June 17, 1947. C. E. HALLMARK 2,422,236

TELEVISION SYNCHRONIZING SIGNAL GENERATOR

Filed April 16, 1945 2 Sheets-Sheet 1

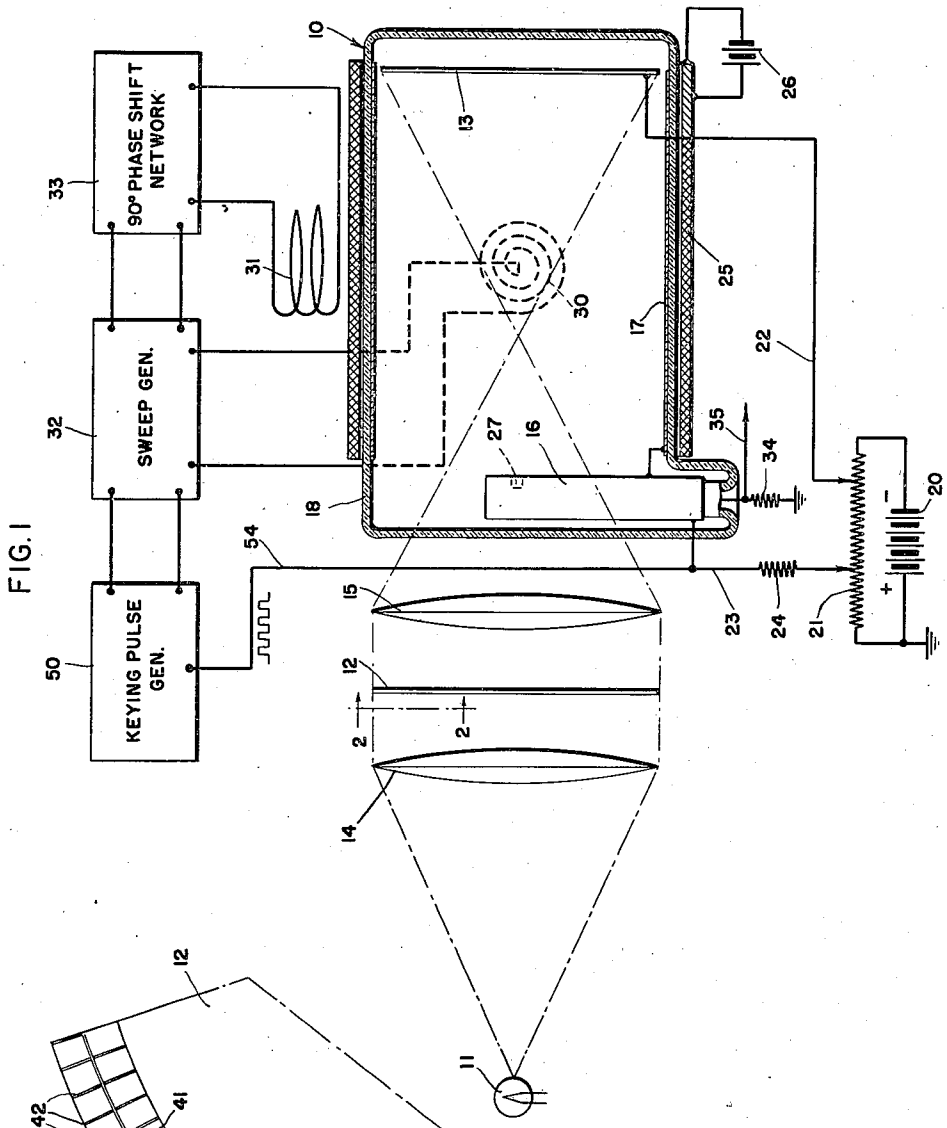


FIG. 1

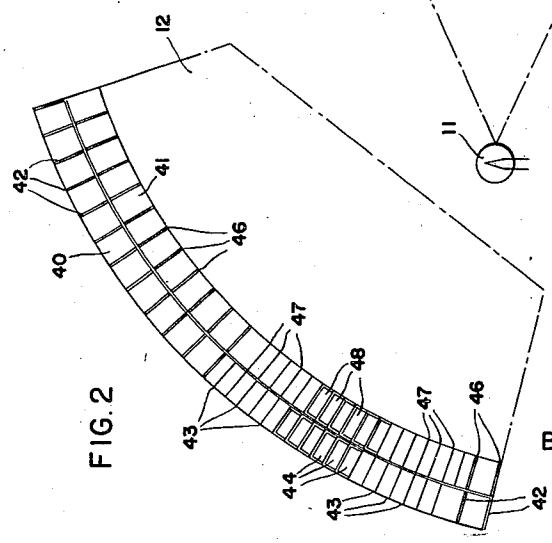


FIG. 2

INVENTOR
CLYDE E. HALLMARK

BY

ATTORNEY

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TELEVISION SYNCHRONIZING SIGNAL GENERATOR

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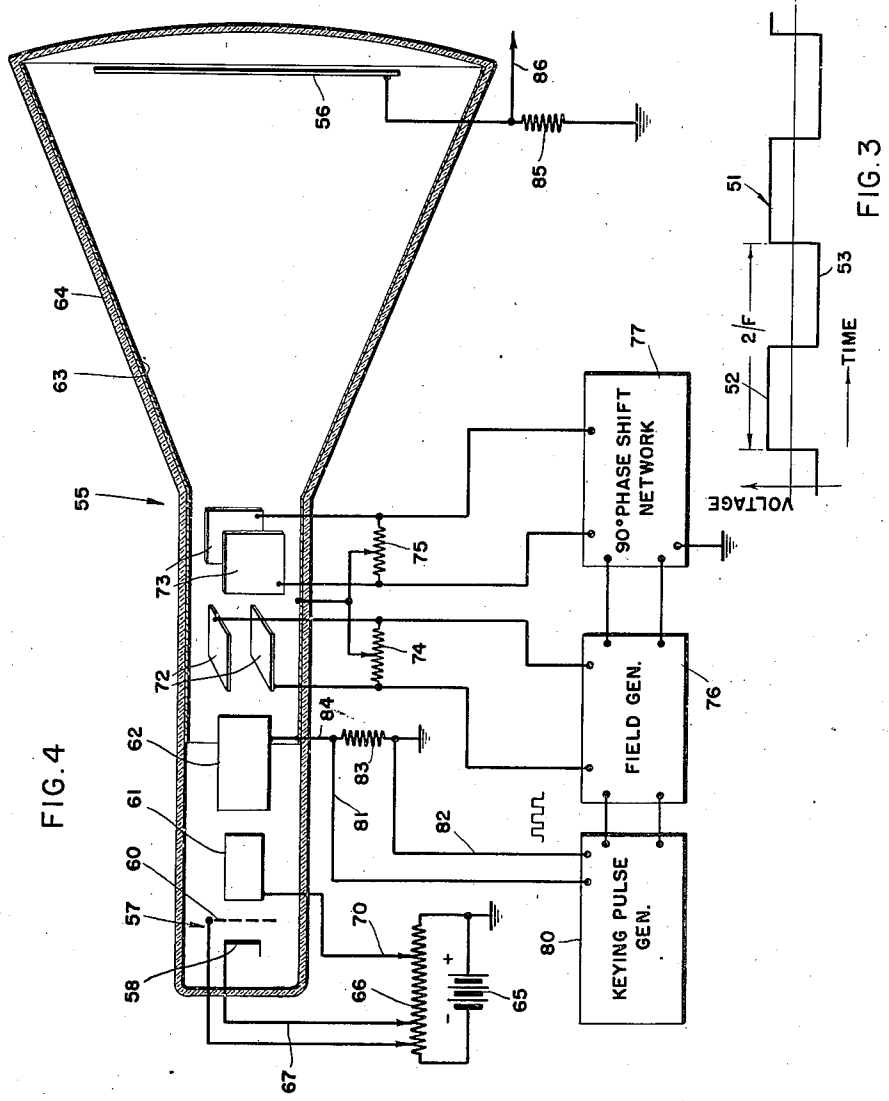


FIG. 4

FIG. 3

INVENTOR
CLYDE E. HALLMARK

BY

ATTORNEY

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2,422,236

TELEVISION SYNCHRONIZING SIGNAL GENERATOR

Clyde E. Hallmark, Fort Wayne, Ind., assignor to Farnsworth Television and Radio Corporation, a corporation of Delaware

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14 Claims. (Cl. 178—69.5)

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This invention relates to pulse generators, and particularly relates to apparatus for deriving composite television synchronizing signals of the type used for obtaining interlaced scanning.

In order to keep the electron scanning beam of a television transmitter in synchronism with the electron scanning beams of a number of television receivers it is customary to transmit two types of signals, usually referred to as horizontal and vertical synchronizing signals. It has become standard practice to scan the object to be reproduced in accordance with an odd-line interlaced scanning pattern so that each frame comprises two fields. Thus, an odd number of lines is used for scanning a frame, the standard number of lines per frame adopted by the Radio Manufacturers Association being 525. Accordingly, each of the two fields which make up a frame is scanned with 262½ lines in such a manner that the first sweep ends when the last horizontal line is scanned half way across the width of the image and the second sweep starts at exactly the same height as the first and begins at the mid-point of the first line. Therefore, the frequency of the horizontal synchronizing signal remains constant as well as the frequency of the vertical synchronizing signal. However, the pattern of the composite synchronizing signal, including horizontal and vertical synchronizing pulses is different for two consecutive fields. During the first field the beginning of the vertical synchronizing signal coincides with one of the horizontal synchronizing pulses, while during the next field the vertical synchronizing signal is spaced a distance corresponding to one half of a horizontal line from the horizontal synchronizing pulses.

It is customary in the television art to provide one timing unit associated with a wave shaping unit for generating the composite synchronizing signal. This timing unit is arranged at the transmitter and serves for controlling two deflection generators which in turn are used for developing electron deflecting fields for scanning the electric image representative of the object to be transmitted. At the same time the timing unit also develops pulses to control the two deflecting generators provided in each receiver for synchronizing the deflecting generators thereof with the deflecting generators of the television transmitter. The timing unit usually consists of a chain of multivibrator oscillators from which signals at the proper frequency are derived. These signals are then shaped in elaborate wave shaping circuits for generating the required horizontal, equalizing and vertical synchronizing pulses as well as the blanking pulses.

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The proper reproduction of the television image depends upon the degree of accuracy with which the periodicity and the phase of the synchronizing signals are maintained. Thus, the frequency as well as the spacing of the waves forming the various pulses which make up the composite synchronizing signal have to be maintained very accurately within extremely narrow limits. Usually each group of pulses of the same frequency is developed by a separate wave shaping unit. Different groups of pulses are then mixed by means of keying tubes, and it is one of the major difficulties to keep constant the phase relationship between the various groups of synchronizing signals. A conventional timing unit and its associated wave shaping unit arranged for generaitng the various pulses required for maintaining transmitter and receivers in synchronism comprise about 70 tubes. In view of the severe demands made upon the accuracy of the pulses generated the various circuits must be very carefully designed and maintained in perfect operating condition.

It is an object of the present invention, therefore, to provide in a television system a novel pulse generator which is particularly adapted for deriving groups of pulses with a minimum of equipment.

Another object of the invention is to provide a generator for developing a composite signal consisting of periodically recurring groups of pulses of different duration and frequency such as a composite television synchronizing signal.

In acordance with the present invention there is provided a pulse generator comprising a target and means for impressing a stationary pattern representative of the pulses to be generated on the target to develop an electric image corresponding to the pattern, the pattern being arranged in a closed path. Means are also provided for cyclically scanning the electric image along the closed path to develop an output signal representative of the pattern.

According to one embodiment of the invention a pulse generator comprises a photosensitive member having a stationary pattern thereon representative of the pulses to be generated. Means are provided which cooperate with the photosensitive member for developing an electric image corresponding to the pattern, the pattern being arranged in a closed path. The electric image is then cyclically scanned along the closed path to develop an output signal representative of the pattern.

Alternatively, a pulse generator includes a light impervious member having openings therein arranged in a pattern representative of the pulses to be generated. Means are provided for projecting an optical image of the light impervious member upon a photosensitive cathode. In this manner an electric image is developed which includes a stationary pattern arranged along a closed path and representative of the pulses to be generated.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings:

Fig. 1 is a schematic view of a pulse generator including an image dissector tube and associated electric circuits embodying the present invention;

Fig. 2 is an elevational fragmentary view on enlarged scale taken on line 2—2 of Fig. 1 and illustrating a disk having openings therein arranged according to a pattern representative of the pulses to be generated;

Fig. 3 illustrates a keying pulse utilized in the generator of Fig. 1; and

Fig. 4 is a schematic view of a cathode ray tube of the monoscope type and associated electric circuits arranged as a generator of television synchronizing pulses.

Referring now more particularly to Fig. 1 of the drawings, there is illustrated a television picture signal generating tube 10 of the dissector type cooperating with light source 11 for developing electron images. Light source 11 is arranged for projecting an optical image of disk 12 onto photocathode 13 of image dissector tube 10. To this end an optical system including lenses 14 and 15 projects a beam of light from light source 11 through disk 12 and focuses an optical image of disk 12 upon photocathode 13. Image dissector tube 10 is further provided with anode finger 16 electrically connected to anode 17 formed by a conductive coating on the inner surface of dissector tube envelope 18.

For the purpose of supplying operating potentials to anodes 16 and 17 as well as to photocathode 13 there is provided a voltage source such, for example, as battery 20 connected across potentiometer 21 and having its positive terminal grounded as shown. By means of lead 22 connected to a tap of potentiometer 21 photocathode 13 may be maintained at a potential of about 1100 volts negative against ground. Lead 23 connecting anode finger 16 through resistor 24 to a tap of potentiometer 21 normally keeps anodes 16 and 17 at a potential which may be about 825 volts negative against ground.

Disk 12 is provided with openings in a manner to be explained hereinafter, and the light passing through the openings of disk 12 liberates photoelectrons from photocathode 13. The photoelectrons thus liberated are attracted towards anode finger 16 by virtue of the accelerating potential between photocathode 13 and anode finger 16. Focusing coil 25 energized through battery 26 focuses the photoelectrons forming the electron image upon aperture 27 provided in anode finger 16. Two pairs of deflecting coils 30 and 31 are provided for deflecting the electron image formed by the photoelectrons liberated from cathode 13 in a predetermined manner across aperture 27. To this end sweep generator 32 arranged to develop a sinusoidal current wave is connected to deflecting coils 30, while deflecting coils 31 are connected to sweep generator 32 through 90 degrees phase shift network 33. Hence, the sinusoidal currents flowing through deflecting coils 30 and 31 are 90 degrees out of phase with respect to each other. Consequently, the electron image is scanned across aperture 27 in a circular path.

Anode finger 16 preferably houses an electron multiplier, not shown, for multiplying in a conventional manner the electron current passing through aperture 27. The output signal developed across load resistor 34, grounded as shown, may be obtained from lead 35. The operation of image dissector tube 10 as described hereinabove is conventional and, therefore, no further explanation is required here.

A fragmentary portion of disk 12 through which light is projected onto photocathode 13 is illustrated on enlarged scale in Fig. 2. Disk 12 comprises two concentric circular rows 40 and 41 each bearing a predetermined pattern of openings. Outer row 40 has openings 42 which are equally spaced for representing horizontal synchronizing pulses. As explained hereinabove, there are 525/2 or 262.5 lines in each field. Openings 42 are followed by two spaced groups of narrow openings 43 of which there are six in each group. Openings 43 represent the equalizing pulses occurring in the composite synchronizing signal. Between the two groups of openings 43 there is provided another group of six very wide openings 44 which represent the vertical synchronizing pulses. It will be observed that the spacing between openings 43 and 44 is half as wide as the spacing between openings 42. The pulses which are generated when the electron image representative of rows 40 and 41 is deflected across aperture 27 have a frequency which is determined by the spacing between the openings and the sweep frequency. Therefore, it will be evident that the frequency of the equalizing pulses, corresponding to openings 43 and of the vertical synchronizing pulses corresponding to openings 44, is twice the frequency of the horizontal synchronizing pulses represented by openings 42 because the spacing between openings 43 and 44 is half as wide as the spacing between openings 42.

Inner row 41 of disk 12 contains substantially the same groups of openings 46, 47 and 48 corresponding, respectively, to the horizontal synchronizing, equalizing and vertical synchronizing pulses. It will be observed that openings 47 and 48 are displaced with respect to openings 43 and 44 by half the distance between two consecutive openings 46 in accordance with the standards for television synchronizing signals adopted by the Radio Manufacturers Association.

In accordance with the present invention an electron image representative of circular rows 40 and 41 is cyclically deflected across aperture 47 in anode finger 16. As explained hereinabove, the electron image is deflected through a circular path by means of deflecting coils 30 and 31. The diameter of the sweep circle is determined, for example, by the accelerating potential between photocathode 13 and anode finger 16 which may normally amount to 275 volts.

By cyclically changing the accelerating potential between photocathode 13 and anode finger 16 the diameter of the sweep circle may be varied periodically. To this end there is provided keying pulse generator 50 which may be connected

to sweep generator 32 for generating square-topped keying pulses having one-half the frequency of that developed by sweep generator 32. Keying pulses 51 developed by pulse generator 50 are illustrated in Fig. 3. If the frequency of sweep generator 32 is F cycles per second, the time consumed for one cycle of keying pulse 51 is 2/F, as shown in Fig. 3. We may assume that the amplitude of positive portion 52 of pulse 51 amounts to +25 volts and the amplitude of negative portion 53 of the keying pulse 51 is —25 volts.

Keying pulse 51 is impressed by lead 54 upon anode finger 16. Accordingly, the accelerating potential between photocathode 13 and anode finger 16 varies between 250 and 300 volts because the potential of anode finger 16 varies periodically between —800 and —850 volts. When the accelerating potential between photocathode 13 and anode finger 16 is 300 volts, the electrons become "stiffer" and are, therefore, deflected less by deflecting coils 30 and 31 and accordingly inner row 41 of disk 12 is now scanned. After a time, which is equal to the reciprocal of the frequency of sweep generator 32, the accelerating potential between photocathode 13 and anode finger 16 is reduced to 250 volts. Accordingly, the electrons are now less stiff and, therefore, are deflected more by deflecting coils 30 and 31 and thus outer row 40 of disk 12 is now scanned.

The electron image focused by the magnetic field developed by focusing coil 25 is only sharply in focus for a certain accelerating potential between photocathode 13 and anode finger 16. Thus, when the accelerating potential between photocathode 13 and anode finger 16 is varied, the electron image may be slightly out of focus. Unless the accelerating potential varies appreciably the defocusing of the electron image will not be very serious. However, it may be desired in some cases to vary the current flowing through focusing coil 25 in synchronism with the changes of the accelerating potential between photocathode 13 and anode finger 16 to keep the electron image sharply in focus at all times. To this end the keying pulse developed by keying pulse generator 50 may be connected in series with battery 26 to key the current flowing through focusing coil 25. When the accelerating potential between photocathode 13 and anode finger 16 assumes its lower value, that is, when outer row 40 is scanned, the current flowing through focusing coil 25 also should be smaller than when the accelerating potential is higher.

The diameter of the circular path across which the electron image is scanned may also be varied by periodically changing the amplitude of sweep generator 32. In that case the accelerating potential between photocathode 13 and anode finger 16 may be kept constant and it will not be necessary to vary the current flowing through focusing coil 25. The amplitude of sweep generator 32 may be periodically varied by conventional means such as a keying pulse generator, not shown in Fig. 1.

It will be obvious then that when light projected through any one of openings 42, 43, 44, 46, 47 or 48 falls onto photocathode 13, electrons are liberated thereby. When these electrons are scanned across multiplier opening 27, they will produce a signal of a duration corresponding to the width of the opening. In this manner a composite television synchronizing signal may be derived from image dissector tube 10.

It is to be understood that instead of image dissector tube 10 any other type of picture signal generating tube may be utilized for generating a signal output representative of the pattern of disk 12 projected thereon. It is also feasible to develop different types of pulses by means of the pulse generator of the invention. All that is necessary is to provide a disk having openings therein arranged along a closed path in a pattern representative of the pulses to be generated. One of the advantages of the pulse generator of the invention is that there are no moving or rotating parts, the scanning being effected electronically.

The pulse generator of the invention has particular utility for deriving a composite signal consisting of groups of pulses which recur periodically. The sweep frequency such as generated by sweep generator 32 when divided by the number of rows in the target to be scanned should be equal to the frequency corresponding to one complete cycle or period of the composite signal. In the instant case, each of rows 40 and 41 should be scanned at a frequency of 60 cycles per second which is the field frequency. The frequency of the composite signal is 30 cycles per second corresponding to the frame frequency. The frequency of the sweep generator, when multiplied, for example, by the number of openings such as 42 arranged in one row of disk 12, should equal the horizontal line frequency.

In order to generate a composite synchronizing signal including horizontal and vertical synchronizing pulses the sweep frequency generated by sweep generator 32 should be 60 cycles per second. Hence, each of rows 40 and 41 is scanned at the field frequency of 60 cycles per second. Openings 42 should be equally spaced to provide 262.5 openings per row. Hence, the frequency of the horizontal synchronizing signal represented by openings 42 is 262.5 times 60, the sweep frequency, or 15,750 cycles per second which is equivalent to the standard horizontal synchronizing pulse frequency. The frequency of one complete cycle of the composite signal is 60 cycles per second divided by two, the number of rows of disk 12, or 30 cycles per second.

It will be seen that the pulse generator illustrated in Figs. 1 to 3 provides a particularly simple means for generating the composite television synchronizing signal. The frequency of sweep generator 32 which has a sinusoidal output wave can be kept very constant by means well known in the art. Openings 42, 43, 44, 46, 47 and 48 in disk 12 can be spaced as accurately as desired, and the group of pulses obtained during each complete sweep of rows 40 and 41 repeats again at the frequency of the output wave of sweep generator 32.

In accordance with the present invention it is not necessary to project an optical image of disk 12 onto photocathode 13. In some cases it may be preferred to prepare photocathode 13 of image dissector tube 10 in such a manner that photosensitive portions alternate with portions that are not photosensitive in accordance with a pattern representative of the pulses to be generated. This may, for instance, be effected by etching or printing the desired pattern on photocathode 13. For example, the pattern may be printed with carbon ink on photocathode 13 which after heating will be reduced to substantially pure carbon having a low photosensitivity. When a photocathode prepared in such a manner and forming part of an image dissector tube is flooded with light, an electron image may be

developed which is representative of the pattern impressed on the photocathode.

Fig. 4 illustrates a cathode ray tube 55 of the monoscope type which is provided with a target 56 having imprinted thereon a stationary pattern. The pattern impressed on target 56 may be identical with that shown in Fig. 2, or any other pattern may be used which is representative of the pulses to be generated. For the purpose of developing an electron beam and focusing it upon target 56, there is provided electron gun 57 including cathode 58, control grid 60, first anode 61 and second anode 62. Anode 63 connected to second anode 62 as shown may consist of a conductive coating arranged on the inner surface of envelope 64.

A voltage source such, for example, as battery 65 having its positive terminal grounded is connected across potentiometer 66 for providing operating potentials to electron gun 57. To this end cathode 58 is connected by lead 67 to a suitable tap of potentiometer 66. Cathode 58 may be maintained at a potential of about 1500 volts negative against ground. Control grid 60 is kept at a potential that is a few volts negative against that of cathode 58 by means of a suitable tap on potentiometer 66. First anode 61 is connected through lead 70 to potentiometer 66 and may be a few hundred volts positive with respect to cathode 58.

Deflecting plates 72 and 73 each have shunt resistors 74 and 75, respectively, connected across their input leads. Resistors 74 and 75 each have a center tap connected to anode 63. For the purpose of deflecting the electron beam developed by electron gun 57, deflecting plates 72 are connected to field generator 76, while deflecting plates 73 are connected to field generator 76 through 90 degrees phase shift network 77. Hence, the voltages supplied to deflecting plates 72 and 73 are 90 degrees out of phase with respect to each other. Thus, the electron beam developed by electron gun 57 and focused upon target 56 is swept circularly across target 56 by means of deflecting plates 72 and 73.

Keying pulse generator 80 is arranged to develop a keying pulse having half the frequency of that derived from field generator 76. The keying pulse developed by keying pulse generator 80 may be substantially identical to keying pulse 51 illustrated in Fig. 3. By means of leads 81 and 82 the keying pulse is impressed across resistor 83 connected by lead 84 between second anode 62 and ground. Thus, the accelerating potential of the electron beam is periodically changed. Hence, in the manner explained hereinabove in connection with Figs. 1 and 3, the electron beam sweeps across target 56 along two concentric circular predetermined paths. The secondary electron emission properties of target 56 vary according to a predetermined pattern and, therefore, the number of secondary electrons collected by anode 63 varies in accordance with the pattern impressed on target 56. The output signal developed across load resistor 85 connected between target 56 and ground may be derived from output lead 86.

While there have been described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A generator for developing cyclically recurring groups of pulses of different duration and frequency comprising a photosensitive member, means for impressing a stationary pattern representative of one cycle of said groups of pulses to be generated on said photosensitive member to develop an electric image corresponding to said pattern, and means for cyclically scanning said electric image to develop an output signal representative of said pattern.

2. A generator for developing a cyclically recurring composite signal including groups of pulses of different duration and frequency, said generator comprising a photosensitive member, means for impressing a stationary pattern representative of one cycle of said composite signal to be generated on said photosensitive member to develop an electric image corresponding to said pattern, and means for cyclically scanning said electric image at the frequency of said composite signal to develop a signal output representative of said pattern.

3. A generator for developing a cyclically recurring signal including groups of pulses of different duration and frequency comprising a target having secondary electron emissive properties varying in accordance with a stationary pattern representative of one cycle of said groups of pulses to be generated, said pattern being arranged in a plurality of concentric circular rows, and means for cyclically scanning said target along each of said circular rows in succession to develop an output signal representative of said pattern.

4. A pulse generator comprising a photosensitive member having a stationary pattern thereon representative of the pulses to be generated, means cooperating with said photosensitive member for developing an electric image corresponding to said pattern, and means for cyclically scanning said electric image to develop an output signal representative of said pattern.

5. A pulse generator comprising a photosensitive member having a stationary pattern etched thereon representative of the pulses to be generated, means for projecting light on said member to develop an electron image corresponding to said pattern, and means for cyclically scanning said electron image to develop an output signal representative of said pattern.

6. A pulse generator comprising a photosensitive cathode, a light impervious stationary member having openings therein arranged in a pattern representative of the pulses to be generated, means for projecting an optical image of said member upon said photosensitive cathode, means cooperating with said photosensitive cathode for developing an electric image representative of said optical image, and means for cyclically scanning said electric image to develop an output signal representative of said pattern.

7. A generator for developing a cyclically recurring composite signal including groups of pulses of different duration and frequency, said generator comprising a photosensitive cathode, a light impervious stationary member having openings therein arranged in a pattern representative of one cycle of said composite signal to be generated, means for projecting an optical image of said member upon said photosensitive cathode, means cooperating with said photosensitive cathode for developing an electric image representative of said optical image, and means for cyclically scanning said electric image at the frequen-

cy of said composite signal to develop a signal output representative of said pattern.

8. A pulse generator comprising a photosensitive cathode, a light impervious stationary member having openings therein arranged in a pattern representative of the pulses to be generated, said openings being arranged in a plurality of concentric circular rows, means for projecting an optical image of said member upon said photosensitive cathode, means cooperating with said photosensitive cathode for developing an electric image representative of said optical image, and means for cyclically scanning said electric image along each of said circular rows in succession to develop an output signal representative of said pattern.

9. The method of generating cyclically recurring groups of pulses of different duration and frequency comprising developing an electric image of a stationary pattern arranged in a plurality of related areas and representative of the pulses to be generated, and cyclically scanning said electric image along each of said areas in succession to derive an output signal representative of said pattern.

10. The method of generating cyclically recurring groups of pulses of different duration and frequency comprising developing an electron image including a stationary pattern arranged in a plurality of related areas and representative of the pulses to be generated, and cyclically scanning said electron image along each of said areas in succession to derive an output signal representative of said pattern.

11. The method of generating cyclically recurring groups of pulses of different duration and frequency comprising projecting an optical image including a stationary pattern arranged in a plurality of rows and representative of the pulses to be generated, developing an electric image from said optical image, and cyclically scanning said electric image along each of said rows in succession to derive an output signal representative of said pattern.

12. The method of generating cyclically recurring groups of pulses of different duration and frequency comprising developing an electric image including a stationary pattern arranged in a plurality of concentric rows and representative of the pulses to be generated, and cyclically scanning said electric image along each of said circular rows in succession to derive an output signal representative of said pattern.

13. A pulse generator comprising a target having a pattern, said pattern including a first area representative of a certain electrical wave train and a second area representative of a different electrical wave train, and means for cyclically scanning said areas in succession to develop an output signal representative of said pattern.

14. A pulse generator comprising a target having a pattern, said pattern including a first group of related areas representative of a certain electrical wave train and a second group of related areas representative of a different electrical wave train, and means for cyclically scanning said groups of areas in succession to develop an output signal representative of said pattern.

CLYDE E. HALLMARK.

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