitive structure that emits electro-magnetic radiation upon excitation by said electrons, said electron-sensitive structure comprising first and second direct current potential establishing means insulated from each other with discrete openings in the potential establshing means disposed towards said electron gun, whereby the electro-magnetic radiation emitted from said structure has a frequency within the range from Hertzian waves to that of X-rays, the frequency being controlled by the potential difference between said first and second means.

9. A structure comprising: a housing containing a member which emits electro-magnetic radiation with a frequency in the range extending from infra-red to that of ultra-violet upon excitation by a scanning beam of energy, means comprising a lens within said housing separated therefrom and positioned to face said member for bundling at least a portion of said electro-magnetic radiation into a concentration thereof.

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