

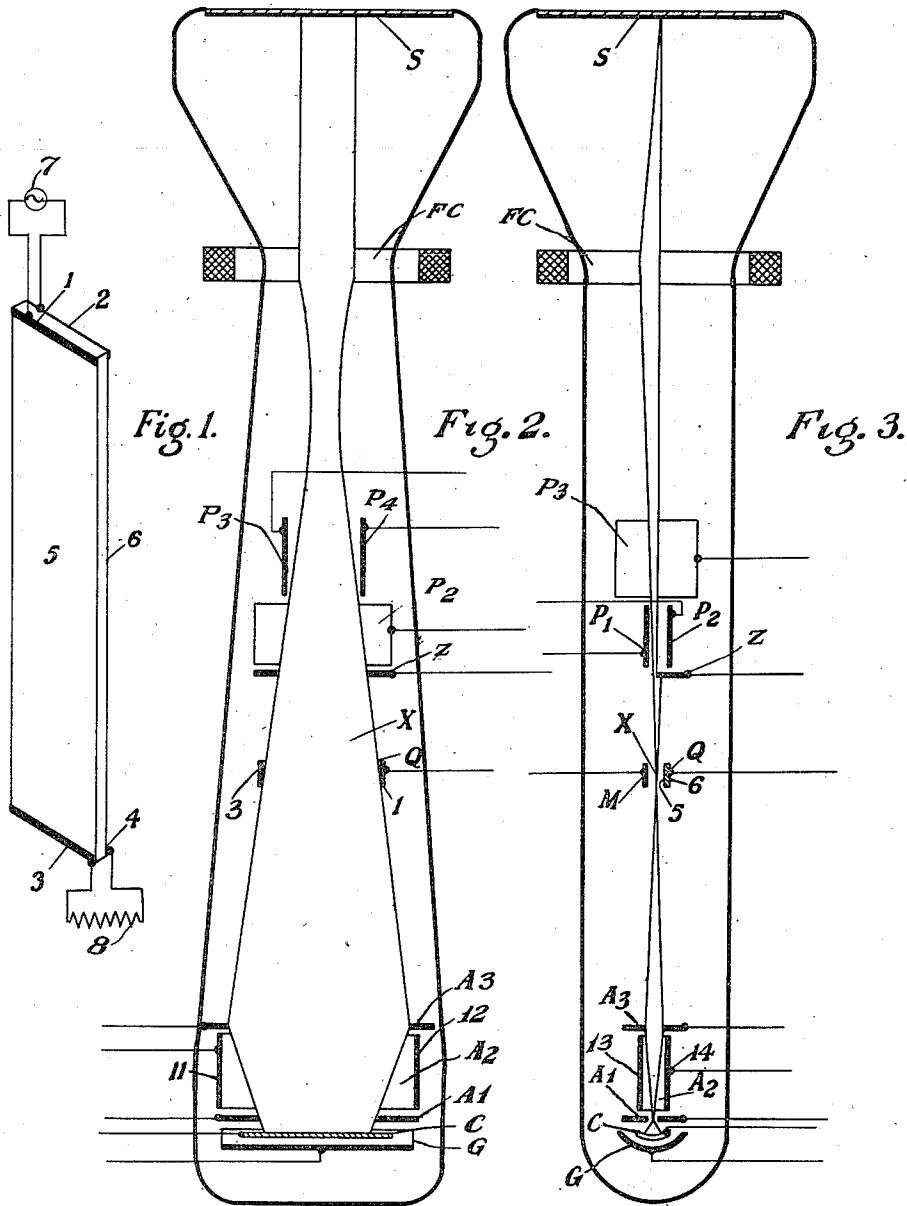
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ELECTRICAL APPARATUS

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# UNITED STATES PATENT OFFICE

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## ELECTRICAL APPARATUS

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This invention relates to electrical apparatus wherein piezo-electric material is employed to produce time delays in electrical voltage variations.

According to one form of the invention, a bar of piezo-electric material is provided with a pair of electrodes at one end and with mechanical or electrical damping means connected to the other end, whereby voltage variations applied between the electrodes at the first end produce stress waves which travel along the bar, which in turn produce corresponding voltage variations with time delay at points along the bar, reflected stress waves being substantially prevented by the damping means.

According to another form of the invention, a delay circuit comprises such a bar of piezo-electric material provided with electrodes and damping means, the input terminals being the pair of electrodes at the one end, and the output terminals being a pair of electrodes which are provided at the other end and between which delayed voltage variations are produced by the stress waves corresponding to the voltage variations between the input terminals.

A further aspect of the invention is the method of deflecting elemental parts of a ribbon cathode ray beam successively in response to a voltage variation, which consists in applying the voltage variation to a pair of electrodes attached to one end of a bar of piezo-electric material which is located parallel to the width of the ribbon beam, whereby a stress wave is caused to travel along the bar, the resultant potential waves along one side of the bar being utilised to deflect successively the elemental parts of the cathode ray beam.

Further aspects of the invention will appear from the following description and appended claims.

In the accompanying drawing, Figure 1 is a perspective view of a quartz bar arranged for use in accordance with the invention, Figures 2 and 3 being diagrammatic cross-sections taken on mutually perpendicular planes through the axis of a cathode ray tube embodying the quartz bar of Figure 1 and functioning according to the method of the present invention.

The quartz bar illustrated in Figure 1 may be 50 millimetres long, 5 millimetres wide and 1 millimetre thick. The quartz crystal is preferably so cut that its length is in the direction known as the Y axis, its width in the Z axis, and its thickness in the X axis. Electrodes 1 and 2, each half a millimetre wide and extending across the whole width of the quartz bar, are arranged close to one end of this bar, on the sides 5 and 6 respectively. Electrodes 3 and 4 are similarly arranged close to the other end.

A signal applied from signal source 7 in the

form of a change of potential difference between electrodes 1 and 2 will initiate a stress wave which will travel along the bar at the velocity of compression waves in quartz, approximately half a million centimetres per second. This stress wave will be accompanied by a potential difference between a line on the side 5 and an opposite line on the side 6, both parallel to electrodes 1 and 2 and moving away from them at this same velocity. A suitable damping circuit shown as resistance 8 connected between electrodes 3 and 4 will prevent reflection of this stress wave and the accompanying potential differences.

The voltage appearing between the moving lines on sides 5 and 6, and finally between the electrodes 3 and 4, will be a delayed copy of the differential, with respect to time, of the voltage applied between electrodes 1 and 2.

If it is desired to obtain from electrodes 3 and 4 a delayed copy of a signal, rather than of the differential, the signal should be applied between electrodes 1 and 2 in the form of modulation of a radio frequency voltage oscillation.

The electron gun of Figures 2 and 3 is of a type which generates an electron beam of ribbon form. The part-cylindrical emissive surface of the cathode C is seen in Figure 3 as having a curvature struck from the centre of the aperture in the first anode A<sub>1</sub>. The control electrode G may be maintained at the same potential as, or negative with respect to, cathode C. It is also part-cylindrical in form and its curvature as seen in Figure 3 may also be struck from the same centre. The first anode A<sub>1</sub> is a flat plate having a long slit to pass the electron beam. The second anode A<sub>2</sub> is of rectangular box form, made up of side plates 11 and 12 parallel to the plane of Figure 3 and of side plates 13 and 14 parallel to the plane of Figure 2. The third anode A<sub>3</sub> is a flat plate having a long slit to pass the electron beam. The anodes A<sub>2</sub>, A<sub>3</sub> together serve to produce a converging electrostatic electron lens, so that the ribbon electron beam is focussed at position X to a very narrow thickness as seen in Figure 3, and a convenient width as seen in Figure 2. For this purpose anodes A<sub>2</sub>, A<sub>3</sub> may be maintained at potentials of the order of 200 and 1,000 volts, respectively, positive to cathode.

A quartz bar Q, similar to that shown in Figure 1, is arranged with its side 5 close beside the electron beam at position X, and parallel to the width of the beam. Since the quartz bar Q will be to some extent subject to bombardment by stray electrons, some return path should be provided for these to leak away. For this purpose the face 5 is given a semi-conducting coating, made for example by platinum sputtering. On the opposite side of the electron beam is a parallel metal plate M, which has the same dimensions as the side 5 of quartz bar Q.

Plate M is maintained at fixed potential, normally equal to the potential of final anode A<sub>3</sub> of the gun. The mean potential of side 5 of the quartz bar is normally equal to the potential of plate M. Potential waves travelling along quartz bar Q, in response to voltage variations between electrodes 1 and 2, will deflect successively, in the direction parallel to the plane of Figure 3, elemental portions of the electron beam.

Each elemental portion of the electron beam will be cut off by a sheet metal stop electrode Z to a degree depending upon the degree of its instantaneous deflection. Stop Z is maintained at fixed potential, normally equal to that of anode A<sub>3</sub>. That part of each elemental portion of the beam which is not cut off by stop Z, will be focussed by magnetic focussing coil FC to converge upon screen S, so that there appears on screen S an image of the cross-section of the beam at X. The elemental portions of this image will have different intensities, according to the potential distribution along face 5 of the quartz bar Q.

Two pairs of deflector plates P<sub>1</sub>, P<sub>2</sub> and P<sub>3</sub>, P<sub>4</sub> are provided to deflect the beam as a whole in the direction parallel to the planes of Figures 3 and 2, respectively.

If the potential difference between the pair of deflector plates P<sub>1</sub>, P<sub>2</sub> is maintained constant, the line trace which the ribbon beam forms by impact on the screen will move in the direction of its length in response to potential differences applied between plates P<sub>3</sub>, P<sub>4</sub>.

The speed and sense of deflection by plates P<sub>3</sub>, P<sub>4</sub> may be made such as to compensate for the travel of the stress wave in quartz bar Q. Thus any point on screen S which at one instant is impinged upon by the elemental portion of the electron beam which has passed the quartz bar Q near its end electrode 1, will subsequently be impinged upon by all the other elemental portions in succession. As each elemental portion passes this point on the screen, so the stress and potential waves in quartz bar Q will have reached the position opposite to that elemental portion in the cross-section X. The intensity of each elemental portion as it impinges on this particular point on the screen will, therefore, be brought to the same value; and the intensity of the response at this point will continue to represent the potential difference which was applied between electrodes 1 and 2 at a particular instant of time. Thus, the variation in the intensity of response along the length of the stationary trace on the screen will correspond with the variation with time of the voltage applied between electrodes 1 and 2.

A television picture may be reproduced by applying the line deflection potentials to plates P<sub>3</sub>, P<sub>4</sub> and frame deflection potentials to plates P<sub>1</sub>, P<sub>2</sub>, the picture brightness signals being applied between electrodes 1 and 2.

In a modification of the tube illustrated in Figures 2 and 3, a second quartz bar similar to bar Q is substituted for plate M. The signals applied to the end electrodes thereof are modulated in opposite phase from those applied to electrodes 1 and 2 of bar Q.

I claim:

1. The method of deflecting elemental parts

of a ribbon cathode ray beam successively in response to a voltage variation, which consists in applying the voltage variation to a pair of electrodes attached to one end of a bar of piezo-electric material which is located beside and parallel to the width of the ribbon beam, whereby a stress wave is caused to travel along the bar, the resultant potential waves along one side of the bar being utilised to deflect successively the elemental parts of the cathode ray beam, and preventing reflection of said stress wave by damping means at the other end of said bar.

2. The method of modulating elemental parts of a ribbon cathode ray beam successively in response to a voltage variation, which consists in deflecting the elemental parts of the beam by applying the voltage variation to a pair of electrodes attached to one end of a bar of piezo-electric material which is located beside and parallel to the width of the ribbon beam, whereby a stress wave is caused to travel along the bar, the resulting potential waves along one side of the bar being utilised to deflect successively the elemental parts of the cathode ray beam, and intercepting by a stop electrode a proportion of each elemental part of the beam according to the degree of its deflection, and preventing reflection of said stress wave by damping means at the other end of said bar.

3. The method of producing on a screen a trace modulated, at any instant, along its length in accordance with the variations of a voltage over a preceding period of time, which consists in modulating elemental parts of a ribbon cathode ray beam according to claim 2, and focussing on the screen an image of a cross-section of the beam in the vicinity of the bar of piezo-electric material.

4. The method of producing upon a screen a stationary trace modulated in intensity along its length in accordance with the variations of a voltage over a preceding period of time, which consists in modulating elemental parts of a ribbon cathode ray beam according to claim 2, focussing on the screen an image of a cross-section of the beam in the vicinity of the bar of piezo-electric material, and deflecting the beam as a whole in the opposite direction to the direction of travel of the stress wave and at such speed as to compensate for the travel of the stress wave.

5. The method according to claim 2, wherein the voltage variations applied to the pair of electrodes attached to the end of the bar of piezo-electric material consist of modulated high frequency voltage variations, the resulting deflections of elemental parts of the beam corresponding to the modulation.

6. A cathode ray tube comprising means for generating an electron beam of ribbon form, a bar of piezo-electric material located adjacent and parallel to the width of said beam, a pair of electrodes connected to one end of said bar to which voltage variations are applied to produce a stress wave traveling along the length of said bar, the resultant potential waves along one side of the bar being effective to deflect successively the elemental parts of the cathode ray beam, and damping means at the other end of said bar for preventing reflection of said stress wave.

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