Aug. 16, 1960 W. A. VEITH 2,949,560

STORAGE TUBE WITH CIRCULAR SCANNING

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Fig.1

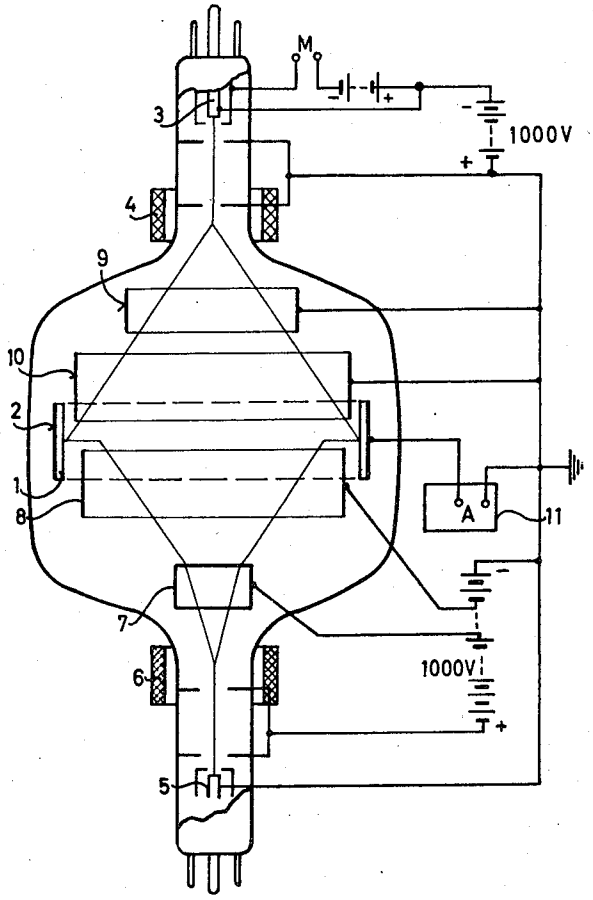

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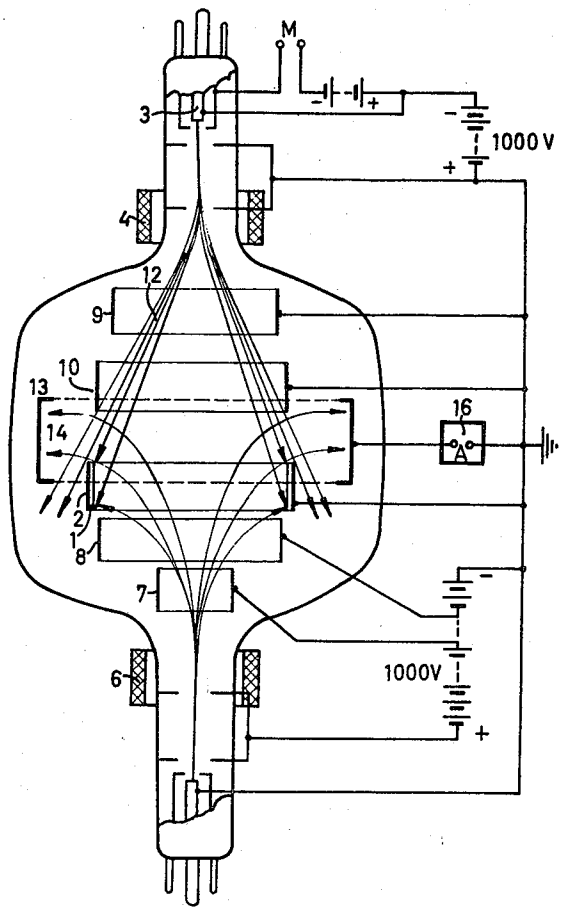
Fig.2



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STORAGE TUBE WITH CIRCULAR SCANNING

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4 Claims. (Cl. 315—12)

The present invention relates to a storage tube in which the recording and reading or pick-up is effected independently and in which the recording and pick-up electron beams strike against the same side of a storage electrode. Such an arrangement has the substantial advantage over known arrangements wherein the recording and pick-up beams strike against opposite sides of a storage electrode, that the charges respectively applied by the recording beam onto the surface of the storage electrode or released therefrom influence the pick-up beam directly from the surface and not through the storage layer, dependent upon a practically very sensitive physical effect.

Known storage tubes have moreover further substantial disadvantages insofar as they require either very high, technically inconvenient beam voltages and have considerable inertia phenomena or else their technical production causes considerable difficulties due to their complicated construction and the high requirements made with respect to the individual parts such as insulators, fine mesh wire grid and secondary-emission multipliers. However, known arrangements wherein the recording and pickup beams strike the same side of the storage electrode also have considerable disadvantages. Due to the fact that only one of the two beams strikes the storage electrode perpendicularly while the other must necessarily strike it obliquely corresponding to a lateral beam-producing system associated with the storage electrode, with axis inclined to the plane thereof, such a structure requires complicated adjustments and furthermore, devices to eliminate the electronoptically produced distorted image and keystone delineation.

The object of the present invention is to provide a storage tube, the simple physical manner of operation of which does not make any demands greater than normal, either on the manufacture and the nature of the individual system parts of the discharge vessel, or on the operating means. Accordingly, the invention provides an electric discharge vessel for the storage of electric signals, comprising a beam generating system for a modulated recording beam of rapid electrons for the recording of the electric signals to be stored and another beam generating system arranged coaxially therewith for an electron beam of slow electrons for the picking up of the stored signals, and a storage electrode arranged between the beam producing system, the storage electrode being in accordance with the invention made of metal-backed mica as a narrow cylindrical member extending coaxial to the axis of the beam system so that the two beams for the recording and pick-up, each describe upon such member a conical path, under control of known deflecting means, thereby recording thereupon circularly in punctiform manner at the same place, the circles coinciding, the recording beam striking obliquely and the pick-up beam, due to electrostatic means which exert a retarding action, striking approximately perpendicularly.

In a storage tube made in accordance with the above noted requirements, the recording beam, in order to obtain a high secondary emission, also strikes the storage electrode obliquely but in contradistinction to prior arrangements in such a manner that the angle of inclination which the beam embraces with the storage electrode is, for instance, on the closed circle, always of the same size for all image points, so that a distortion correction is not necessary at all or, if needed, may be made in a very simple manner.

The invention will now be described with reference to the accompanying drawing, wherein

Fig. 1 shows schematically an embodiment of a storage tube in accordance with the invention wherein the recording and pick-up beams always describe coinciding circles on the storage electrode; and

Fig. 2 shows diagrammatically in a partial view the electrode arrangement and the beam path in the vicinity of the storage electrode of a modified embodiment.

The invention will first be explained with reference to Fig. 1. The necessary electrodes contained in a discharge vessel are shown in schematic manner, and the beam path which develops as a result of the electric potentials on the electrodes are also indicated.

Coaxially to the axis of the discharge vessel, there is provided a storage electrode 1 made in the form of a cylindrical shell and comprising a storing layer, in the simplest case, of mica, and a metal coating 2 serving as signal plate or electrode. Coaxially with this storage electrode, there is provided at one end of the discharge vessel an electron gun 3 which supplies for the recording of the electric signal, an electron beam of an energy corresponding to an acceleration potential of about 1000 volts. The beam is, in known manner, deflected by means of a deflecting system 4 so as to form a conical outline in such a manner that the image point of the beam describes on the storage electrode 1, a circle. Such a deflection is obtained in known manner for instance, by a pair of coils which are perpendicular to each other and traversed by a sinusoidal current. The recording signal may be impressed upon the beam, by means of a control electrode (not shown), thereby controlling the intensity of the beam. In a similar manner, a further electron gun 5, disposed coaxially with and diametrically opposite to the electron gun 3 produces an electron beam the velocity of which is at first approximately of the same value and which is also deflected in a corresponding deflecting system 6 so as to form a conical outline. Before reaching the storage electrode, the pick-up beam which has been deflected as described, passes through two serially disposed cylindrical electrodes 7 and 8 having diameters and potentials which differ corresponding to the beam path and is so decelerated and radially deflected as a result of the cylindrical lens which is thereby formed that the electrons strike the storage electrode 1 approximately perpendicularly and furthermore, with a velocity of zero. This is obtained due to the fact that, corresponding to the signal plate or electrode 2 biased to about 1000 volts, the cathode of the pick-up beam-producing system already has a potential of 1000 volts. The image point described by the pick-up beam describes a circle in the same way as in the case of the recording or writing beam on the storage electrode at the same place so that by suitable adjustment or by selection of the electric potentials, the recording and pick-up circles coincide. Due to the oblique striking of the recording-beam electrons, there will result a high secondary emission and the charges produced by the recording beam on the storage layer will always be positive. The cylindrical electrode 8 due to its positive potential with respect to the signal electrode serves as collector for the secondary electrons which are thereby released. The slow electrons of the pick-up beam which strike approximately perpendicularly make possible a pick-up of excellent efficiency

which is not disturbed by secondary emission or similar effects.

In the case of the described embodiment, it is absolutely necessary for the dependable operation of the storage tube, that the circles described by the beams for the recording and pick-up on the storage electrode coincide exactly in height along the axis of the tube. For this purpose an adjustment is generally necessary which may be effected by means of the deflecting system. The stored signal is removed from the signal electrode **2** and fed, if desired, with the interposition of a filter, to a video-amplifier **11**.

According to a further feature of the invention, a simplification may be achieved by using, in place of the image point circles, narrow cylindrical surfaces composed in line form. This may be done by inserting another cylindrical electrode **9** in the path of the recording beam and by partially masking the storage electrode by means of a further cylindrical electrode **10**, thereby imparting to the beam a radial distortion, by the cylindrical lens thereby formed, similar to the astigmatism of oblique pencils of rays in optics, and thus deforming the beam into a sort of flat beam. The same result may be obtained in connection with the pick-up beam by the electrodes **7** and **8**, so that a narrow cylindrical surface of axial image lines is in each case delimited on the storage electrode by the electrodes **8** and **10**. With such an arrangement, it is easily possible to bring about coincidence of the cylindrical paths described by the pick-up and recording beams.

In accordance with a further feature of the invention, an embodiment may be provided comprising an electrode system for producing complete separation of the recording and pick-up beams. Fig. 2 shows a portion of a corresponding storage tube with the electrode arrangement necessary for understanding the mechanics of operation.

The storage electrode **1**, **2** is so dimensioned and disposed directly in back of the electrodes **8** and **10**, as seen in the direction of the beam, that it occupies one-half (namely the half located on the pick-up beam side) of the gap cross-section formed between the electrodes **8** and **10**. The obliquely incident recording beam **12** then strikes the storage electrode only in part, while its other part is lost to the storage proper. A collector **13** is disposed in back of the half of the gap section which remains free, for receiving that portion **14** of the pick-up beam which passes through the free gap and therefore does not extinguish the positive charges on the storage plate. The collector **13** is furthermore so far from the electrodes **8** and **10** that no recording electrons can strike it. Since the potential of the collector is positive with respect to the electrodes **8** and **10** which act as shutters, similar conditions occur as are present in a triode. The space filled with slow electrons from the free half of the gap may be considered as a virtual cathode from which the electrons arrive at the collector **13** which acts as anode, the electrons being controlled by the potential field formed by the electrodes **8** and **10**, corresponding to a control grid of a triode. Positive charges produced by the recording beam on the storage layer **1**, will effect a change of the potential in the open gap half so that more electrons of the pick-up beam pass to the collector **13** and thus control the collector current corresponding to the stored signal. The pick-up signal can thus be fed to an amplifier **16** completely separated from the recording signal.

As is well known, upon the recording or indicating of electric signals with the use of a storage tube in which the recording and pick-up beams operate always with the same frequency, the phenomenon occurs in many cases, for instance in connection with use for radar purposes, that the stored signal differs in its magnitude only negligibly from the noise level. This situation may be remedied by the application of frequency compression connection with the continuous pick-up, thus employing for the pick-up a lower frequency than for the recording. This is in practice effected by respectively recording or storing the electric signal in connection with the recording beam, for instance up to 50 times, before or while effecting only one pick-up operation. For such a storage operation, with the use of a frequency compression, the storage tube of the invention is particularly suitable insofar as in the described form of the picture point line or picture line cylinder surface, no special precautionary measures are necessary in order to obtain true coincidence of the individual signals. Furthermore, very high frequencies may be employed and the compression factor may be selected as desired; it therefore need not be absolutely a whole number. One prerequisite for proper operation in connection with such frequency compression is that the signals are additively amplified, in this case stored, and that their indication takes place in a linearly faithful manner. These conditions are however fulfilled in the storage tube in accordance with the invention since in connection with the individual recording operations, the noise levels in question are not correlated as the signals themselves. The individual noise levels rather, due to their varying instantaneous values, give upon summation an average level which is approximately constant for all storage points and from which the additively amplified signal clearly differs.

Changes may be made within the scope and spirit of the appended claims.

I claim:

1. In a double ended electron tube for storing electric signals and having an amplifier output for subsequent release and further utilization of said signals, a first system for generating a recording beam of fast electrons which beam is modulated by electric signals to be stored, and a second system disposed coaxially to the first system and axially spaced therefrom for generating a constant electron stream of slow electrons for the pick-up and release of the stored signals, a cylindrical storage electrode disposed between the beam generating systems, said cylindrical storage electrode being made of mica backed by a cylindrical metal sheet constituting a signal plate and extending coaxial to the axis of said beam generating system, first deflecting means generating a rotating field for causing the fast-electron signal-modulated recording beam to assume cone-like configuration so as to strike said cylindrical storage electrode obliquely on the inside thereof and to trace thereon a circular path, thereby impressing positive electric charges on said storage electrode corresponding to said signals for the purpose of storing said signals, second deflecting means generating a rotating field including electrostatic means for causing said slow-electron pick-up beam to assume cone-like configuration and to exert retarding action thereon and thereby causing said pick-up beam to strike the inside of said cylindrical storage electrode perpendicularly and to trace thereon a similar circular path which coincides spatially with the circular path of positive charges traced thereon by said recording beam, said pick-up beam sensing the positive charges stored on said storage electrode and causing release thereof for further utilization of the signals corresponding thereto.

2. Electric discharge device, according to claim 1, comprising two cylindrical electrodes of different diameter corresponding to the cone configuration of said pick-up beam disposed on the side of the pick-up beam between said second deflecting means and the storage electrode, said electrodes being traversed by the beam and being so arranged coaxially to the axis of the beam system and provided with electric potentials, that the decelerated slow electrons strike the storage electrode approximately perpendicularly.

3. Electric discharge device, according to claim 1, comprising for each beam generating system two cylindrical electrodes of different diameter, respectively disposed between the corresponding deflecting means and said storage electrode corresponding approximately to the beam path,

said electrodes being so arranged and provided with such electric potentials that a cylindrical lens is respectively formed thereby in which the obliquely traversing recording and pick-up beams, respectively, are subjected to a radial line-like delineation similar to astigmatism of oblique pencils of rays in optics so as to form approximately flat beams, the recording and pick-up beams passing upon said storage electrode cylindrical paths which are composed in a line-like manner of dashes in the axial direction and the length of which is at least partially determined by the width of the annular space between the cylindrical electrodes adjacent said storage electrode.

4. An electric discharge device, according to claim 3, comprising an electrode arrangement for the complete separation of recording and pick-up signals, said storage electrode being so dimensioned and radially outwardly arranged in back of the adjacent two cylindrical electrodes to form an adjacent cylindrical-surface electrode with the

effective width of said storage electrode being less than the width of said annularly shaped space, a cylindrical collector disposed in operative radial alignment with the remaining unobstructed portion of said annular space and so disposed radially outwardly with respect thereto that only the pick-up beam part arrives at said collector, the positive charges produced on the storage layer being operative to affect the effective potential at the unobstructed portion of said annular space, whereby the adjacent electrodes cooperate thereat in the manner of operation of a control grid of a triode.

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