June 18, 1957 P. E. FISKE 2,796,549

ELECTRONICS MATRIX SOLVER TUBE

Filed Sept. 12, 1952 2 Sheets-Sheet 1

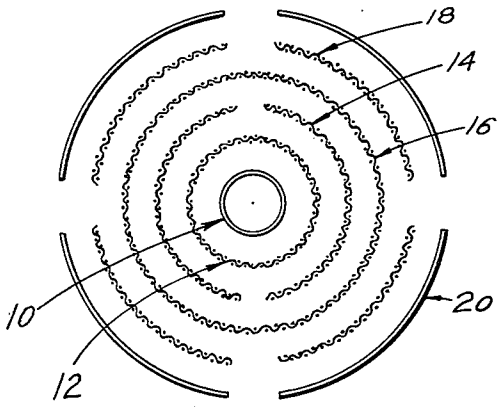


Fig. 1.

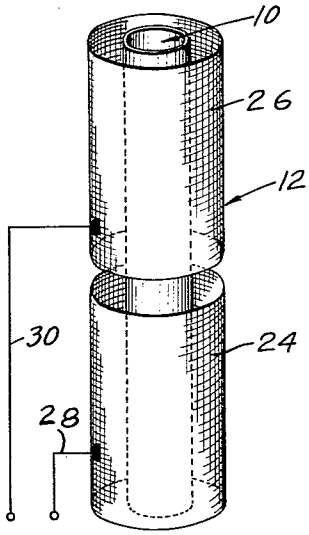


Fig. 2.

Fig. 3.

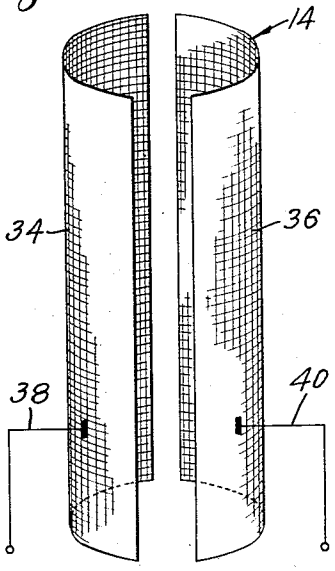
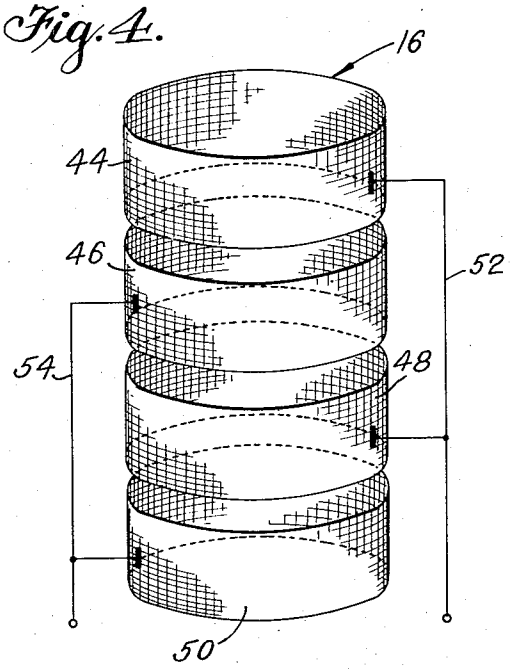


Fig. 4.



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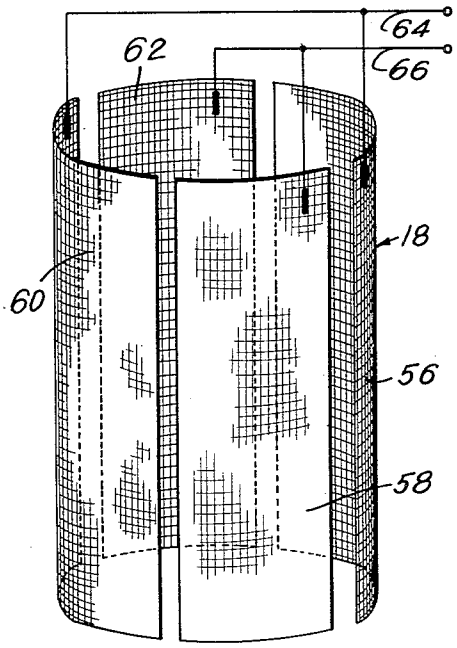


Fig. 5.

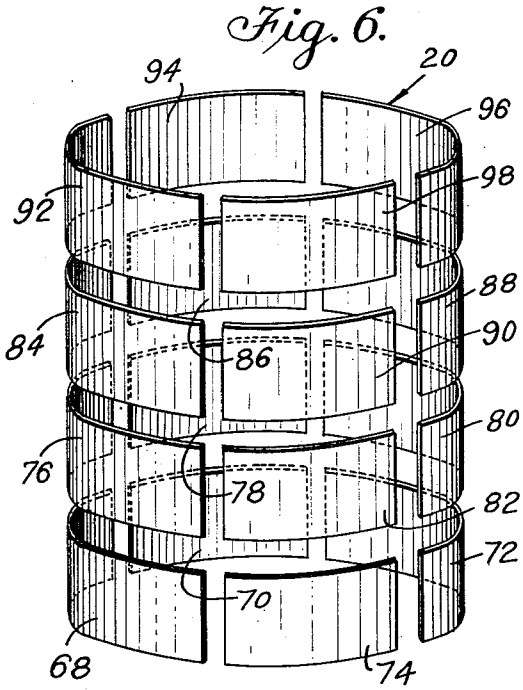


Fig. 6.

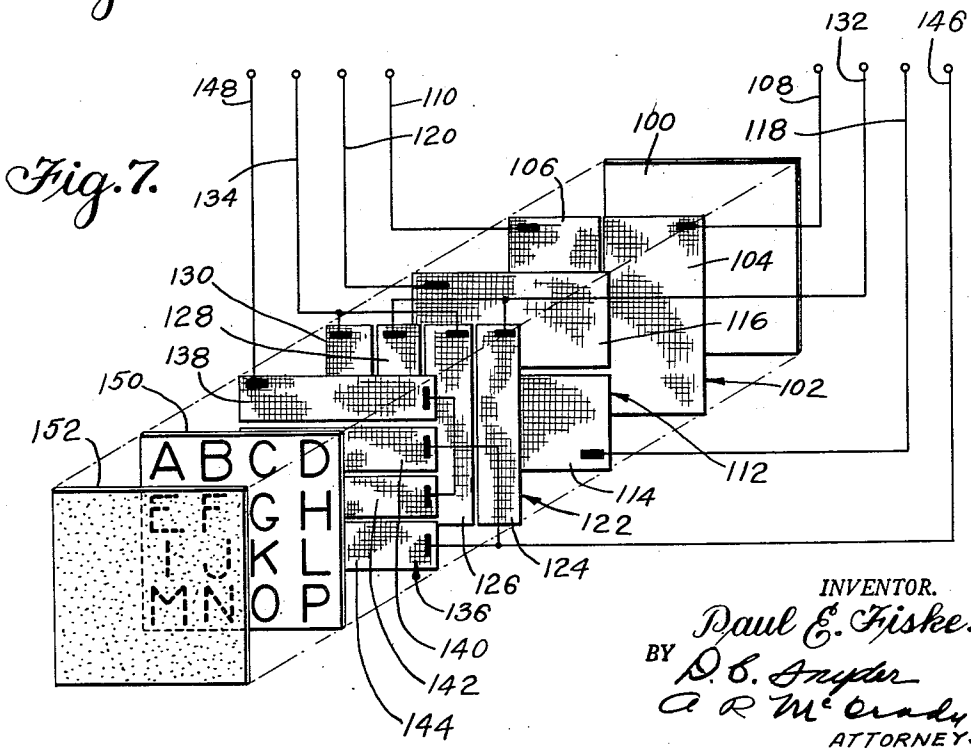


Fig. 7.

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ELECTRONICS MATRIX SOLVER TUBE

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7 Claims. (Cl. 313—300)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to electronic discharge tubes of the type wherein a plurality of grids permit selective current flow to one of a plurality of plates.

In data transmission and computer work, it is a requirement in many applications that one and only one output be made available for a given code configuration input. Known methods of performing this function include mechanical matrix solvers, the Teletype for example, and crystal diode arrangements. The mechanical matrix is, of course, extremely slow for computer work, and a crystal matrix uses an excessive number of crystals and has a very low impedance input. In the instant invention, a small number of grid assemblies in an electronic tube is utilized for controlling current flow selectively to various grid assembly segments.

An object of the invention is to provide an improved apparatus wherein one and only one output is rapidly and efficiently made available by the application of a given code configuration input.

An additional object of this invention is to provide a display apparatus for presenting information which has been transmitted in code.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following description.

Fig. 1 is a plan view of the tube assembly as seen from above;

Fig. 2 is a perspective view of a cathode and a first grid assembly;

Fig. 3 is a perspective view of a second grid assembly;

Fig. 4 is a perspective view of a third grid assembly;

Fig. 5 is a perspective view of a fourth grid assembly;

Fig. 6 is a perspective view of a plate arrangement; and

Fig. 7 is a perspective view of a tube assembly suitable for data display.

In Fig. 1, the tube elements are shown as seen from above. A centrally located cathode **10** is concentrically surrounded by a first grid assembly **12** appearing as an unbroken wire mesh cylinder, a second grid assembly **14** appearing as a mesh cylinder divided into two grid elements, a third grid assembly **16** having the same appearance as the first grid assembly enlarged, a fourth grid assembly **18** divided into four elements, and a plate arrangement **20** comprising a metal cylinder divided four ways. The longitudinal openings between the various broken elements are radially aligned; the transverse division lines which are shown in following figures are also aligned. The structure and manner of operation of the tube assembly will be explained in the following detailed description of the individual plate and grid assembly units.

The apparatus shown in Fig. 2 comprises cathode **10** for emitting electrons and grid assembly **12** for controlling

the outward movement of the electrons. The grid assembly is made up of two cylindrical grid elements **24** and **26** having leads **28** and **30** respectively and positioned concentrically around cathode **10**. Elements **24** and **26** are not interconnected within the tube. The effective area of the grid assembly may consist of a wire mesh or lattice such as that utilized in conventional vacuum tubes; the actual structure is immaterial since the grid assembly is called upon only to prevent the flow of electrons over a given area when the grid assembly is negative over that area with respect to the cathode and to allow electrons to pass freely through the grid assembly surface area which is positive. Cathode **10** is shown as being of the indirectly heated type; the heater filament is not shown since it may be conventional. A directly heated cathode will function in the apparatus in the same manner as the indirectly heated cathode. Leads **28** and **30** are brought out of the tube envelope to separate pin connections. These two leads are to be regarded as a single input to be connected to a normal "push-pull" type output. The external circuitry with which the matrix solver tube is used is such that one element, for example element **24**, will normally be biased to permit electron flow through the grid assembly mesh while the other element will be biased to cut off electron flow. When a signal is applied, the situation reverses and element **26** normally causing plate current cut-off will then permit flow of plate current and simultaneously element **24**, which previously permitted flow of plate current, will permit the flow of plate current. When the signal is no longer applied or is reversed the tube reverts to the original condition. Conventional push-pull circuits suitable for operation with the matrix solver tube are known to workers in the art. All grid assemblies in the tube are provided with two leads and are biased and exert control over electron flow in the same manner as first grid **12**.

Grid assembly **14** as shown in Fig. 3 comprises a mesh cylinder divided longitudinally to form two similar elements **34** and **36**. Elements **34** and **36** are connected to separate pin connections by means of leads **38** and **40** respectively to provide a second input for signals. At any given instant one element will permit the flow of electrons therethrough while the other element will prevent the flow of electrons.

Grid assembly **16** shown in Fig. 4 comprises a mesh cylinder divided transversely into four similar elements **44**, **46**, **48** and **50**. Elements **44** and **48** are connected to a pin connection by means of lead **52**, while elements **46** and **50** are connected to another pin by means of lead **54**. These pin connections provide a third input for signals.

The fourth grid assembly **18** shown in Fig. 5 comprises elements **56**, **58**, **60** and **62**. Elements **56** and **60** are connected to one pin by means of lead **64** while elements **58** and **62** are connected to another pin by means of lead **66**. Leads **64** and **66** provide a fourth input to the tube.

A plate arrangement suitable for use with the grid assemblies of Figs. 2, 3, 4 and 5 is shown in perspective in Fig. 6. It comprises a cylinder divided longitudinally and transversely into 16 identical plates. The bottom ring includes plates **68**, **70**, **72**, and **74**; the next ring includes plates **76**, **78**, **80**, and **82**; the third ring from the bottom includes plates **84**, **86**, **88**, and **90**; and the top ring includes plates **92**, **94**, **96**, and **98**. Each plate is a solid curved sheet of metal; it will be understood that, in actual practice, a lead (not shown) will be attached to each plate to make available, at a pin connection of the tube, one of the 16 possible outputs for the configuration shown.

When cathode **10** is heated, electrons are emitted which are attracted to the plate due to the plate voltage

applied as in conventional vacuum tubes. The electrons pass freely through a grid element positive with respect to the cathode but are unable to pass through a negatively charged grid element. Since one element of grid element **12** is negative and the other element is positive, electrons pass through only one half of the grid assembly area exposed to the cathode. The second grid assembly likewise limits the electron stream by one half, and the third and fourth grid assemblies in turn each cut down the cross sectional area of the electron beam by one half. The end result is that for any given code configuration input, electrons can reach one and only one of the 16 plates. For example, if grid elements **26**, **36**, **44** and **58** are positive, plate **98** only will conduct providing the component parts are oriented in the assembled form in the same relative position as shown in Figs. 2, 3, 4, 5, and 6.

In the embodiment of the invention shown in Fig. 7, the source of electrons is a flat cathode **100**. The preferred form is an oxide covered sheet heated indirectly by a filament, not shown, positioned adjacent the sheet on the side away from the grid assemblies. Alternatively, an electron gun may be adapted to furnish the required electrons. A first grid assembly **102** including elements **104** and **106** having leads **108** and **110** respectively is positioned adjacent cathode **100**. A second grid assembly **112** including elements **114** and **116** having leads **118** and **120** respectively is positioned adjacent the second grid assembly. A third grid assembly **122** including elements **124**, **126**, **128** and **130** connected alternately to leads **132** and **134** is positioned adjacent the second grid. A fourth grid assembly **136** including elements **138**, **140**, **142** and **144** connected alternately to leads **146** and **148** is positioned adjacent the third grid assembly. The display mask **150** comprises a sheet of material effective to prevent the passage of electrons except where portions of the mask are cleared by engraving or otherwise to allow the electrons to pass through. The electrons that are permitted to pass through the various grid assemblies and through openings in mask **150** strike phosphor coated transparent viewing plate **152**. For any given code configuration input applied to the four grid assemblies, one and only one character on display mask **150** will be subjected to an electron beam. The electrons that pass through the openings defining that character will cause a corresponding area on viewing plate **152** to glow, thus giving a display which may be viewed directly. The grid assemblies of the structure shown in Fig. 7 perform the same functions in the same manner as the circular grid assemblies of Figs. 2, 3, 4, and 5. Leads **108** and **110** provide a first input, leads **118** and **120** a second input, leads **132** and **134** a third input, and leads **146** and **148** a fourth input. If leads **108**, **118**, **132** and **146** are made positive, it will be readily seen that the letter P and P only will glow. For other code input configurations different characters will be illuminated.

It is immaterial which of the two innermost grid assemblies is positioned nearest the cathode in any of the arrangements thus far described. It is likewise immaterial which of the two outermost grid assemblies is nearest the plate assembly or display support.

It is obvious that a number of grid assemblies other than four may be utilized. The number of outputs for any particular structure will be 2^n where n is the number of control grid assemblies. If it is necessary to gate the output for certain purposes, a gating or control grid may be added between the first grid assembly and the cathode.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An electronic discharge tube structure comprising an elongated cathode, a first generally cylindrical grid assembly concentrically surrounding said cathode and divided transversely into two substantially equal parts, a second generally cylindrical grid assembly concentrically surrounding said first grid assembly and divided longitudinally into two substantially equal parts, a third generally cylindrical grid assembly concentrically surrounding said second grid assembly and divided transversely into four substantially equal parts, a fourth generally cylindrical grid assembly concentrically surrounding said third grid assembly and divided longitudinally into four substantially equal parts, a generally cylindrical plate surrounding said fourth grid assembly and divided longitudinally and transversely into 16 substantially equal segments the longitudinal divisions of said plate and said grid assemblies being radially aligned, input leads connected to separate parts of said grid assemblies, and output leads connected to the segments of said plate.

2. An electronic matrix solver tube comprising an elongated cathode, a cylindrical plate surrounding the cathode and divided longitudinally and transversely into sixteen segments, a fourth grid assembly disposed within said plate and divided longitudinally into four parts with each part registering with four of said segments and having alternate parts interconnected, a third grid assembly disposed within the fourth grid assembly and divided transversely into four parts with each part registering with four of said segments and having alternate parts interconnected, a second grid assembly disposed within said third grid assembly and divided longitudinally into two separately connected parts with each part registering with eight of said segments, and a first grid assembly disposed within said second grid assembly and surrounding said cathode and divided transversely into two separately connected parts with each part registering with eight of said segments.

3. A vacuum tube element assembly comprising a cathode, 2^n anodes equally spaced from said cathode, n pairs of grids positioned between said cathode and anodes at successively increasing distances from said cathode, grids of adjacent pairs of grids disposed along mutually transverse lines, and n pairs of input leads, one lead of each pair connected to one of the grids of each pair of grids and the other lead of each pair connected to the other one of the grids of each pair of grids, whereby voltages of opposite polarity applied to the leads of each pair of leads will permit only one anode to receive electrons emitted by said cathode.

4. A vacuum tube assembly comprising a cathode, 2^n anodes equally spaced from said cathode, n grid assemblies having each grid assembly positioned between said cathode and anodes at successively increasing distances from said cathode, adjacent grid assemblies having sections along mutually transverse lines to form a plurality of grids, each successive pair of grid assemblies having a number of grids double the number of grids in the preceding pair of grid assemblies, and n pairs of input leads where n equals the number of grid assemblies, each pair of leads having one lead connected to half of the grids of a grid assembly and the other lead connected to the other half of the grids of the grid assembly, whereby voltages of opposite polarity applied to the leads of each pair of leads will permit only one anode to receive electrons emitted by said cathode.

5. An electronic discharge assembly comprising means for emitting an electron beam, first control means positioned in the path of said beam for passing therethrough a predetermined portion of said beam and for simultaneously blocking the remaining portion of said beam, second control means positioned in the predetermined portion of said beam for passing therethrough a predetermined part of the beam portion passed by said first control means and for simultaneously blocking the remaining part of said passed beam portion, and means positioned in that beam part which is passed by said second control means for indicating said beam part.

6. The assembly recited in claim 5 wherein said indicating means includes a plurality of discrete electron re-

ceiving means equal in number to at least twice the number of said control means.

7. The assembly of claim 5 wherein said indicating means includes an apertured mask and an electron sensitive screen.

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