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CATHODE RAY TUBE MODULATOR IN A PULSE MULTIPLEX TRANSMITTER

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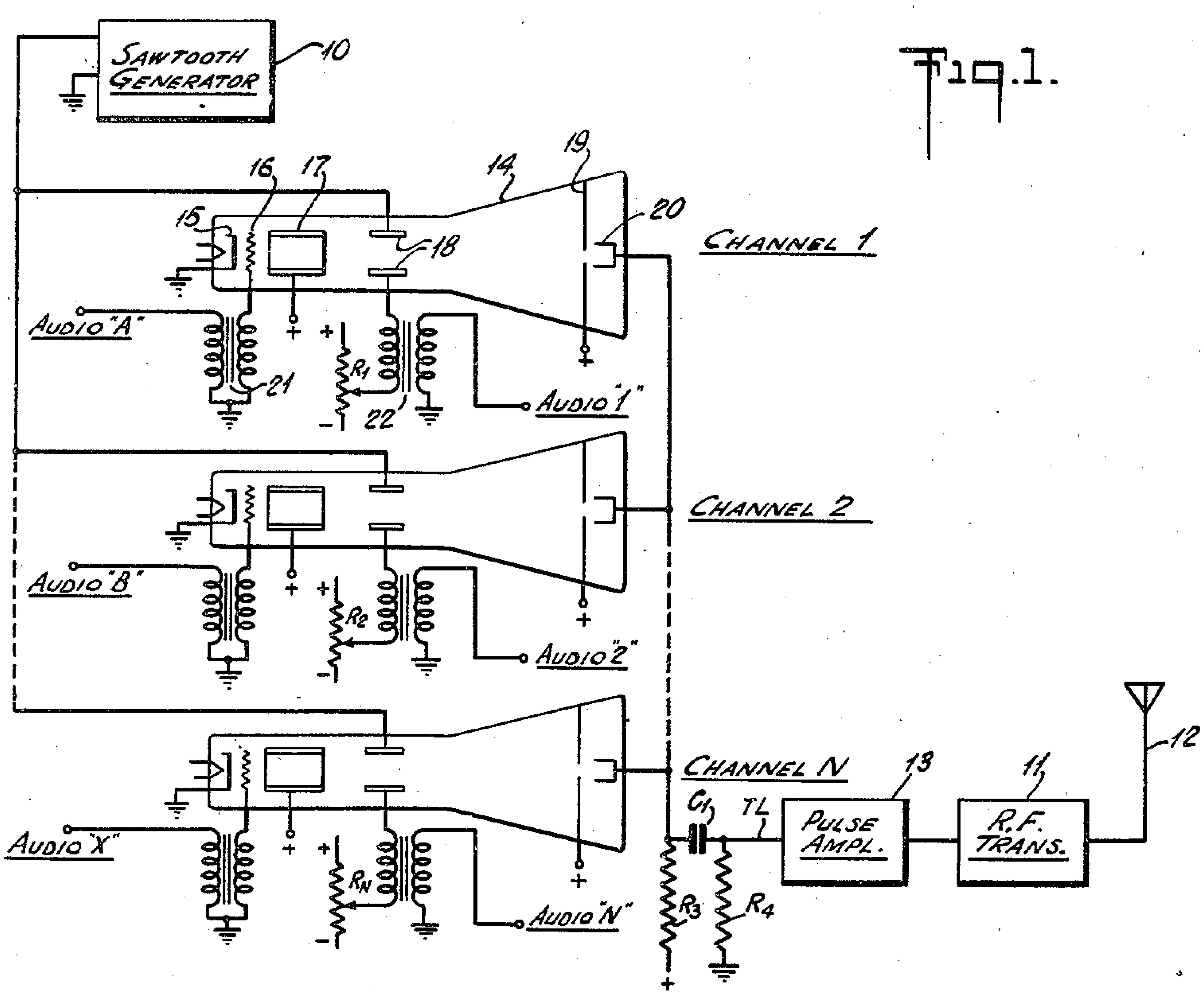

Fig. 1.

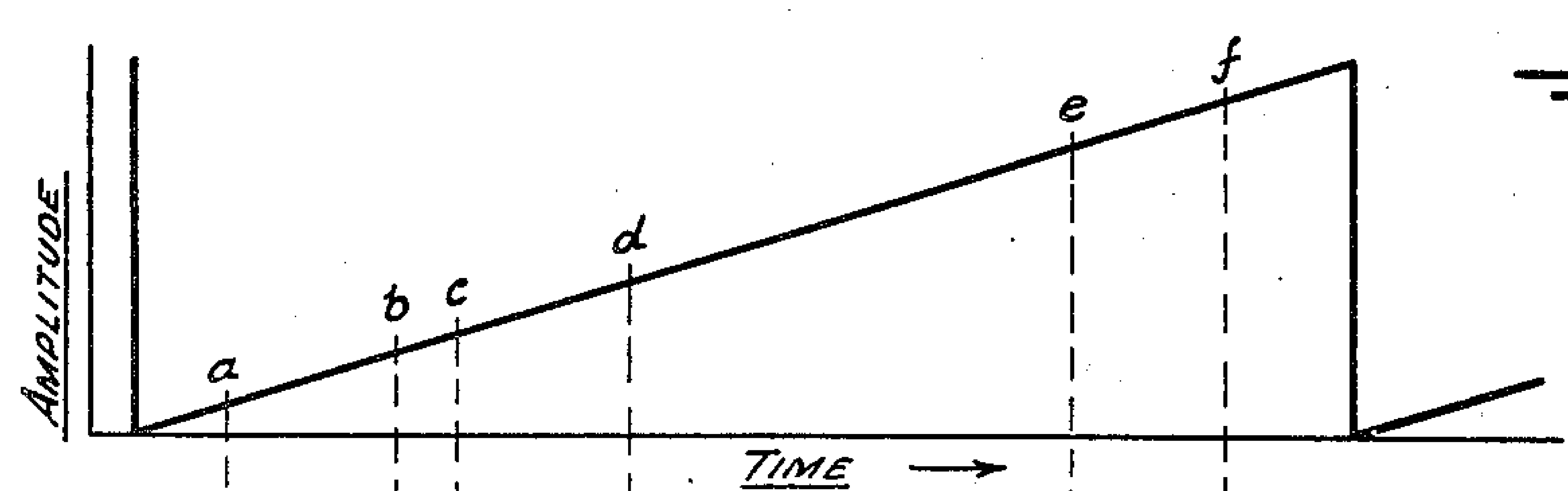

Fig. 2a.

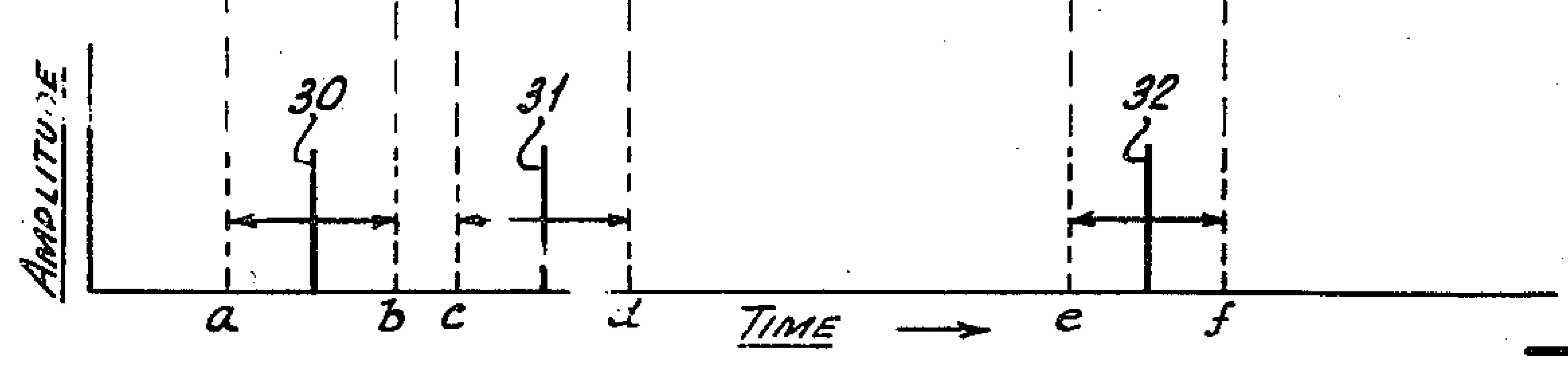

Fig. 2b.

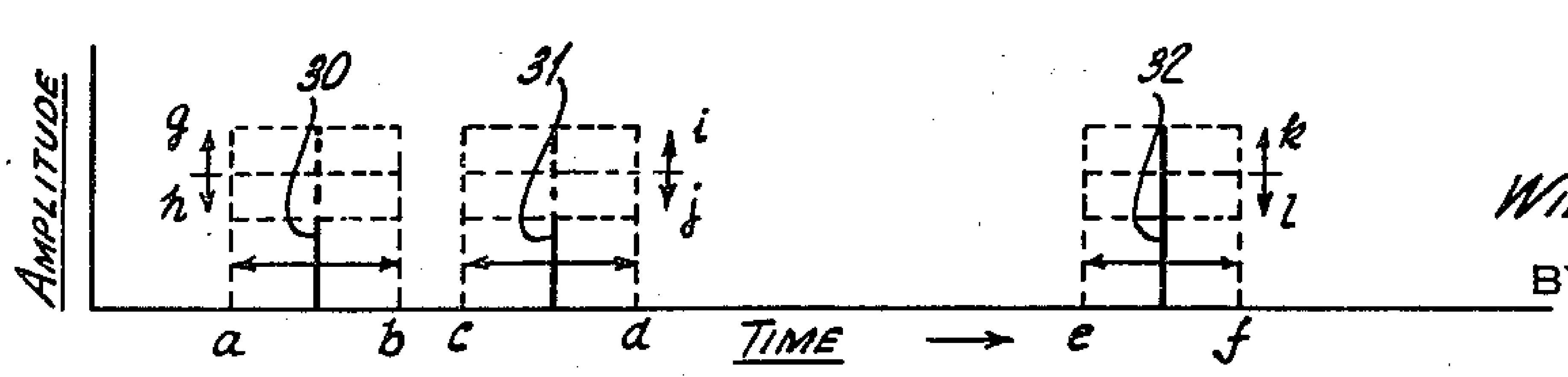

Fig. 2c.

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CATHODE-RAY TUBE MODULATOR IN A PULSE MULTIPLEX TRANSMITTER

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11 Claims. (Cl. 179—15)

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This invention relates to a pulse communication system, and to novel methods of and apparatus for generating pulses modulated in accordance with the signal intelligence.

An object of the invention is to enable the modulation of generated pulses by two different kinds of modulation to thereby increase the number of messages transmitted by a single train of pulses.

Another object is to provide a cathode ray tube type of pulse generator having means for modulating both the phase and amplitude of the generated pulses by different modulation sources.

A further object of the present invention is to provide a multi-channel pulse transmission system utilizing cathode ray tubes for generating and modulating the pulses in each channel.

A still further object is to provide a multi-channel pulse transmission system in which each channel has a series of pulses whose phase and amplitude are individually modulated by different sources of intelligence, to thereby increase the effective number of messages to be transmitted.

In accordance with the embodiment of the invention illustrated in the appended drawing and described hereinafter, the multi-channel transmitting system of the invention comprises a plurality of channels producing short duration pulses. Each channel is equipped with a cathode ray tube pulse generator having electrodes for enabling two different kinds of modulation to be impressed on the generated pulses. All channels are fed with a common saw-tooth voltage wave, and the different channels are assigned different non-overlapping portions of the linear slope of the saw-tooth wave for their respective operating times. It will thus be seen that the operating voltage levels are different for the different channels. By modulating the pulses in each channel in different manner with two different audio frequency signals, it is possible to double effectively the number of signals sent out over the channels.

A feature of the invention lies in the use of the cathode ray tube system for generating pulses and for modulating these pulses both as to amplitude and phase.

Other objects and features of the invention will appear from a reading of the following description which is accompanied by a drawing, wherein:

Fig. 1 illustrates a multi-channel pulse generating and transmitting system in accordance with the invention; and

Figs. 2*a*, 2*b* and 2*c* are graphs given in explanation of the operation of the system of Fig. 1.

Referring to Fig. 1, there is shown a multi-

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channel pulse transmitting system comprising n channels 1, 2 . . . n, each modulated by two audio signals or programs and all channels locked together by means of a common saw-tooth voltage generator 10 so that the pulses produced in the different channels occupy different time periods although occurring at the same frequency. The channels 1, 2 . . . n are coupled to a common transmission line TL extending to a radio frequency transmitter 11 and an associated radiating antenna 12. A pulse amplifier 13 located between the line TL and the transmitter 11 serves to amplify the pulses impressed on the line from the different channels. The antenna 12 may be any suitable structure, preferably a directive type of antenna which is pointed to be most effective toward the remote receiver (not shown).

The three channels shown in Fig. 1 are similar in construction and each includes a cathode ray tube 14 having, within an evacuated envelope, a cathode 15, a grid 16, a focusing anode 17, a pair of vertical deflecting plates 18, a plate 19 having a horizontal slot therein, and an output anode 20. The grid 16 is connected to the secondary winding of an audio frequency transformer 21 whose primary winding is coupled to a source of audio signals A. One vertical deflecting electrode of the pair 18 is connected to the saw-tooth generator 10, while the other vertical deflecting plate is connected to a resistor R1 through the secondary winding of an audio frequency transformer 22. The primary winding of transformer 22 is connected to a source of audio signals 1. Audio frequency sources A and 1 represent different signals or sound programs. The other channels are supplied with other different signals or sound programs. The plate 19 with the horizontal slit is supplied with a suitable positive polarizing potential. The output anode 20 is cup-like in form in order to prevent secondary electrons which might result from the bombardment of the output anode from leaving the confines of the output anode. Resistor R1, it should be noted, has opposite terminals connected to positive and negative leads of a suitable source of unidirectional potential. The secondary winding of the transformer 22 is connected to a tap or positioning control on R1 for enabling the connection to any desired point on the resistor R1. By means of this tap on the resistor R1, I am able to apply a direct current bias to one of the vertical deflecting plates 18 which causes the electron beam emitted from the cathode 15 to cross the slit or opening in the plate 10 at a particular time interval corresponding to a desired portion of the saw-tooth voltage wave applied from generator 10.

Normally, the electron beam in the cathode ray tube 14 is made to move vertically to cross the opening or slot in the plate 19. Each time the electron beam crosses the slot in plate 19, a pulse of electron current will flow to the anode 20. By means of transformer 22, and the audio signal applied to the primary of this transformer, I am able to vary the effective voltage wave on the vertical deflecting plates 18, and as a result of this to vary the particular time at which the electron beam crosses the slot in the plate 19. It will thus be seen that by applying varying voltages to the vertical deflection plates by means of the audio transformer 22 the electron beam will move across the slot at different levels of the saw-tooth input wave and thus produce phase modulated output pulses.

By differently setting the taps or position controls on the resistors R1, R2 . . . R*n* in the different channels, it will be evident that different direct current biases will be applied to the different vertical deflection plates of the cathode ray tubes of the channels. Since the saw-tooth generator 10 is common to the vertical deflection plates of all the channels, the frequency or rate of repetition of the output pulses from the different channels will be the same, but by means of suitable adjustments of the taps or positioning control on the resistors R1, R2 . . . R*n*, I am able to assign different portions of the saw-tooth voltage wave to the different channels. Putting it in other words, the pulse generated in channel 1 will occur when the saw-tooth wave reaches a desired voltage level determined by adjustment of the resistor R1, while the pulse generated in channel 2 will occur at a different time when the saw-tooth wave reaches another desired voltage level, determined by the adjustment of resistor R2, etc. It is desired that the different channels have different operating voltage regions selected for them by adjustment of the resistors R1, R2 . . . R*n*, and that these different voltage regions have substantially the same latitude of voltage. For example, if the saw-tooth voltage wave varies from zero volts to 105 volts maximum and only a three channel transmitting system is employed, each of the three channels will operate over a 25 volts region. Channel 1 can operate over the region of, let us say, 5 to 30 volts. Channel 2 can operate over the region of 40 to 65 volts. Channel 3 can operate over the region of 75 to 100 volts on the saw-tooth wave.

A clear description of the operation of the invention may be had by referring to Figs. 2*a*, 2*b* and 2*c*.

Fig. 2*a* illustrates the saw-tooth voltage wave supplied from the generator 10 to the vertical deflection plates of the different cathode ray tubes of the different channels. By suitable adjustment of the taps or positioning controls in the different channels, the pulses generated in channel 1 will occupy a time interval equivalent to *a*—*b* on the saw-tooth voltage wave of Fig. 2*a*, while the pulses generated in channel 2 will occupy a different time interval equivalent to *c*—*d* on the saw-tooth of Fig. 2*a*. Channel *n* will occupy the time interval equivalent to *e*—*f* of the saw-tooth wave of Fig. 2*a*. If the transmitting system is designed to use more than three channels, then the fourth channel may occupy some time interval located between *d* and *e* on the saw-tooth voltage wave of Fig. 2*a*. It will thus be seen that different channels have different assigned non-overlapping portions on the linear slope of the saw-tooth wave and that the different channels have the same latitude of voltage change.

The modulating voltage applied to the transformer 22 varies the direct current bias on the vertical deflection plates and varies the exact time at which the pulse occurs in the channel between the limits assigned to that channel on the saw-tooth voltage wave. This will be clear from an inspection of Fig. 2*b*. In Fig. 2*b*, the pulses from the different channels are represented by the vertical lines 30, 31 and 32 and are shown as occurring exactly in the center of the operating voltage region assigned for the saw-tooth wave of Fig. 2*a*. This will be the case if no signal is applied to the transformer 22. When the signal is applied to the transformer 22, these pulses represented by 30, 31 and 32 will vary in time between the limits assigned to the channels. The boundaries of these limits are represented by the horizontal double arrow line. Thus, the pulse 30 generated in channel 1 can vary in time anywhere between the limits *a* and *b*, while the pulse 31 generated in channel 2 can vary in time anywhere between the limits *c* and *d*, and the pulses generated in channel *n* can vary anywhere between the limits *e* and *f*. These limits can be fixed by using an audio limiter stage. The phases of these pulses will thus vary in dependence upon the signal applied to the transformer 22, although the frequency or rate of repetition of the pulses in the different channels will be the same.

Fig. 2*c* graphically illustrates the manner in which the pulses may be modulated as to amplitude. The beam intensity of the pulses is varied by applying a signal to the transformer 21, in turn connected to the grid 16. This new signal is represented as audio A in channel 1, audio B in channel 2, and audio X in channel *n*. Fig. 2*c* shows that the pulses 30, 31 and 32 can vary in phase between the limits assigned to the different channels and simultaneously vary in amplitude or intensity. Thus, the pulse 30 in channel 1 can vary in amplitude anywhere between the limits *g* and *h*, as represented by the vertical line with the double arrows, depending upon the voltage of the audio frequency signal applied to the transformer 21. The pulse 31 of channel 2 can vary in amplitude anywhere between the limits *i* and *j*, and similarly the pulse 32 in channel *n* can vary in amplitude anywhere between the limits *k* and *l*. These limits in each channel are also set by an audio limiter or other device since otherwise a large audio signal applied to A could cause cut-off of electron beam and hence no pulse would be present at 20. It will thus be seen that the pulse from each channel is phase modulated by an audio signal and at the same time can be amplitude modulated by a different audio signal. Although three channels are illustrated in Fig. 1, it is possible to transmit six different messages over these three channels, thus doubling the effective number of channels.

The output pulses from each channel should occur at a rate three times the highest audio frequency transmitted. Hence the repetition rate of the saw-tooth voltage wave should also be three times the highest audio frequency. The pulses collected from the different channels are generated across the load resistor R3 by virtue of the IR drop in this resistor. Condenser C1 in the output circuit is merely an output coupling condenser to keep high voltage from line TL. Resistor R4 serves to tie one end of condenser C1 to ground to prevent a static charge from being present if line TL were disconnected. The pulses appearing across resistor R4 are preferably amplified in pulse amplifier 13 and used to turn on or 100% modulate the radio frequency transmitter 11. The transmitter 11 serves to generate radio frequency energy whose duration and time of occurrence corresponds to the duration and times of occurrence of the pulses generated in the different channels. The pulses generated in each channel are very short compared to the time intervals between pulses appearing in the same channel.

What is claimed is:

1. A pulse generator system comprising an electron ray tube having an electron beam producing electrode, a plate provided with a slot, and an output electrode for collecting the electrons passing through said slot, deflecting elements for said tube so arranged as to cause the electron beam to traverse said slot, means for applying a triangular shaped voltage wave to said deflecting elements, and means for superimposing a variable voltage on said deflecting elements which varies in accordance with a modulating signal.

2. A pulse generator system comprising a cathode ray tube having an electron emitting cathode, a plate provided with a slot, deflecting plates so arranged as to cause the electron beam to traverse said slot, and an output electrode for collecting the electrons passing through the slot, a source of recurring triangular shaped voltage waves coupled to said deflecting plates, means for applying a direct current bias to said deflecting plates, and means for varying said bias in accordance with a modulating signal.

3. A pulse generator system comprising a cathode ray tube having an electron emitting cathode, a plate provided with a slot, deflecting plates so arranged as to cause the electron beam to traverse said slot, a grid between said cathode and said deflecting plates, and an output electrode for collecting the electrons passing through the slot, a source of recurring triangular shaped voltage waves coupled to said deflecting plates, means for applying a direct current bias to said deflecting plates, an audio frequency modulating signal coupled to said grid, and means for varying said bias in accordance with another audio modulating signal.

4. A pulse generator system comprising an electron ray tube having an electron beam source, a grid, a plate having a slot, electron deflecting elements, a source of triangular shaped voltage waves coupled to said deflecting elements for causing said beam to traverse said slot recurringly at predetermined intervals, and signal modulating means in circuit with said tube for varying between limits the exact time at which said beam traverses said slot, to thereby modulate the phase or relative timing of the generated pulses, and other signal modulating means coupled to said grid to vary the amplitude of the generated pulses.

5. A multi-channel pulse transmitting system comprising a plurality of channels, a cathode ray tube in each channel, said cathode ray tube having electron beam deflecting elements, a triangular wave generator coupled in common to the beam deflecting elements of the cathode ray tubes of said channels, and means coupled to said beam deflecting elements for selecting different operating voltage regions for said channels corresponding to different portions on the linear slope of said triangular wave.

6. A multi-channel pulse transmitting system comprising a plurality of channels, a cathode ray tube in each channel, said cathode ray tube having electron beam deflecting elements, a triangular wave generator coupled in common to the beam deflecting elements of the cathode ray tubes of said channels, and means in said channels coupled to said beam deflecting elements for selecting different operating voltage regions corresponding to different portions on the slope of said triangular wave, and different signal modulating sources coupled to the beam deflecting elements of said cathode ray tubes.

7. A multi-channel pulse transmitting system comprising a plurality of channels, a cathode ray tube in each channel, said tube having electron beam deflecting elements, a saw-tooth wave generator coupled in common to the beam deflecting elements of the cathode ray tubes of said channels, and means coupled to said beam deflecting elements for selecting different operating voltage regions for said channels corresponding to different portions on the linear slope of said saw-tooth wave, and different audio frequency modulating sources coupled to the beam deflecting elements of said cathode ray tubes.

8. A pulse generator system comprising a cathode ray tube having an electron emitting cathode, a plate provided with a horizontally arranged slot, vertical deflecting plates so arranged as to cause the electron beam to traverse said slot, and an output electrode for collecting the electrons passing through the slot, a source of recurring triangular shaped voltage waves coupled to said deflecting plates, means for applying a direct current bias to said plates, and means for varying said bias in accordance with a modulating signal.

9. A multi-channel pulse transmitting system comprising a plurality of channels, a cathode ray tube in each channel, said cathode ray tube having electron beam deflecting elements, a plate having a slot across which said beam is adapted to move, and an output electrode for collecting the electrons passing through said slot, a triangular wave generator coupled in common to the beam deflecting elements of the cathode ray tubes of said channels, and means coupled to said beam deflecting elements for selecting different operating voltage regions for said channels corresponding to different portions on the linear slope of said triangular wave, and a load circuit coupled in common to the output electrodes of said cathode ray tubes.

10. A pulse generator system comprising an electron ray tube having an electron beam source, a grid, a plate having a slot, and electron deflecting elements, a source of triangular shaped voltage waves coupled to said deflecting elements for causing said beam to traverse said slot recurringly at predetermined intervals, and signal modulating means in circuit with said tube for varying between limits the exact time at which said beam traverses said slot, to thereby modulate the phase or relative timing of the generated pulses, and other signal modulating means coupled to said grid to vary the amplitude of the generated pulses, the repetition rate of said triangular shaped voltage waves being substantially at least three times higher than the highest modulating frequency.

11. A pulse generator system comprising a cathode ray tube having beam deflecting ele-

ments, a triangular wave generator coupled to said beam deflecting elements, and adjustable means coupled to said beam deflecting elements for selecting a particular operating voltage region on the linear slope of said triangular wave, and a signal modulating source coupled to said beam deflecting elements.

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