Oct. 22, 1957 K. F. ROSS 2,810,859

CATHODE RAY FILTER

Filed May 27, 1955

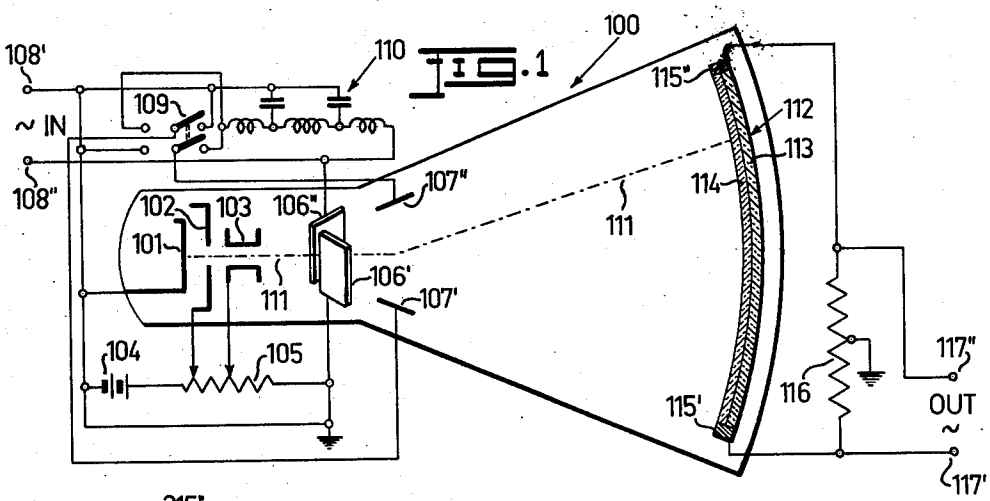


FIG. 1

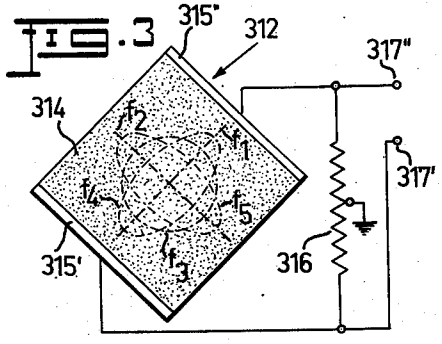


FIG. 3

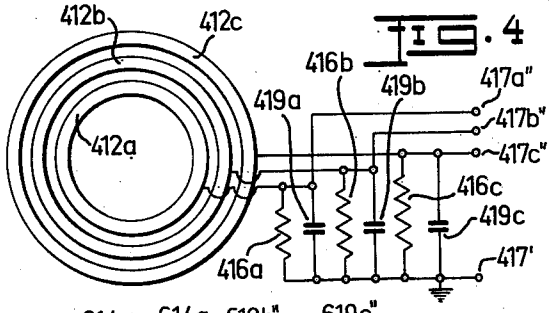


FIG. 4

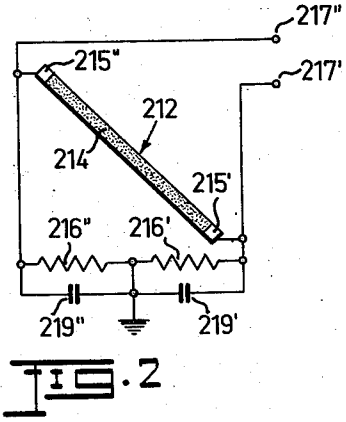


FIG. 2

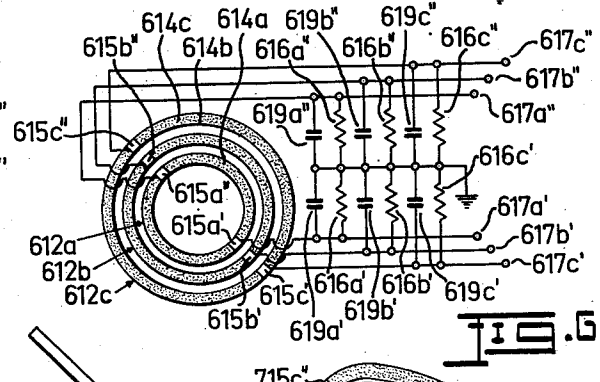


FIG. 6

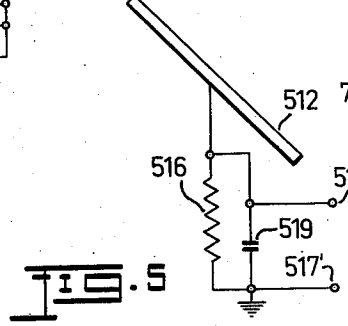


FIG. 5

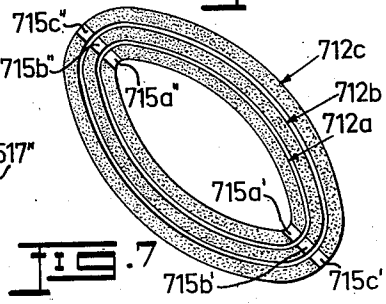


FIG. 7

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CATHODE RAY FILTER

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14 Claims. (Cl. 315—21)

My present invention relates to a cathode ray filter for electromagnetic waves. This application is a continuation-in-part of my co-pending application Ser. No. 155,205, filed April 11, 1950, now Patent No. 2,728,854, issued December 27, 1955.

An object of my present invention is to provide means in a cathode ray tube for discriminating between waves of different frequencies and selectively producing an output representative of one or more of such waves.

Another object of this invention is to provide a filter adapted to accept certain wavelengths within a given band while rejecting other wavelengths, in combination with means for interchanging the pass and stop bands of such filter.

A further object of the invention is to provide sharply discriminating filter means for channeling single-frequency waves of different amplitudes into respective signaling circuits.

In a system as herein disclosed there are provided first and second deflecting means for deflecting the beam of a cathode ray tube in different (usually perpendicular) planes, in combination with a network for varying the relative phase of signal waves applied to these two deflecting means in dependence upon their frequency. (A similar system utilizing a network for varying the relative amplitude, rather than phase, of such signal waves has been disclosed and claimed in co-pending application Ser. No. 155,207, filed April 11, 1950 by Phil Cutler and myself, now Patent No. 2,728,911, issued December 27, 1955.)

A feature of the instant invention resides in providing, in a cathode ray tube system as set forth above, a plurality of concentric annular output electrodes each shaped and positioned to register with the trace of the beam when the latter is deflected by a signal of predetermined frequency and amplitude; if these output electrodes are all similar to each other (e. g. all circular), they will all respond to signals of the same frequency but of different amplitudes.

Another feature of my invention resides in the provision of an output electrode having at least one but not more than two axes of symmetry, each axis of symmetry being inclined with respect to the two planes of deflection of the beam. An electrode of this description has a preferred dimension which, if positioned at a 45° angle relative to the planes of deflection, will coincide with the axis of an ellipse which will be the major axis for some frequencies and the minor axis for others. A relatively large output will then be obtainable from waves in the first-mentioned frequency group while only a negligible output will result from waves of said other frequencies. When the connections between the signal source and the two deflecting means are reversed, the positions of the two frequency groups in the spectrum are interchanged.

Advantageously, therefore, a cathode ray tube according to the invention comprises target means in the shape of a plurality of distinctly elliptical, concentric and similar ellipses whose major and minor axes extend at 45°

angles with respect to two perpendicular planes, in combination with means for subjecting the beam of the tube to out-of-phase deflecting forces in said two planes derived from the same input signal.

My invention will be more fully described with reference to the accompanying drawing in which:

Fig. 1 shows a circuit arrangement of a cathode ray tube system embodying the invention; and

Figs. 2–7 illustrate different targets adapted to be used as output electrodes with the system of Fig. 1.

Throughout the drawing, similar elements have been denoted by the same reference numerals prefixed by different hundreds digits identifying the respective figures.

In Fig. 1 there is shown a cathode ray tube **100** comprising a source of electrons shown as a cathode **101** and focusing or beam-forming means shown as a first anode **102** and a second or accelerating anode **103**. The electrodes **101**, **102** and **103** derive their potentials from a battery **104** and a potentiometer **105** in series therewith.

Two pairs of deflecting electrodes **106′**, **106″** and **107′**, **107″**, arranged in mutually perpendicular planes, receive signals from input terminals **108′**, **108″** to which the horizontal deflectors **106′**, **106″** are connected directly; the vertical deflectors **107′**, **107″** are connected across the signal source **108′**, **108″** through a reversing switch **109** and a delay network **110**. This network, shown schematically as composed of a pair of ladder-type filter sections, may be a four-terminal network with lumped constants, a coaxial line, or any other combination of circuit elements adapted to impart a progressive phase shift to a range of signals within a predetermined frequency range without materially varying their relative amplitudes.

The beam **111**, produced by the electron gun **101—103**, impinges upon an output electrode generally indicated at **112** and consisting of a dielectric backing **113**, a layer **114** of resistance material thereon and a pair of highly conductive terminal members **115′**, **115″** in contact with that layer at diametrically opposite locations. Electrode **112** may be similar to the target **312** shown in face view in Fig. 3, having its terminal members **115′**, **115″** inclined at 45° with respect to the horizontal and vertical planes of deflection; these terminal members are connected across an output resistor **116**, grounded at its center, and to respective output terminals **117′**, **117″**.

The operation of the system of Fig. 1 is as follows:

With switch **109** in its right-hand position of closure, ground on signal terminal **108′** is applied to horizontal deflecting electrode **106′** and to vertical deflecting electrode **107′**. It will be convenient to consider these two electrodes as located on the negative half-axes of a coordinate system. A positive signal voltage applied to terminal **108″** will then appear instantaneously on electrode **106″**, thus tending to deflect the beam in the "positive horizontal" direction; after a delay θ, dependent upon the signal frequency, it will also appear on electrode **107″** so as to tend to deflect the beam in the "positive vertical" direction. If the position of switch **109** is now reversed, the phase of the signal on electrode **107″** is shifted by 180° and the lagging phase angle θ is converted into a leading phase angle of like magnitude. It will thus be seen that a phase reversal on one set of deflecting electrodes is equivalent to a transfer of delay network **110** from one set of electrodes to the other.

If, for a given signaling frequency, the phase angle θ is equal to 0, 360° or any multiple thereof, the deflected beam will produce a linear trace bisecting the positive and negative quadrants of the coordinate system. In Fig. 2 I have shown a target electrode **212** aligned with such trace, comprising an elongated body **214** of resistance material inclined at 45° to the horizontal and vertical planes of deflection. Terminal members **215′**, **215″** at

the ends of body **214** are connected across series resistors **216'**, **216''** which are grounded at their junction, each resistor being bridged by a respective condenser **219'**, **219''** serving as a shunt for impulses due to brief crossings of target **212** by the beam when the latter is deflected by signal waves not having the proper frequency. The output terminals of the system are shown at **217'**, **217''**.

The target electrode **312** of Fig. 3 comprises a rectangular resistive body **314** bounded on two opposite edges by terminal strips **315'**, **315''**, the latter being connected across output terminals **317'**, **317''** which are bridged by resistor **316** grounded at its midpoint. Owing to the arrangement of strips **315'**, **315''**, the face of electrode **312** (as also of electrode **212**) has but two axes of symmetry even if its resistance body **314** is a perfect square; these axes are again inclined at 45° angles to the horizontal and vertical planes of deflection.

If f_1 is a signal frequency for which the phase delay introduced by network **110** is 180° or an odd multiple thereof, and if f_2 is a frequency for which this phase delay is zero or any even multiple of 180° as considered in connection with Fig. 2, the trace of the beam will be a straight line perpendicular (f_1) or parallel (f_2) to the strips **315'**, **315''**. In the first instance the output at terminals **317'**, **317''** will be a maximum; in the second instance this output will vanish. When the switch **109** is reversed, the positions of traces f_1 and f_2 will be interchanged whereby only the latter frequency will produce an output. It will thus be seen that the device now being described acts as a filter having a pass band centered on a first frequency f_1 and a stop band centered on a second frequency f_2, the switch **109** serving as a means for interchanging the positions of these bands in the frequency spectrum.

A frequency f_3, for which the phase delay is 90° or an odd multiple thereof, will give rise to a circular trace as likewise shown in Fig. 3; this trace will be unaffected by reversals of switch **109**, producing output oscillations of equal amplitudes in the two switch positions. Intermediate frequencies will produce elliptical traces having their major axes perpendicular (f_4) or parallel (f_5) to terminal strips **315'**, **315''**. These frequencies will, accordingly, result in a relatively large and a relatively small output respectively, subject to reversal by operation of switch **109**. It will be noted that the relative amplitudes of the output oscillations in Fig. 3 are determined by the extent of the beam sweep in a preferred dimension (perpendicular to strips **315'**, **315''**) and are substantially independent of the location of the beam trace on the face of electrode **312**.

In Fig. 4 I have shown a type of target adapted to discriminate between a single, pure sine wave of predetermined frequency on the one hand and other types of waves, including or not including the desired frequency, on the other. Such devices are particularly useful in voice frequency signaling systems of telephone circuits wherein it is necessary to guard against false operation of a relay or other switching mechanism by speech waves that happen to contain the critical frequency.

The target of Fig. 4 comprises three concentric ring electrodes of highly conductive material, indicated at **412***a*, **412***b* and **412***c* respectively. Each of these electrodes is connected to a respective output resistor **416***a*, **416***b*, **416***c* and a respective output terminal **417***a''*, **417***b''*, **417***c''*, the later in turn being connected to grounded terminal **417'** by way of respective condensers **419***a*, **419***b*, and **419***c*.

If an incoming signal consists of a pure sine wave of frequency f_3, the beam **111** will trace a circular path which, depending upon the amplitude of the wave, may be made to coincide with one of the electrodes **416***a*, **416***b*, **416***c*, thus giving rise to a D.-C. output signal at the corresponding set of terminals. If the frequency of the wave has a value other than f_3 as defined above, the beam will only intermittently intersect the electrodes of Fig. 4, thereby producing a series of short pulses which will be ineffective to result in any switching operation, being largely shunted to ground through the respective condensers **419***a*, **419***b*, **419***c* (the same as in the system of Fig. 2). A similar situation will exist if some other signal is superimposed upon the wave of frequency f_3, since then the trace will be displaced from its concentric position with respect to the electrodes **412***a*, **412***b*, **412***c*.

Fig. 5 shows a single electrode **512** consisting of a conductive strip inclined at 45° and connected to an output resistor **516**, the output terminals **517'**, **517''** being bridged by a condenser **519**. From the foregoing it will be understood that this electrode responds only to a signal wave of frequency f_2 and substantially rejects all other waves, but that in contradistinction to the target **212** of Fig. 2 it produces a steady output potential rather than an oscillating voltage in response to such signal. The output appearing across terminals will, furthermore, be independent of the amplitude of the incoming signal wave.

Fig. 6 illustrates a target combining the features of the systems of Figs. 2 and 4, designed to produce an oscillatory output which is channeled into one of several load circuits according to the amplitude of the incoming wave. This figure shows three concentric electrodes **612***a*, **612***b*, **612***c* comprising respective annular layers **614***a*, **614***b*, **614***c* of resistance material and pairs of diametrically opposite terminal elements **615***a'*, **615***a''*; **615***b'*, **615***b''*; **615***c'*, **615***c''*. Each of these terminal elements is grounded by way of a respective output resistor **616***a'*, **616***b'*, **616***c'* and **616***a''*, **616***b''*, **616***c''*, shunted by a respective condenser **619***a'*, **619***b'*, **619***c'* and **619***a''*, **619***b''*, **619***c''*. The corresponding output terminals are indicated at **617***a'*, **617***b'*, **617***c'* and **617***a''*, **617***b''*, **617***c''*.

In Fig. 7 I have shown a target consisting of three concentric annular electrodes **712***a*, **712***b*, **712***c*, which are similar to the electrodes of Fig. 6 but are in the form of elongated ellipses rather than circles. Again, each electrode consists of resistance material and is provided with diametrically opposite terminal elements **715***a'*, **715***a''*; **715***b'*, **715***b''*; **715***c'*, **715***c''*. It will be noted that all of these ellipses are similar, i. e. that the ratio of their axes is the same (corresponding to a predetermined signal frequency, such as f_5), and that the major axes are inclined at 45° to the planes of deflection. The output connection of the target electrodes have not been shown in Fig. 7 and may be the same as in Fig. 6. The positioning of the terminal members at the apices of the ellipses is convenient but not essential.

The reversing switch **109**, which would be functionless in the case of circular target electrodes as shown in Figs. 4 and 6, may be used in conjunction with the system of Fig. 7 for varying the frequency to which the system is designed to respond, as by changing it from f_5 to f_4. It will be understood that a steady rather than an oscillating output may be derived from the electrodes **712***a*, **712***b*, **712***c* by constructing them of highly conductive material and connecting them across respective load resistors in the manner illustrated in Fig. 4.

From the foregoing description it will be apparent that the beam of the cathode ray tube will describe a generally elliptical path in response to any particular frequency component within the frequency band considered, the straight lines f_1, f_2 and the circular trace f_3 being extreme and specific instances of such elliptical path. Useful output will, of course, also be obtainable if only part of the beam trace registers with the target, as where a portion of one or more of the annular electrodes in Figs. 4, 6 and 7 is omitted. The invention is, accordingly, not limited to the specific embodiments described and illustrated but is capable of different modes of realization without departing from the spirit and scope of the appended claims.

I claim:

1. A wave filter comprising a source of electrons, focusing means forming said electrons into a beam, a

source of signal waves, first and second deflecting means positioned along the path of said beam, first circuit means connecting said source of signal waves to said first deflecting means for deflecting said beam in one plane under the control of said waves, second circuit means connecting said source of signal waves to said second deflecting means for deflecting said beam in another plane under the control of said waves but with a phase delay relative to its deflection in said one plane, and target means in the path of said beam comprising at least one output electrode having at least one but not more than two axes of symmetry each inclined with respect to said planes.

2. A wave filter according to claim 1, further comprising switch means for reversing the relative phase of said signal waves as applied to said first and second deflecting means.

3. A wave filter according to claim 1, wherein said output electrode is in the form of an elongated ellipse.

4. A wave filter according to claim 3, wherein said output electrode comprises a body of resistance material provided with output connections at diametrically opposite points.

5. A wave filter according to claim 1, wherein said output electrode comprises an elongated strip bisecting the angle between said planes.

6. A wave filter according to claim 1, wherein said output electrode comprises a substantially rectangular element of resistance material provided with highly conductive terminal strips along opposite edges, said terminal strips extending substantially parallel to the bisector of the angle between said planes.

7. In a cathode ray tube, in combination, means for producing an electron beam, a source of signal waves, means connected to said source for deflecting said beam along generally elliptical traces in response to signal waves of a predetermined frequency, a plurality of similar, concentric annular output electrodes shaped and positioned to coincide with said traces for different amplitudes of said waves of predetermined frequency, and a load circuit connected to each of said output electrodes.

8. The combination according to claim 7, wherein said output electrodes are in the shape of elongated ellipses.

9. The combination according to claim 7, wherein said output electrodes comprise annular bodies of resistance material provided with output connections at diametrically opposite points.

10. In a cathode ray tube a target electrode having the shape of at least a substantial part of an elongated ellipse.

11. In a cathode ray tube a target electrode comprising an elongated elliptical body of resistance material and output connections at diametrically opposite points of said body.

12. In a cathode ray tube, in combination, means for producing an electron beam, a source of signal waves, first means connected to said source for deflecting said beam in one plane in the rhythm of said waves, second means connected to said source for deflecting said beam in another plane in the rhythm of said waves but out of phase with the deflection of said beam in said one plane, and an elliptical target electrode in the path of said beam, said electrode having a major axis inclined with respect to said planes.

13. The combination according to claim 12, wherein said planes are perpendicular to each other, said major axis extending at 45° with respect to said planes.

14. The combination according to claim 12, further including switch means for reversing the relative phase of deflection of said beam in said planes.

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