March 23, 1965 M. M. BIRNBAUM ETAL 3,175,121

ARRANGEMENT FOR DEFLECTING THE ELECTRON BEAM OF A CATHODE RAY TUBE IN A ROSETTE PATTERN

Filed July 3, 1961 3 Sheets-Sheet 1

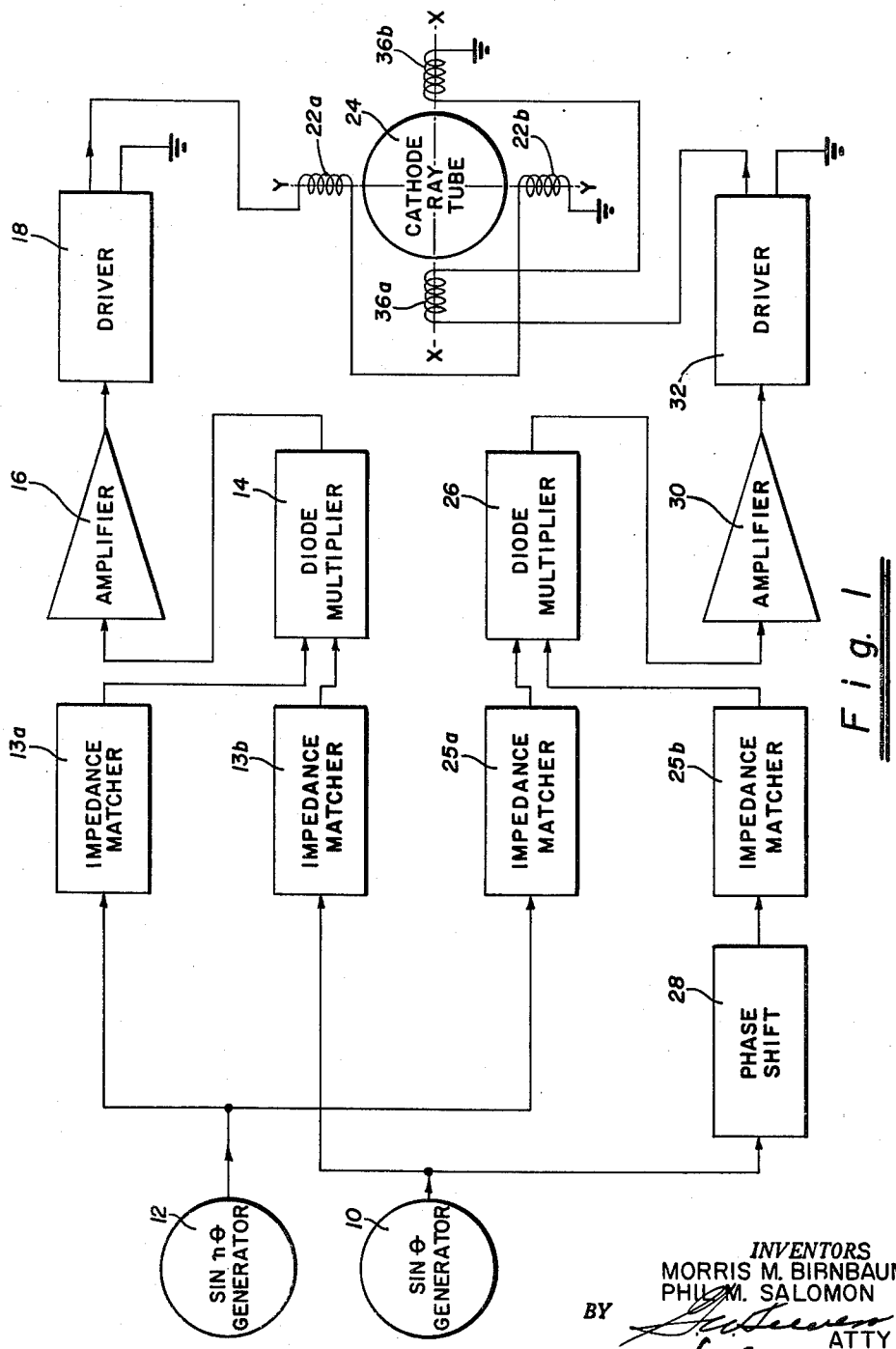


Fig. 1

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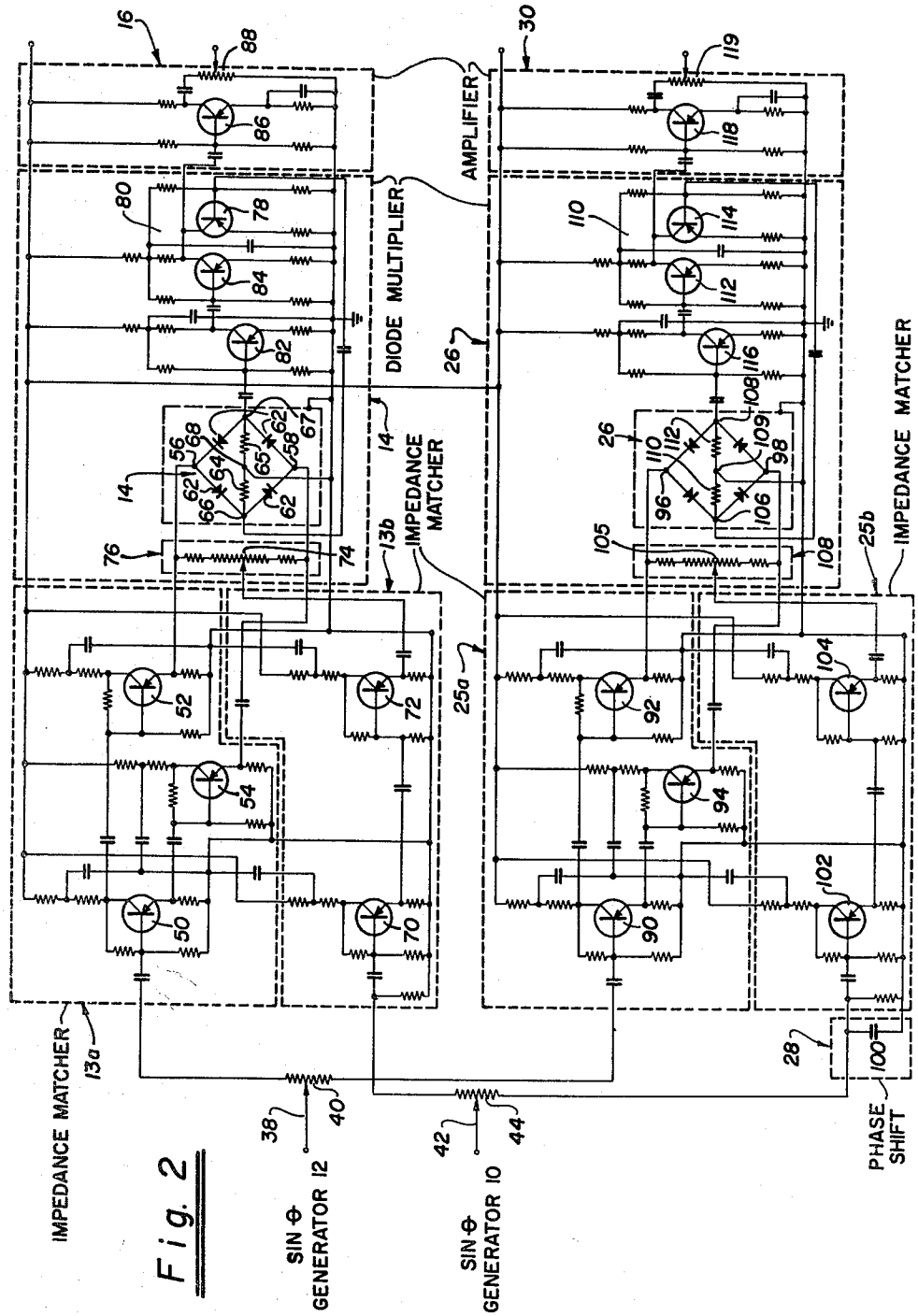


Fig. 2

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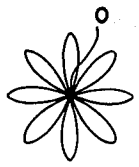


Fig. 3 Size Control Only By varying "a," amplifier gain

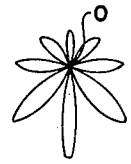


Fig. 7 Varying Center Control

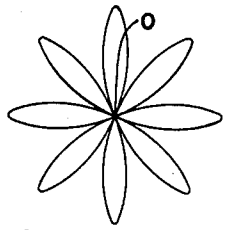


Fig. 4 Symmetrical & Centered

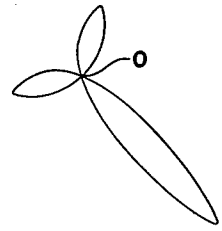


Fig. 8



Fig. 5 Varying "n," (the ratio of Signal Generator Frequencies)

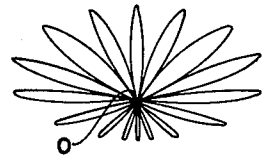
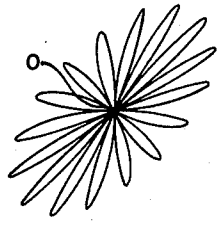


Fig. 9



Varying of Symmetry Control

Fig. 6

NOTE:
All Controls May Be Varied Simultaneously

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3,175,121

ARRANGEMENT FOR DEFLECTING THE ELECTRON BEAM OF A CATHODE RAY TUBE IN A ROSETTE PATTERN

Morris M. Birnbaum, Pasadena, and Phil M. Salomon, Sunland, Calif., assignors to General Precision, Inc., a corporation of Delaware

Filed July 3, 1961, Ser. No. 121,479
2 Claims. (Cl. 315—23)

The present invention relates to arrangements for deflecting the electron beam of cathode ray tubes in a manner effective to cause the beam to trace predetermined patterns on the phosphor screen of such tubes. In order to deflect the electron beam from a rectilinear course directed against the center of the screen, deflection elements are usually placed at opposite sides of the normal path of the beam, within or externally adjacent to the cathode ray tube. Such elements may be formed by opposed capacitive plates and/or magnetizing windings, and by applying predetermined voltages to said elements, electrostatic or magnetic fields are set up between the elements, which deflect the electron beam from its normal course in one or the other direction depending upon the polarity of the voltages at the opposed elements at the moment; and by varying the magnitude and phase relationship of these voltages in an appropriate manner, the composite deflection effect of the resultant fields may be such as to cause the electron beam to trace predetermined patterns upon the phosphor screen. Well known examples of such arrangements are the arrangement for producing sine wave patterns on the screen of an oscillograph or the arrangement for causing the electron beam of a television tube to scan the television screen in a multitude of successively lower horizontal paths.

It is an object of our invention to provide a simple and effective arrangement for causing the electron beam of a cathode ray tube to trace a rosette pattern upon the phosphor screen.

Another object of the invention is to produce a simple and effective arrangement for sweeping an electron beam across the phosphor screen while tracing rosette patterns in continuous rapid succession.

Still another object of the invention is to provide an arrangement, of the type referred to, which may readily be adjusted to vary the number of the petals of the rosette traced upon the phosphor screen.

Additionally, it is an object of the invention to provide an arrangement, of the type referred to, which may readily be adjusted to vary the size of the petals of the rosette traced upon the screen.

Furthermore, it is an object of the invention to provide an arrangement, of the type referred to, which may be adjusted to produce a rosette having petals of different size.

In addition, it is object of the invention to provide an arrangement, of the type described, that may be set to produce a rosette pattern of a desired non-symmetrical configuration.

Still another object of the invention is to provide an arrangement, of the type referred to, that may be set to provide a rosette pattern wherein the point of origin of the rosette is located at a selected point that is removed from the geometrical center point of the configuration.

Yet another object of the invention is to provide an arrangement, of the type described, that may be set to produce a rolling rosette pattern of any desired shape or size upon the phosphor screen.

These and other objects of the present invention will be apparent from the following description of the accompanying drawings which illustrate a preferred embodiment thereof, and wherein—

FIGURE 1 is a block diagram illustrating the principles of the invention;

FIGURE 2 is a circuit diagram illustrating a practical embodiment of the invention;

FIGURES 3, 4 and 5 illustrate the traces of symmetrical rosette patterns of different sizes and different numbers of petals such as may be produced by appropriate adjustment of the arrangement of our invention;

FIGURES 6, 7, 8 and 9 illustrate different non-symmetrical rosette patterns such as may be produced by appropriate adjustment of the arrangement of our invention.

The present invention proceeds from the polar equation of a rosette which is

$$r=a \sin n\theta \qquad (1)$$

wherein the factor "a" determines the diameter of the rosette and "n" is the number of petals of the rosette. Transformed to the Cartesian system, the corresponding equations read as follows:

$$x=a \sin n\theta \cos \theta \qquad (2)$$

$$y=a \sin \theta \sin n\theta \qquad (3)$$

In accordance with the invention we multiply a sine wave signal of a predetermined frequency with a sine wave signal of a higher frequency and convert the resultant product voltages into a varying deflection field extending across the electron beam of the cathode ray tube in a predetermined direction, and we simultaneously multiply a sine wave signal of said higher frequency with a cosine wave signal of said predetermined frequency and convert the resultant product voltages into a varying deflection field extending across the electron beam at substantiallv right angles to said first field. Thus Equations 2 and 3 are satisfied, and the varying deflection fields affect the electron beam of the cathode ray tube in such a manner that it traces rosettes upon the phosphor screen of the tube.

In practice, we employ two sine wave generators, one set to generate a sine wave signal of a predetermined frequency and the other one set to generate a sine wave signal of a higher frequency, and we deliver part of the output of both said generators to a first diode bridge multiplier and apply the product voltages of said first multiplier to a first set of a series-connected deflection elements that are arranged along a first axis at opposite sides of the first electron beam of a cathode ray tube and we pass part of the output of said second sine wave generator through a phase shift network to convert it into a cosine signal, and deliver said converted signal and part of the output of said first generator to a second diode bridge multiplier, and apply the product voltages of said second multipler to a second set of series-connected deflection elements that are arranged at opposite sides of the cathode ray tube at either side of the electron beam along an axis substantially at right angles of the axis of said first set of elements. Under the influence of the periodically varying deflection fields set up in this manner, the electron beam of the cathode ray tube traces perfect rosettes upon the phosphor screen of the tube, such as illustrated in FIGURES 3, 4 and 5.

In FIGURE 1 the circle **10** represents a sine wave generator that is set to generate a signal of sin θ and the circle **12** represents a sine wave generator that is set to generate a signal of sin $n\theta$. Sine wave generators are well known in the art and are readily available on the market so that it is unnecessary to describe them here in greater detail. Part of the outputs of both generators are simultaneously applied through impedance matchers represented by the blocks **13***a* and **13***b* to an analog multiplier represented by the block **14** where they are continuously multiplied. Suitable high speed analog multipliers are disclosed in pending U.S. patent application No. 4,404 of Morris M.

Birnbaum and William Wichman, which application is assigned to the same assignee as the present application. The product voltages supplied by multiplier **14** are passed through an amplifier represented by the triangle **16** and are applied through a driver represented by the block **18** across two series-connected field producing elements such as magnetizing coils **22***a* and **22***b* which may have the form of flat spirals and may be located along an axis *y*—*y* directly upon the neck of a cathode ray tube represented by the circle **24**. The remaining parts of the outputs of the two generators **10** and **12** are delivered through impedance matchers represented by the blocks **25***a* and **25***b* to another analog multiplier represented by the block **26**, but the output of the sin θ generator **10** is first subjected to a phase shift in a suitable phase shift network represented by the block **28**, to convert it into a cosine signal; and the product voltages supplied by the multiplier **26** are delivered to an amplifier **30** and are applied through a driver **32** across another set of two series-connected field-producing elements such as magnetizing coils **36***a* and **36***b* that are located at diametrically opposite points of the neck of cathode ray tube **24** along an axis *x*—*x* at right angles to the axis *y*—*y* determined by magnetizing coils **22***a* and **22***b*.

FIGURE 2 is a diagram illustrating a practical transistorized embodiment of the circuit arrangement represented by the block diagram of FIGURE 1. In FIGURE 2 the output line of sine wave generator **10** is represented by the movable arm **42** of an adjustable voltage divider network **44** and the output line of generator **12** is represented by the movable arm **38** of an adjustable voltage divider network **40**. Part, for instance one-half, of the output of generator **12** is passed through a transistor **50** which is connected to act as phase splitter, and through transistors **52** and **54** which are connected to act as emitter followers and is applied across one set of opposite junctions **56** and **58** of a diode bridge multiplier circuit **14** of the type described in the above-mentioned pending patent application, Serial Number 4,404 of Morris M. Birnbaum and William Wichman. As explained in said application, said bridge is composed of four matched diodes **62** and includes a pair of equal resistors **64** and **65** which are connected across the other set of opposite junctions **66** and **67** thereof and which have their center junction **68** connected to ground. A part, for instance one-half of the signal generated by generator **10** is delivered to the same multiplier bridge **14** through transistors **70** and **72** which act as emitter followers. The low impedance signal derived from said emitter followers is applied to the bridge circuit **14** across a point **74** of a resistor network **76** connected between the bridge junction **56** and **58**, and the grounded junction point **68** of resistors **64** and **65**. As explained in the repeatedly mentioned patent application of Morris M. Birnbaum and William Wichman, when two signals are applied to the bridge in the described manner, voltages of opposite polarity appear across resistors **64** and **65** and the algebraic sum of these voltages is representative of the products of the applied signals. The voltages appearing across resistor **64** are therefore delivered directly to the base of a transistor **78** that forms part of a voltage adding circuit **80**, while the voltages appearing across resistor **65** are first applied to the base of a transistor **82** that is connected to act as a voltage inverter. From said voltage inverter they are delivered in inverted condition to the base of another transistor **84** which forms part of the aforementioned voltage adding circuit **80**. The voltages appearing in the common collector circuit of transistors **78** and **84** are representative of the sum of the voltages appearing across resistors **64** and **65** of the diode bridge circuit and represent the product of the signals applied to said bridge circuit. Said voltages are delivered to the base of yet another transistor **86** that is connected to act as an amplifier and which corresponds to the amplifier **16** of the block diagram shown in FIGURE 1, and the voltages appearing

in the collector circuit of said transistor **86** are delivered through a voltage divider **88** to the driver stage represented by the block **18** in FIGURE 1 and from there to the vertically superposed deflection coils **22***a* and **22***b* likewise shown in FIGURE 1.

Similarly, a portion of the output of sin $n\theta$ generator **12** is applied through transistors **90**, **92** and **94** to the opposite junctions **96** and **98** of the second diode bridge multiplier circuit **26**, and a portion of the output of sin θ generator **10** is passed through a phase shift network **100** corresponding to block **28** of FIGURE 1 to convert it into a cosine wave signal, and is delivered through transistors **102** and **104** to the bridge circuit **26** to which it is applied across a point **105** of a resistor network **108** connected between the junctions **96** and **98** of said bridge circuit, and the grounded junction **109** of resistors **110** and **112**; and the voltages of opposite polarity that are developed across the resistors **110** and **112** of said bridge circuit are added in a voltage adding circuit **110** comprising the transistors **112** and **114**, after one of said voltages has been inverted in an inverter stage represented by transistor **116**. The voltages appearing in the common collector circuit of the transistors **114** and **116** are representative of the products of the sine and cosine signals applied to the multiplier bridge **26**. They are passed through a transistor **118** which corresponds to the amplifier **30** of FIGURE 1, and are delivered through voltage divider network **119** and driver **32** to deflection coils **36***a* and **36***b*.

Thus, the voltages applied to the vertically superposed deflection coils **22***a* and **22***b* are proportional to the product of sin $n\theta$ and sin θ and the voltages applied to the horizontally aligned deflection coils **36***a* and **36***b* are proportional to the product of sin $n\theta$ and cos θ. Hence, the system illustrated in FIGURES 1 and 2 satisfies the initially mentioned Equations 2 and 3, and as long as the deflection coils **22***a* and **22***b*, **36***a* and **36***b* are energized in the described manner, the electron beam emitted by the cathode of tube **24** is continuously deflected in such a manner as to trace a rosette upon the phosphor screen of the tube, whether it remains otherwise stationary or is swept across the screen.

The size, i.e. the radial length of the rosette petals thus produced upon the phosphor screen of the tube is determined by the amplitude of the wave forms generated by either or both generators **10** and **12**. Thus, by varying the amplitude of the waves produced by generator **10** and/or generator **12** in a well known manner, it is possible to vary the size of the rosettes traced upon the screen of tube **24** in any desired manner, such as from the size shown in FIGURE 3 to the size shown in FIGURE 4.

The number of petals possessed by the rosettes traced upon the phosphor screen of the cathode ray tube is determined by the ratio "*n*" of the frequencies of the waves produced by generators **10** and **12** and is always $2n$. The desired number of petals of the rosettes may therefore be established by appropriately controlling the frequencies of the signals produced by the generators. Thus, it is possible to selectively vary the number of the petals of the rosette, for instance, from eight petals as illustrated in FIGURE 3 corresponding to a frequency ratio 4:1 to three petals as illustrated in FIGURE 5 corresponding to a frequency ratio of 1.5:1. It should here be noted that if the value of $2n$ is not an integer, the rosette traced upon the phosphor screen assumes a rolling motion.

The arrangement of the invention permits also of adjustment to a condition wherein the envelope of the petals of the rosette traced upon the phosphor screen of the cathode ray tube is non-symmetrical, such as illustrated in FIGURE 6. It is merely necessary to manipulate arms **38** and/or **42** (FIGURE 2) of the voltage divider networks **40** and **44**, respectively, in the output lines of the generators **10** and **12** in such a way that said

voltage dividers deliver predetermined unequal parts of the generator outputs to the diode multipliers **14** and **26**, and the rosettes assume non-symmetrical contours in varying degrees. Alternatively, it is possible to cause the arrangement of our invention to deflect the electron beam of the cathode ray tube in such a manner that it traces off-center rosettes upon the phosphor screen, i.e. rosettes whose point of origin *o* is located at points removed from the geometrical center point of the created configuration, such as illustrated in FIGURE 7. This may be accomplished by applying one of the signals to the diode bridge **14** or **26**, respectively at a point of resistor networks **76** or **108** other than the exact center point thereof. Thus, by varying the location of contact points **74** and **105** on the resistor networks **76** and **108**, respectively the location of the point of origin of the rosette may be varied at will.

It will be understood that by varying some or all of the mentioned parameters of the described arrangement simultaneously, a limitless variety of rosettes may selectively be established by the arrangement of our invention. Thus, it is possible to create a rosette of non-symmetric envelope which has only three petals and whose point of origin *o* lies grossly off-center such as illustrated in FIGURE 8, or a rosette of non-symmetrical elliptical envelope which has as many as 12 petals and has its point of origin *o* located closely adjacent to one of the shallow sectors of its periphery, as illustrated in FIGURE 9.

The rosette-producing arrangement of our invention is of extraordinary flexibility. It may be set to produce rosettes of any number of petals, the size of the petals may be varied at will, the point of origin of the rosette may selectively be located anywhere within its envelope, and the shape of its envelope may be varied at will by the simplest of manipulations; and the rosettes may be made to tumble and roll if desired. This is of great significance in many fields oaf application. For instance, in scanning diapositives of landscapes with a point source of light for the purpose of deriving contour lines therefrom such as described in U.S. patent application, Serial Number 4,404 of Morris M. Birnbaum and William J. Wichman for an Automatic Contour Plotter which is assigned to the same assignee as the present patent application, different types of scanning patterns have proven to produce different degrees of accuracy for different types of diapositives or landscapes of different character.

While we have described our invention with the aid of a particular embodiment thereof, it will be understood that our invention is not limited to the specific circuitry and the specific circuit components shown and described, which may be departed from without departing from the scope and spirit of the invention.

We claim:

1. An adjustable arrangement for deflecting the electron beam of a cathode ray tube in predeterminable rosette patterns having points of origin that depart from the geometrical center point of the envelope of the rosette comprising first and second sine wave generators, a phase-shift network, first and second means for establishing deflection fields across the path of the electron beam substantially at right angles to each other, a first diode bridge voltage multiplier having first input means including a resistor connected across one set of opposite diode junctions and second input means including a variable tap on said resistor and connected across said variable tap and a point between the other set of opposite diode junctions, a second diode bridge multiplier having first and second input means, means for delivering a part of the output of one of said generators to the first input means of one of said diode bridge multipliers and another part of said output to the first input means of the other diode bridge multiplier, means for delivering a part of the output of the other generator to the second input means of said first multiplier and another part thereof through said phase-shift network to the second input means of said second multiplier, means for applying the output of said first multiplier to said first field deflection means, and means for delivering the output of said second multiplier to said second field deflection means.

2. An adjustable arrangement for deflecting the electron beam of a cathode ray tube in predeterminable rosette patterns having points of origin that depart from the geometrical center point of the envelope of the rosette comprising first and second sine wave generators, a phase-shift network, first and second means for establishing deflection fields across the path of the electron beam substantially at right angles to each other, first and second diode bridge voltage multipliers each having first input means including a resistor connected across one set of opposite diode junctions and a second input means including a variable tap on said resistor and connected across said variable tap and a point between the other set of opposite diode junctions, means for delivering a part of the output of one of said first generators to the first input means of said first diode bridge multiplier and another part of said output to the first input means of said second diode bridge multiplier, means for delivering a part of the output of the other generator to the second input means of said first diode bridge multiplier and another part thereof through said phase-shift network to the second input means of said second diode bridge multiplier, means for applying the output of said first multiplier to said first field deflection means, and means for delivering the output of said second multiplier to said second field deflection means.

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