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VIRTUAL FLOOD-ELECTRON SOURCE

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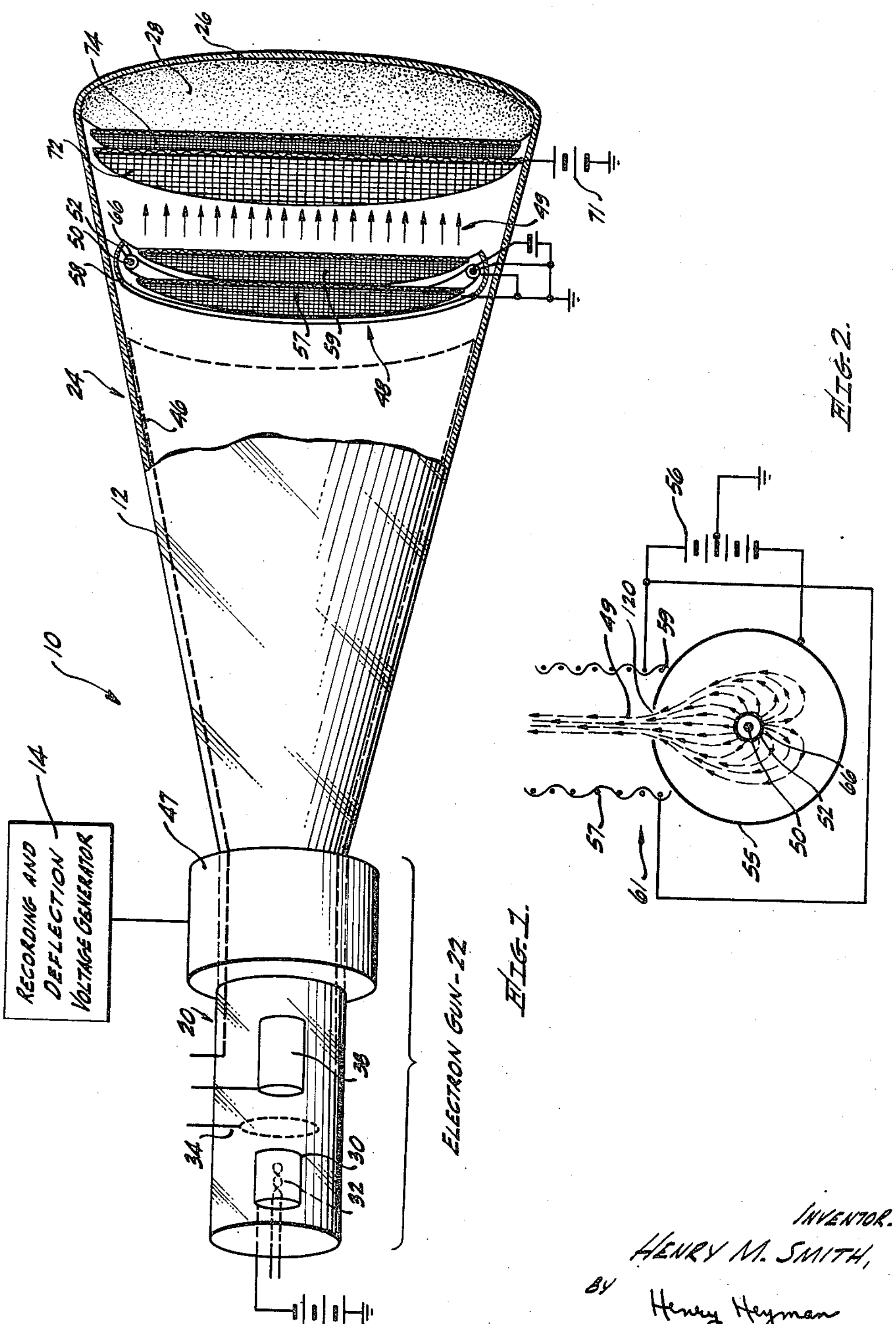

FIG. 1.

FIG. 2.

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VIRTUAL FLOOD-ELECTRON SOURCE

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This invention relates to storage type cathode-ray tubes and more particularly to an electron source for flooding the storage electrode in a storage tube with electrons having substantially the same approach velocities normal to the plane of the storage electrode and phosphor display screen.

An electron source called a flood gun is generally provided in a cathode-ray type storage tube to reproduce information stored on a foraminated storage electrode. The flood electrons are directed over the entire surface of the storage electrode. In order to cause electrons to impinge upon the storage electrode with substantially uniform normal velocities, it is necessary to make the usual cathode source of the flood electrons relatively small to position the source as far from the storage target as is practically possible, and to place the source as near the symmetrical axis of the tube as possible. It is usually impracticable to put the flood gun exactly along the axis of the tube, because the focusing and deflecting means for the high voltage recording, or writing, beam is directed along that axis; and it is desirable that neither the beam nor its control means interfere with the flood gun.

In the design of a flood gun for a cathode-ray type storage tube all the above recited design considerations are usually necessary but all are undesirable. One disadvantage of a small electron source is that the available current is small. When the flood gun is spaced a considerable distance from the storage tube target electrode, positive ion generation prevents a good reproduction of the charge pattern. Also for a half-tone storage tube, positive ion current limits the useful storage time of the storage electrode. Furthermore, actual symmetry of the flood gun can never be achieved unless it is placed on the symmetrical axis of the tube. Recent developments in direct-viewing storage tubes have made it imperative that variation of the electron velocities be minimized.

The flood electrons transmitted through the openings in the storage electrode are utilized in direct-viewing storage tubes to illuminate a phosphor viewing screen. This transmitted flood current in a tube then rises from essentially zero to that required for full brilliance when voltage of the storage electrode surface varies as little as three volts. This voltage control range has recently been expanded to as large as fifteen or twenty volts; however, the production of flood electrons having uniform normal velocities when approaching the storage electrode is still extremely desirable. This is particularly true when reasonable accuracy is required in producing intermediate illumination for half-tone operation. For a storage tube utilizing intermediate illumination, reference may be made to a copending application, Serial No. 459,403, filed September 30, 1954, by E. E. Herman and G. F. Smith, entitled "Direct-Viewing Half-Tone Storage Device," which is now U. S. Patent No. 2,790,929, granted April 30, 1957.

It is therefore an object of the invention to provide an improved flood electron source for a cathode-ray type storage tube.

It is another object of the invention to provide a storage tube electron source flooding the storage electrode with electrons having substantially the same normal velocities when they approach the storage electrode.

In accordance with the invention, an annular cathode is positioned about the symmetrical axis of a storage tube to provide a symmetrical electron flood having a uniform normal velocity distribution. A metallic grid is positioned on each side of the annular cathode for forming an electron cloud or a virtual flood cathode between the grids. An annular focusing electrode is then positioned externally about the cathode to direct the electrons emitted from the annular cathode into the space between the grids.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which two embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only, and is not intended as a definition of the limits of the invention.

Fig. 1 is a sectional view of a direct-viewing storage tube incorporating an embodiment of the virtual electron source of the present invention; and

Fig. 2 is an enlarged broken-away sectional view of another embodiment of the electron source of the present invention.

Referring to Fig. 1, there is shown a storage tube **10** having an evacuated envelope **12** and provided with a recording and deflection voltage generator **14**.

Envelope **12**, which may be made of glass, has a neck portion **20** enclosing a writing beam electron gun **22** and an enlarged portion **24** having a viewing end **26**. The viewing end **26** may be made of any suitable clear glass and coated internally of the envelope **12** with a luminescent phosphor material **28**.

Writing beam gun **22** comprises a cathode **30** which is provided with a filament **32**, a current control grid electrode **34** and an accelerating anode **38**. Cathode **30** is maintained at a few thousand volts negative with respect to ground. Accelerating anode **38** is then maintained at ground potential.

Painted onto the internal surface of the envelope **12** is a conductive coating **46** which may be made of a commercial preparation known as Aquadag. Conductive coating **46** is also maintained at ground potential. Conventional deflection yoke is shown disposed about neck portion **20** and coupled to deflection voltage generator **14**.

A flood electron source **48**, constructed in accordance with the present invention to produce a flood electron stream **49**, is shown in the enlarged portion **24** of the envelope **12**. Electron source **48**, which is employed to produce flood electrons, comprises a single annular wire filament **50** which is also shown in Fig. 2, having a hollow toroidal metallic cathode sleeve **52** disposed thereabout. Annular filament **50** is connected across a source of potential **56** and cathode sleeve **52** is maintained at ground potential.

A toroidal focusing electrode **58** is disposed externally about partially enclosing cathode sleeve **52**. The focusing electrode **58** is also mechanically connected to back and front metallic grids **57** and **59**, respectively, which are disposed on both sides of the cathode sleeve **52**. Control electrode **58** and back and front grids **57** and **59** are maintained at the same potential as cathode sleeve **52**.

Filament **50** could be used without the cathode sleeve **52** to provide a directly heated cathode; however, the voltage drop across the length of the filament will generally cause a non-uniform cross-sectional velocity distribution and may defeat the purpose of the flood electron source **48**. Hence, an indirectly heated cathode, viz., cathode sleeve **52**, is preferably employed as a unipotential source of electrons. An electron emissive layer **66** is deposited on the cathode sleeve **52**. This is more clearly indicated in Fig. 2.

Focusing electrode **58** need not have the exact shape illustrated, but may be constructed simply as a hollow cylindrical cup or may have any other convenient shape. The potential of control electrode **58** may be kept somewhat below or equal to the potential of cathode sleeve **52** in order to cause electrons emitted from cathode sleeve **52** to be initially confined in the space between front and back grids **57** and **59**.

Between electron source **48** and the luminescent material **28** on the viewing end **26** of the envelope **12**, a screen grid electrode **72** is disposed adjacent storage electrode **74**. Electrode **74**, which is employed as the storage device, may comprise an electroformed mesh having patches of a dielectric storage material disposed over its left surface in the drawing.

Screen grid **72** is maintained at a potential a few hundred volts positive with respect to ground by a connection to the positive terminal of potential source **71**.

The flood electron source **48** is easily mountable within the enlarged portion **24** of an envelope **12**, as shown. The fact that the flood gun **48** may be mounted there is advantageous for two reasons, viz., the unusual proximity of the flood gun **48** to storage electrode **74** reduces positive ion generation, and the writing beam developed by gun **22** may be usefully focused and deflected without interfering with the operation of the flood electron source **48**.

In the reproducing operation of the storage tube **10** the flood beam **49** is directed toward the storage electrode **74** and those electrons which penetrate the storage electrode illuminate the screen **28** according to the electrostatic charge pattern recorded on the storage electrode. The uniform velocity spread over the flood beam **49** then permits half-tone operation wherein the brilliance of an elemental area on the viewing screen **28** is caused to be proportional to the amount of electric charge stored on the storage electrode **74**.

An alternative embodiment of the electron source of the present invention is shown in Fig. 2. An accelerating field is employed in an electron source **61**. The filament **50** is also shown in Fig. 2 with cathode sleeve **52**, electron emissive layer **66**, back and front grids **57**, **59**, potential source **56**, and the flood beam **49**. A focusing electrode **55**, different in construction than that of focusing electrode **58**, is disposed about cathode sleeve **52** and electron emissive layer **66** so as to both focus the electrons emitted at the electron emissive layer **66** into the space between back and front grids **57**, **59** and to control the current in the flood stream **49**. For this reason an arcuate aperture **120** in the toroidal shaped focusing electrode **55** is maintained at a potential a few volts negative with respect to that of the cathode sleeve **52**. The front and back grids **57**, **59** are maintained at a potential generally less than 100 volts positive with respect to that of cathode sleeve **52** by means of a potential source **51**.

In the operation of the electron source **61** electrons emitted at the electron emissive layer **66** and thus directed through the aperture **120** in focusing electrode **55** and accelerated into the space between back and front grids **57**, **59**. Electrons are then drawn through the interstices in the front grid **59** by the axial electric field produced between the front grid **59** and the storage electrode **74**.

What is claimed is:

1. In a cathode-ray type storage tube having an evacuated envelope, and a storage electrode within the envelope, a writing beam gun adapted to scan the storage

electrode, an annular cathode disposed within the envelope; two metallic grids disposed one on each side of said annular cathode, means for directing electrons emitted from said annular cathode radially inward into the space between said metallic grids, and an attracting electrode disposed between one of said metallic grids and the storage electrode for accelerating the electrons directed into the space between said grids toward the storage electrode and for collecting secondary electrons liberated from the storage electrode.

2. In a cathode-ray type storage tube including an evacuated envelope having a storage electrode disposed at one end, and a writing beam gun adapted to scan the storage electrode: an annular cathode disposed transversely to and symmetrically about the longitudinal axis of the envelope; two metallic grids disposed one on each side of said cathode; means for directing electrons emitted from said cathode radially inward into the space between said metallic grids; and means for directing said emitted electrons through the interstices of one of said metallic grids toward and uniformly over the storage electrode.

3. In a cathode-ray type storage tube having a storage electrode disposed at one end of an evacuated envelope, and a writing beam gun adapted to scan the storage electrode: an annular cathode disposed transversely to and symmetrically about the longitudinal axis of the envelope and spaced from the storage electrode; a focusing electrode disposed partially about said cathode; and two metallic grids disposed one on each side of said cathode to cause the electrons emitted at said cathode to form a virtual flood cathode in the space between said metallic grids, said emitted electrons being adapted to be directed toward the storage electrode.

4. A cathode-ray type storage tube having a storage electrode for storing an electrostatic charge pattern, a writing beam gun, a virtual flood electron source for producing an electron stream to flood the storage electrode with electrons, and an attracting electrode disposed between the electron source and the storage electrode, said electron source comprising: an annular cathode sleeve; a filament disposed within said cathode sleeve for heating said cathode; a toroidal focusing electrode having two rims extending radially inward and partially enclosing said cathode sleeve; two metallic grids disposed one on each side of said cathode; and means for maintaining said cathode sleeve, said focusing electrode and said metallic grids at the same potential.

5. A cathode-ray type storage tube comprising: an evacuated envelope; a writing beam electron gun disposed at one end of said envelope for producing a writing beam of electrons; a storage electrode disposed at the opposite end of the envelope for storing electrostatic charge patterns produced by the electrons of said writing beam gun; a flood beam electron source including an annular cathode a focusing electrode disposed about said cathode and two metallic grids disposed one on each side of said cathode, said electron source being disposed between said writing beam gun and said storage electrode; and means for directing said writing beam through said metallic grids to said storage electrode.

6. A cathode-ray type storage tube comprising: a storage electrode; a flood beam electron source comprising an annular cathode; a hollow toroidal focusing electrode having an internal arcuate aperture disposed about said cathode; two metallic grids disposed one on each side of said cathode; means for maintaining said focusing electrode at a potential negative with respect to the potential of said cathode to focus the electrons emitted from said cathode; and means for maintaining said metallic grids at a potential positive with respect to that of said cathode to direct electrons emitted from said cathode radially inward into the space between said metallic grids.

7. A cathode-ray type storage tube comprising: an evacuated envelope; a writing beam electron gun disposed

at one end of said envelope for producing a writing beam of electrons; a storage electrode disposed at the opposite end of the envelope for storing electrostatic charge patterns; and a flood beam electron source disposed between said writing beam gun and said storage electrode and including an annular cathode, a focusing electrode disposed about said cathode, means for maintaining said focusing electrode at a potential negative with respect to the potential of said cathode to focus the electrons emitted from said cathode, two metallic grids disposed one on each side of said cathode, and means for maintaining said metallic grids at a potential positive with respect to that of said cathode to direct electrons emitted from said cathode radially inward into the space between said metallic grids.

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