

Oct. 6, 1959

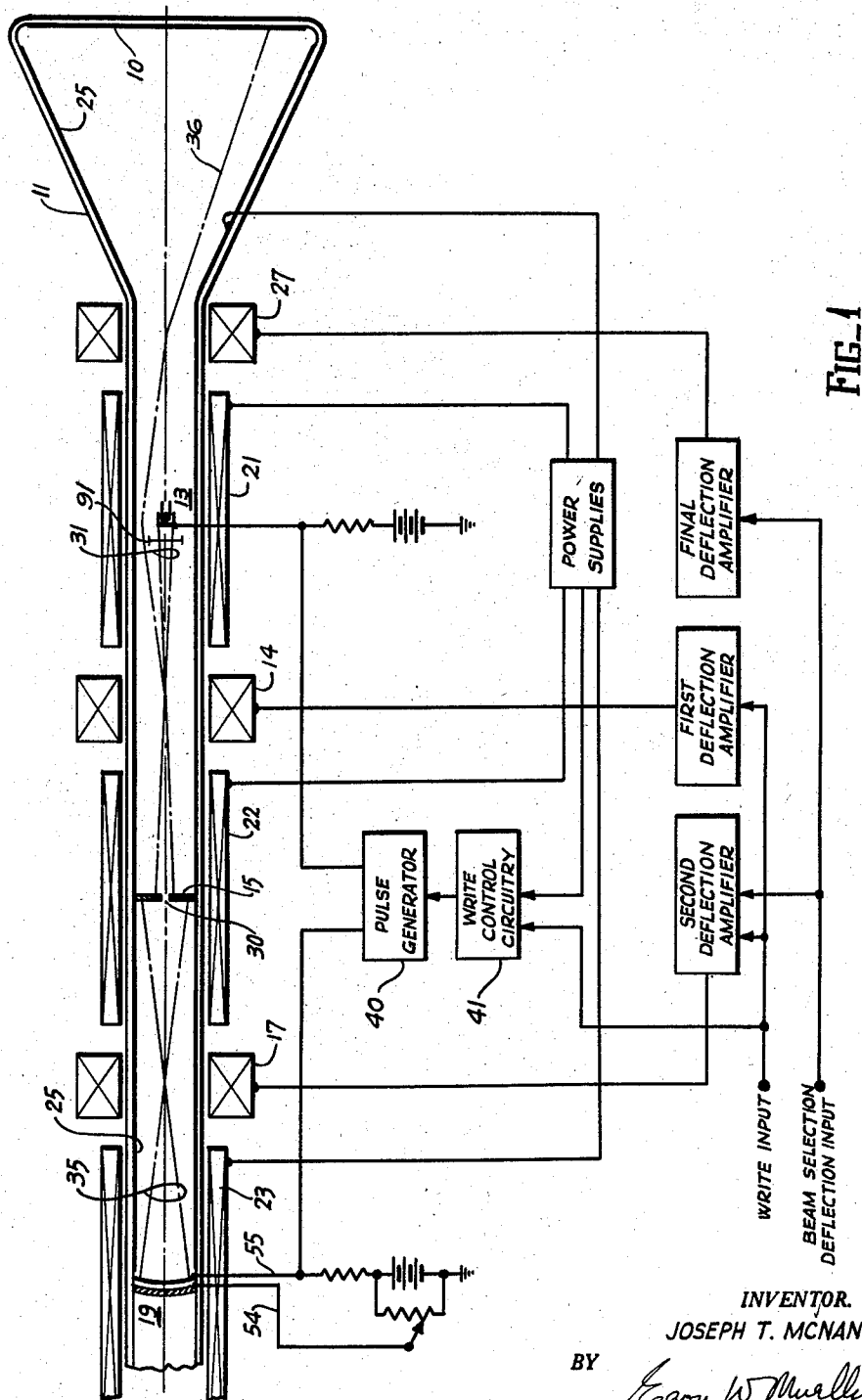
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2,907,907

CATHODE RAY TUBE APPARATUS

Filed Dec. 13, 1956

5 Sheets-Sheet 1



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5 Sheets-Sheet 2

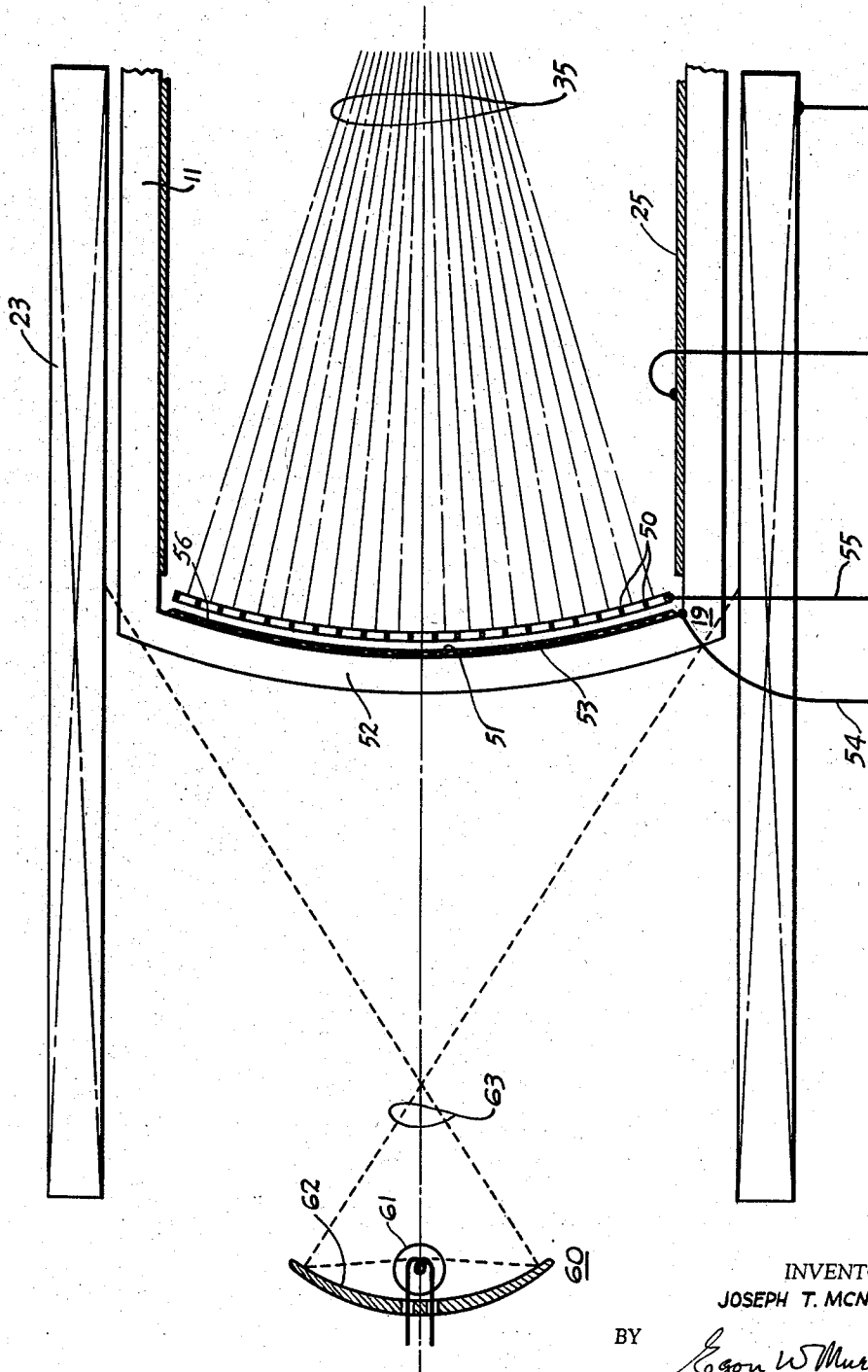


FIG. 2

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5 Sheets-Sheet 3

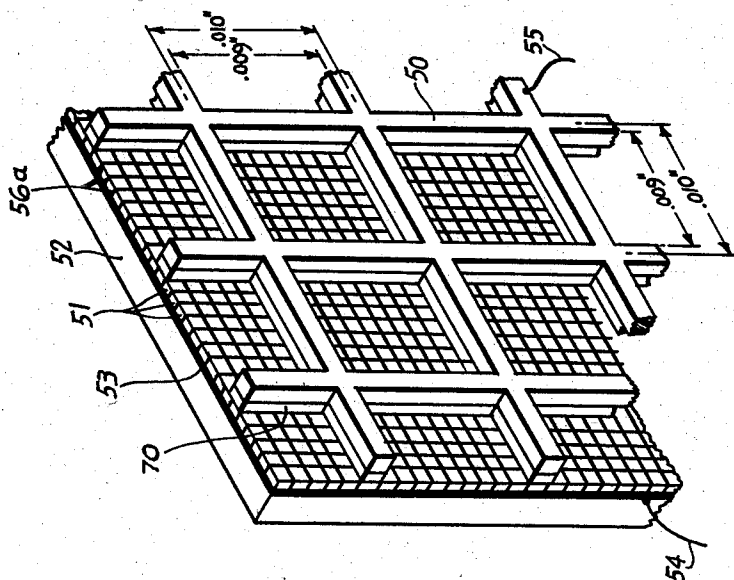


FIG-7

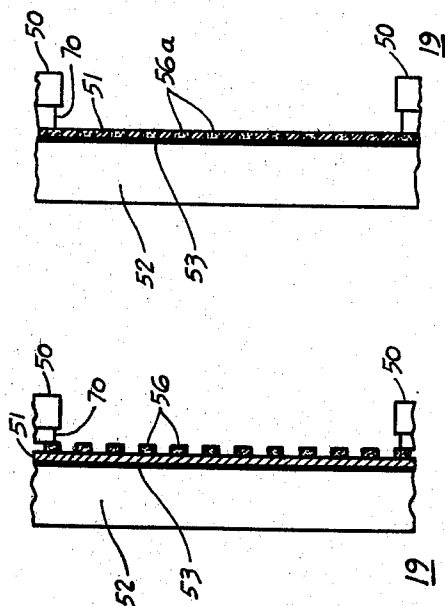


FIG-3

FIG-4

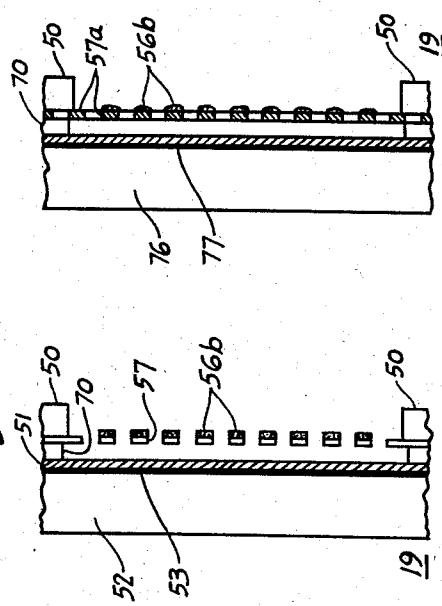


FIG-5

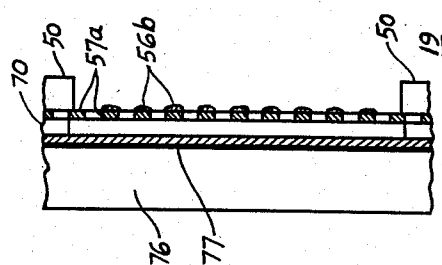


FIG-6

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5 Sheets-Sheet 4

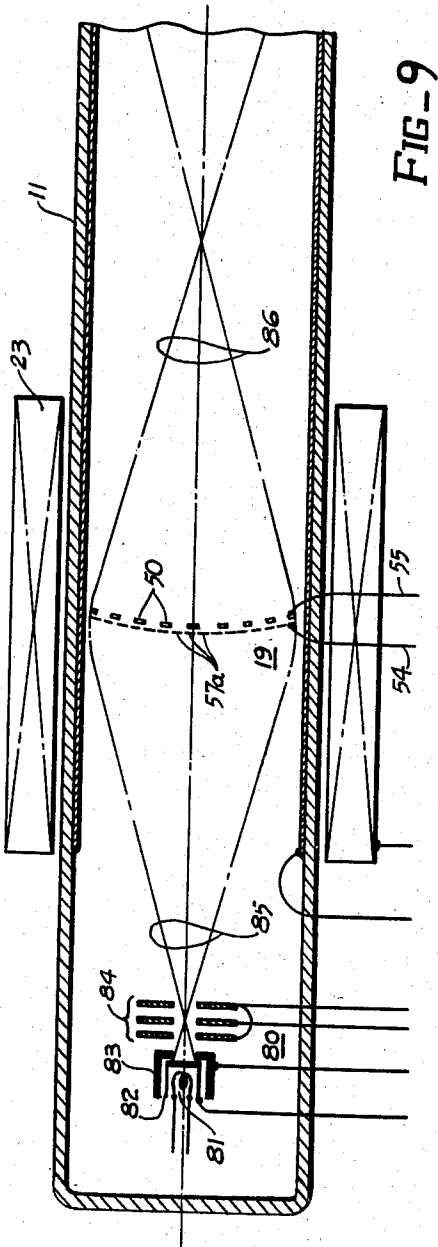


FIG-9

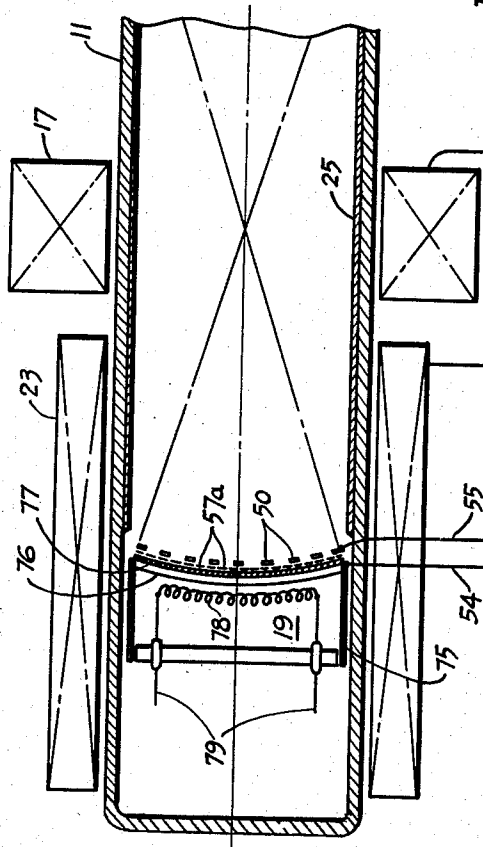


FIG-8

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2,907,907

CATHODE RAY TUBE APPARATUS

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Application December 13, 1956, Serial No. 628,044

16 Claims. (Cl. 313—70)

The present invention pertains to cathode ray tubes capable of displaying intelligible information on a viewing screen in the form of letters, numerals and symbols which may, for example, be representative of the identity and position of aircraft flying in space.

Present display system requirements are not being fully met by existing cathode ray tubes. It is desirable from the standpoint of operating efficiency to include in such tubes a form of memory or storage to retain data which may represent target identity for continuous display on a large situation display viewing screen. Practical viewing areas of screens in display cathode ray tubes having storage or memory and developed thus far, have generally been rather limited to small usable viewing diameters.

It is an object of the present invention to provide an evacuated display apparatus wherein the viewing screen may be of a large diameter and is not limited in size by the difficulties of existing memory devices.

It is another object of this invention to provide apparatus capable of utilizing a memory or storage means for the purpose of retaining desired data, which data may then be selectively displayed and positioned on a viewing screen.

It is another object of this invention to provide a cathode ray tube apparatus capable of storing selected data and allowing the projection of such data to desired positions on the viewing screen under the control of independent deflection data.

It is another object of this invention to provide improved resolution of displayed message characters over those obtainable by use of the more conventional storage tubes.

It is another object of this invention to provide an electrostatically controllable electron emissive cathode system for generation and projection of the ultimately viewed information.

It is another object of this invention to provide electron emissive means whose areas of emissivity may be controlled with regards to electron density and time by control means all positioned within the evacuated container or cathode ray tube.

It is another object of this invention to provide electron emissive cathode means capable of generating sustained character shaped beams whose cross-sectional shapes and duration of emission are determined by electrostatic charge writing methods.

It is another object of this invention to establish electrical charges on the control surfaces of a cathode whereby these charges will control the emission of electrons in accordance with the pattern of electrical conditions established thereupon.

Objects and advantages other than those set forth will be apparent from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a simplified schematic of one embodiment of the invention showing in a block diagram form conventional control circuitry;

Figure 2 shows an enlarged diagrammatic view of a light sensitive cathode ray or second beam generator preferably utilized in Figure 1;

Figures 3, 4, 5 and 6 are enlarged and fragmentary cross-sectional views of portions of further embodiments of the second beam generator;

Figure 7, a partial view in perspective, shows in greater detail, the construction of the control means or element of the second beam generator as shown in Figure 2;

Figure 8 shows an additional embodiment of a second cathode beam generator of a thermionic type;

Figure 9 is still another embodiment of a beam control for the second beam generator;

Figure 10 is a schematic view of an additional embodiment of the invention wherein the first beam generator is displaced from the tube axis;

Figure 11 illustrates a beam shaping member suitable for use in the invention.

Referring to Figure 1, an evacuated container or envelope 11, shaped as a cathode ray tube, has disposed symmetrically with respect to the longitudinal axis of the envelope 11 a target or screen 10 located at one end thereof. The target 10 may be of any known electron responsive target construction and utilizes preferably electron to light conversion, such as, phosphor construction.

The constituent parts of the preferred embodiment of the invention as shown in Figure 1 includes a primary electron message character beam generator or first beam generating means 13, a first deflection system 14, a beam selection aperture plate 15, a second deflection system 17 and a secondary electron beam control generator or second beam generating means 19. In cooperation with these parts a system of individual electron lenses 21, 22 and 23 have been provided, which in combination with beam accelerator 25, may be utilized to direct and project electron beams along their desired or prescribed paths. A third deflection system or unit 27 is used to deflect electron beams generally from axis to predetermined areas of the target 10. Both the deflection systems and the lens systems may be of known electromagnetic or electrostatic construction and are exemplified herein as electromagnetic construction.

The lens systems, namely, first lens system 21, second lens system 22 and third lens system 23 which, as stated, may be, for example, of an electrostatic or electromagnetic type, is exemplified as of an electromagnetic construction. Such a desired construction is also disclosed, in detail, in copending applications Serial Nos. 507,856, now Patent No. 2,824,250, and 507,902, both assigned to the common assignee of this invention.

Primary beam generation or first beam generating means 13, may utilize any known electron beam generating cathode construction, such as thermionic or photoelectric, but is preferably shown as a thermionic cathode. The first generator 13 generates and projects an electron beam through a beam shaping matrix 91 of the general type shown in Figure 11, thereby projecting a first beam cross section 31 of a desired cross sectional configuration or may in accordance with the teachings of my U.S. Patents 2,735,956, 2,761,988 or copending applications Serial Nos. 537,112 and 606,060 project any one beam or group of beams having one or more predetermined cross sections. Various embodiments of the beam generator 13 are shown in the referenced patents and applications. In all of these embodiments, a beam of electrons from the cathode may be formed directly or be directed through a beam forming matrix 91 as shown in Figure 11 thereby deriving one or a plurality of character shaped electron beams. At least a selected beam cross-section of the first beam cross section 31 may be selected and directed through an aperture 30 in aperture plate 15.

by application of predetermined control voltages generated by a first deflection amplifier to the deflection system 14. Figure 10 shows an additional embodiment which is capable of selecting one of a plurality of cross sections generated by first generator 13.

The magnetic lens or first lens system 21 assists in the control of such beams by causing the electrons of the beam 31 to converge on, and cross-over at, substantially, the midpoint of the first deflection system 14 along the longitudinal axis. Lens system 21 may also be so designed as to effect an image of the beam cross section 31, as generated by first generator 13, at the plane of the aperture plate 15. After a beam has been selected through the aperture 30, a second lens system or magnetic lens 22, acts on the beam to cause it to converge on, and cross over at, substantially, the midpoint of the second deflection system 17 and along the longitudinal axis.

Deflection system 17 effects imaging of the selected cross sections upon an electrostatic potential control surface of the second electron beam generator or second beam generating means 19. The second deflection system 17, which is supplied with predetermined control voltages from the second deflection amplifier, permits the selected beam to be directed to any desired position upon the control surface of the secondary beam generator 19.

The second beam generating means may be a planar unit or a curved unit, it being exemplified in the preferred embodiment as parabolically shaped to aid in directivity of the re-emitted second beam cross section. Operational details of this generator 19 will be explained in conjunction with descriptions of its various embodiments wherein the electrons generated and projected may be generated in the manner shown in Figures 2, 8 and 9. However, in general, all electron beams stored or re-emitted therefrom, or therethrough, will be the cross sectional configuration or shape of the actuating first beam cross section, which of course, may be in the form of message characters, such as symbols, letters and numerals, as predetermined by the selected beam cross section 31. The ability to maintain electron emission, as a second beam cross section 35, from the secondary beam generator 19, in the form of predetermined shaped beams, will be a function of the control characteristics of the generator which will also be explained along with the descriptions of the embodiments.

Electron beams emitted from the second generator 19 are caused by the action of the third lens system or magnetic lens 23 to cross over at a point substantially along the axis and substantially at the midpoint of the second deflection system 17, and, to image on the surface of the aperture plate 15. Application of desired control voltages, from second deflection amplifiers, to the deflection system 17, will permit any one or group of electron beams from one or a plurality of predetermined shaped beams or second beam cross sections 35 to be directed, or selected, through the aperture 30. The magnetic lens 22 then effects focusing of the selected shaped beam of electrons or second cross section to cross over at a point midway of the first deflection system 14. Application of predetermined bias voltages to deflection plates 14 will, for example, cause the selected second cross section or beam 36 to be deflected off the longitudinal axis and into the field of the magnetic lens 21. The selected beam 36 is deflected around the character beam generator 13 and returned to the longitudinal axis of the tube at a point substantially midway of third deflection system or deflection yoke 27 by lens 21. The third deflection system 27 may deflect the beam 36 to cause impingement of the beam cross section at any desired position on the screen or target 10.

Generally speaking, only two types of information inputs are needed, namely, writing information and beam selection-deflection or reading information. Under normal operating conditions, the first beam generating means or beam shaping gun 13, is used to write secondary elec-

tron charge potentials upon the control surface of the generator 19 in response to coded input information usually furnished by a computer. These potentials may be distributed over discrete areas of the generator 19, namely, on its control surfaces, in conformance with the shape of the one or more beams selected from the one or plurality of first beam cross sections 31. This may be accomplished by establishing positive potentials on selective portions of the control surfaces through secondary emission in a manner that will become more apparent later. These potentials once established will be retained to control and shape electron beam 35 until erased. When it is desired to establish certain conditions of emissivity on the control surface of generator 19, or write, energizing voltages from a pulse generator 40 are applied to the control elements of the electron source 13 and a control element of the generator 19 whereby both of these are energized to a potential that will permit a secondary emission condition on the control surface of generator 19. The application of pulsed potentials may be under the control of write control circuitry 41, which may be a simple switching device such as an Eccles-Jordan flip-flop, as is well known in the art. After the writing is accomplished, second generator 19 retains the charge potentials caused by the first beam cross section as electrostatic charges thereon until erased by gun 13.

Various embodiments of the second beam generating means are included in this invention, namely, Figures 3, 4, 5 and 6. The important differences in these embodiments reside in their construction and method of control. In each case the operation of second beam generating means 19 depends upon certain well known principles employed in cathode ray storage tubes, namely, that induced conductivity may be effected in or upon certain electrical insulating materials by means of high energy electron beam bombardment. In Figures 3, 4, 5 and 6 the secondary beam generating means 19 utilizes an electrically resistive material 56, 56a and 56b, hereinafter referred to as resistive material 56, that may be charged in a positive sense with respect to the energized photo-emissive cathode 51 when subjected to bombardment by high energy electrons from gun source 13. This bombardment results in secondary electrons being emitted from material 56 in areas contacted by the electron beam 31, which emitted electrons are collected by collector 50 leaving a positive condition on the surface of material 56. At the time it is desired to write character information on resistive material 56, the photocathode 53 is in a non-energized condition and collector 50 has a given potential. The given potential on collector 50 at this point is insufficient to provide a voltage differential between collector 50 and resistive material 56 that will permit a secondary emission condition to occur on the surface of resistive material 56. When a write control pulse is received from write control circuitry 41, pulse generator 40 supplies output pulses to the beam generating gun 13 and the collector 50. The pulse received by collector 50 raises its positive voltage to a magnitude where the voltage differential between the potential on collector 50 and the potential of resistive material 56 is sufficient to permit secondary emission to occur on the surface of resistive material 56. The pulse received by gun 13 from pulse generator 40 causes a high energy electron beam 31 to be projected onto the resistive material 56. The beam 31 bombards the surface of the resistive material 56 causing secondary electrons to be knocked therefrom, which electrons are collected by collector 50. The secondary electrons knocked from the surface of material 56 exceed the number of primary electrons absorbed by material 56. This occurs since there is sufficient positive potential magnitude on collector 50 to draw the secondary electrons from the surface of material 56. The loss of secondary electrons by the surface of material 56 creates a positive voltage condition to exist on the surface bombarded by beam 31. After the positive

voltage condition has been established on desired areas of material 56, the gun 13 is de-energized and the positive voltage pulse supplied to collector 50 is terminated. The reduced magnitude of the potential on collector 50 is now insufficient to permit secondary emission to occur but will not affect the positive condition already stored on the surface of material 56. The resultant voltage impressed on the selective areas of resistive material 56 from impingement by beam 31 will have a potential that is positive with respect to emitter 51 in the energized condition and less positive than collector 50. The electron beam generated by emitter 51 will now pass through the areas of the material 56 that have a more positive charge thereon and will substantially not pass through the areas of material 56 not bombarded by beam 31. Thus, resistive material 56 is capable of shaping the electron beam generated by emitter 51. When it is desired to erase the positively charged areas on material 56, the beam generating gun 13 is energized projecting an electron beam 31 that will flood the surface of material 56. This bombardment of the material 56 by beam 31 will not cause a secondary emission condition to occur because no positive pulse is supplied to collector 50. Thus, the potential differential between material 56 and collector 50 is insufficient to permit effective secondary emission. The electrons in beam 31 are therefore able to remove the aforesaid positive conditions on the surface of resistive material 56 through their negative charges. The theory and operation of various such devices are set forth and described in detail by M. Knoll and B. Kazan in "Storage Tubes and Their Basic Principles," published by John Wiley & Sons, Inc., New York, New York.

One of the preferred embodiments of second generator 19 is shown in Figure 2. In Figure 2, the beam control generator 19 includes an electron collector 50, an electron emitter 51, and a transparent window support 52 in envelope 11. An electrically conductive surface 52 energized by a lead-in conductor 54 is preferably disposed on support 52 and contiguous with the emitter 51 and a resistive material 56 is placed on the surface of emitter 51 in substantially the manner shown in Figures 3 and 4. The grid 50 is provided with a lead-in conductor 55. The emitter 51 may be thermionic or photo emissive and is shown as of the photocathode type. Emitter 51 may be energized from any light source and is exemplified by an external light source 60, which source includes a lamp 61 and light reflector 62. When the emitter 51 is exposed to light rays 63 it will emit photoelectrons through resistive material 56 as second beam cross sections 35. Resistive material 56 either prevents or permits passage of the photo electrons therethrough and effects shaping of second beam cross sections 35 in response to its induced charge pattern. Collector 50 can function either as a collector for secondary electrons emitted from material 56 or as an overriding grid control.

Figures 3, 4, 5 and 6 present fragmentary views of the beam control generator 19 with four different construction arrangements which may be utilized to control or modulate electron emission therethrough or therefrom. Figures 3, 4 and 5 are varied construction arrangements of the second beam generating means 19 as shown in Figure 2, and Figure 6 is an additional embodiment of means 19 as shown in Figure 8. In each of the Figures 3, 4 and 5, electron emissive material 51 is deposited on a conductive coating 53, which, in turn, is supported by the window or support 52. In Figure 3 an electrically resistive material 56 in the form of spaced apart islands, is applied to the emitting surface of the photocathode 51. The resistive material may be any known material, metallic or non-metallic, which is capable of secondary emission and of a high electrical resistance, such as talc, carbon and others, as set forth in bibliography of "Storage Tubes and Their Basic Principles" Ibid. In Figure 4, a similar resistive material 56a is applied directly to the conducting layer 53 in spaced apart islands with a

mosaic of the photocathode 51 disposed adjacent the material in the intervening spacing. In Figure 5, the resistive material 56b is supported on a fine wire mesh or perforated conductive or non-conductive element 57, which mesh or element 57 is located adjacent the photocathode 51.

Figure 6 will be adequately explained in connection with Figure 8.

In Figure 7, a three-dimensional view of a small section of a beam control generator 19, as exemplified in Figure 4, is shown for the purpose of showing the electron control grid 50 in greater detail. The construction of the grid 50 is such that it will provide individual apertures or openings, 0.009" x 0.009", for example, through which the individual characters shaped cross sections, emitted from the surface of the photocathode 51, may pass. Each opening frame or grid opening performing the function of a switch as well as an electron accelerator. The photocathode may, in this case, be in the form of a mosaic of islands of light responsive materials separated by the electrically resistive material 56a. The photocathode or light responsive materials 51 may be of any known type such as set forth in my copending applications Serial Nos. 568,236 or 604,931, now Patent 2,850,657. The light responsive materials 51 are applied or coated on the conducting layer 53 which, in turn, is supported on the inner surface of the window 52. An insulating spacer 70, such as mica, glass, and so forth, is shown in the various embodiments to support and establish the predetermined mechanical relationship and spacing of the grid 50 with respect to the remaining parts of the structure 19.

Under preferred operating conditions, the control grid 50 serves as a collector of secondary electrons emanating from the resistive material 56. This emission of secondary electrons occurs when the resistive material 56 is subjected to bombardment by high energy electrons from the first beam generating means 13 which effects the writing of static charges on material 56. After positively charged patterns have been established on resistive material 56, generally within the confines of the individual aperture frames of grid 50, excitation of the appropriate portions of cathode 51 will cause emission of photo-electrons, namely second beam cross section 35, in the form of individual message characters. The grid 50, having a more positive potential applied to it than the cathode 51 will also cause the second beam cross section 35 to be accelerated through the respective apertures or frame of the grid 50 in the direction of the midpoint of the second deflection plate system 17 on axis. The curvature of the second beam generating means 19 could additionally aid in focusing all emitted electrons at the stated midpoint of system 17.

Another embodiment of the beam control generator 19 is shown in Figure 8 exemplifying a thermionic emitter. The structure, shown in detail in Figure 6, includes an emitter support 75 housed within and adjacent envelope 11. Supported by emitter support 75 is a concaved portion 76 having deposited thereon an oxide cathode material 77. Any known thermionic electron emitting material may be used for cathode material 77, such as thorium oxide, barium oxide or the like, or any of the known dispenser type cathodes may also be used. In a heat transfer, a heater element 78 is provided with a pair of electrical energizing conductors 79 to effect desired heat transfer or heating of the concaved portion 76 and material 77. The operation of the thermionically emissive cathode 77 is similar to the previously described structures except that the photo-emitter 51 has been replaced with the thermionic emitter 77. The wire mesh 57a has likewise been provided with the electrically resistive material 56b, as shown in Figures 5 and 6, which is deposited thereon.

In another embodiment of the beam control generator 19 as shown in Figure 9, the second beam generating

means 19 may include means to modulate another electron beam in a manner that will provide second beam cross-section 86 by flooding and projection through the storage grid 50. Included in the means is a conventional cathode ray gun 80, having a heater 81, a cathode 82, a control grid 83 and an electrostatic lens 84. A low velocity electron beam 85 is generated and projected by gun 80 into the magnetic field of the lens 23, flooding the perforated grid 50 carrying the electrically resistive material 57a (i.e., electrostatically chargeable material 56b may be supported by a wire mesh 57 as shown in Figure 5). Prior to the passage of electrons 85 through the openings of the modulator element 57a, the beam of electrons will have been formed in accordance with the electrical potentials established by first beam cross section 31 on the control surfaces adjacent the openings therein. With the potential upon grid 50 and the field strength of the lens 23, the modulated beam 86 is caused to converge at the midpoint of the deflection system 17 on the axis. From thereon, the previously described operational conditions may be utilized.

The manner in which electrostatic charges are established on the resistive elements 56 of the control surface in each embodiment is similar. It should also be understood that once the conditions for modulating the second beam cross section have been established, the control of the character shaped beams 35, derived from the generator 19, is similar in each embodiment. For additional information regarding the theory involving the establishing of a charge pattern on the surface of resistive materials by means of secondary emission, attention is called to the aforesaid book "Storage Tubes and Their Basic Principles."

Figure 10 exemplifies an additional embodiment wherein the first beam generating means 13 is displaced from the axis of the envelope or tube 11. The generating means 13 may, for example, generate the entire character format desired and be lensed to a cross-over point at, for example, a coplanar set of electrostatic selection plates 90. Plates 90 would be capable of selecting the desired one or more first beam cross sections 31 to be passed through auxiliary aperture 30a in plate 15. The entire parts, namely, first beam generating means 13, plates 90 and auxiliary aperture 30a may be so aligned as to cause the selected first beam cross section to be projected to the midpoint on axis of deflection system 17.

This embodiment would simplify the deflecting of second beam cross section 36 around means 13 as shown in Figure 1, in that cross section 36 would be selected on axis through aperture 30 and thereafter be capable of final position deflection by deflection system 27.

The particular embodiments of the invention illustrated and described herein are illustrative only and the invention includes such other modifications and equivalents as may readily appear to those skilled in the art and in the scope of the appended claims.

I claim:

1. In an evacuated envelope having a longitudinal axis, the combination comprising, an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and substantially adjacent the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having at least one aperture therethrough, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said aperture being adapted to cause a selected beam cross section of said plurality of first beam cross sections to pass therethrough, said second beam generating means being capable of responding to said first beam cross section and being adapted to cause selectively stor-

ing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the first beam cross section through said aperture plate at said aperture for impingement upon said target.

2. In an evacuated envelope having a longitudinal axis, the combination comprising, an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and substantially symmetrically disposed with respect to the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having an aperture therethrough coaxial with the axis, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said aperture being adapted to cause a selected beam cross section of said plurality of first beam cross sections to pass therethrough, said second beam generating means being capable of responding to said first beam cross section and being adapted to selectively cause storing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the first beam cross section through said aperture plate at said aperture for impingement upon said target.

3. In an evacuated envelope having a longitudinal axis, the combination comprising, an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and disposed off the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having two apertures therethrough, one of said apertures being disposed coaxially with and along said axis, and the other of said apertures being disposed off the axis, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said other of said apertures being adapted to cause a selected beam cross section of said plurality of first beam cross sections to pass therethrough, said second beam generating means being capable of responding to said first beam cross section and being adapted to selectively cause storing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the first beam cross section through said aperture plate at said one of said apertures for impingement upon said target.

4. In an evacuated envelope having a longitudinal axis, the combination comprising, an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, said second beam generating means including an electron charge storage mesh and an electron generator positioned adjacent each other with the mesh intermediate the generator and the target, a first beam generating means positioned intermediate the target and the second beam generating means and disposed substantially adjacent the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having at least one aperture therethrough, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said aperture being adapted to cause a selected beam cross section of said plurality of first beam cross sections to pass therethrough, said second beam generating means being capable of responding to said selected

beam cross section of said first beam cross sections and being adapted to cause storing of the first beam cross section on said mesh as an electrostatic charge pattern, said generator being adapted to cause electron emission to project or shadow through said mesh a second beam cross section corresponding in cross section to the electrostatic charge pattern stored on said mesh, said second beam cross section being projected through said aperture for impingement upon said target.

5. The invention in accordance with claim 4 wherein the electron generator includes a light radiation responsive photocathode disposed at the other end of the envelope.

6. The invention in accordance with claim 4 wherein the electron generator includes a thermionically actuable cathodic surface substantially conterminus with the mesh, said cathodic surface being disposed intermediate the mesh and said other end.

7. The invention in accordance with claim 4 wherein the electron generator includes means for generating and projecting a low electron velocity flood beam, said flood beam being adapted to cause electron illumination of said mesh and shadowing said stored second cross section upon said target.

8. In an evacuated envelope having a longitudinal axis, the combination comprising an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and adjacent the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having at least one aperture therethrough, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said aperture being adapted to cause at least a selected beam cross section of said plurality of first beam cross sections to pass therethrough, said second beam generating means being capable of responding to said first beam cross section and being adapted to selectively cause storing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the first beam cross section through said aperture plate at said aperture for impingement upon said target, and a plurality of deflection and convergence means for effecting desired beam cross overs and imaging of the beam cross sections.

9. In an evacuated envelope having a longitudinal axis, the combination comprising an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and substantially symmetrically disposed with respect to the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having at least one aperture therethrough, a first deflection system positioned intermediate said first beam generating means and said aperture plate, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, said first deflection system being capable of deflecting said first cross sections to cause at least a selected beam cross section of said plurality of first beam cross sections to pass through said aperture, said second beam generating means being capable of responding to said selected beam cross section of said first beam cross section and being adapted to cause selectively storing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the selected beam cross section, a second lens system disposed substantially adja-

cent said aperture plate for imaging said selected beam cross section upon said second beam generating means, a third lens system disposed substantially adjacent said second beam generating means for imaging said second beam cross section at said aperture, a second deflection system positioned intermediate the aperture plate and the second generating means for selectively positioning said second beam cross section through said aperture, said second lens system being adapted to cause said second beam cross section to cross over at said first deflection system, said first deflection system being further capable of deflecting said second beam cross section around said first beam generating means, a first lens system positioned adjacent said first beam generating means for effecting desired imaging and cross over of said second beam cross section, and a third deflection system intermediate the first lens system and the target positioned adjacent the cross over effected by the first lens system for deflecting the second beam cross section to impingement at a desired position upon the target.

10. In an evacuated envelope having a longitudinal axis, the combination comprising an electron responsive target at one end thereof, a second beam generating means positioned at the other end of the envelope and substantially symmetrically disposed with respect to the axis, a first beam generating means positioned intermediate the target and the second beam generating means and displaced from the axis, an aperture plate positioned intermediate the first and second beam generating means transversely disposed with respect to the axis and having one aperture therethrough disposed coaxially with the axis and an auxiliary aperture aligned with said first beam generating means, an electrostatic character selection means positioned intermediate said first beam generating means and said aperture plate in alignment with said first means and said auxiliary aperture, said first beam generating means being adapted to cause projection of a plurality of first beam cross sections toward said aperture plate, selection means being capable of deflecting said first cross sections to cause at least a selected beam cross section of said plurality of first beam cross sections to pass through said auxiliary aperture, said second beam generating means being capable of responding to said selected beam cross section of said first beam cross section and being adapted to cause selectively storing of said first beam cross section and projection of a second beam cross section corresponding in cross section configuration to the selected beam cross section, a second lens system disposed substantially adjacent said aperture plate for imaging said selected beam cross section upon said second beam generating means, a third lens system disposed substantially adjacent said second beam generating means for imaging said second beam cross section at said aperture, a second deflection system positioned intermediate the aperture plate and the second generating means for selectively positioning said second beam cross section through said aperture, said second lens system being adapted to cause said second beam cross section to cross over at said first deflection system, and a third deflection system intermediate the second lens system and the target positioned adjacent the cross over effected by the second lens system for deflecting the second beam cross section to impingement at a desired position upon the target.

11. In an evacuated envelope having opposite ends the combination comprising, an electron responsive target at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope and responsive to impingement by said first electron beam cross section for selectively storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second

electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target.

12. In an evacuated envelope having opposite ends the combination comprising, an electron responsive target at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope and responsive to impingement by said first electron beam cross section for selectively storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target, said second beam generating means including an electrostatically controllable electron emissive means, and said electron emissive means being capable of storing said first beam cross section electrostatically.

13. In an evacuated envelope having opposite ends the combination comprising, an electron responsive target having at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope and responsive to impingement by said first electron beam cross section for storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target, said second beam generating means including an electrostatically controllable electron emissive means, and said electron emissive means being capable of projecting said second beam cross section corresponding to electrostatically stored charges created on said emissive means by said first beam cross section.

14. In an evacuated envelope having a longitudinal axis and opposite ends, the combination comprising, an electron responsive target at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope and disposed adjacent said axis for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope substantially symmetrically disposed with respect to said axis and responsive to impingement by

said first electron beam cross section for selectively storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target.

15. In an evacuated envelope having a longitudinal axis and opposite ends the combination comprising, an electron responsive target at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope and substantially symmetrically disposed with respect to and along said axis for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope substantially symmetrically disposed with respect to said axis and responsive to impingement by said first electron beam cross section for selectively storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target.

16. In an evacuated envelope having a longitudinal axis and opposite ends the combination comprising, an electron responsive target at one end thereof, a first electron beam generating means positioned intermediate said target and the other end of said envelope and disposed off said axis for projecting a first electron beam cross section toward said other end, a second electron beam generating means positioned at said other end of said envelope substantially symmetrically disposed with respect to said axis and responsive to impingement by said first electron beam cross section for selectively storing the image of said first beam cross section for a desired period of time and for subsequently projecting a second electron beam cross section having an image corresponding in cross sectional configuration to said first beam cross section for impingement upon said target.

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