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Orthuber et al.

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[45] **June 26, 1973**

[54] **ELECTRON TUBE VOLTAGE CONTROL DEVICE**

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[73] Assignee: **International Telephone and Telegraph Corporation**, New York, N.Y.

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[21] Appl. No.: **138,088**

[52] **U.S. Cl.** ..... **315/12**, 315/31 R, 313/70 R, 315/13 R

[51] **Int. Cl.** **H01j 29/41**

[58] **Field of Search** ..... 315/12, 31 R, 13 R; 313/70 R

[56] **References Cited**

UNITED STATES PATENTS

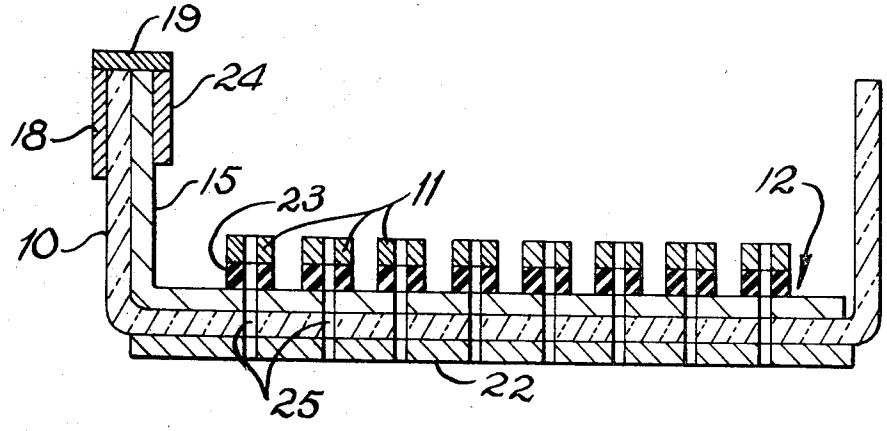
2,967,972	1/1961	De Haan	315/13
2,937,315	5/1960	Aiken	315/27
3,088,047	4/1963	Groendijk	315/8.5
3,502,927	3/1970	Suzuki et al.	313/78
3,541,254	11/1970	Orthuber	178/5.4 R X

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[57] **ABSTRACT**

A sequential device for two perpendicular sets of conductive strips employed with a channel-type electron multiplier to allow only one hole through the multiplier to accept and emit electrons at a time. The device may utilize an electron gun for each set of strips to provide an electron beam to scan each set simply by use of a sawtooth deflection voltage. An effective raster-type scan of the multiplier may thus be accomplished. The device is an improvement because arrangements requiring counters or staircase generators are much more expensive.

11 Claims, 13 Drawing Figures



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SHEET 1 OF 3

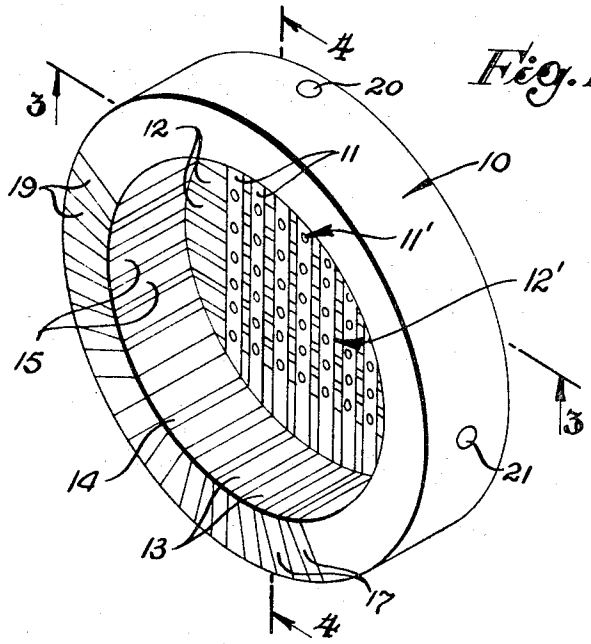


Fig. 1.

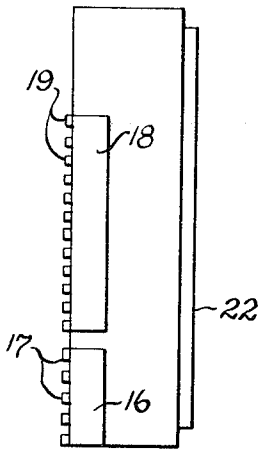


Fig. 2.

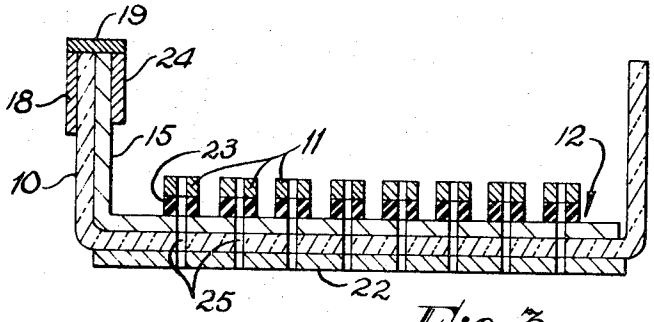


Fig. 3.

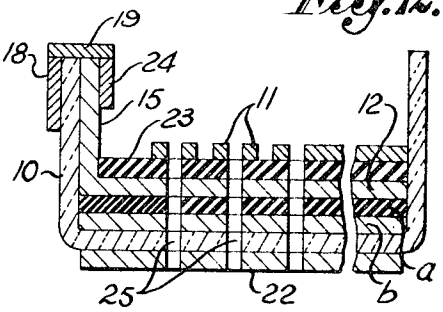


Fig. 12.

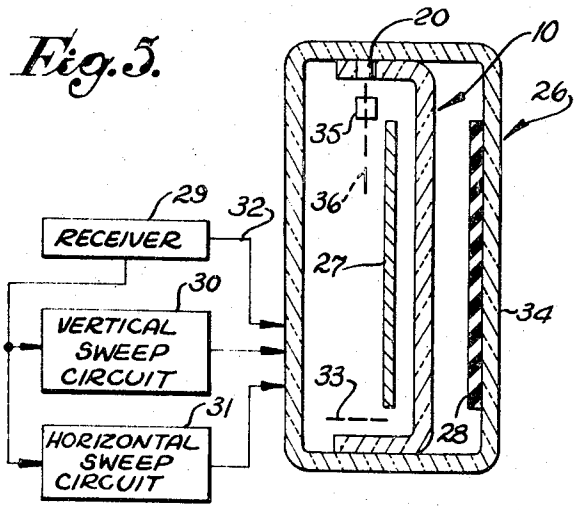


Fig. 5.

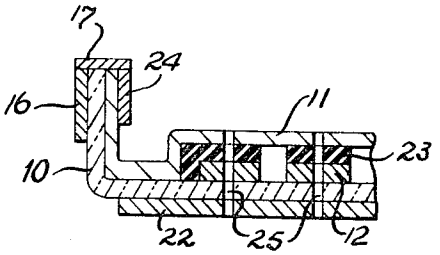


Fig. 4.

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Fig. 6.

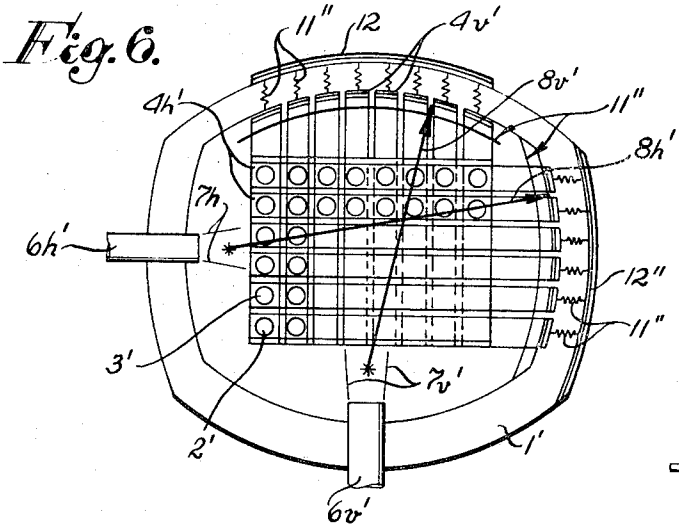


Fig. 10.

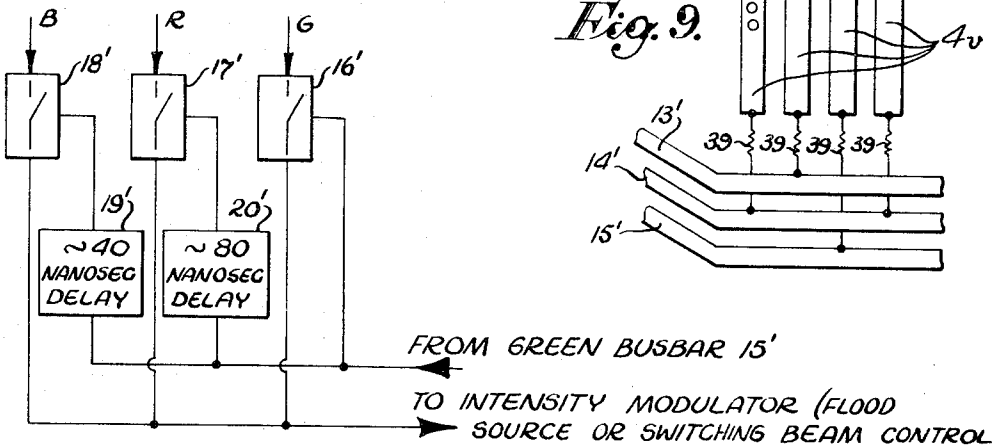


Fig. 9.

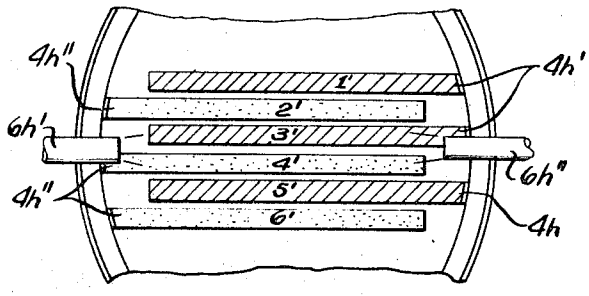


Fig. 11.

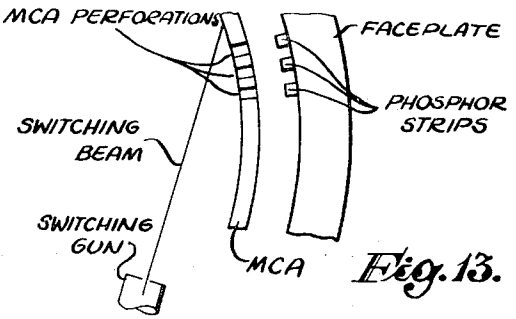
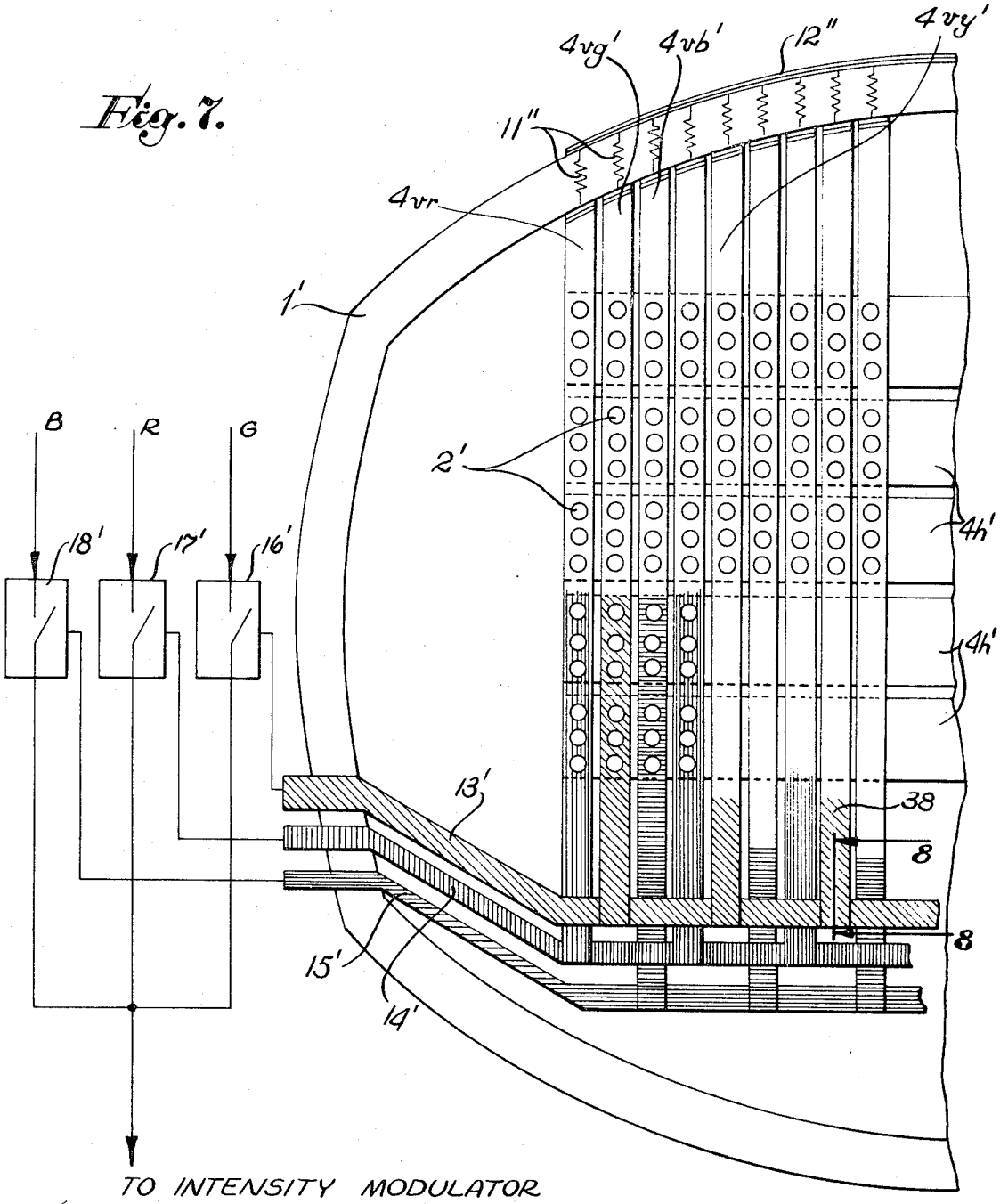


Fig. 13.

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Fig. 7.



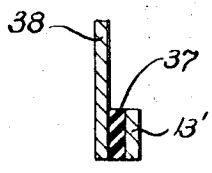


Fig. 8.

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ELECTRON TUBE VOLTAGE CONTROL DEVICE

BACKGROUND OF THE INVENTION

This invention relates to electronic apparatus, and more particularly, to an arrangement for controlling the potential of a conductor inside a vacuum tube without supplying the potential directly to the conductor through the tube wall.

The present invention will have applications other than those disclosed herein and should not be limited thereto for this reason. However, the invention will be found to be especially useful when used in connection with a television (TV) picture tube or the like as disclosed in my copending application, Ser. No. 753,448, filed Aug. 19, 1968, for TELEVISION DISPLAY DEVICE WHICH UTILIZES ELECTRON MULTIPLIERS, now U. S. Pat. No. 3,541,254, issued Nov. 17, 1970.

In the past, solid state TV displays have required the use of counters and/or staircase generators for matrix switching to, in effect, produce a raster scan of all of the individual spots of light which make up a complete TV picture. The use of counters or staircase generators for this purpose is very expensive because all of this gear must take into account each one of the multitude of spots which make up the picture.

A low cost switching system has not been available to the present time either for the type of kinescope disclosed in said patent or for solid state displays.

In said patent, a tricolor kinescope is described which eliminates the three long deflected electron beams which, in the familiar shawdowmask kinescope, simultaneously excite three phosphor dots emitting in the three principal colors red, green and blue.

Instead, it is disclosed in said patent to trigger in time sequence the emission of secondary electrons from adjacent holes of a multichannel array (MCA) by means of an "X–Y" gating matrix and to accelerate these secondary electrons onto a closely spaced tricolor phosphor registered with the secondary emitting holes and arranged parallel with one set of strips of the gating matrix.

This arrangement is described in detail in said patent. The present invention is concerned with an inexpensive means of providing proper gating pulses to the horizontal and vertical strips of the gating matrix essential to the performance of a TV-type scan by the MCA of the prior application.

In the said patent, it was disclosed that gating pulses should be produced and applied to the horizontal and vertical gating strips by the use of a clock pulse generator. When an external pulse generator is used, this can give rise to a very complicated, and thereby sometimes unreliable, feedthrough array through the tube wall to permit independent connection of the approximately 2,000 gating strips evaporated onto the MCA.

The cost involved in this approach can be substantial at least for home TV applications. The same would be true if, to avoid the serious feedthrough problem, the clock pulse generator is produced by integrated circuit techniques inside the tube, e.g. around the rim of the MCA support plate.

SUMMARY OF THE INVENTION

In accordance with the device of the present invention, an electron gun switch or the like is employed.

To overcome the problems described hereinbefore in a relatively inexpensive fashion, time-sequential gating pulses are produced in a manner such that they travel horizontally and vertically across the gating matrix by means of two electron beams, one for each scan direction, oriented perpendicularly to each other when undeflected and traveling approximately parallel to the plane of the perforated part of the MCA.

Preferentially, the said beams have a roughly rectangular cross-section, being very thin in the direction of the deflection and wide perpendicular to this direction, i.e. ribbon beams.

Each beam is deflected back and forth in one direction only.

The above-described and other advantages of the present invention will be better understood from the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings which are to be regarded as merely illustrative:

FIG. 1 is a perspective view of a channel-type electron multiplier constructed in accordance with the present invention;

FIG. 2 is a side elevational view thereof;

FIG. 3 is a horizontal sectional view therethrough taken on the line 3—3 shown in FIG. 1;

FIG. 4 is a vertical sectional view therethrough taken on the line 4—4 shown in FIG. 1;

FIGS. 5 and 6 are a vertical sectional and transverse sectional views through a TV picture tube constructed in accordance with the invention;

FIG. 7 is a diagrammatic view of a tricolor kinescope constructed in accordance with the invention;

FIG. 8 is a sectional view of a portion of the embodiment taken on the line 8—8 shown in FIG. 7;

FIG. 9 is a diagrammatic view of another embodiment of the present invention;

FIG. 10 is a block diagram alternative to that shown in FIG. 7;

FIG. 11 is a diagrammatic view of another alternative embodiment of the invention;

FIG. 12 is an alternative arrangement for that of FIG. 3; and

FIG. 13 is another form of the device using a curved electron multiplier plate.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a pan-shaped glass or ceramic plate 10 is shown having perpendicular conductive sets 11′ and 12′ of strips 11 and 12 thereon, respectively, strips 11 having extensions 13 bonded to an inner cylindrical wall 14 of plate 10, and strips 12 having extensions 15 bonded to wall 14.

As shown in FIGS. 1, 2, 3 and 4, extensions 13 are connected to a conductor 16 by resistive coatings 17, and extensions 15 are connected to a conductor 18 by resistive coatings 19.

Electron guns 20 and 21 are fixed 90 degrees apart through wall 14 of plate 10.

As shown in FIGS. 2, 3 and 4 a conductive layer 22 is evaporated onto the output face of plate 10.

A layer of insulation extends between strips 11 and 12 as indicated at 23 in FIGS. 3 and 4. Insulation 23

need not be in strip form, however, it must not cover secondary emissive surfaces **24** of all the extensions.

The material of plate **10** is treated to make the surfaces of the holes **25** therethrough semiconductive and secondary emissive. Note that strips **11** and **12**, insulation **23**, and layer **22** all have holes that lie in registration with holes **25**. Electron multiplication is achieved in the manner set forth in said patent.

In FIG. **5**, plate **10** is again shown. All the structure shown in FIGS. **1–5** is also employed in FIG. **5**, but not shown for clarity.

An evacuated envelope **26** is shown in FIG. **5** surrounding plate **10**, a flood electron source **27**, and a phosphor screen **28**.

A TV receiver **29** has vertical and horizontal sweep circuits **30** and **31**, respectively. Receiver **29** produces an intensity control signal on a lead **32** which may be connected to control the current of source **27** or to the current control electrodes of either one or both of guns **20** and **21**. The output of circuit **30** is connected to one pair of the deflection plates of one gun. The output of circuit **31** is connected to one pair of the deflection plates of the other gun.

Note in FIG. **5** that each gun is associated with a collector electrode **33** that accurately spans all of the strips in the set corresponding thereto.

Conductors **16** and **18** are negatively biased with respect to flood source potential.

Source **27** (panel-shaped) is arranged between the bottom of the microchannel plate (MCP) **10** and the switching beams **36** of guns **20** and **21**.

Alternating red-green-blue phosphor strips may be used in the case of a tricolor device. These phosphor strips, or in the case of a monochrome tube a contiguous P4 phosphor are deposited on faceplate **34** of envelope **26**.

On the upper side of FIG. **5**, electron gun **20** is shown together with a pair of electrostatic deflection plates **35** to sweep the preferentially ribbon-shaped electron beam **36** emerging from gun **20** in a plane perpendicular to the plane of the drawing.

The electron beam **36** impinging on any one extension **13** of the gating strips **11** with an impact energy above first secondary emission cross-over will then charge positive the gating strip provided the emitted secondaries are drawn off by the slotted collector-electrode **33**. The extensions of the gating strips **11** and **12** are provided at **24** with a coating which enhances secondary emission yield, such as Ag-Mg or Cu-Be as used in commercial electron multipliers. This will reduce the current requirements for the switching beam. The coatings **17** and **19** to the bias-electrodes **16** and **18**, respectively, serve the purpose of bleeding off rapidly positive charges generated during beam impact as the beam progresses to the next adjacent gating strip.

For further clarification, a combination of a monochrome MCA with the horizontal and vertical switching guns is shown in FIG. **6**.

FIG. **6** shows both sets of gating strips, the vertical $4v'$ and the horizontal $4h'$, on top of each other associated with guns $6h'$ and $6v'$, which produce, respectively, a horizontally directed, vertically deflected switching beam $8h'$ and a vertically directed, horizontally deflected beam $8v'$. Each beam performs independently sequential gating of the strips in the associated set and, thus, scanning in the direction of its deflection.

The arrangement of FIG. **6** shows that in spite of the application of long deflected beams for switching the problem of convergence of three phosphor exciting beams as it exists in the shadowmask tube and also the need for relatively long tubes to avoid excessive deflection angles, also present in the shadowmask tube, are not resurrected. The beam switched MCA color kinescope can be built shallow (3 to 4 inches thick) and is free of convergence problems.

In order to produce tricolor pictures, it was disclosed in said patent that to perform the horizontal scan, the vertical strips should be divided into three narrow strips each having approximately one-third the width of the original horizontal strip and each being associated with an equally wide red or green or blue phosphor strip.

In order to apply time-sequentially the red-green-blue video signals to the proper strips (or properly timed to the flood source), it is necessary to sample the three video channels for red or green or blue in synchronism with the sweep of the beam $8v'$ over the upturned extensions of the red-green-blue controlling gating strips $4v'$. Then the red video is sampled at the exact instant when the beam gates on a strip, controlling excitation of a red phosphor strip; green video is sampled only when a strip controlling excitation of a green phosphor strip is gated on, and the same with blue.

In order to perform this synchronization even in the case of not perfectly linear deflection or deviations between sampling and switching rate, the arrangement of FIG. **6** can be modified to that shown in FIG. **7**. FIG. **7** shows in a larger scale the MCA of FIG. **6** modified for color display. Guns **6'** and associated deflector plates **7'** are omitted in FIG. **7** to avoid cluttering the drawing.

The horizontally and vertically positioned gating strips correspond to those shown in FIG. **6** (about 7.6 mils wide for the vertical strips and 23 mils wide for the horizontally positioned strips in a 20 inch diameter display). The $4v'$ strips in FIG. **7** are similarly drawn up to the rim of the MCA pan as the corresponding strips $4v'$ in FIG. **6** and are also connected over a resistive layer or strips to a biasing electrode **12**.

Since the vertically oriented strips $4v'$ have to be scanned far more rapidly than the horizontally oriented strips $4h'$ (which perform the rather slow vertical scan), it is preferred that the strip system $4v'$ form the top layer of the sandwich of the electrodes and insulating spacer layers deposited on the MCA, while the horizontally oriented strip system $4h'$ (seen from the flood source) is hidden behind the system of vertically positioned strips $4v'$ and the insulative spacer layer separating $4h'$ and $4v'$.

Thus, the vertically oriented strips, being not sandwiched between the horizontal strips and the contiguous channel-energizing electrode, will have the lower capacitance of the two gating strip systems and be better able to perform the more rapid gating required from it.

The essential difference between the monochrome (FIG. **6**) and tricolor (FIG. **7**) MCA is shown in the lower part of FIG. **7** in the form of three busbars **13'**, **14'** and **15'**. Busbars **13'**, **14'** and **15'** are each insulated from each other and from all the vertical strips. However, a different third of the vertical strips overlie each corresponding busbar $4vr'$ over busbar **14'**, $4vg'$ over busbar **13'**, and $4vb'$ over busbar **15'**. The strips

of a corresponding busbar are separated by an insulating layer forming a capacitor coupling. Such a layer is shown at **37** in FIG. **8** with a strip **38** and busbar **13'**. The capacitive reactance of each capacitive coupling should be large in comparison to the resistance of each corresponding resistor **11''**.

Busbar **13'** is capacitively coupled to all vertical gating strips **4***vg'* facing green phosphor strips, busbar **14'** with strips **4***vr'* exciting red phosphor strips, and busbar **15'** with the "blue" strip system. Thus, the switching beam in inducing a gating pulse in any green strip **4***vg'* will, at the same time, furnish a sampling command through busbar **13'** to the sampling switch **16** to connect, for the duration of one gating pulse, the green video channel with the intensity modulating means provided by a modulated flood source or the intensity control of the switching beam, which varies the amplitude of the gating signals on the vertical strips in accordance with the simultaneous green video amplitude. In this way video sampling in all three color channels is synchronized with the gating pulses even in the case of significant scan nonlinearity.

To facilitate significantly the fabrication of the busbar arrangement, this synchronization procedure can be simplified by omitting two busbars, e.g. **14'** and **15'**, and their connecting extensions to the associated gating strips, retaining only, e.g., the green busbar **13'** connected to strips **4** *vg'*. With good scan linearity over the entire deflection range, this is sufficient to synchronize the following blue and red pulse also, without tapping the blue and red strips.

An alternative embodiment of the invention is illustrated in FIG. **9.** This embodiment may be identical, if desired, to that shown in FIG. **7,** except that the said capacitive couplings have been replaced by resistors **39.** In this case the resistance of each resistor **39** should be substantially larger than that of each corresponding resistor **11''**.

FIG. **10** shows a schematic for simplified procedures described in the last four paragraphs. According to FIG. **10,** the green video channel is connected to the intensity modulator, e.g. control grid of switching gun **6***v'* in FIG. **6,** at the instant that the beam strikes a strip **4***vg'*. Forty nanoseconds later switch **16'** opens, and **18'** begins to sample the blue video. Another 40 nanoseconds later, **18'** opens and the red video is sampled by **17'**.

To the switching scheme previously discussed and illustrated in FIGS. **6, 7** and **8,** one feature may be added which is desirable for applications of the tube for commercial TV receivers. This feature is interlacing of the vertical scan.

In FIG. **6,** the gun **6***h'* performs the vertical scan by sweeping the beam **8***h'* over the upturned ends of the horizontal gating strips **4***h'* shown on the right-hand side of FIG. **6.** This arrangement produces a noninterlaced scan.

If, as in commercial TV, interlaced vertical scan is desirable, an arrangement utilizing a modification of FIG. **6** may be employed. In FIG. **11,** only the odd numbered horizontal gating strips **4***h'* are drawn up on the right-hand side of the MCA base. Thus, during the first field scan (performed within 1/60 second) only strips **1', 3', 5',** etc., are switched by gun **6***h'* while simultaneously the beam from gun **6***h''* is suppressed by biasing its intensity control grid.

The subsequent field is, then, scanned out by biasing off gun **6***h'* and actuating gun **6***h''*, which then sequentially switches the interlaced system of even-numbered gating strips **4***h''* for the next one-sixtieth second to complete an interlaced frame within one-thirtieth second.

Circuits **30** and **31** may produce sawtooth voltages identical to those produced for horizontal and vertical beam deflection in present day commercial TV.

The phrase "means to supply a negative voltage" and the phrase "means to supply a sweep signal" are hereby defined for use herein and in the claims to mean one or more conductors with or without a power supply or source of potential.

An intensity control may be employed as disclosed herein or as disclosed in the said patent.

Flood electrons may be supplied by the means disclosed herein or by those means disclosed in the said patent.

An alternative for the structure shown in FIG. **3** is shown in FIG. **12.**

FIG. **12** is identical to FIG. **3** except that two layers a and b are added and b would be a continuous conductive electrode like **22,** not divided into strips and having the only purpose of supplying to **22** the channel energizing field. It would, like **22,** be on a stable D.C. potential and would be isolated from the lower gating strips **12** by an insulating layer a. Layers *a* and *b* are the full equivalents to the electrodes on the two surfaces of a conventional intensifier MCP.

The electron multiplier need not be "frying pan" shaped but may be concavo-convex as shown in FIG. **13.**

If properly constructed, the structure of FIG. **12** when combined with the switching resistors **11''** and other structures shown in FIGS. **6, 7, 8** and **9** has another outstanding advantage.

When the structure of FIG. **3** is employed large, fast gating voltages must be employed for the strips **11** and **12.** On the other hand, strips **11** and **12** in FIG. **12** only require small gating voltages because they act, more or less, like the grid of a triode which requires only a small voltage to gate the anode current. In the same way, strips **11** and **12** in FIG. **12** are located between the source of primary electrons and the multiplier. Strips **11** and **12** in FIG. **12** require only small voltages to completely cut off primary electron current to the multiplier.

There is also another problem which exists. Due to the need for some finite structural integrity, the multiplier cannot have a one hundred percent transmission. Further, gating reduces primary electron flow to the multiplier. Flood source size and multiplier gain must thus be increased. Energy storage could minimize this increase, but excessive storage can produce ghosts on the screen.

In accordance with the device of the present invention, all of the aforesaid problems are solved by properly constructing each said resistor **11''** and the interelectrode capacitance between each strip **11** and one or more of the tube electrodes such as strips **12.** If R is the resistance of each resistor **11''** and C is the said interelectrode capacitance, then said construction should be such that the product of R and C should be equal to between about 0.5 T_r and 1.5 T_r, where T_r is the horizontal retrace period, i.e. about 10 microseconds.

The arrangement described in the immediately preceding paragraph is then used when the TV intensity control signal is applied to the control grid or other electrode of the electron gun which gates on and of the strips which effect the faster, e.g. horizontal, scan.

What is claimed is:

1. In an electron discharge device, the combination comprising: an evacuated envelope having a transparent input faceplate at one end and an output faceplate at the other end; an electron multiplier extending transversely across said envelope between said ends, said multiplier having a transverse dielectric plate of uniform cross section and peripheral edges extending longitudinally toward said input faceplate, a first conductive layer of uniform thickness bonded to the output side of said dielectric plate, said electron multiplier having holes extending through said plate from the input side to the output side thereof, a first set of conductive strips insulated from each other and having one side bonded to the input side of said dielectric plate, a dielectric layer of uniform thickness having one side bonded to the other side of said first conductive strips, a second set of conductive strips insulated from each other and bonded to the other side of said dielectric layer at an angle relative to said first strips, all of said layers and all of said strips having holes aligned with said plate holes, said plate holes having secondary emissive surfaces, the ends of both sets of said strips having conductive strip extensions along said peripheral edges; common conductive means connected to said extensions; first and second electron guns for said first and second strip sets, respectively, said first gun being fixed relative to said envelope inside thereof to direct its corresponding electron beam to bombard only one of said first set of strip extensions at a time, said second gun being fixed relative to said envelope inside thereof to direct its corresponding electron beam to bombard only one of said second set of strip extensions at a time; first means to supply a first sweep signal to said first gun to cause said beam thereof to sweep said first strip extensions in a direction perpendicular thereto and repeatedly in succession; second means to supply a second sweep signal to said second gun to cause said beam thereof to sweep said second strip extensions repeatedly in a direction perpendicular thereto and repeatedly in succession; and collector means fixed relative to said envelope inside thereof in position to collect electrons from said first and second strip extensions, respectively.

2. The invention as defined in claim 1, wherein said plate has an extension including said peripheral edges integral therewith extending at an angle relative thereto, said strip extensions being fixed to said plate extension in positions to extend in the same general direction as the corresponding strips of which they are extensions, said guns being located in positions such that their electron beams are askew, one gun being located at 90° around said plate relative to the other, said beams being movable approximately in planes parallel to said plate, said sweep signals being approximately sawtooth, one sweep signal having a frequency substantially larger than that of the other, means fixed relative to said envelope inside thereof between said beams and said plate to flood the input side of said multiplier with electrons, a luminescent screen fixed relative to said envelope inside thereof in a plane approximately parallel to said plate adjacent said output faceplate.

3. The invention as defined in claim 1, wherein said sweep signals are approximately sawtooth, said first sweep signal having a frequency substantially larger than that of said second sweep signal, means fixed relative to said envelope inside thereof between said beams and said multiplier to flood the input side of said multiplier with electrons, a luminescent screen fixed relative to said envelope inside thereof in a plane approximately parallel to said multiplier adjacent said output faceplate, said first and second means being synchronized to sweep said first gun beam the entire set of said first strips while sweeping said second gun beam across one strip in said second set.

4. The invention as defined in claim 1, including means fixed relative to said envelope inside thereof between said beams and said multiplier to flood the input side of said multiplier with electrons, a luminescent screen fixed relative to said envelope inside thereof in a plane approximately parallel to said multiplier adjacent the output side thereof.

5. The invention as defined in claim 1 wherein said conductive extensions of said sets of strips have secondary emissive surfaces on the side thereof facing said electron guns, said conductive means includes means to bias said extensions to a negative potential, and resistive means connected between said extensions and said conductor means.

6. The invention as defined in claim 5, wherein said first sweep signal means causes said first gun beam to sweep past all of said first strip extensions approximately each time said sweep signal means causes said second gun beam to traverse the width of one second strip extension, said first and second means being adapted to cause said first and second sweep signals to be supplied synchronously.

7. The invention as defined in claim 6, including third means to modulate the intensity of each electron stream emanating in succession from each corresponding set of said aligned holes in synchronism with said first and second sweep signals.

8. The invention as defined in claim 7, including a television receiver network having first, second and third conductive output leads and means to impress first, second and third color intensity control signals on said first, second and third output leads, respectively, first, second and third gates connected from said first, second and third output leads, respectively, to said third means, said third means being adapted to modulate the intensity of each electron stream emanating in succession from each corresponding set of said aligned holes in accordance with the magnitudes of the signals appearing at the outputs of said gates, a conductive bus connected to all three of said gates to close said gates repeatedly at mutually exclusive different periods of times, a first delay device connecting said bus to said first gate, a second delay device connecting said bus to said second gate, said third gate being connected directly from said bus, one of said delay devices providing a time delay twice as long as that of the other, said bus being coupled to every third one of said first strip extensions to supply a close gate signal each time said first gun beam bombards each of said every third one of said first strip extensions.

9. The invention as defined in claim 8, wherein each of said every third one of said first strip extensions is coupled to each bus by a capacitor.

10. The invention as defined in claim 8, wherein each of said every third one of said first strip extensions is coupled to said bus by a resistor.

11. In an electron discharge device, the combination comprising: an evacuated envelope; an electron multiplier, said multiplier having a dielectric plate of uniform cross section sandwiched in between first and second parallel conductive layers of uniform thickness bonded to the input and output sides thereof, respectively, a first dielectric layer of uniform thickness having one side bonded to said first conductive layer sandwiching it between said first dielectric layer and said plate, said electron multiplier having holes extending through said plate from the input side to the output side thereof, a first set of conductive strips insulated from each other and having one side bonded to the other side of said first dielectric layer in positions extending across corresponding sets of hole openings on the input side of said multiplier, a second dielectric layer having one side bonded over the other sides of said first strips, a second set of conductive strips insulated from each other and bonded to the other side of said second dielectric layer in positions extending across corresponding sets of hole openings at an angle relative to said first strips, all of said layers and all of said strips having holes in alignment with passageways through said base forming said holes, said plate holes having secondary emissive surfaces; first means fixed within said envelope inside thereof and actuable to raise and lower the potential of each successive strip repeatedly in said first set beginning with the first strip on one extreme side of said set, the potential of said first set first strip being repeatedly raised and lowered after the potential of the last strip on the other extreme side of said first set thereof is raised and lowered; second means fixed with said envelope inside thereof and actuable to raise and lower the potential of each second set strip repeatedly in the same said manner as said first set strip potentials are raised and lowered and in synchronism therewith, each said second set strip being gated on by one of said potentials for a length of time that the entire first set of strips is gated on once, said first means having a construction requiring a retrace period of time, T_r, to gate said first strip on after gating said last strip off; and resistive means connected from each strip of said first set, each resistive means having a resistance, R, the capacitance between each first set strip and at least one other electrode in said envelope being C, the product of R and C being equal to between about 0.5 T_r and 1.5 T_r.

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