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CENTERING SYSTEM FOR AN ELECTROSTATIC WRITING TUBE

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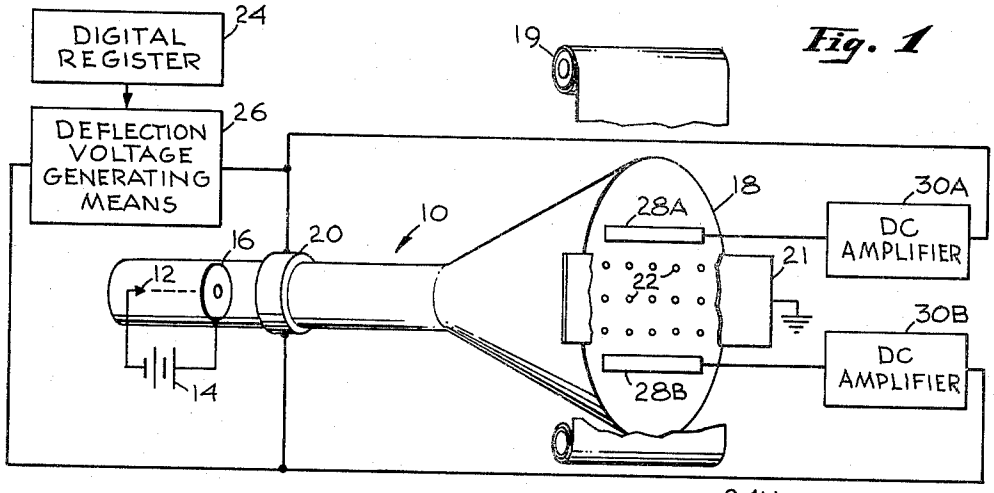


Fig. 1

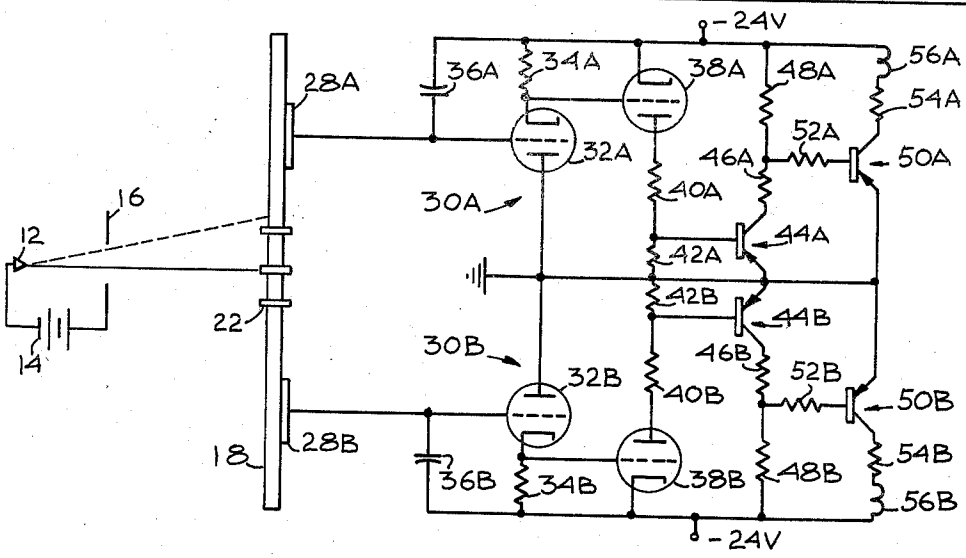


Fig. 2

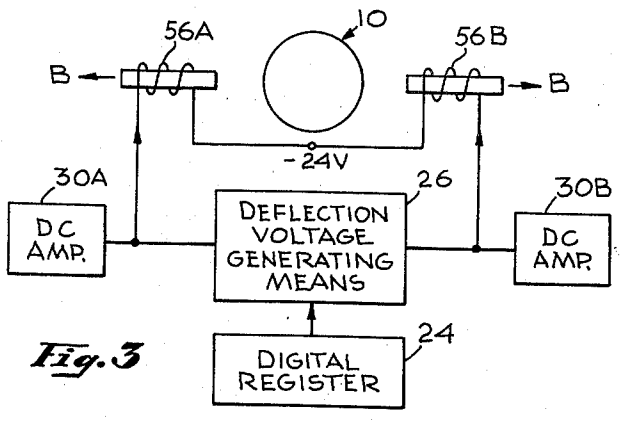


Fig. 3

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CENTERING SYSTEM FOR AN ELECTROSTATIC WRITING TUBE

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This invention relates to cathode ray tube apparatus used as an electrostatic printing device and more particularly to a system for automatically centering the electron beam of an electrostatic printing tube on the printing matrix thereof.

An electrostatic printing tube was developed in connection with apparatus which can be caused to operate in accordance with the conventional binary output of data processing equipment. The electrostatic printing tube essentially comprises a cathode ray tube having a matrix of wires extending perpendicularly through the face of the tube. Printing is accomplished by selectively deflecting the cathode ray tube electron beam so as to cause it to impinge selected wires of the matrix. A paper medium is moved past the face of the tube. The opposite surface of the paper consists of a ground plane. The contacted wires can therefore deposit an electrostatic charge pattern on the paper in accordance with information applied to the deflecting circuits of the tube. Subsequent deposition of suitable powders on the electrostatically charged paper renders the patterns visible to the eye. It should be readily appreciated that the positioning of the electron beam with respect to the matrix is critical; i.e. the beam must be precisely deflected in accordance with the input information in order to properly establish the desired charge pattern on the moving paper.

It has been found that under certain operating conditions, the beam drifts away from its normal position which is directed at the center of the matrix in the absence of any input signal, causing deflection. This drift of the beam causes the printed information to be either incorrect or at best, distorted. Several factors have been recognized as causing this drift. Initially, changing magnetic fields within the associated apparatus can cause the beam to drift off the matrix center. Secondly, vibration within the machine can cause a slight repositioning of the electron beam deflection yokes sufficient to shift the beam. Thirdly, a slight drifting of the vertical centering current is sometimes encountered which also may cause the beam to drift. Although the beam can be repositioned manually by trial and error while observing the resultant printing or by viewing the blue phosphorescence within the tube which indicates the position of the beam, such procedures are tedious and time consuming.

In light of the above, it is an object of this invention to provide means for automatically centering the electron beam in a cathode ray tube.

It is a further object of this invention to provide means for automatically centering a cathode ray tube electron beam which is simple, relatively reliable, and inexpensive.

It is a still further object of this invention to provide means for automatically centering an electrostatic printing tube electron beam which can be easily incorporated in existing electrostatic printing tube apparatus without requiring any internal modification thereof.

Briefly, the invention herein comprises the provision of sensing means, in the form of conductive strips, on the outside surface of the face of the electrostatic printing tube immediately above and below the printing matrix together with feedback circuit means connecting the conductive strips to the tube deflection means. Any vertical drift of the beam will generate by capacitive action, a

charge unbalance between the conductive strips. The charge unbalance is amplified and fed back to the tube deflection apparatus to deflect the beam in a direction to compensate for the drift.

Other objects and advantages, which will subsequently become apparent reside in the details of circuitry and operation as more fully hereinafter described and claimed, further reference being made to the accompanying drawing forming a part hereof, wherein like identifying numerals refer to like parts throughout the several figures, and in which:

FIGURE 1 is a perspective, partially cut away view of an electrostatic printing tube showing the manner in which the teachings of the invention herein can be applied thereto in order to automatically deflect the tube beam toward the matrix center in the absence of any input information;

FIGURE 2 is a schematic diagram of the circuit means employed to couple the conductive strips disposed on the outside surface of the tube face to the tube deflection means;

FIGURE 3 is a block diagram illustrating the manner in which the correction signals and information signals are applied to the tube deflection means for deflecting the beam in a desired manner over the matrix.

Referring to FIGURE 1, an electrostatic printing tube 10 is illustrated modified in accordance with this invention. The printing tube 10 is similar to other conventional cathode ray tubes to the extent that it has an electron gun including a cathode 12 capable of emitting electrons which are accelerated by potential source 14 to an apertured anode 16. Although most of the electrons emitted by cathode 12 hit the anode 16, those which pass through the aperture in the anode form a beam and travel along the neck of the tube 10 and impinge upon the inner surface of the dielectric tube face 18. A deflection yoke 20 is disposed about the tube neck and upon proper energization is adapted to selectively deflect the beam. While the inner surface of the face of a conventional cathode ray tube is coated with a phosphor material in order to emit light when an electron strikes, the face 18 of the printing tube 10 has a plurality of wires 22, arranged in a matrix, extending perpendicularly through the face 18. The beam, under the influence of the deflection yoke 20 is adapted to selectively impinge on any of the matrix wires. Paper 19 from a roll passes between the face of the tube 18 and a grounded metal plate 21. The paper is in contact with the wires of the matrix and the metal plate. Both metal plate and paper are broken away to show the face of the tube 18. Any of the wires of the matrix which are contacted by the cathode ray beam for a sufficient period can deposit an electrostatic charge on the paper.

Electrostatic printing tubes are finding many applications inasmuch as printing can be easily accomplished by deflecting the beam in accordance with binary coded information representing discreet letters or symbols. For example, information from data processing apparatus may be loaded into a digital register 24 which in turn is connected to deflection voltage generating means 26. The deflection voltage generating means 26 performs the function of generating output analog voltages dependent upon the binary representation in the digital register 24. The output of the deflection voltage generating means 26 is applied to the deflection yoke 20 in order to deflect the electron beam over the matrix of wires 22 in order to deposit an electrostatic charge pattern on the moving paper 19 in accordance with the information in register 24.

As previously pointed out, if the electron beam is not normally directed at the center of the matrix, that is not directed at the center of the matrix in the absence of the

application of information deflection signals to deflection yoke 20, inaccurate or distorted printing will result. In order to insure proper centering of the electron beam, a pair of conductive strips 28*a* and 28*b* are respectively disposed on the outer surface of the face 18 of the tube 10 above and below the matrix of wires 22. Direct coupled voltage amplifiers 30*a* and 30*b* respectively couple the conductive strips 28*a* and 28*b* to the deflection yoke 20 in order to deflect the beam in a direction to compensate for the drift. The conductive strips 28*a* and 28*b* may comprise conductive paint applied to the outer surface of the tube face, or in lieu thereof strips of foil adhered to the outer surface of the tube face.

Attention is now called to FIGURE 2 wherein the dotted line extending from the cathode 12 to the tube face 18 is representative of the electron beam. As pointed out, in the absence of any deflection caused by information signals applied to the deflection yoke 20, the beam may drift away from the center of the matrix of wires 22 due to any of the various factors above mentioned. Assume for example, that the beam drifts upward, in the direction shown, toward conductive strip 28*a* above the matrix of wires 22. This drifting will cause a greater number of electrons to collect on the inside surface of the tube face 18 in the area of conductive strip 28*a* than will collect in the area of conductive strip 28*b*. By capacitive action, a charge unbalance will develop between the conductive strips 28*a* and 28*b*; i.e. conductive strip 28*a* will become more positively charged than conductive strip 28*b*. Each of conductive strips 28*a* and 28*b* is respectively connected to the input of a direct coupled amplifier 30*a* and 30*b*. The direct coupled amplifiers 30*a* and 30*b* are identical and accordingly the details of only amplifier 30*a* will be discussed.

Conductive strip 28*a* is connected to the grid of vacuum triode 32*a* whose cathode is connected through resistor 34*a* to a minus 24 volt source and whose anode is connected directly to ground. A capacitor 36*a* is connected between the minus 24 volt source and the grid of vacuum triode 32*a*. The cathode of vacuum triode 32*a* is connected to the grid of vacuum triode 38*a* whose cathode is connected directly to the minus 24 volt source and whose anode is connected through serially connected resistors 40*a* and 42*a* to ground. The base of transistor 44*a* is connected to the junction point between resistors 40*a* and 42*a* while the emitter of transistor 44*a* is connected directly to ground. The collector of transistor 44*a* is connected through serially connected resistors 46*a* and 48*a* to the minus 24 volt source. The base of transistor 50*a* is connected through resistor 52*a* to the circuit junction between resistors 46*a* and 48*a*. The emitter of transistor 50*a* is connected directly to ground while the collector thereof is connected through resistor 54*a* and one half of the vertical deflection winding 56*a* to the minus 24 volt source.

In operation, as previously pointed out, drift of the cathode ray tube beam toward conductive strip 28*a* causes an excess of positive charges to be developed on conductive strip 28*a*. The positive charges so developed tend to charge capacitor 36*a* which performs an integrating or time averaging function, so as to assure that the time average component in the incremental charge variation of the strip 28*a* is amplified rather than any extremely short duration variations. The time averaging function is essential in order to ascertain the amount of drift in the absence of deflection caused by input information. More particularly, the input information will deflect the beam above and below the center of the wire matrix and an average of the deflections will reveal that the beam is generally deflected above the center as often as below the center. By time averaging, these time varying components will be removed and only the average unbalance between the charges on the strips 28*a* and 28*b* will be amplified by the amplifiers 30*a* and 30*b*.

The utilization of vacuum triode 32*a* provides a high input impedance which matches the high output impedance derived from conductive strip 28*a*. When a sufficient positive charge level is established on the conductive strip 28*a*, the conduction of triode 32*a* will be initiated thereby raising the voltage of the cathode thereof. This in turn raises the grid potential of vacuum triode 38*a* and initiates conduction thereof thereby lowering the potential of the circuit junction between resistors 40*a* and 42*a*. Inasmuch as the base of PNP transistor 44*a* is connected directly to the circuit junction, transistor 44*a* will be biased on causing current flow in the emitter-collector path thereof through resistors 46*a* and 48*a*. This action raises the potential of the circuit junction between resistors 46*a* and 48*a* and in turn raises the base potential of PNP transistor 50*a* thereby reducing the emitter-collector current flow therethrough and through the half of deflection winding 56*a* which in turn reduces the upward deflection on the cathode ray tube beam. It should be appreciated that the vacuum triodes 32*a* and 38*a* essentially comprise voltage amplifiers while transistors 44*a* and 50*a* comprise current amplifiers for developing sufficient current for deflection winding 56*a*.

Summarizing the operation of the amplifiers 30*a* and 30*b*, it will be realized that centering currents normally flow through the half deflection windings 56*a* and 58*a* in order to center the electron beam. If the beam drifts vertically however, an excess amount of positive charge will appear on one of the conductive strips. If the beam drifts upward, as illustrated, the excess positive charge will appear on conductive strip 28*a* and according to the sequence described above will reduce the centering current in the half deflection winding 56*a* to permit the normal centering current in the half deflection winding 56*b* to deflect the beam downward.

This action can be better understood from a consideration of FIGURE 3. Therein the tube 10 is illustrated with the beam coming out of the paper toward the reader. The half windings 56*a* and 56*b* are illustrated in a schematic manner such that currents driven respectively therethrough in the directions of the arrows will establish magnetic fields B respectively to the left and right which act upon the electron beam to respectively deflect it upward and downward. From the foregoing, it will be appreciated that each of the direct coupled amplifiers 30*a* and 30*b* will provide a quiescent centering current to the respective half windings 56*a* and 56*b*. When the beam drifts vertically upward as shown in FIGURE 2, the current through winding 56*a* will be reduced thereby reducing the magnetic field caused by that half winding. This will in turn, of course, reduce the upward force on the electron beam and permit the magnetic field established by the current through half winding 56*b* to deflect the beam downward.

FIGURE 3 also illustrates the manner in which information in the digital register 24 is coupled to the deflection voltage generating means 26 and thence to the half deflection windings 56*a* and 56*b*. It should be realized that so long as no voltage output is provided from the generating means 26, the centering currents provided by the amplifiers 30*a* and 30*b* will determine the position of the beam. When, however, the right terminal of the generating means 26, for example, goes to plus 10 volts while the left output terminal remains at ground, a greater current will be driven through half deflection winding 56*b* than through 56*a* resulting in a downward deflection of the beam. In this manner the beam is moved in accordance with the information loaded into the digital register 24.

Although one preferred embodiment of the invention has been disclosed herein, it should be understood that there is no intention to limit the scope of the invention to the specific structural organization illustrated and it is understood that modifications within the scope of the invention will readily occur to those skilled in the art.

For example, it is recognized that many different amplifier circuit arrangements are capable of performing the requisite function herein. Also it is realized that the invention can prove equally useful in horizontally centering a beam as vertically and that deflection can be accomplished electrostatically as well as magnetically. Accordingly, it is intended that all suitable modifications and equivalents shall fall within the scope of the invention as claimed.

We claim:

1. In a cathode ray tube having a dielectric envelope, and having enclosed within said dielectric envelope means for generating and accelerating an electron beam toward the face portion of said dielectric envelope and having deflection means for deflecting said beam, the improvement comprising correction means for automatically energizing said deflection means to direct said beam toward a predetermined area in said face, said correction means comprising first and second sensing means respectively mounted on the outside of said face portion of said dielectric envelope immediately adjacent to and on opposite sides of said predetermined area for detecting the drift of said electron beam toward one of the sides of said predetermined area and for producing signals indicative thereof, and means connecting said first and second sensing means to said deflection means for actuating said deflection means responsive to signals from said first and second sensing means to deflect said electron beam to correct for said drift.

2. In a cathode ray tube as recited in claim 1 wherein said first and second sensing means each comprises a strip of conductive material on the outside of said face portion of said dielectric envelope.

3. In a cathode ray tube as recited in claim 1 wherein said means connecting said first and second sensing means to said deflection means includes first and second amplifiers connected to each of said deflecting means, and first and second integrating means connected between each of said sensing means and its corresponding amplifier.

4. The combination with an electrostatic printing tube of the type having a face of dielectric material and a matrix of wires extending therethrough, and having means for generating an electron beam, and deflecting means for selectively deflecting an electron beam to points on said matrix in accordance with input information applied to said deflection means, of centering means for automatically maintaining said beam in the center of said matrix in the absence of input information, said centering means comprising:

first and second conductive strips respectively disposed on said face above and below said matrix; and first and second amplifier means respectively connecting said conductive strips to said deflecting means for deflecting said beam in a direction opposite to any drift of said beam toward one of said strips.

5. The combination with an electrostatic printing tube including a face of dielectric material having a matrix of wires extending therethrough and means for generating and selectively deflecting an electron beam to points in said matrix in accordance with input information of centering means for automatically maintaining said beam in the center of said matrix in the absence of input information, said centering means comprising:

first and second conductive strips respectively disposed on said face remote from said beam generating means above and below said matrix; substantially identical amplifier means connected to each of said strips; and means connecting each of said amplifier means to said deflection means for energizing said deflection means to deflect said beam in a direction to correct for a charge unbalance between said strips responsive to a drift of said beam away from said matrix center.

6. The combination of claim 5 wherein each of said amplifier means includes integrating means for time averaging any charge unbalance between said strips.

7. The combination of claim 5 wherein each of said amplifier means comprises a high impedance direct coupled voltage amplifier.

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