

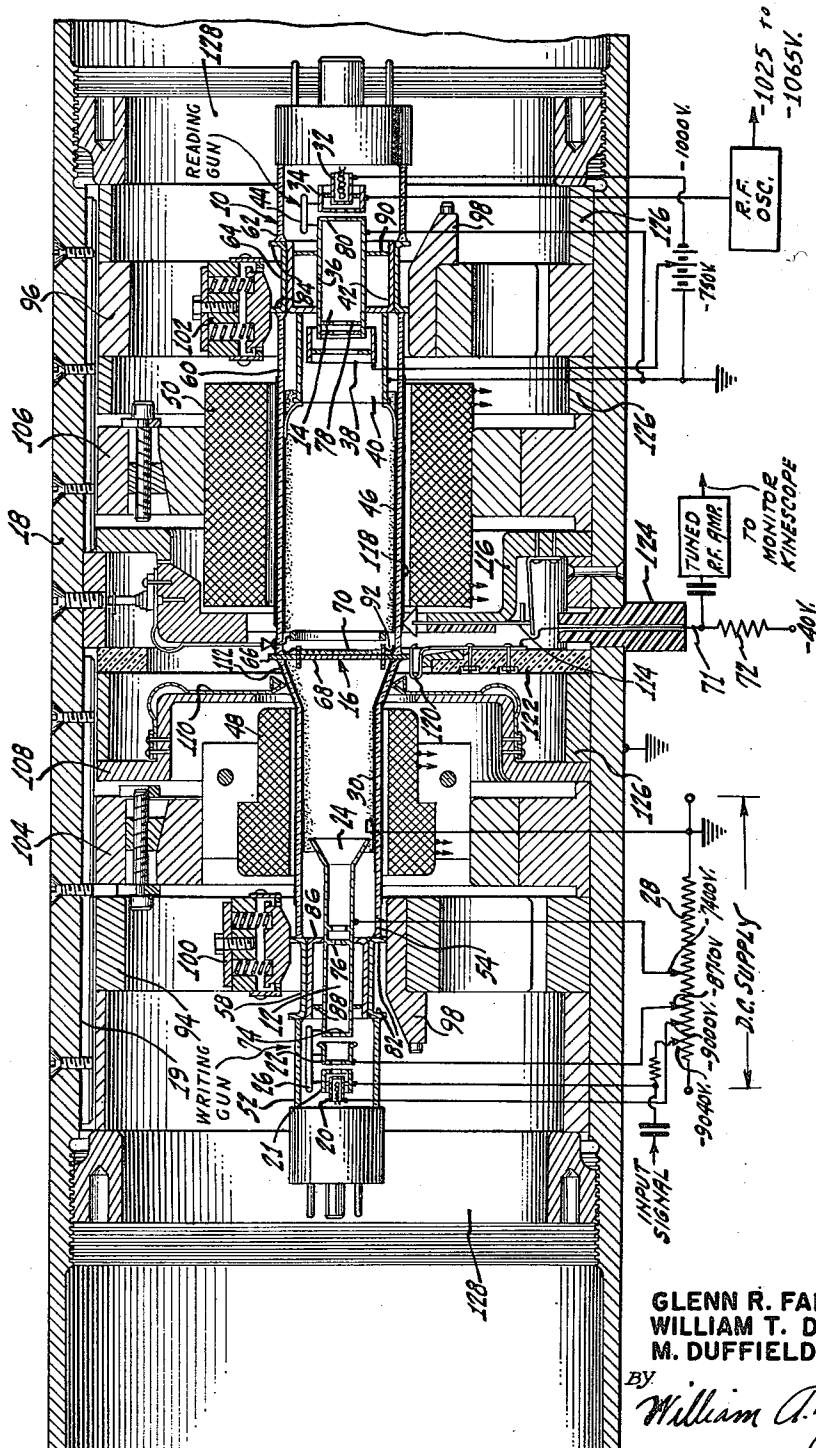
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GRAPHECHON STORAGE TUBE

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This invention is described to an electron discharge device and more particularly to a storage tube for the conversion of one type of electrical signal to another type of electrical signal.

The invention relates specifically to a storage tube having an insulating target upon which a signal charge pattern is established. The charge pattern is used to provide output signals of the tube corresponding to the charge pattern and which is utilized to provide a visual picture of the pattern. One storage tube of this type is that which is fully disclosed in U. S. application Serial Number 29,746 of L. Pensak, filed May 28, 1948, now abandoned. One modification of this type of storage tube utilizes a target electrode having a thin film of insulating material. An electron beam is directed against one side of the target film to provide a charge pattern on the insulating film. A second electron beam is scanned over the charged surface of the target film to discharge the film and provide an output signal from the tube, which may be amplified and fed into a kinescope or viewing tube to provide a visual picture of the charge pattern on the storage tube target.

Such a storage tube consists essentially of a first electron gun, called a writing gun, directed at one side of the target electrode and a second electron gun, known as the reading gun, directed at the opposite side of the target. Both of the guns are substantially on the same axis and the target electrode is positioned intermediate the guns and substantially normal thereto. The target is formed with a supporting mesh screen coated with an electron pervious aluminum film on one surface of the screen and with a thin film of insulating material on the exposed surface of the aluminum film. The writing gun provides a high velocity beam which penetrates through the aluminum and insulating films and discharges the surface of the insulating film to the potential of the aluminum film. The reading gun faces the insulating film surface and provides a relatively low velocity beam which is scanned over the insulating target film to drive the insulating film to an equilibrium potential positive to the potential of the aluminum film. When the writing gun beam is modulated by a signal applied to the gun, there is established on the target surface a charge pattern corresponding to the incoming signals applied to the writing gun. The reading gun then upon scanning the charged target surface charges the surface from point to point to the equilibrium potential and by an amount depending on the charge at that point. This charging of the target surface provides a signal in the target circuit which can be amplified and fed to the kinescope or viewing tube so that the charge pattern on the storage tube is visually represented.

For certain applications, it is a requisite that the charge pattern written on the storage tube target, shall coincide with the pattern read off the target to at least 1/2 of 1% of the geometrical dimensions of the target. Any difference between the pattern read from the tube and the pattern written into the tube produces a position error

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or misregistration. Such a tube has use in applications such as radar, as part surveillance radar, and target designator equipment, in which incoming electrical signals are stored on the tube target and then reproduced visually to provide a picture of the incoming signals. In such applications, good registration between the incoming pattern and the reproduced pattern is important, if not required.

However, in tubes of this type there are many reasons why the written pattern does not coincide with the read pattern. For example, if the electron guns are not aligned normal to the target surface, there is produced a keystoning of the raster. Furthermore, if the electron beams do not pass through their respective deflection yokes and perpendicular to the flux lines of the magnetic deflection fields, spiralling motion of the beam occurs and displaces the scanned raster. It is thus very important to control the errors caused by misalignment of the tube parts to minimize misregistration.

It is thus an object of the invention to provide a storage tube in which misregistration of the input and output signal rasters is at a minimum.

It is another object of the invention to provide a storage tube in which the tube parts are closely controlled to minimize misregistration of input and output signal rasters.

It is another object of the invention to provide a storage tube in which keystoneing of the input and output rasters on the target electrode is at a minimum.

It is another object of the invention to provide a storage tube in which the spiralling motion of the beam which results in misregistration of the input and output scanning rasters is at a minimum.

The invention includes the use of metallic cylinders as part of the tube envelope of a storage tube to accurately position the electron guns within the envelope. Furthermore, the envelope is constructed to accurate dimensions on the outside, as well as on the inside, so that the axis of the deflecting coils for each gun can be made to substantially coincide with the corresponding electron beam axis. The alignment of gun parts is such that the beams from the two electron guns within the tube strike the target electrode very close to the same spot and close to the center of the target. Furthermore, the electron beams will strike the target at very nearly normal incidence.

The figure of the drawing is a sectional view of a storage tube incorporating the invention and also showing an accurately aligned mounting and shielding structure for the tube.

The figure shows an electron discharge device consisting principally of a storage tube having a tubular envelope portion 10. At one end of the envelope 10 there is mounted an electron gun 12 to be described as the "writing gun" of the tube. At the opposite end of the envelope there is mounted an electron gun 14 to be known as the "reading gun" of the tube. Intermediate the electron guns 12 and 14 there is positioned a target electrode 16, positioned transversely to the axes of the electron guns 12 and 14. The tube envelope 10 is supported within a tubular metal alignment cylinder 18, which is used to accurately position the electron tube 10 relative to its deflection yokes, to be described below.

The storage tube 10 is one known as a graphechon, a type which has been fully described in the copending application of Pensak cited above. The writing gun 12 consists principally of a cathode electrode 20 mounted within a cup like control grid electrode 21 and coaxially aligned with a first accelerating electrode 22 and the second accelerating electrode 24. Electrodes 21, 22 and 24 are mounted successively along a common axis by any well-known means such as glass support rods 26 sealed

to metal studs projecting from each electrode, as shown. Cathode 20 consists primarily of a closed cylinder with the closed end facing target 16 and being coated with an electron emitting material. The electrodes 21, 22 and 24 have apertures therethrough on the common axis of the gun to provide a passage for electrons emitted from the cathode coating. During tube operation, the cathode emitting surface is heated to provide a copious emission of electrons which are drawn by the positive field of the accelerating electrode 22 away from the cathode surface. These electrons pass through the apertures of electrodes 21, 22 and 24, while the fields between the electrodes form the electrons into a beam, which is brought to a minimum cross sectional area or spot on the surface of target 16. The final focusing of electron beam of gun 12 on target 16 is provided by the field established between the tubular electrode 24 and a conductive wall coating 30 applied to the inner surface of the tube envelope between electrode 12 and the target 16. The parts of the electron gun 12 are conventional and the electron optics of such a gun and its operation are well-known and are not further described herewith as they do not constitute a part of this invention.

As shown in the figure, the several electrodes of gun 12 are connected to a voltage divider 28 for providing operating voltages to the respective electrodes of the gun. A set of voltages is indicated in the drawing. These voltages represent values which have been used in the successful operation of a tube of the type described, but are not meant to be limiting.

Electron gun 14 includes a cathode electrode 32 and a control grid electrode 34 similar respectively to electrodes 20 and 21 of gun 12. Mounted successively along the common gun between the control grid 34 and the target electrode are an accelerating electrode 36, a focusing electrode 38 and a second accelerating electrode 40. Accelerating electrodes 36 and 40 are connected directly to each other through a common supporting metal cup or gun holder 42. The cathode-control grid assembly of gun 14 is rigidly mounted to the accelerating electrode 36 by means of glass support rods 44, as shown. A conductive coating 46 extends over the inner surface of the envelope 10 from the accelerating electrode 40 to a point adjacent the screen electrode 16.

As indicated in the figure, the several parts of gun 14 are also connected to external sources of potential for providing operating potentials to the gun electrodes. During tube operation, the gun 14 forms an electron beam with the electron emission from the cathode 32, which is directed onto the target 16 and focused to a fine spot at the point it strikes the target.

Both of the beams of guns 12 and 14 are respectively scanned over the surface of target 16 by deflecting yokes 48 and 50. These deflection yokes are of conventional design, in that they consist of two pairs of deflecting coils mounted in the yoke with the coils of each pair on opposite sides of the tube envelope 10. The coils of each pair are connected in series to a source of saw tooth currents for providing a magnetic field in the path of the respective electron beam. The fields of each yoke 48 or 50 provides line and frame scansion of the respective electron beams over the surface of target 16. Such deflection coils and their mode of operation is well-known in the prior art and since they do not constitute a part of this invention, they are not described in further detail.

The envelope 10 of the tube is formed from several tubular sections. The portion, for example, enclosing the gun 12 is formed from a pair of glass tubular members 52 and 54 which are connected together through a metal alignment cylinder 58 sealed thereto. In a similar manner the portion of envelope 10 enclosing gun 14 is formed from a pair of tubular glass members 60 and 62 which are joined together through an intermediate alignment cylinder 64.

Target electrode 16 is mounted on a flat ring 66, to

which the tubular portions housing the respective guns 12 and 14 are both sealed to close the envelope. Target 16 consists primarily of a thin electron pervious aluminum film 68 coated on its surface facing gun 14 with a thin film 70 of insulating material such as magnesium fluoride, for example.

The operation of the tube is substantially that in which input signals are applied to the control grid 21 of gun 12 to modulate the electron beam of the gun while it is scanned over the surface of target 16. The aluminum target film 68 is maintained in the order of a -40 volts negative to ground. The electron beam of gun 14 is unmodulated and is scanned over the surface of the magnesium fluoride film 70 in a substantially rectangular raster formed by a normal frame and line television scansion. The beam of electron gun 14 will strike the dielectric target film 70 at energies in the order of 1,000 volts. These energies are between the first and second crossover potentials for the magnesium fluoride screen so that the very point on target film 70 where the beam of gun 14 strikes there is initiated a secondary electron emission from the film which is greater than unity. The secondary electrons are drawn away and collected by the positive collecting coating 46. The loss of secondary electrons from film 70 raises the potential of the scanned target surface positively to a point close to the potential of coating 46 which is held at ground potential. This potential is an equilibrium potential and is that state at which the secondary electrons leaving the target surface are equal in number to the primary electrons of the beam of gun 14 striking the surface.

The modulated electron beam of gun 12 strikes the target with energies in the order of 9,000 volts which is sufficient to cause the electrons of the beam of gun 12 to penetrate through the target films 68 and 70 as described in the above cited copending application of L. Pensak. The magnesium fluoride film 70 is a material which is normally insulating, but which becomes conducting when struck by high velocity electrons at those points where the electrons penetrate substantially through the magnesium fluoride film. Thus, during tube operation, the modulated high velocity beam of gun 12 provides conductivity between the aluminum film 68 at a -40 volts and the exposed scanned surface of the magnesium fluoride film 70 at equilibrium potential close to that of ground potential of the collecting coating 46. The conductivity induced at any one point through the magnesium fluoride film 70 is proportional to the strength of the beam of gun 12 inducing the conductivity. Thus, the beam of gun 12 will discharge the positive surface of film 70 toward the negative potential of the aluminum film 68 and in proportion to the strength of the beam inducing the conductivity at each point. Thus the scanning of the high velocity modulated beam of gun 12 over the surface of target 16 establishes on the exposed surface of film 70 a negative charge distribution or pattern corresponding to the sequential input signals applied to the control grid 21 of gun 12.

The beam of gun 14, on scanning over the charged surface of the film 70, will drive the areas discharged by the beam of gun 12 back toward equilibrium potential. When the beam of gun 14 strikes a negative area of film 70 the collection of the secondary emission from this point is instantaneously greater than from a positive area. This instantaneous charging of any one point of film 70 results in a corresponding pulse in the circuit 71 of plate 68 causing a change in the voltage across the high resistance 72 of the plate circuit. This voltage is detected and amplified in well-known manner to provide an output signal from the tube, which is fed to a monitor kinescope. Thus, as the beam of gun 14 scans the charged pattern established by the beam of gun 12 on film 70, there is provided a succession of signal pulses which vary in amplitude as determined by the potential of the areas charged.

If the beam of gun 14 is scanned over the charged sur-

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face of target film 70 in a normal television scan, the output is a television signal which will produce on the monitor kinescope a scanning visual representation of the charge pattern written on film 70 of the storage tube. By controlling the beam current of gun 14, it is possible to control the storage time of the charge pattern on film 70. Thus, if the beam current of gun 14 is sufficiently small, the charge pattern on target film 70 may remain for a determinable length of time before it is entirely erased. In this manner then, the scanning rate of the beam of gun 12 may be different from that of the beam of gun 14. Furthermore, the pattern or scanning raster established on film 70 may be written down differently than the reading raster of gun 14. For example, the writing gun 12 may be operated to provide a radar raster of the charge pattern, which is laid down on the target 70 in several seconds, while simultaneously the pattern may be continually read off by the reading gun 14 with a television scan frame time of $\frac{1}{30}$ th of a second.

As pointed out above, such a tube has utility in radar applications in which incoming radar signals can be reproduced visually. However, in certain of these applications, it is desirable that the reproduced pattern or picture is an accurate reproduction of the radar pattern or picture put down on the target. That is, it is desirable that the charge pattern or raster written onto target 16 coincides with the raster of the reading gun 14, so that there will be little or no misregistration between the reading and writing raster patterns. An accurate scan conversion is provided with a minimum of misregistration and thus with a minimum of positional error. To provide a minimum of misregistration of reading and writing rasters, it is essential that the two electron beams, respectively of guns 12 and 14, strike the target at as near normal incidence as possible; that the two electron beams strike the target very close to each other and close to the center of the target when they are undeflected; and that the axes of deflecting coils, 48 and 50 respectively, can be made to coincide as closely as possible with the corresponding electron beam axis.

In accordance with the invention not only are the two parts of the storage tube 10 constructed and mounted to provide these results, but there is also provided a tube mounting means wherein the tube and the deflecting yokes are accurately aligned to provide the desired results. To achieve these results and in accordance with the invention, both of the electron guns 12 and 14 have their respective parts accurately aligned before rigidly mounting them together by means of the glass support rods 26 and 44. However, the final electron beam paths are mainly determined respectively by the cylindrical electrode 24 of gun 12, and cylindrical electrodes 36 and 40 of gun 14. The path of the electron beam through electrode 24 of gun 12 is determined by apertured diaphragms or plates 74 and 76, for example. These diaphragms are formed with their center apertures on the axis of the tubular electrode 24. In a similar manner, the tubular electrode 36 of gun 14 is provided with apertured diaphragms 78 and 80 whose apertures are accurately aligned on the axis of the cylindrical electrode 36.

In order that the electron beams from both guns strike the center of target 70 at the same spot and substantially normal thereto, it is necessary that the electron guns 12 and 14 be accurately aligned with each other on a common axis passing through target 16 and substantially normal thereto. For aligning the electron guns with each other and with the target, the envelope 10 is formed with the alignment cylinders 58 and 64, mentioned above. In assembling the envelope, the tubular glass portions 52 and 54 are first sealed to the alignment cylinder 58 and the glass tubular envelope portions 60 and 62 are respectively sealed to the cylindrical alignment element 64. The inside surfaces of both alignment cylinders 58 and 64 are finished off by lapping or having to a tolerance of plus or minus $\frac{1}{4}$ mil for the inside diameters of the cylinders.

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This provides an accurately formed cylindrical inner surface for both members 58 and 64. A mandrel is used to seal the glass tubular portion 54 and 60 to the target support ring 66. The mandrel slips through the envelope portions of cylinders 58 and 64 and has accurately formed seats which form a closely fitting contact respectively with the inner cylindrical surfaces of alignment cylinder 58 and 64. When the alignment cylinders 58 and 64 are tightly seated on the mandrel, they will be accurately positioned on a common axis. The target ring 66 is also held by the mandrel perpendicularly to this axis. With these parts held accurately in their aligned positions by the mandrel, both of the glass tubes 54 and 60 are sealed to the target support ring 66. After sealing and cooling the mandrel is removed from the open end of the tube.

Both the alignment cylinders 58 and 64 are flanged at their ends as shown at 82 and 84 and these flanges project beyond the tubular surfaces of the glass envelope portions respectively sealed thereto. These flanges 82 and 84 are finished off accurately to provide accurate surfaces which have the same axis as the accurately formed inner surfaces of cylinders 58 and 64, respectively. This then provides on the outside of the tube envelope, an accurate reference with respect to the common axis of the alignment cylinders 58 and 64.

To accurately align the electron gun 12 with the common axis of alignment cylinders 58 and 64, the tubular anode electrode 24 has brazed thereto an alignment cup 86, as shown in figure. The open end of the cup is supported from the tubular electrode 24 by a plate structure 38 brazed thereto. The outside cylindrical surface of the alignment cup 86 is finished off accurately after the brazing operation by grinding the surface to a tolerance of plus or minus $\frac{1}{4}$ mil for the outside diameter of cup 86. This provides an accurately formed cylindrical surface having an axis coincident with or common to the electrode cylinder 24.

In a similar manner electron gun 14 is accurately aligned and mounted with its axis coincident to the axis of the cylindrical alignment cup 42. First the tubular accelerating electrode 36 is brazed into the aperture through the bottom of cup 42, as shown in the figure. Electrode 36 is fixed in the open end of cup 42 by the plate 90 brazed thereto. Also the cylindrical accelerating electrode 40 is accurately mounted by brazing to cup 42 with its axis coincident with the axis of electrode 36. After these brazing operations, the outer cylindrical surface of cup 42 is ground off accurately to provide an accurately formed cylindrical outer surface having an axis coincident to that of the tubular electrode 36.

The target 16 is mounted prior to the insertion of the guns by welding supporting clips 92 to the target support ring 66. The welding process is performed while the target is held with the surface of the target film 70 substantially normal to the common axis of the alignment cylinders 58 and 64. The tilt of the target to this common axis is thus held to a minimum during manufacture.

The tube assembly is completed by slipping the alignment cups 86 and 42 of each gun respectively into the corresponding alignment cylinders 58 and 64. The accurately finished outer surfaces of alignment cups 86 and 42 provide a close fit inside their corresponding alignment cylinders. The fit of the alignment cups 86 and 42 is the controlling factor in determining the position of the axis of each beam with respect to the common axes of the alignment cylinders 58 and 42.

After the guns have been mounted within their corresponding alignment cylinders, the open ends of the tube envelope 10 are closed off by sealing and the tube is evacuated and processed in the normal manner for such tubes.

As described above, to provide accurate registration between the reading and writing scans of the target 16, the electron guns themselves must not only be accurately aligned on a common axis normal to the target

but it is a requisite that the deflecting fields produced by the coils of yokes 48 and 50 should be so positioned that the flux lines of each deflecting field shall be perpendicular to the corresponding electron beam path. To provide this condition, however, in accordance with the invention it is a requisite that the deflecting yokes 48 and 50 be accurately mounted relative to the tube 10 so that the yokes are on a common axis which is coincident to the common axis of the alignment cylinders 58 and 64 as well as that of the electron guns 12 and 14. Furthermore, it is necessary to provide not only an accurately made but an unyielding mounting means for rigidly holding the electron tube envelope 10 in its accurately aligned position relative to the yokes 48 and 50. Furthermore, to prevent the influences of spurious fields external to the electron tube, which under some circumstances would effect the beam path relative to the deflecting yokes 48 and 50, it has been found necessary to provide a shielding member 13 for the discharge device assembly. Member 13 is formed as a cylinder of a high permeability, low reluctance, iron-nickel alloy. Such an iron alloy may consist of 80% nickel, one form of which is commercially known as $m\mu$ metal.

The $m\mu$ metal cylinder 18 also provides a supporting mount for both the storage tube envelope 10 and the deflecting yokes 48 and 50. The support cylinder 18 has an accurately formed inner surface 19 into which are closely fitted mounting cylinders for supporting the various parts of the assembly. For example, the electron tube envelope 10 is supported from cylindrical rings 94 and 96, each of which is provided with supporting blocks 98 upon which rest the flanges 82 and 84 of the respective alignment cylinders 58 and 64. Supporting blocks 98 are accurately positioned within the support rings 94 and 96, respectively, so that in accordance with the invention the common axis of alignment cylinders 58 and 64 is coincident to the axis of the supporting cylinder 18. Alignment cylinders 58 and 64 are held tightly in contact with mounting blocks 98 by spring pressed blocks 100 and 102 respectively supported in rings 94 and 96. Such a tension support permits the insertion of the tube 10 into the supporting cylinder 18 in such a manner that the flanges 82 and 84 will ride onto the supporting blocks 98 and under the spring press blocks 100 and 102.

In a similar manner the yokes 48 and 50 respectively are locked into supporting rings 104 and 106 respectively. The supporting means are not part of this invention and are not further described in detail. However, they are of a nature to accurately align the cylindrically shaped yokes 48 and 50 with their axes coincident with the axis of the supporting cylinder 18. Yoke 48 is formed so that when the tube envelope is inserted into cylinder 18 from the right hand opening the flanges 82 of the tube envelope will pass through yoke 48 and onto their respective mounting blocks 98. When the tube envelope 10 is inserted in this manner, then, the accurately positioned mounting blocks 98 will hold the tube envelope 10 with the common axis of the alignment cylinders 58 and 64 coincident with the supporting cylinder axis 13 as described and thus also coincident with the common axis of the yokes 48 and 50 in accordance with the invention.

Rings are fitted into support cylinder 18 also for mounting certain lead structures in contact with the tube envelope. For example, ring 108 is formed as a cup shaped element having fixed thereto a spring pressed contact 110 which is pressed onto an external coating 112 extending from the target support ring 66 over the tubular envelope portion 54 and beyond the ends of yoke 48. In a similar manner, there is provided a spring contact 114 mounted on a cup-like annular element 116 which makes contact with a similar coating 118 over the outer surface of tubular envelope portion 60 and in the region of the deflecting yoke 50. Both of the spring contacts 110 and 114 tie the respective tube coatings 112 and 118 to ground, by contacting the coatings respectively to the

cylindrical support cylinder 18, which is grounded as shown.

The target electrode 16 is connected to external circuit 71 by a spring contact 120 mounted on an insulator ring 122 and spring pressed against the exposed portion of the target support ring 66, as shown in the figure. Contact 120 is connected exteriorly of support cylinder 18 by a lead passing through an insulating sleeve 124 fixed in the wall of support cylinder 18. The several supporting cylinders mentioned above are spaced from each other by cylindrical spacing element 126, for example. All of the various supporting and spacing rings are nested in contact with each other within the support cylinder 18 and are clamped into position by screw threaded locking cylinders 128, which are threaded into each end of the cylinder 18.

The support structure described and contained within cylinder 18 provides a means for quickly and accurately mounting the tube 10 into its operative position, in which it is accurately aligned with the yoke structures 48 and 50, as described. The tube can be manually inserted and withdrawn rapidly due to the spring contacts of the supporting means and the several lead means. The arrangement provides the almost instantaneous replacement of one tube by another without any loss in time for realignment of the tube with its operating parts.

The invention described above thus provides a minimum of misregistration between the written raster of the writing gun 12 and the reading raster of the reading gun 14. The mounting arrangement described provides optimum alignment of the electron beams of the tube and results in the electron beams being aligned perpendicularly to the flux. This eliminates spiralling motion of the beam due to misalignment and thus minimizes misregistration of the scanning rasters. The described arrangement also reduces to a minimum keystoning of the raster of each gun due to misalignment of the electron beam with the normal to the target surface. Also misregistration of reading and writing rasters is reduced to a minimum by the precision alignment of the electron beams with each other and with the target.

The above described tube operation is that in which reading and writing are done sequentially. However, if reading and writing are to be performed simultaneously, the reading beam can be modulated at a radio frequency and the signal amplifier can be tuned to the same frequency.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An electron discharge device comprising, an envelope, a target electrode having a plane surface within said envelope, a first electron gun within said envelope on one side of said target and a second electron gun within said envelope on the other side of said target, said electron guns each including a plurality of annular electrodes, means mounting said annular electrodes of each gun successively and coaxially on an axis, said envelope including a coaxial tubular alignment portion on each side of said target, a tubular alignment element fixed to each gun and coaxial thereto, one tubular alignment element coaxially fitted within each of said tubular envelope portions, and means mounting said target normal to the common axis of said tubular envelope portions at the center of said target surface.

2. An electron discharge device comprising, an envelope, a target electrode having a plane surface within said envelope, a first electron gun within said envelope on one side of said target and a second electron gun within said envelope on the other side of said target, said electron guns each including a plurality of annular electrodes arranged successively and coaxially on an axis, said envelope including coaxially aligned cylindrical metal por-

tions sealed therein one on each side of said target with the common axis of said cylindrical envelope portions normal to said target at the center of said target surface, an alignment cylindrical element coaxially fixed to each gun, one cylindrical element coaxially fixed within each of said aligned cylindrical envelope portions.

3. An electron discharge device comprising, an envelope, a target electrode having a plane surface within said envelope, an electron gun within said envelope on one side of said target, said electron gun including a plurality of annular electrodes, means mounting said electrons of each gun successively and coaxially on an axis, said envelope including a cylindrical metal portion sealed therein on said one side of said target electrode with the axis of said cylindrical envelope portion normal to said target at the center of said target surface, a cylindrical alignment element coaxially fixed to said gun, said cylindrical alignment element fitted within said cylindrical envelope portion with said gun axis coincident to the axis of said tubular envelope portion.

4. An electron discharge device comprising, an envelope, a target electrode having a plane surface within said envelope, a first electron gun within said envelope on one side of said target and a second electron gun within said envelope on the other side of said target, said electron guns each including a plurality of annular electrodes arranged successively and coaxially on an axis, said envelope including a pair of coaxially aligned tubular portions sealed therein one on each side of said target with the common axis of said tubular envelope portions normal to said target at the center of said target surface, a tubular alignment element coaxially fitted to each gun, one alignment element coaxially fixed within each of said aligned tubular envelope portions, a pair of deflecting yokes, means mounting said yokes spaced apart on a second common axis, said mounting means supporting said envelope with said target between said spaced yokes, said mounting means including portions thereof in con-

tact with said aligned tubular envelope portions for maintaining said tubular envelope portions coaxial with said second common axis.

5. An electron discharge device comprising, an envelope, a target electrode having a plane surface within said envelope, a first electron gun within said envelope on one side of said target and a second electron gun within said envelope on the other side of said target, said electron guns each including a plurality of annular electrodes arranged successively and coaxially on an axis, said envelope including a pair of coaxially aligned cylindrical portions sealed therein one on each side of said target with the common axis of said cylindrical envelope portions normal to said target at the center of said target surface, a cylindrical alignment element coaxially fixed to each gun, one cylindrical alignment element closely fitted within each of said aligned cylindrical envelope portions to align said guns on said common axis, a pair of annular deflecting yokes, means mounting said yokes spaced apart on a second common axis, mounting means supporting said envelope within said annular yokes with said target between said spaced yokes, said mounting means having portions thereof in contact with said aligned cylindrical envelope portions for maintaining said cylindrical envelope portions coaxial with said second common axis.

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