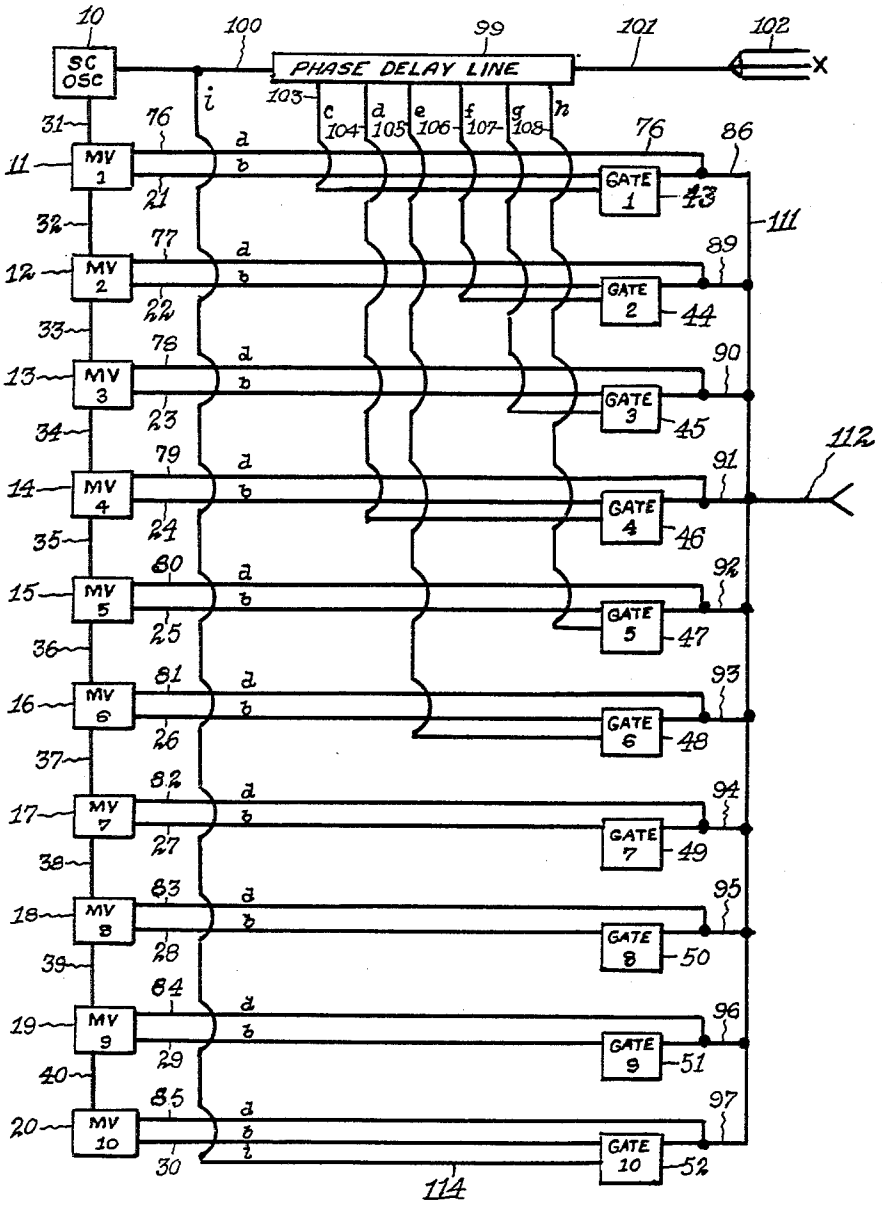
May 31, 1960 H. R. FOSTER ET AL 2,939,085

MEANS FOR PRODUCING COLOR SIGNAL WAVES

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Fig. 1.



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Fig. 2.

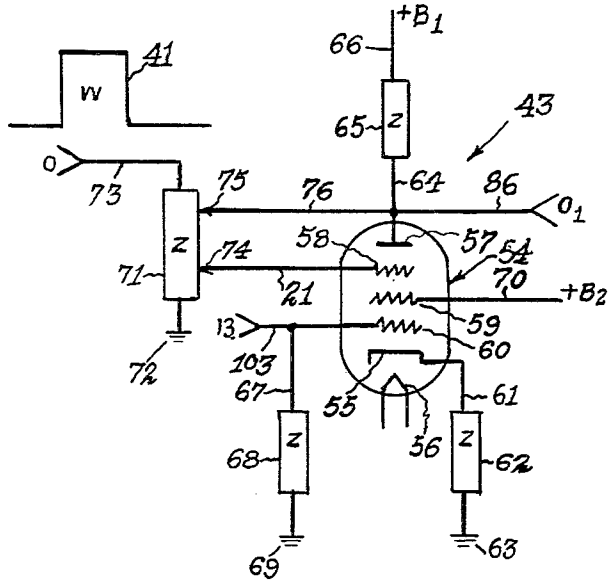
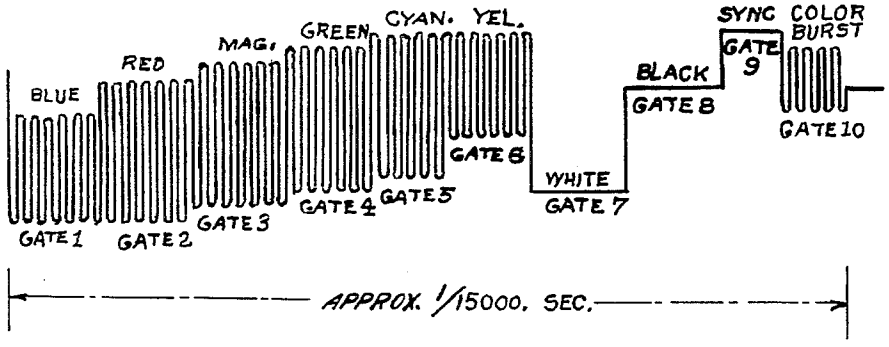


Fig. 3.



Fig. 4.



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MEANS FOR PRODUCING COLOR SIGNAL WAVES

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Continuation of application Ser. No. 423,397, Apr. 15, 1954. This application Feb. 9, 1956, Ser. No. 564,456

21 Claims. (Cl. 328—187)

This invention relates to the producing of electrical waves of the type suitable for use as color signals in connection with color cathode-ray equipment, as for example color television sets and the like.

The present application is a continuation of our co-pending application Serial No. 423,397 filed April 15, 1954, now abandoned and entitled, "Means for Generating Basic Colors for TV Work."

In the producing of color signals for use in color television and the like, there is employed an electrical wave form or train having a frequency in the neighborhood of 3½-megacycles, more specifically 3.58 mc., the amplitude and phase of which are made adjustable, such wave form being often referred to as a sub-carrier and the frequency of 3.58 mc. being referred to as a sub-carrier frequency.

An object of the present invention is to provide a novel and improved means and method for producing an electrical wave which may include frequencies as above, and may therefore constitute a color signal for use with color cathode-ray equipment, such means and method being effective and reliable at all times.

Another object of the invention is to provide an improved means and method as above set forth, which is characterized by relative simplicity and is less expensive than prior methods and apparatus.

Yet another object of the invention is to provide an improved device for generating or producing signals of the above type, which may be easily and quickly calibrated and/or adjusted and is easy to use, thereby to provide the maximum degree of convenience to the operator.

A feature of the invention resides in the provision of an improved means and method in accordance with the above, wherein simple and readily available components may be utilized in a simple organization or combination, without the necessity of requiring especially designed or constructed parts which might involve high tooling costs or fabrication expense.

A still further object of the invention is to provide an improved signal generating or producing device of the above type, which may be relatively small and compact, and which is readily portable so that it may constitute a convenient servicing instrument for color television use and the like.

Other features and advantages will hereinafter appear.

In the drawings accompanying this specification, similar characters of reference indicate corresponding parts wherever possible in the several views, in which:

Figure 1 is a schematic circuit diagram illustrating the improved signal generating apparatus of the invention.

Fig. 2 is a schematic circuit diagram of one of the gating components of the circuit of Fig. 1.

Fig. 3 is a graphical representation of a wave shape obtainable from the the output of the gating component shown in Fig. 2.

Fig. 4 is a graphical representation of a wave shape obtainable from the output of the generating apparatus shown in Fig. 1.

Referring first to Fig. 1, the novel and improved signal generating apparatus of the present invention comprises an oscillator or primary signal generator **10** of the type capable of producing, for example, a continuous wave such as a television sub-carrier wave having a frequency of 3.58 mc. The output of the generator **10** may be sinusoidal, or it may have other wave forms of alternating or fluctuating nature.

Connected with and responsive to the generator **10** is a plurality of pulse generators **11—20** which are responsive to a suitable wave, or to suitable triggering pulses applied to the inputs. The pulse generators **11—20** may, for example, be conveniently in the form of multi-vibrators, and such pulse generators are shown as having output circuits **21—30** (**21—26** of which are hereinafter referred to in the claims as a first plurality of circuits or a first-mentioned plurality of circuits). The group of generators or multi-vibrators **11—20** is triggered by the oscillator or generator **10**, and the multi-vibrators may be connected as shown in Fig. 1, with the input of the multi-vibrator **11** joined by a line **31** to the output of the generator **10**, the output of the multi-vibrator **11** joined by a line **32** with an input of the multi-vibrator **12**, the output of the latter being joined by a line **33** with the input of the multi-vibrator **13** and so on, utilizing additional connecting lines numbered **34—40**.

The multi-vibrators **11—20** are so constituted and arranged that each produces, approximately once every one fifteen-thousandth of a second, a single pulse in its output circuit, which may have a square wave form as indicated at **41** in Fig. 2. The frequency of recurrence of such pulses may be made a sub-multiple of the keying or driving frequency of 3.58 mc. of the generator **10**. In addition, the pulses in the output circuits **21—30** of the multi-vibrators are made to occur sequentially, that from the multi-vibrator **11** occurring first, then the pulse from the multi-vibrator **12** occurring, thereafter the pulse from the multi-vibrator **13**, and so on, and the complete succession of pulses in the output circuits **21—30** is made to transpire in the said interval or approximately one fifteen-thousandth of a second.

Further, in accordance with the invention, the outputs of the multi-vibrators **11—20** as supplied to the lines **21—30** are impressed individually on a plurality of gate devices or circuits **43—52**, said devices having the lines **21—30** connected respectively to their inputs.

For the sake of facility in understanding and explaining the circuit of Fig. 1, the multi-vibrators **11—20** are labeled MV1, MV2, etc. respectively, and the gate devices **43—52** are labeled respectively Gate 1, Gate 2, etc.

Each of the gates **43—52** may be constituted of an organization as shown in Fig. 2, such organization forming the subject matter of our second-referred-to copending application above mentioned, and being described and claimed in said copending application. By way of example, the gate device **43** (Gate 1) is shown in detail in Fig. 2, it being understood that the other gate devices **44—52** may all be of generally similar construction.

As shown in Fig. 2, the gate **43** may comprise a multi-element electron device or vacuum tube **54** having a cathode **55** and heater **56** therefor, a plate or anode **57**, a suppressor grid **58**, a screen grid **59**, and a control grid **60**. The cathode **55** is connected by means of a wire **61** and an impedance **62** to a ground **63**. The anode **57** is connected by a wire **64** and an impedance **65** to a wire **66** which may be connected to a B+ supply as shown, the negative terminal of such supply for example being grounded. The control grid **60** may be connected by a

wire 67 and impedance 68 to a ground 69. The screen grid 59 may be connected by a wire 70 to a second B+ supply, as indicated. The suppressor grid 58 is shown as connected to the line 21 which comes from the output of the multi-vibrator 11. Within the multi-vibrator 11 there may be disposed an impedance 71 connected at one end to a ground 72 and at the other end to a wire 73 which may receive the output from the multi-vibrator 11. Adjustable taps or sliders 74 and 75 may be provided on the impedance 71, the slider 74 being connected with the output line 21 and the slider 75 being connected with an output line 76 which joins with the plate circuit wire 64 of the tube 54. The multi-vibrators 12—20 may likewise have impedances similar to the impedance 71 shown in Fig. 2, and output lines 77—85 similar to the line 76. Pulses in the output lines 76—85 will occur simultaneously with pulses in the output lines 21—30, as will be readily understood.

From the wire 64 in Fig. 2 there is led an output line 86. With the circuit as thus far described, pulses which are fed to the line 21 from the multi-vibrator 11 will render the suppressor grid 58 more positive, thereby causing plate current flow in the wire 64 and a drop in potential at said wire due to the voltage drop across the impedance 65. Such drop in potential will be manifested as a negative pulse in the output wire 86, and the amplitude of such negative pulse is affected, and adjustable by virtue of the connection of the wire 76 and the adjustable tap 75 on the impedance 71. This is because the wire 76 may conduct positive pulses to the plate circuit wire 64 in step with and in opposition to the negative output pulses from the tube 54, whereby the resultant output pulses in the wire 86 will be the difference of the sets of pulses. Varying the strength of the positive pulses in the wire 76 will accordingly vary the amplitude of the output pulses in the wire 86.

The gates 44—52 have output circuits 89—97 respectively, similar to the output wire 86 in Fig. 2, and the output wires or circuits 86 and 89—93 are hereinafter referred to in the claims as a third plurality of circuits.

It will be understood at this point that, by virtue of the connection of the gates 43—52 to the multi-vibrators 11—20, the gates will have in their outputs recurring, sequentially-occurring negative pulses the amplitudes of which may be adjusted at the will of the operator by virtue of the tapped impedances (71 and others not shown) in the multi-vibrators.

The negative pulses in the output wires 86 and 89—97 will be exactly in step with the positive output pulses from the respective associated multi-vibrators 11—20 connected with the gates 43—51 which have the output lines 86, 89—97, and all of the negative pulses from the gates, in addition to occurring sequentially, will form a sequence which is complete in a time interval of approximately one fifteen thousandth of a second.

In accordance with the present invention we further provided modulating inputs to the gates 43—48, said inputs having the same frequency as the oscillator 10 viz. 3.58 mc., but being phase shifted by progressive increments from the output wave of the oscillator or generator 10. In accomplishing this, we provide a phase delay cable 99 connected by a line 100 with the output of the generator 10. The cable 99 has a termination wire or line 101 which may be grounded, as indicated at 102. Also, the cable 99 has a plurality of taps to which are connected lines 103, 104, 105, 106, 107 and 108. The cable 99 and the taps thereof are so arranged that phase-displaced waves are provided in the lines 103—108 having the same frequency as the generator 10, i.e. 3.58 mc., said displaced-waves being phase shifted by progressive increments from the wave of the generator 10. The wire 103 is shown in Fig. 2 as being connected with the wire 67 leading to the control grid 60 of the tube 54. In like manner, the wires 104—108 lead to the control grids of the gates 44—48, not in regular order preferably but as shown in Fig. 1. That is, the wire 106 goes to the gate 44, the wire 107 to the gate 45, the wire 104 to the gate 46, the wire 108 to the gate 47 and the wire 105 to the gate 48. The phase position of the waves in the wires 103—108 will determine the particular color which is produced by functioning of the gate to which the wire is connected, as will be later explained in further detail.

Referring again to Fig. 2, it will be understood that during those intervals when the tube 54 is conducting by virtue of current flowing in the plate circuit thereof, this being characterized by a negative potential pulse in the plate, modulation of such pulse will occur by virtue of the 3.58 mc. signal impressed on the control grid 60. Fig. 3 illustrates the modulated negative potential pulse in the plate circuit. The modulated pulse has a frequency 3.58 mc., although the period of recurrence of the pulse is approximately fifteen thousand cycles per second, and the duration of the pulse is approximately one-tenth of this or one one-hundred-fifty-thousandth of a second.

In Fig. 3 the amplitude of the modulation is indicated by the span B, and the average amplitude of the negative pulse is indicated by the span A. The magnitude of A (average value of the negative pulse) may be varied at the will of the operator by changing the position of the slider 75 which feeds opposing positive pulses to the plate circuit. The amplitude B of the modulating wave may be varied by varying the strength of the signal applied to the control grid 60 through the wire 103.

Considering again Fig. 1, we provide a connector or common output wire 111 to which are joined the output wires 86 and 89—97 from the gates 43—52, and such connector wire is joined to a single output line 112 which carries the output wave from the apparatus shown.

By virtue of the circuit as above set forth, a wave will be produced in the output line 112, which has an appearance substantially as shown in Fig. 4. In this figure there are indicated, from left to right, the colors blue, red, magenta, green, cyan, yellow, white and black, proceeding from left to right. Following the black "color" there is represented a pulse labeled "sync," and following the sync pulse there is a wave train labeled "color burst." Under the color wave trains in Fig. 4 appear the labels Gate 1, Gate 2, etc., up to Gate 8. Under the sync pulse there appears the label Gate 9 and under the wave train labeled "color burst," there appears the label Gate 10. The portion of the wave labeled Blue, Gate 1, is that supplied by the output from the gate 43, and the phase position of the modulating wave, with respect to the output wave of the generator 10 and the sync pulse (Gate 9) is such that a blue color will be produced in the screen of a color television set if the output line 86 is fed thereto. The portion of the wave of Fig. 4 labeled Red, Gate 2 will be supplied through the output wire 89, and the red coloring will result from the particular phase position of the modulating energy in this portion of the wave. In like manner, the magenta, green, cyan and yellow, $R-Y$, $B-Y$, I, Q, or any other color can be produced in the television picture tube in accordance with the phase positions of the modulating waves in the outputs of the gates 45–48.

The gate 49 which is indicated as producing the white color where indicated does so by virtue of the position of the pulse or wave portion labeled White, with respect to the sync pulse, and by virtue of the fact that no modulating wave is incorporated therein. From Fig. 1 it will be seen that the gate 49 receives no modulation from the phase delay cable 99, and the same is true of gate 50 whose output is indicated as following the output of gate 49, reading from left to right in Fig. 4. The sync pulse of Fig. 4 is obtained from gate 51, which also receives no modulation from the phase delay cable 99.

Further, in accordance with the present invention, we provide in conjunction with the gates 43—51, the gate 52 which however receives modulation, through a line

114 directly from the oscillator or generator 10, thereby to produce in the wave shown in Fig. 4 the color burst at the extreme right end of the illustration, labeled Color Burst, Gate 10.

It will be noted that, from a consideration of Fig. 4, the time interval between the color burst produced by the Gate 10 and the yellow pulse (i.e., the immediately preceding one of the sequentially occurring pulses producing color) is greater than the intervals between succeeding ones of the color pulses producing the blue, red, magenta, green, cyan, and yellow effects.

In the appended claims the lines 103—108 leading from phase delay cable 99 are referred to as a second plurality of circuits, and it will be understood that such phase delay cable and second plurality of circuits, by modulating the output pulses from the gates 43—52 will produce in the outputs thereof the pulses occurring in step with the sequentially-occurring pulses from the multivibrators 11—20 and respectively having modulations effected individually by the phase-shifted waves in the said second plurality of circuits.

In accordance with the method of the invention a color signal is produced by first generating a sub-carrier wave of suitable frequency, producing from such wave a plurality or set of recurring, sequentially-occurring pulses, producing from said carrier wave a plurality of waves of like frequency to each other and to said carrier wave but phase-shifted by progressive increments therefrom, producing from said sequentially-occurring pulses and phase-shifted waves output pulses occurring in step with the sequentially-occurring pulses and respectively having individual modulations effected individually by said phase-shifted waves, and leading said output pulses to a single output circuit.

The apparatus and method of the present invention are effective and reliable in operation. The apparatus may be readily adjusted as regards the amplitudes of various portions of the output signal, and is simple to understand and to operate. It is constituted of components which are commonly available and which do not require tooling or fabrication. The circuit is relatively simple, and the apparatus economical to fabricate as a consequence. Moreover, the components required are neither particularly heavy or bulky, and the apparatus may thus be made readily portable so as to constitute a piece of testing equipment not confined to the laboratory or workshop.

Variations and modifications may be made within the scope of the claims, and portions of the improvements may be made without others.

We claim:

1. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a single signal generator for producing a wave of predetermined frequency; means connected with and excited by said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to and excited by said generator and including a second plurality of circuits, for producing continuous waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments; means connected with both said pluralities of circuits and including a third plurality of circuits, for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; and means for transmitting said output pulses to the said output circuit.

2. The invention as defined in claim 1 in which there are means for adjusting the average amplitude of the modulated output pulses.

3. The invention as defined in claim 2 in which the adjusting means includes means for applying to said single output circuit pulses occurring simultaneously and in step with the said modulated output pulses.

4. The invention as defined in claim 3 in which the simultaneously-occurring pulses are produced by the means producing the sequentially recurring pulses.

5. The invention as defined in claim 4 in which the means producing the sequentially recurring pulses includes drop impedances having variable taps at which the said simultaneously-occurring pulses are evident.

6. The invention as defined in claim 5 in which there are additional variable taps on the drop impedances, connected to the first plurality of circuits.

7. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a signal generator for producing a wave of predetermined frequency; means connected with and responsive to said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to said generator and including a second plurality of circuits, for producing waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting the said modulated output pulses to the single output circuit; another output circuit; means for producing in said other output circuit substantially unmodulated, white-producing pulses occurring after said sequentially-occurring pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to include white-producing components in the color signal of the said combined output circuit and in which the circuits of the said first plurality are connected to suppressor grids of said vacuum tubes, said suppressor grids and anode circuits receiving simultaneously-occurring pulses of positive polarity.

8. The invention as defined in claim 2 in which the means for producing the said output pulses include multi-grid vacuum tubes, and in which the means for adjusting the average amplitude of the pulses includes connections to the anode circuits of the said vacuum tubes.

9. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a single signal generator for producing a wave of predetermined frequency; means connected with and excited by said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits, the recurrence frequency of the pulses in each circuit being a submultiple of the frequency of said wave; means connected to and excited by said generator and including a second plurality of circuits, for producing continuous waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said plurality of circuits and including a third plurality of circuits, for producing in the latter output pulses occurring in step with the said sequentially-occurring pulses and having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; and means for transmitting said output pulses to the said output circuit.

10. The invention as defined in claim 9 in which the means for producing the said output pulses include multi-element electronic valves.

11. The invention as defined in claim 10 in which the electronic valves comprise multi-grid vacuum tubes, and

in which circuits of the first plurality are connected to suppressor grids of said vacuum tubes.

12. The invention as defined in claim 9 in which the frequency of the wave produced by the generator is on the order of three and one half megacycles.

13. The invention as defined in claim 9 in which there are means connected to said second plurality of circuits, for presetting the amplitude of the said phase-shifted waves.

14. The invention as defined in claim 9 in which the means for producing the phase-shifted waves comprises a phase-delay cable having a plurality of taps connected to the circuits of the said second plurality.

15. The invention as defined in claim 9 in which the means producing the sequentially-occurring pulses comprise a plurality of multi-vibrators triggered one by another, the outputs of which are connected to the circuits of the said first plurality.

16. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a single signal generator for producing a wave of predetermined frequency; means connected with and excited by said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to and excited by said generator and including a second plurality of circuits, for producing continuous waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits, for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting the said modulated output pulses to the single output circuit; another output circuit; means for producing in said other output circuit color-burst pulses occurring after said sequentially-occurring pulses and having modulations effected by said first-mentioned wave, the time interval between said color-burst pulses and the immediately preceding sequentially-occurring pulses being greater than the intervals between succeeding ones of the latter pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to produce color-burst components in the color signal of the said combined output circuit.

17. The invention as defined in claim 3 in which the means producing the output pulses with individual modulations includes a device for producing pulses occurring simultaneously with said output pulses, said device being connected with the means producing the sequentially-occurring pulses.

18. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a signal generator for producing a wave of predetermined frequency; means connected with and responsive to said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to said generator and including a second plurality of circuits, for producing waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting the said modulated output pulses to the single output circuit; another output circuit; means for producing in said other output circuit substantially unmodulated, white-producing pulses occurring after said sequentially-occurring pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to include white-producing components in the color signal of the said combined output circuit.

19. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a signal generator for producing a wave of predetermined frequency; means connected with and responsive to said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to said generator and including a second plurality of circuits, for producing waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits, for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting the said modulated output pulses to the said output circuit; another output circuit; means for producing in said other output circuit substantially unmodulated black-producing pulses occurring after said sequentially occurring pulses, the time interval between said black-producing pulses and the immediately preceding sequentially-occurring pulses being greater than the intervals between succeeding ones of the latter pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to include black-producing components in the color signal of the said combined output circuit.

20. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a signal generator for producing a wave of predetermined frequency; means connected with and responsive to said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to said generator and including a second plurality of circuits, for producing waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits for producing in the latter output pulses having individual modulations effected individually by said phase-shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting said output pulses to the said output circuit; another output circuit; means for producing in said other output circuit substantially unmodulated pulses occurring after said sequentially-occurring pulses, the time interval between said unmodulated pulses and the immediately preceding sequentially-occurring pulses being greater than the intervals between succeeding ones of the latter pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to include substantially-unmodulated components in the color signal of the said combined output circuit.

21. In an apparatus for producing color signals suitable for use with color cathode-ray equipment, a signal generator for producing a wave of predetermined frequency; means connected with and responsive to said generator and including a first plurality of circuits, for producing a plurality of recurring, lower frequency and sequentially-occurring pulses respectively in said circuits; means connected to said generator and including a second plurality of circuits, for producing waves in the latter of like frequency to each other but phase-shifted by progressive predetermined increments from said first-mentioned wave; means connected with both said pluralities of circuits and including a third plurality of circuits, for producing in the latter output pulses having individual modulations effected individually by said phase-

shifted waves in accordance with a predetermined order; a single output circuit; means for transmitting said output pulses to the said output circuit; another output circuit; means for producing in said output circuit substantially unmodulated synchronizing pulses occurring after said sequentially-occurring pulses, the time interval between said synchronizing pulses and the immediately preceding sequentially-occurring pulses being greater than the intervals between succeeding ones of the latter pulses; and means connecting said single and other output circuits together to form a combined output circuit, thereby to include synchronizing components in the color signal of the said combined output circuit.

References Cited in the file of this patent

UNITED STATES PATENTS

2,403,561	Smith	July 9, 1946
2,414,265	Lawson	Jan. 14, 1947
2,435,195	Bomberger et al.	Feb. 3, 1948
2,465,355	Cook	Mar. 29, 1949
2,570,716	Rochester	Oct. 9, 1951
2,577,141	Mauchly	Dec. 4, 1951
2,719,187	Pierce	Sept. 27, 1955

FOREIGN PATENTS

950,152	France	Sept. 20, 1940