

Nov. 25, 1947.

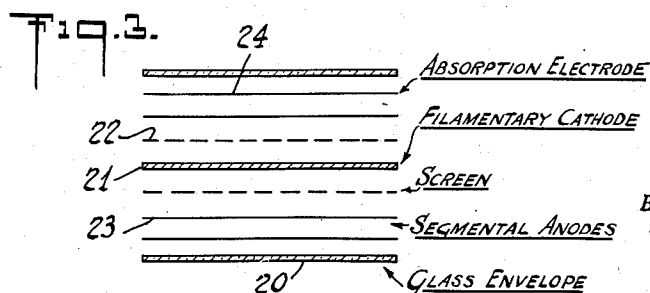
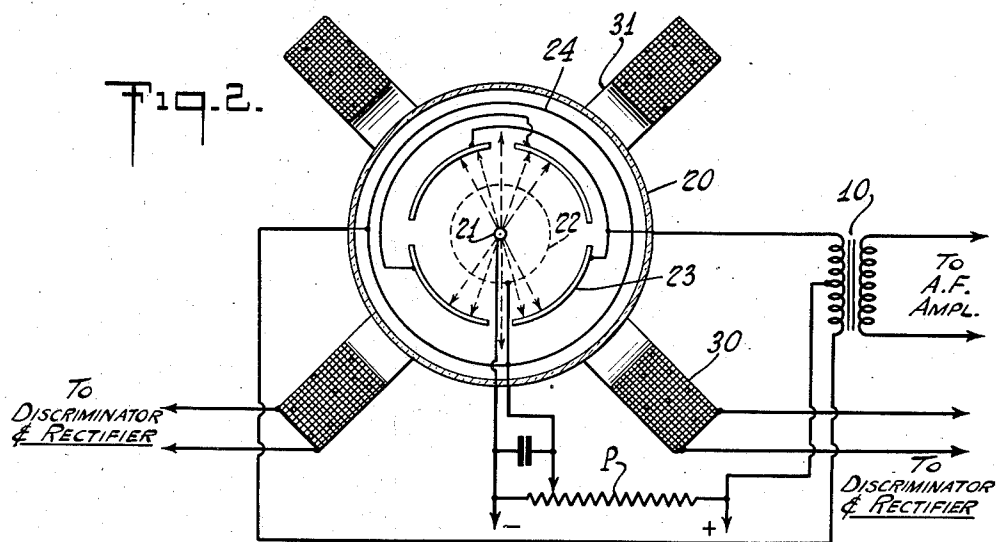
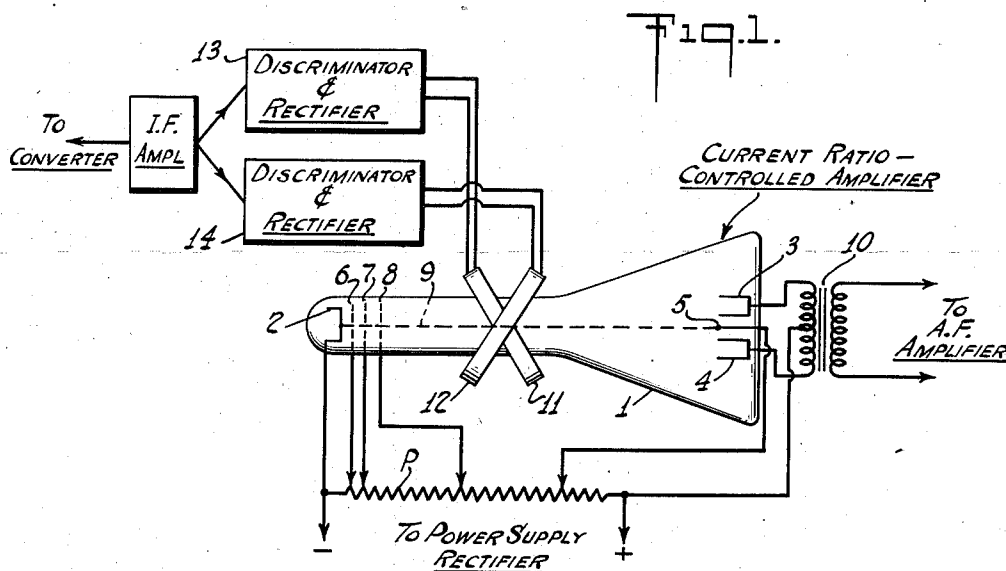
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2,431,396

CURRENT MAGNITUDE-RATIO RESPONSIVE AMPLIFIER

Filed Dec. 21, 1942

2 Sheets-Sheet 1



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CURRENT MAGNITUDE-RATIO RESPONSIVE AMPLIFIER

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2 Sheets-Sheet 2

Fig. 4.

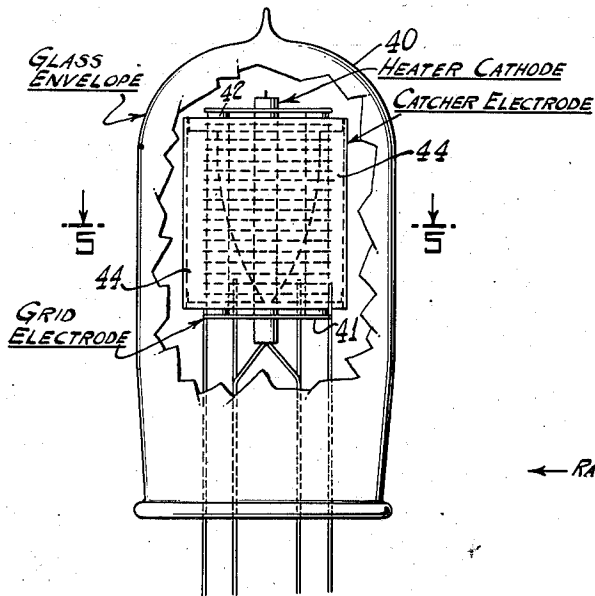


Fig. 6.

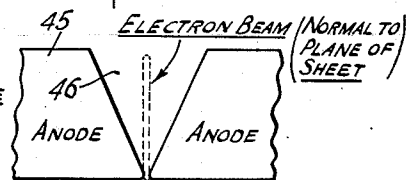


Fig. 7.

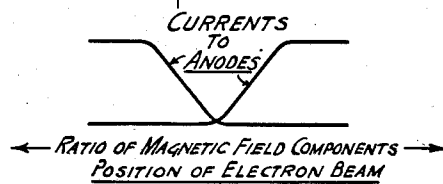


Fig. 8.

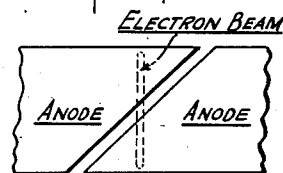


Fig. 9.

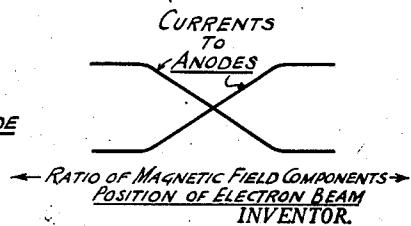
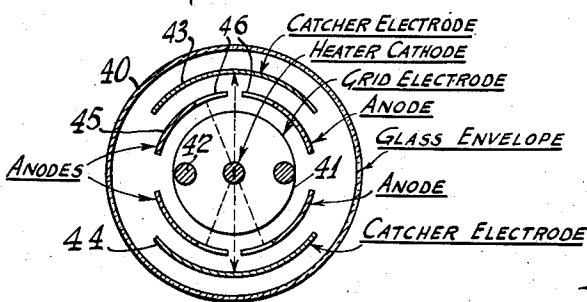


Fig. 5.



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UNITED STATES PATENT OFFICE

2,431,396

CURRENT MAGNITUDE-RATIO RESPONSIVE
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Application December 21, 1942, Serial No. 469,647

21 Claims. (Cl. 250—27)

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My present invention relates to current mag-
nitude ratio-responsive electron discharge de-
vices, and more especially to amplifier circuits
which are responsive solely to current magnitude
ratios.

It has been known in the past to provide a
response according to the ratio of the magnitudes
of two currents but the only device available, of
which I am aware, has been a current ratio
metering instrument in which a magnet bearing
a needle is mounted inside two crossed magnetiz-
ing coils. In this case the magnet aligns itself
parallel to the magnetic field set up by currents
flowing through the coils. The needle indicates
on a suitable scale the ratio of the currents.
However, it has not been known how to secure
an electronic current magnitude ratio-responsive
device.

One of the main objects of my present inven-
tion is to provide a method of controlling the
division of a current into two parts according to
the ratio of the magnitudes of two control cur-
rents.

I have found that when a magnetic field in a
vacuum is made strong enough substantial elec-
tron motions can take place only in the direction
parallel to the magnetic field. Any component
of motion in other directions is overcome, be-
cause the magnetic field bends the path of mo-
tion in these directions back to the axis from
which they started. Having confined the motion
of electrons to directions parallel to a magnetic
field, this direction may be controlled by vary-
ing the direction of the field.

Accordingly, it may be stated that it is an
important object of this invention to provide a
pair of crossed magnetizing coils within which is
located a cathode and an arrangement of anodes,
the distribution of electron current to the anodes
being controlled by controlling the direction of
the magnetic field, and the latter in turn being
controlled by the ratio of the magnitudes of the
currents in the two coils independently of the
individual amplitude of these currents.

In the reception of frequency or phase modu-
lated carrier wave energy, and which generically
may be referred to as "angular velocity-modu-
lated carrier wave energy," it has been the prac-
tice in the past to utilize an amplitude modula-
tion limiter prior to the frequency modulation
detector. The purpose of the amplitude limiter
has been to minimize the effect of noises, unde-
sirable impulses external to the receiver and other
well known effects.

Another important object of this invention is

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to provide a method of receiving angular veloc-
ity-modulated carrier wave energy wherein
amplitude limitation prior to the detector is not
employed, but in place thereof, and subsequent
to the detection of the wave energy, there is
provided an audio frequency output which, over
a large range of amplitudes, is substantially in-
dependent of the amplitude of the radio fre-
quency input energy to the receiving system.

Still other objects of my invention are to im-
prove generally the operation of frequency mod-
ulation receivers, and more especially to provide
current magnitude ratio-controlled electron dis-
charge devices which are reliable and efficient, as
well as economical to construct.

The novel features which I believe to be char-
acteristic of my invention are set forth with
particularity in the appended claims; the inven-
tion itself, however, as to both its organization
and method of operation will best be understood
by reference to the following description taken
in connection with the drawing in which I have
indicated diagrammatically several circuit or-
ganizations whereby my invention may be car-
ried into effect.

In the drawings:

Fig. 1 shows a schematic diagram of a frequency
modulation receiver embodying one form of my
invention,

Fig. 2 shows in lateral section a modification of
the current ratio-controlled amplifier,

Fig. 3 is a longitudinal section through the
amplifier of Fig. 2,

Fig. 4 shows another form of current ratio-
controlled electron discharge device,

Fig. 5 is a section on line 5—5 of Fig. 4 looking
in the direction of the arrows,

Fig. 6 shows one form of anode configuration
useful in the device of Fig. 4,

Fig. 7 is the anode current response character-
istic for the anodes of Fig. 6,

Fig. 8 shows a modified form of anode con-
figuration,

Fig. 9 is the anode current characteristic for
the anodes of Fig. 8.

Referring, now, to the system of Fig. 1, there
is shown an electron discharge device which I
have designated as a "current magnitude ratio-
controlled amplifier." The device generally com-
prises an evacuated glass envelope 1 which has
a relatively constricted portion housing an elec-
tron emission element, or cathode, 2. The flared
portion of envelope 1 houses at the broad end
thereof a pair of spaced hollow collector elec-
trodes 3 and 4. Between these electrodes is posi-

tioned an electrode 5. The electrodes 6, 7 and 8 are spaced in succession along the electron stream 9 to cause the stream to act as a beam, and to focus the beam normally upon the electrode 5. The potentiometer P supplies direct current voltages to the various electrodes. Thus, electrodes 3 and 4 are connected to opposite ends of the primary winding of transformer 10. The midpoint of the primary winding is connected to the positive terminal of the potentiometer P.

Electrode 5 is connected to a less positive point on P, while electrodes 8, 7 and 6 are connected to points of successively less positive potential. Cathode 2 is connected to the negative terminal. Any desired form of heater element may be used for the cathode. The device described thus far comprehends the elements within the tube envelope. A pair of crossed annular coils 11 and 12 are provided at a point of the envelope such that a magnetic control field is set up which will control the electron beam 9. The coils 11 and 12 are supplied with the currents whose magnitude ratio is to be indicated at the output 10.

The tilted coils 11 and 12 produce a magnetic field whose direction depends on the ratio of the magnitudes of currents flowing through the coils, but not on their individual amplitudes. The electron stream 9 can flow only in the direction of the field, if the latter is strong enough. The energizing currents flowing through coils 11 and 12 may be derived from any desired sources of high frequency current whose ratio is to be determined. By way of illustration, and as one object of my invention, the current sources are shown as consisting of a pair of separate discriminator-rectifier networks 13 and 14.

The networks 13 and 14 may correspond to the back to back detectors for frequency modulated (FM) carrier waves which are well known in the art. These networks may be tuned to the operating intermediate frequency (I. F.) value where the receiver is of the superheterodyne type. The circuits of such a receiver are too well known to require detailed description. In the case of a frequency modulation receiver of the superheterodyne type, there may be applied, for example, signals whose mean frequency lies in a range of 42-50 megacycles (mc.), the presently assigned FM band. The frequency deviation is over a permissible range of 150 kilocycles (kc.). However, the selector circuits are made wider so that the entire modulation-representative deviations will be applied to the discriminator networks thereby reducing distortion and the effects of noise. For example, at the discriminator the pass band width can be 200 kc.

The discriminator-rectifier networks 13 and 14 may be of the type wherein network 13 is a rectifier having a resonant input circuit off-tuned to one side of the center, or mean, frequency in excess of 75 kc., while network 14 may be a second rectifier whose resonant input circuit is off-tuned to the opposite side of the center frequency in excess of 75 kc. Thus, as the FM signal energy from the I. F. amplifier (which may be tuned to an I. F. chosen from 3 to 15 mc.) is applied to the off-tuned circuits, there will be produced in the rectifier output circuits the modulation currents corresponding to the frequency deviations of the carrier. The outputs of the rectifiers consist of two currents, the ratio of whose amplitudes is varied in response to frequency variation of carrier. In place of the off-tuned discriminator there may be used a discriminator of the type shown by S. W. Seeley in his U. S. Patent No.

2,121,103, granted June 21, 1938. This type uses a center-tuned resonant circuit to produce two alternating currents which vary differentially as the frequency is varied.

If no amplitude modulation were present in the FM waves, the output of networks 13 and 14 could be combined by means of a transformer to provide a single output containing modulation frequency currents corresponding to the frequency deviations. However, if amplitude modulation exists on the carrier wave, and which modulation may be due to noise and other extraneous impulses, the amplitude modulation will also appear in the transformer output to a greater or lesser extent depending upon how far the carrier frequency has been deviated from the condition of equal output currents from the two detectors.

In the past it has been proposed to overcome this interfering output, due to amplitude modulation, by inserting some form of amplitude limiter ahead of the discriminator. In my present invention I overcome the difficulty by eliminating a special limiter ahead of the discriminator, and using instead the presently-disclosed current magnitude ratio-controlled amplifier. The output of the latter depends upon the ratio, and variations in ratio, of the magnitudes of two input currents, and not upon their individual amplitudes. The cathode ray tube shown in Fig. 1 is purely illustrative. It is somewhat like the devices shown in my following patents: U. S. Patent No. 1,850,104; U. S. Patent No. 1,938,331; U. S. Patent No. 1,986,632; U. S. Patent No. 1,988,621; U. S. Patent No. 2,066,037; U. S. Patent No. 2,202,376; U. S. Patent No. 2,138,162; U. S. Patent No. 2,247,234.

However, in the present device the electron stream is magnetically deflected by means of a magnetic field strong enough to constrain the motion of the electron stream substantially parallel to the magnetic field. It is more or less known in the art that electrons can be given a substantial movement only in directions parallel to the magnetic field when the latter is strong enough. This is the phenomenon used in connection with magnetic focussing of electron beams. By passing the output currents of networks 13 and 14 through a pair of respective crossed magnetizing coils 11 and 12, there may be produced a magnetic field whose direction is dependent completely upon the magnitude ratio of currents flowing through the two coils. If this magnetic field is strong enough in proportion to the kinetic energy of the moving electrons, the electron stream must take a direction substantially parallel to the field. Hence, modulations in the ratio of the two currents control almost completely the distribution of electron current between the output anodes. Since the electron current is constant and its distribution between the anodes depends only upon the ratio of the magnitudes of the currents in the coils, and not on the individual amplitudes of these currents, the device functions to eliminate substantially all effects of amplitude modulation of the received carrier energy.

By changing the magnitude ratio of the currents flowing through coils 11 and 12 the beam 9 can be moved from the predominantly central position on electrode 5 to either collector 3 or 4. The electrode 5 is intended to reduce flow of wasteful currents between the anodes, due to secondary emission, when the anodes have a substantial difference in potential. The cup shape of the anodes has the same purpose of

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suppressing secondary emission by causing electrons to strike in the cups where there is little electric field for drawing out secondary electrons. The secondary emission can cause wasteful loading of the output circuits and distortion in response characteristics. If the coil currents change by equal ratios, there occurs substantially no movement of the beam. The collectors 3 and 4 catch the electron stream when displaced from the normal position. The division of current between the collectors is controllable by the ratio of currents in the two magnetized coils substantially independently of the sum of the currents of the coils. The device provides, therefore, one means by which there can be provided an FM receiver having an output substantially independent of the received carrier amplitude, and having an output substantially free from output derived from amplitude modulation of the carrier current and without using an amplitude limiter.

It is possible to change the construction of the current magnitude ratio-responsive device considerably, and yet secure the same result. For example, in Fig. 2 there is shown a lateral section through an electron discharge device whose longitudinal section is depicted in Fig. 3. Description of this modification will be given by concurrent reference to both figures. The tube comprises a cylindrical evacuated envelope 20 which is provided with an axial filamentary cathode 21. A positively biased screen 22 surrounds the cathode; the potentiometer P again provides the direct current potentials for the various tube electrodes. The numeral 23 designates four anodes in the shape of four segments of a cylinder surrounding screen 22. An absorption electrode 24, in the form of a cylinder concentric with the segmental anodes 23, surrounds the latter.

The tube is disposed within two crossed magnetizing coils 30 and 31. The coils are represented in cross-section, and the wires thereof are schematically represented. The coils 30 and 31 set up a magnetic field at right angles to the direction of the axis of the device. The coils produce magnetic fields in directions parallel to the plane of the paper. The electron currents flow in similar directions, parallel to the field. The direction of this field with respect to the disposition of the anodes 23 is controllable by controlling the magnitude ratio of currents in the two coils. If the two coils carry equal currents, electrons are able to flow only in up and down directions as Fig. 2 is viewed. However, if the magnitude ratio of currents is varied so as to result in a variation in the direction of the magnetic field, the current to one pair of diametrically opposite anodes will be increased, while the current to the diametrically opposite anodes is decreased. Accordingly, diametrically opposite anodes 23 are electrically connected together, and each pair of anodes is connected to a respective end of the primary winding of transformer 10.

Since the midpoint of the primary winding of audio transformer 10 is connected to the positive terminal of potentiometer P, it will be seen that each pair of anodes 23 is supplied with direct current and potential. The controlled current for each of coils 30 and 31 is provided from the respective discriminator-rectifier networks 13 and 14, as shown in Fig. 1. Accordingly, as the frequency of the received carrier current is modulated, the distribution of currents between the pairs of anodes 23 is modulated to provide an audio frequency output which is substantially in-

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dependent of the amplitude of radio frequency input to the FM detector system.

In the arrangement shown the screen electrode 22 makes it possible to have the electrons travel over the greater part of their path from cathode 21 to anodes 23 at relatively low velocity. Accordingly, only moderate magnetic field strength is required to control the direction of electron flow. The anodes are operated at much higher potential than the screen electrode in order that it may be possible to derive large amounts of power from the device. The arrangement shown in Fig. 2 may be given an improved operating characteristic if there is provided a means to hold constant total current to coils 30 and 31. For example, reference is made to my co-pending patent application Serial No. 423,881, filed December 22, 1941, for a suitable means for maintaining a constant current to the magnetizing coils. The advantage of constant total current to the two coils is that there is eliminated minor variations in response characteristics of the device due to variations in concentration of the electron stream which could be brought about from variations in the total strength of the magnetic field.

In Figs. 4 and 5 I have shown a further modification of a current magnitude ratio-controlled device in which the distribution of electron currents between two sets of anodes is controlled by means of the direction of the magnetic field. The direction is, in turn, controlled by the magnitude ratio of currents in the crossed control coils. In the modification of Figs. 4 and 5 the crossed magnetizing coils are not shown, because it can readily be seen from Fig. 2 that the modification of Fig. 5 differs solely in the arrangement of the electrodes. In general, the tube structure is similar to that of the modification of Fig. 2.

Referring, then, to Fig. 4 the glass envelope 40 is substantially a hollow cylinder, and has located at the axis thereof an indirectly heated cathode which is surrounded by a screen grid 41. The supporting rods 42 of the screen grid are shown in Fig. 5. The four segmental anodes surround the screen grid. Catcher electrodes 43 and 44 are shown in spaced relation. One of the catcher electrodes is symmetrically located behind the upper pair of anodes, while the second catcher electrode is symmetrically located behind the lower pair of anodes. The anodes are connected in the same way as in Fig. 2. It is assumed that a magnetic field passes through the tube which is directionally controllable around a direction up and down as viewed in Fig. 5. This, of course, presupposes a pair of coils arranged as coils 30 and 31 in Fig. 2. With this type of tube, as the direction of the field is varied the distribution of currents between adjacent anodes and the catcher electrodes is varied.

The law of response of anode currents to magnetic field direction is controllable by controlling the design, or configuration, of the anode segments. Suppose, for example, that one wishes to obtain anode currents corresponding to the currents contained in a class B amplifier. Then, the gap 46 between adjacent ends of anodes, where the electron stream impinges, may be shaped as shown in Fig. 6. In Fig. 6 the electron stream is assumed to be normal to the plane of the sheet of the drawing. In Figs. 4 and 5 the gap between adjacent anodes is suggested, but is more clearly shown in Fig. 6. It will be noted that the gap is substantially V-shaped. Such

a gap results in a response characteristic similar to that represented in Fig. 7.

If, now, it is desired to secure a response characteristic corresponding to a class A amplifier, then the gap between adjacent edges of anodes may be made substantially as shown in Fig. 8. In this case the gap is an inclined slit whose opposed edges are parallel. The resulting response characteristic is shown in Fig. 9. To see why the electrode configurations of Figs. 6 and 8 give the indicated response characteristics consider that the electron beam, enclosed by the dotted lines, moves from right to left in response to change in direction of the magnetic field, and that the flow of current to each electrode is proportional to the area of the portion of the beam falling on it. By using various other shapes and configurations, dimensions, and the like, of the gap between adjacent ends of anodes, one may obtain substantially any type of response characteristic desired. The type of tube shown in Figs. 4 and 5 provides a most practical arrangement for obtaining any law of response with respect to input control which may be desired. The structure is simple and rugged, and the sensitivity should be considerable if the device is designed to operate with relatively low potential between the cathode and grid electrode in which most of the electron stream deflection takes place. The anodes 45 may then be operated at any higher potential for obtaining relatively high power output. The electron efficiency of the device can be made quite high by so designing the cathode and screen that substantially all of the emission from the cathode is drawn out and forced to follow a path more or less parallel to the magnetic field.

It will be understood that the catcher electrodes 43 and 44 of Fig. 5 are connected together and connected to a moderate potential source which is less than the anode potential source. In practice, the catcher electrode potential would usually be as low as possible, perhaps 25 or 30 volts, so as to minimize secondary emission currents from the catcher back to the anodes.

By simply physically turning the tube about its axis, within fixed field coils, one may differentially bias the tube in one direction or the other, as desired. Thus, if the tube is used in indicating current magnitude ratios, or as a ratio control device, one may change the ratios at will by physically rotating the tube within the magnetizing field coil. Of course, if desired, the tube may be left stationary, and the magnetizing coils may be rotated around the axis of the tube.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. The method of indicating the ratio of magnitudes of two separate currents which includes the steps of initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a field whose influence forces the charged particles to flow substantially only along the axis of the stream, utilizing one of said currents to control one component of said field, concurrently utilizing said other current to control another component of said field having an angular relation to said first

component whereby the direction of said field is dependent upon said ratio and the preponderance of one component over the other produces a transverse deflection of said charged particles.

2. The method of indicating the ratio of magnitudes of two separate currents which includes the steps of initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a field whose influence forces the charged particles to flow substantially only along the axis of the stream, utilizing one of said currents to control one component of said field, concurrently utilizing said other current to control another component of said field having an angular relation to said first component whereby the direction of said field is dependent upon said ratio and the preponderance of one component over the other produces a transverse deflection of said charged particles, and collecting said charged particles on spaced electrodes distributed in response to said deflection.

3. The method of indicating the ratio of magnitudes of two separate currents which includes the steps of initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a magnetic field whose influence forces the charged particles to flow substantially only along the axis of the stream, utilizing one of said currents to control one component of said field, concurrently utilizing said other current to control another component of said field having an angular relation to said first component whereby the direction of said field is dependent upon said ratio and the preponderance of one component over the other produces a transverse deflection of said charged particles.

4. A method of securing a response to the ratio between the magnitudes of at least two alternating currents which includes the steps of providing an electron stream to a pair of output electrodes, providing a magnetic field whereby a substantial electron stream can flow only in the direction parallel to the magnetic field, and controlling the distribution of electron current to the electrodes by controlling the direction of the field in response to solely said ratio.

5. In an electronic system, a tube having at least an electron emitter, at least two spaced anodes, said emitter projecting an electron stream toward the anodes, means providing a magnetic field whose influence forces electron current to flow only in a direction parallel to the field and to a point between the spaced anodes, and additional means for applying to said magnetic field means at least two alternating currents whose magnitude ratio is solely utilized to deflect said stream.

6. The method of determining the ratio of magnitudes of two audio currents subject to amplitude variation which includes the steps of initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a magnetic field of sufficient strength to substantially suppress components of flow at right angles to the direction of the field, utilizing one of said audio currents to control one component of said field, utilizing said other audio current to control another component of said field having an angular relation to said first component, the preponderance of one component over the other producing a transverse deflection of the magnetic field and of said charged particles, and translating the deflection into an indication of solely said ratio free of said amplitude variation.

7. The method of producing a response to the ratio of magnitudes of two alternating currents subject to amplitude variation which includes the steps of projecting a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a magnetic field strong enough to confine the flow substantially to a direction parallel with the field, utilizing one of said currents to control one component of said field, concurrently utilizing said other current to control another component of said field having an angular relation to said first component whereby the direction of said field is determined solely by said ratio and the preponderance of one component over the other produces a transverse deflection of the direction of flow of said charged particles.

8. In a system for indicating the ratio of magnitudes of two separate currents which comprises means for initiating a flow of charged particles, means for subjecting said charged particles over a substantial portion of its path of travel to a field which permits substantial flow only in a direction parallel to the field, means utilizing one of said currents to control one component of said field, means concurrently utilizing said other current to control another component of said field having an angular relation to said first component, and the preponderance of one component over the other producing a transverse deflection of said charged particles.

9. In a system for determining the ratio of magnitudes of two audio currents subject to amplitude variation which includes an electronic device having a means for initiating a flow of charged particles, a pair of magnetizing coils whose planes are crossed subjecting said charged particles over a substantial portion of its path of travel to a field for determining the direction of flow, means applying one of said audio currents to one coil thereby to control one component of said field, means applying the second current to the second coil thereby to control another component of said field having an angular relation to said first component, the preponderance of one component over the other produces a transverse deflection of said charged particles.

10. A method of indicating the ratio between the magnitudes of at least two audio frequency currents subject to amplitude variation which includes the steps of providing an electron stream to a pair of electron collectors, providing a magnetic field whereby substantial electron current flow can take place only in the direction parallel to the magnetic field and to a point between said collectors, and controlling the distribution of electron current to the collectors by controlling the direction of the field in response to solely said magnitude ratio of said currents.

11. A system for indicating the ratio between the intensity of at least two currents, which comprises an electron discharge device having a cathode, a pair of spaced anodes, crossed magnetizing coils surrounding the device propagating an electron stream from the cathode to a point intermediate the anodes, said coils normally providing a magnetic field for controlling the direction of flow of the stream, and means applying said currents separately to said respective coils thereby to control the direction of the field and the intensity of electron current collected by either anode as a function solely of said ratio.

12. The method of indicating the ratio of magnitudes of two separate currents which includes producing two angularly disposed components of

magnetic field in response to the currents to form a resultant field whose direction depends upon the ratio of the two currents, and utilizing the resultant field to control the direction of flow of charged particles substantially independently of the sum of the two currents.

13. The method of indicating the ratio of magnitudes of two separate currents which comprises utilizing the currents to produce a resultant magnetic field the direction of which is dependent only on the ratio of magnitudes of the two currents, and utilizing the resultant magnetic field to determine the direction of flow of electron current in a vacuum tube.

14. The method of utilizing the ratio of magnitudes of two separate currents substantially independently of their individual magnitudes which comprises utilizing the currents to produce a magnetic field the direction of which is dependent only on the ratio of the magnitudes of the currents, and utilizing the direction of the field to control distribution of electron current between electrodes in a vacuum tube.

15. Means responsive to the ratio of the magnitudes of two currents comprising magnetizing coils crossed over at an angle for producing a resultant magnetic field, means for producing a constant current electron stream, and means for collecting currents from the stream whose sum is constant but whose division is determined by the direction of the magnetic field.

16. In a system for obtaining currents responsive to the magnitude ratio but not the separate amplitudes of two currents comprising means to set up a magnetic field whose direction is determined by the ratio, and means to utilize the direction of the magnetic field to determine the distribution of electron current between electrodes of a vacuum tube.

17. In a system as defined in claim 16, characterized by adjustment of the strength of magnetic field to be great enough so that, over an operating range of field strengths, the distribution of electron current is nearly independent of the strength of the field.

18. The method of receiving angular-velocity modulated carrier waves subject to amplitude variation which includes deriving from the waves two separate modulation currents subject to said variation, initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a field whose influence forces the charged particles to flow substantially only along the axis of the stream, utilizing one of said modulation currents to control one component of said field, utilizing said other modulation current to control another component of said field having an angular relation to said first component whereby the preponderance of one component over the other produces a transverse deflection of said charged particles, and translating said deflection into a resultant modulation current free of said variation.

19. The method of receiving frequency modulated carrier waves subject to undesired amplitude variation, which includes deriving from said waves two audio currents subject to said undesired variation, initiating a flow of charged particles, subjecting said charged particles over a substantial portion of its path of travel to a magnetic field of sufficient strength to substantially suppress components of flow at right angles to the direction of the field, utilizing one of said audio currents to control one component of said field, utilizing said other audio current to control an-

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other component of said field having an angular relation to said first component, the preponderance of one component over the other producing a transverse deflection of the magnetic field and of said charged particles, and translating the deflection into a resultant audio current free of said undesired variation.

20. In a receiver of frequency modulation waves, a network for deriving two audio currents from received waves, an electronic device having a means for initiating a flow of charged particles, crossed magnetizing coils subjecting said charged particles over a substantial portion of its path of travel to a field for determining the direction of flow, means applying one of said audio currents to one coil thereby to control one component of said field, means applying the second current to the second coil thereby to control another component of said field having an angular relation to said first component whereby the preponderance of one component over the other produces a transverse deflection of said charged particles, and means translating said deflection into a resultant audio current.

21. In a frequency modulated carrier wave receiver of the type provided with a demodulator

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network constructed and arranged to produce two separate modulation currents; the improvement which comprises means for eliminating amplitude variation in said currents comprising an electron discharge device having a cathode, a pair of spaced anodes, crossed magnetizing coils surrounding the device propagating an electron stream from the cathode to a point intermediate the anodes, said coils normally providing a magnetic field for controlling the direction of flow of the stream, and means applying said modulation currents separately to said respective coils thereby to control the direction of the field and the intensity of electron current collected by either anode.

CLARENCE W. HANSELL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
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