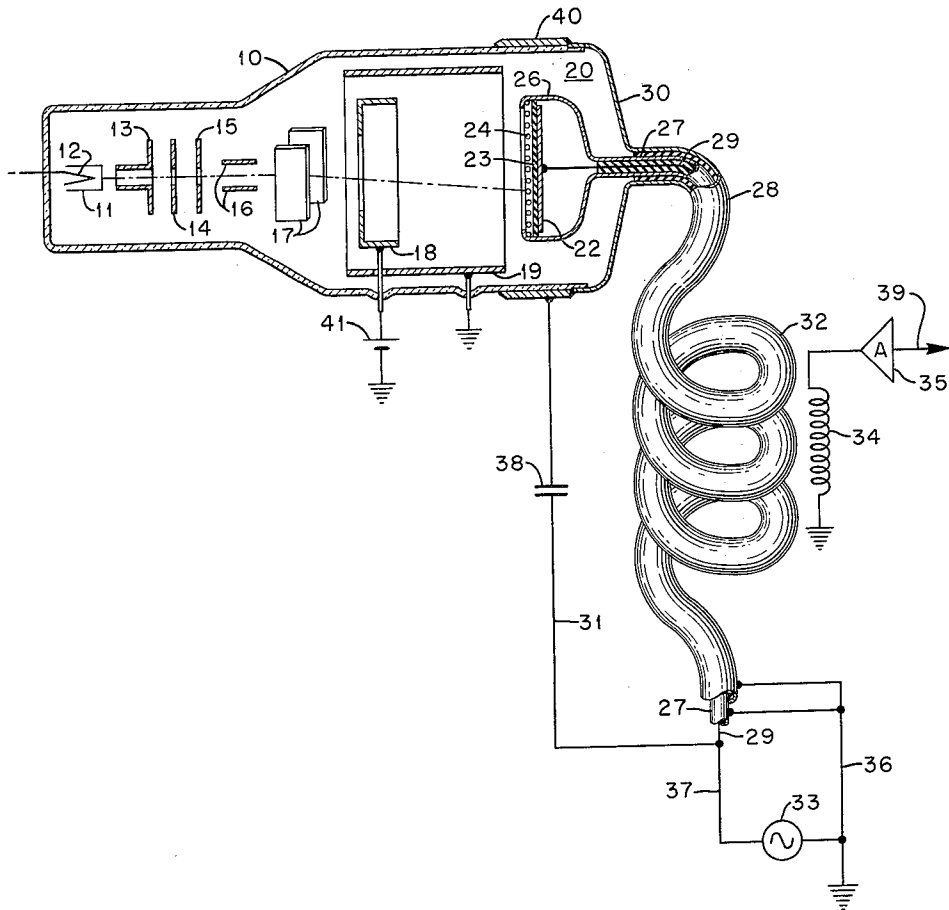


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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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This invention relates to an electron discharge device of the beam storage type and more particularly to the reading and writing of information in such a device.

One type of fast access short storage memory that has been employed in recent memory or storage systems utilizes electron discharge devices of the beam storage type and particularly of the type known as a barrier-grid storage tube. Such tubes are well known in the art, being described, for example, in an article "Barrier-grid Storage Tube and Its Operation," by A. S. Jensen, J. P. Smith, M. H. Mesner, and L. E. Flory, R.C.A. Review IX, pp. 112, 135, March 1948.

This invention is an improvement over the system set forth in U.S. Patent No. 2,844,722, to M. E. Hines, issued July 22, 1958, entitled "Electron Discharge Devices."

In a barrier-grid storage tube, a target, such as a dielectric sheet, has a conductive electrode or back plate secured to one face thereof. An electron gun projects a concentrated electron stream against the other face of the dielectric sheet through a barrier grid which is positioned directly adjacent to this other face of the dielectric sheet. In the operation of such a tube, the beam is deflected in two co-ordinate directions; for example, it may be repeatedly swept in one direction and selectively deflected in the other direction, or it may be turned on and deflected to a particular spot on the dielectric surface if completely random access is desired. The operation of the device involves, basically, two cycles, one store or write and the other remove or read. During the writing cycle the potential or charge of elemental areas of the bombarded dielectric surface is varied in accordance with an input signal, the charge change being dependent on the signal at the time the beam impinges on the area. During the reading cycle, the charges upon these areas are removed by action of the electron beam.

In the aforementioned patent, the writing signal is applied directly to the back plate portion of the target assembly, and the reading signal is taken directly from the target assembly as a whole. A co-axial line is connected through the envelope of the tube so that its inner conductor is connected to the back plate and its outer conductor is connected to a shielding member encompassing the target assembly, the barrier grid being supported by the shielding member so that the outer conductor is in effect connected to the barrier grid. The co-axial line has a portion wound as an inductor with the two conductors having essentially equal inductances and a mutual inductance between the two conductors equal to the self inductance of either. The input or writing signal is then applied between these two conductors. The charging current requisite for the capacitance between the barrier grid and the back plate flows to the target along the inner conductor and returns along the outer conductor. However, when the information is being read, the surface of the dielectric sheet is being charged or discharged through capacitances to both the barrier grid and back plate simultaneously so that current flows in both conductors of the line in the same direction. This current produces an output signal voltage across the coiled portion of the co-axial line which can be detected and utilized by an output circuit.

In the above described system, there is a very small direct capacitance between the back plate and the other

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elements in the tube, specifically the shield and the collector, through the holes in the barrier grid. This capacitance can be considered as a back plate-to-ground capacitance since the shield and collector are grounded. Accordingly, not quite all of the charging current, during the application of a writing signal, which flows through the inner conductor will return through the outer conductor. Some very small fraction of the return current appears as displacement current through the holes in the barrier grid to ground. Thus, a small residual error signal is produced during the application of a writing signal. This is undesirable and the patentee eliminates this error signal by connecting a canceling pulse generator directly to the reading amplifier to apply a canceling pulse of proper sign and magnitude. A second effect which prevents the perfect current balance desired is caused by the finite resistance of the outer conductor of the co-axial line. The charging current will therefore induce a slight voltage between the barrier grid and ground. Since this voltage can be kept quite small in comparison to the magnitude of the reading output signals, discrimination between the two types of induced signals can be accomplished. The small voltage developed across the barrier grid and finite resistance of the outer conductor charges up stray capacities to ground, and the currents in the inner and outer coax conductors are not exactly equal and opposite.

Therefore, it is an object of this invention to provide an electron discharge device with a simple, inexpensive means to further reduce the spurious output signal due to the small, but finite, resistance of the conductor enclosing the inner conductor of the input-output line to the device.

It is another object of this invention to provide an electron discharge device with a barrier grid target, means for storing signals on said target, reading out the stored information on said target, and to provide means for compensating for direct back plate-to-ground capacities due to the imperfect shielding of the barrier grid.

These and other objects and advantages of this invention will become apparent upon a consideration of the following detailed specification and the accompanying drawing wherein the single FIGURE illustrates one embodiment in which the principles of this invention may be carried out.

The above objects have been accomplished in this invention by using a triax cable with the inner conductor being connected to a source of input writing signals and to the back plate of a barrier-grid target assembly disposed in an electron discharge tube. The middle conductor of the cable is connected to a shielding member encompassing the target assembly, the barrier grid of the assembly being supported by the shielding member so that the middle conductor is in effect connected to the barrier grid. The outer conductor of the triax cable is connected to a shield surrounding the target assembly. The triax cable has a portion wound as an inductor. Both the middle and outer conductors are connected to ground. The input or writing signal is applied between the inner and middle conductors in a manner identical to that described above in the aforementioned patent. When the information is being read, the surface of the dielectric sheet of the target assembly is being charged or discharged through capacitances to both the barrier grid and back plate simultaneously so that current flows in both the inner and middle conductors of the cable in the same direction. This current produces an output signal voltage across the coiled portion of the triax cable which can be detected by a transformer winding inductively coupled to the coiled portion and utilized by an output circuit. By using a triax cable, the currents charging up the stray capacities, referred to above, flow back through the outer conductor of the cable, and no spurious output is observed across the

transformer secondary. A small trimmer condenser is connected between the shield surrounding the target assembly and the inner conductor of the cable to compensate for the direct back plate-to-ground capacity due to the imperfect shielding of the barrier grid.

Referring now to the drawing, the single figure depicts an illustrative embodiment of this invention utilizing a barrier grid storage tube 10. The tube 10 is in form of an open ended envelope, such as glass. Means to be described is provided to seal the open end of the envelope which is then evacuated. Disposed within the envelope is an electron gun including a cathode 11, heater 12, and accelerating and focusing electrodes 13, 14, and 15, defining an electron lens, deflection plates 16 and 17, a collector electrode 18, a shield 19, and a target assembly 20. Shield 19 is connected to ground and collector 18 is connected to a source of positive potential 41. The negative terminal of source 41 is connected to ground. The target assembly 20 includes a back plate 22, a dielectric sheet 23, and a barrier grid 24, positioned directly in front of the dielectric sheet 23. The back plate 22 and dielectric sheet 23 are enclosed within a shielding member 26 to which the barrier grid is attached.

In storage tubes of the kind described above, information is stored by an electrostatic charge on a discrete zone or area of the surface of the dielectric sheet. To place such a negative charge on the surface, the electron beam is turned on while the back plate is temporarily raised to a positive potential. This temporarily raises the potential of the front face of the dielectric sheet through capacitive action. The electron beam then charges this surface with negative electrons sufficiently to drop its potential to that of the barrier grid which is the equilibrium potential. During the charging operation, the secondary emission electrons from the dielectric sheet return to it and cannot escape. When the beam is turned elsewhere and the back plate potential returned to normal, the charge remains, leaving the dielectric sheet surface at a negative potential.

In the embodiment of the invention shown in the figure, the writing circuit, which applies the positive writing potential to the back plate 22 during the storage operation just described, comprises a tri-axial cable 28 having its inner conductor 29 connected to the back plate 22, its middle conductor 27 connected to the shielding member 26 and thus to the barrier grid 24, and its outer conductor 30 connected to a shield 40 disposed about the tube 10 which encompasses the target 20. Shield 40 and conductor 30 are affixed to the open end of the glass envelope of tube 10 to provide an airtight enclosure. The tri-axial cable 28 has a portion 32 wound as an inductor. A transformer winding 34 is inductively coupled to the coiled portion 32 of cable 28. One side of winding 34 is grounded, while the other side is connected to an amplifier 35 which in turn is connected to an output line 39. The middle conductor 27 and the outer conductor 30 are connected to ground through a lead 36. A source 33 of input writing signals is connected between the inner conductor 29 and the middle conductor 27 by lines 37 and 38, respectively.

It is one aspect of this invention that the objectional direct back plate-to-ground capacity referred to above, is compensated for by a small trimmer condenser 38. One plate of condenser 38 is connected to shield member 40, and the other plate of this condenser is connected by a line 31 to the junction of lines 29 and 37.

When a writing signal is applied by the source 33, the current flows along the inner conductor 29 to charge the internal capacitance of the target assembly 20 and returns via the middle conductor 27. As in the above described patent, a small voltage is developed across the middle conductor 27 due to its finite resistance. This voltage will charge up stray capacities to ground. It is another aspect of this invention to eliminate from the reading circuit spurious signals induced by these charged stray capacities. This is accomplished by the grounded outer conductor 30

of the tri-axial cable 28 and its extension 40. The currents charging up these stray capacities flow back through outer conductor 30 and no spurious output is observed across the transformer secondary 34. Thus, it can be seen that a simple and inexpensive means has been provided in this invention for eliminating from the reading circuit spurious signals induced from other sources than the electron beam current.

The information stored in a spot or zone on the surface of the dielectric 23 is subsequently read by returning the electron beam to this spot. The beam in striking the dielectric releases more secondary electrons than there are primary electrons striking it, and these are repelled from the surface, causing the potential to rise to that of the barrier grid. The potential will not become more positive than the barrier grid through this type of action because the secondary electrons in that case would return to the surface and fail to escape. At equilibrium, the dielectric surface releases as many electrons as arrive and remains at the barrier grid potential. It should be thus apparent that when the information is being read out, the surface of the dielectric is being discharged through capacitances both to the barrier grid and the back plate simultaneously. Accordingly, current will flow in both the inner conductor 29 and the middle conductor 27 in the same direction. These currents produce a signal voltage across the coiled portion 32 of the tri-axial cable 28. This signal voltage induces a signal voltage in the transformer winding 34 which voltage is amplified by the amplifier 35 before being fed to the output line 39.

Thus, it should be apparent from the above discussion, application of the writing signal alone to the back plate will induce no signal into the reading amplifier. However, the electron beam will affect the reading amplifier by applying current to the storage assembly as a whole. The net current to the target will be the difference between the impinging beam current and the escaping secondary electron current. Any change in this net current will cause a signal to appear and be amplified. Whenever the dielectric surface is being charged or discharged, whether in reading or writing, there will be a deficiency or excess of secondary electron current escaping from the target; the detection and interpretation of these current changes constitutes the reading operation.

The discharge device described above may be used for storing and reading binary digital information in the same manner as described in the system set forth in the Bell System Technical Journal (vol. XXXIV, No. 6, November 1955: "Digital Memory in the Barrier-Grid Storage Tubes," by M. E. Hines, M. Chrunev and J. A. McCarthy). It may be desirable to use opposite polarity charges to store zeros and ones, as opposed to one polarity and no charge as described in this journal. This is accomplished by writing a 1 with the back plate at a suitable positive voltage, and writing a 0 with the back plate at a suitable negative voltage. Reading is done with the back plate at 0 volts.

This invention has been described by way of illustration rather than limitation and it should be apparent that numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a digital memory system having a barrier-grid storage tube, said tube having an electron gun, drift tube, electron lens, deflection plates, collector, and storage target, the said target having a back plate and barrier grid separated by a dielectric sheet, the improvement which comprises an improved read-out circuit for said target, said circuit comprising a triax cable consisting of an outer shield, inner shield and a central conductor disposed within said shields, a source of writing potential connected to one end of said conductor and to one end of said inner shield, the other end of said conductor being connected to said back plate, means for connecting the

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other end of said inner shield to said barrier grid, means for connecting both shields at the source end of said cable to ground, said outer shield adjacent said target being formed in the shape of a cup to provide an external shield to enclose one end of said tube, a trimmer condenser connected between said external shield and the source end of said inner conductor to compensate for the direct back plate-to-ground capacity caused by imperfect shielding by said grid, said triax cable being coiled to form the primary of a transformer, a transformer secondary disposed in an inductive relation to said primary coil, an amplifier, means for connecting one end of said secondary to ground, and means for connecting the other end of said secondary through said amplifier to an output line, said outer shield serving as a means for preventing an output signal being applied to said output line on application of a writing signal to said back plate.

2. An electron discharge device comprising a glass envelope having disposed therein a storage target and an electron gun means for directing a beam of electrons onto said storage target, said target including a back plate and barrier grid separated by a dielectric sheet, and means including said gun means, said back plate, and said barrier grid for storing information on said dielectric sheet and for receiving stored information from said dielectric sheet, said last mentioned means further including a source of writing signals and a tri-axial cable with an

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inner conductor, a middle conducting shield and an outer conducting shield, said cable being provided with a coiled portion, a shielding member encompassing said back plate and dielectric sheet and mounting said barrier grid, said shielding member being connected to said middle conducting shield, one end of said inner conductor being connected to said back plate, said source of writing signals being connected to the other end of said inner conductor and to said middle shield beyond said coiled portion of said cable, means for connecting the source end of said middle shield and outer shield to ground, an external shield disposed around said envelope and encompassing said target and being connected to said outer shield of said cable, and a trimmer condenser connected between said external shield and the source end of said inner conductor.

3. The device set forth in claim 2 and further including means coupled to said coiled portion of said cable for receiving output signal voltages developed thereacross, said outer shield serving as a means for preventing an output signal being applied to said output means on application of writing signals to said inner conductor and said middle shield.

References Cited in the file of this patent

UNITED STATES PATENTS

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