Oct. 11, 1955 J. R. DEEN 2,720,585

MEANS FOR PRODUCING RELATIVELY LONG GATE VOLTAGES FROM A SERIES OF PULSES

Filed June 8, 1951 2 Sheets-Sheet 1

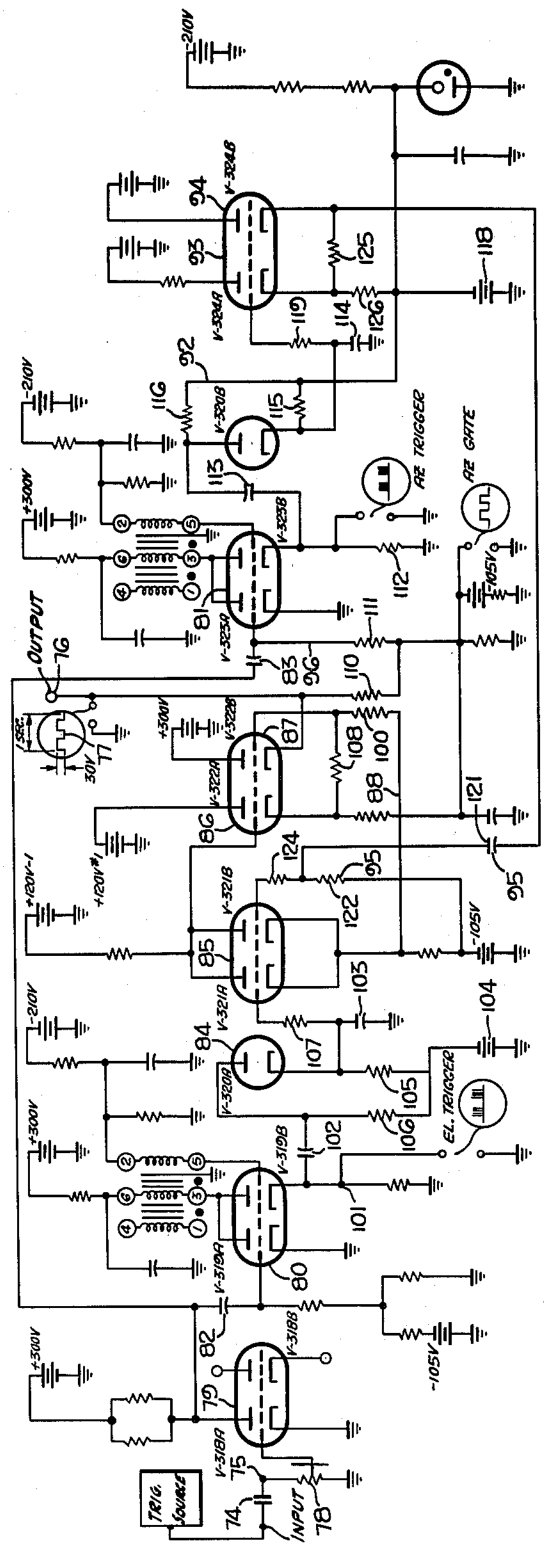

FIG. 3.

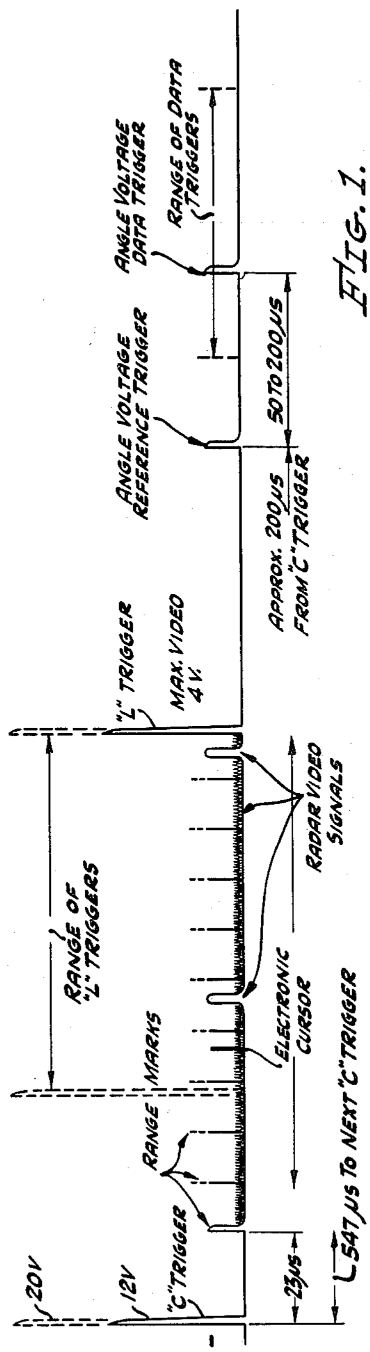

FIG. 1.

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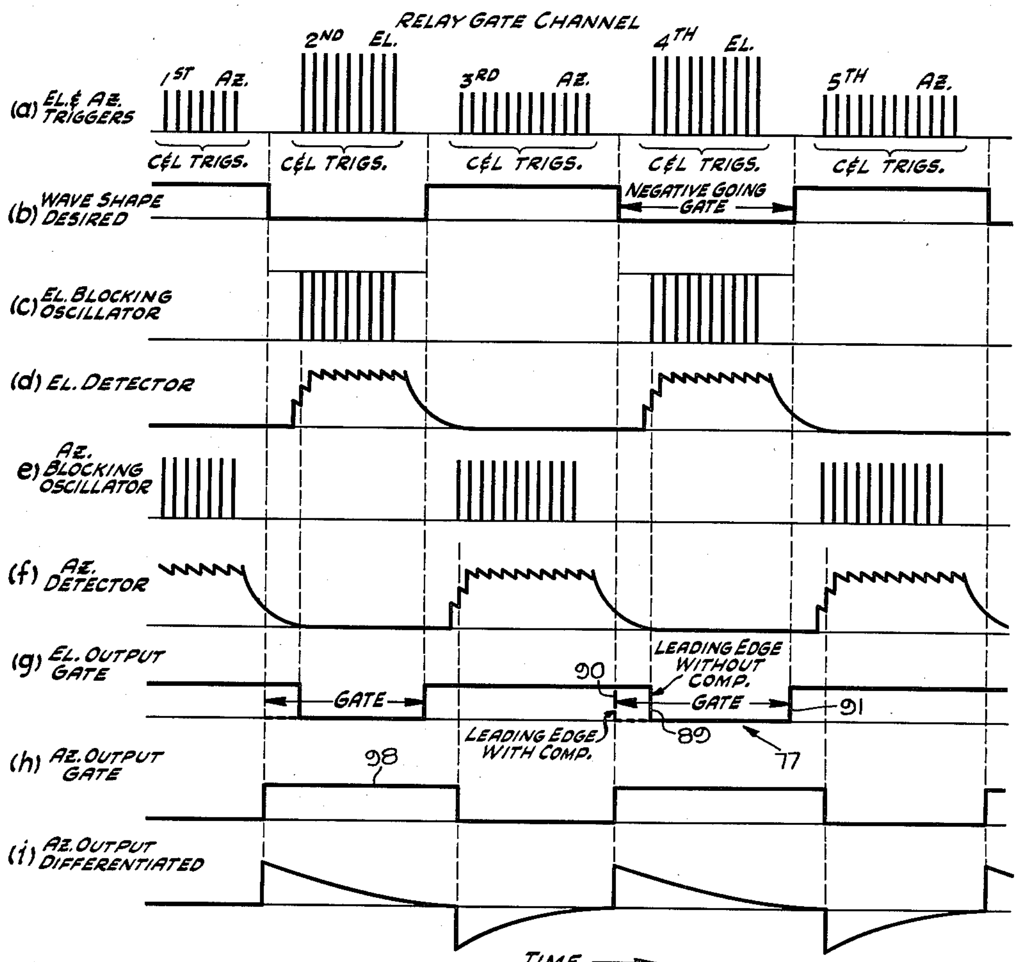

FIG. 4.

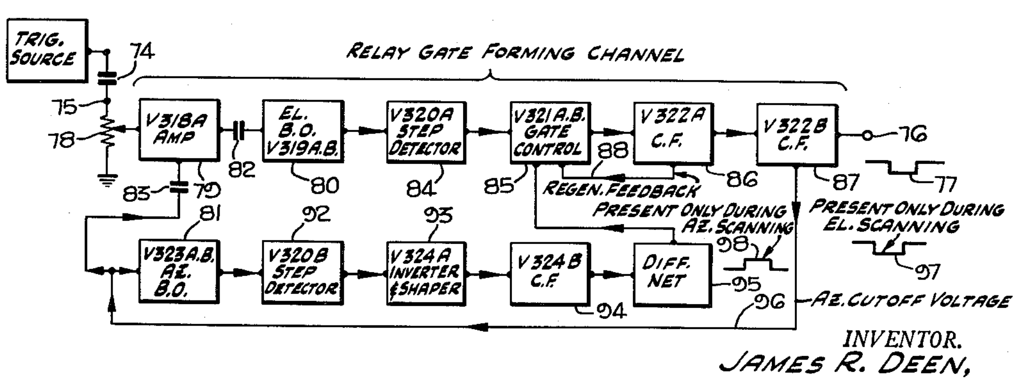

FIG. 2.

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MEANS FOR PRODUCING RELATIVELY LONG GATE VOLTAGES FROM A SERIES OF PULSES

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Application June 8, 1951, Serial No. 230,646

6 Claims. (Cl. 250—27)

The present invention relates to means and techniques whereby a relatively long gating voltage is produced in accordance with the intensity modulation on a series of pulses, and without limiting the scope of the present invention, it is described herein as embodied in remotely controlled radar equipment wherein it is desired to recreate a relay gate for adjusting the electrical center of a cathode ray tube display from one position during development of the elevation display to a second position during development of the azimuth display in producing a combined azimuth-elevation display at a remote location and for producing related control effects.

Various techniques have been developed for producing combined azimuth and elevation displays at a remote location. The equipment for this purpose is shown, described and claimed in the copending patent application of Landee et al., Serial No. 247,616, filed September 21, 1951, the output of which comprises a composite video train of the character shown therein. This video train, as shown in Figure 1 herein, includes many different components, such as the radar echo video, range marks, cursor pulses for developing electronically the glide path and runway lines on a display, the range marks being modulated in amplitude to develop so-called V-follower lines, and in accordance with important aspects of the present invention, the C and L triggers used in the aforementioned system and bracketing those video components which are made visible in the display, are utilized to produce a so-called relay gate having a time duration which is commensurate with the duration of the azimuth antenna beam scanning period.

The present invention, therefore, contemplates the provision of improved means whereby the relay gate for moving the electrical adjusted center from the point O_1 to the point O_2 in the composite display shown in the aforementioned patent application, Serial No. 247,616, and for causing related control effects, is produced in accordance with the amplitude modulation of the C and L triggers.

It is therefore one of the objects of the present invention to provide improved means and technique whereby the result indicated in the preceding paragraph may be realized.

While the present invention may be incorporated in equipment for producing the aforementioned specific result, it is evident that the invention in its broader aspects may be used in other installations where generally it is desired to produce a relatively long gating voltage or current in accordance with intelligence on a series of sharp triggers or pulses, and therefore another object of the present invention is to provide means and technique whereby the invention may be applied to other systems than the one specifically referred to herein.

In general, in the system described herein, the C and L pulses in each composite video train have a relatively large amplitude during the elevation antenna beam scanning period and a relatively small amplitude during the azimuth antenna beam scanning period. The relatively

large C and L triggers are used to develop a negative-going gating voltage. It is desired that the leading edge of this negative-going gate voltage occur at a definite perdetermined time interval, midway between the end of an azimuth scanning period and the start of the next succeeding elevation scanning period. In other words, such negative-going gate starts prior to reception of the relatively large amplitude C and L triggers. In order to produce this result, the circuit described herein incorporates what may be termed as anticipating means for establishing the leading edge of the negative-going gate prior to reception of the relatively large intensity C and L triggers which cause formation of the remaining and substantially largest portion of such negative-going gate voltage.

It is therefore another object of the present invention to provide an improved gating voltage generating apparatus of this character which incorporates anticipating means of the type alluded to above.

It is noted that the interval between completion of the azimuth display and start of the elevation display is in the order of 30 milliseconds or more, and that the C and L triggers stop immediately at the completion of each display. It is desired that the relay gate, i. e., the aforementioned negative-going gating voltage, start midway in this interval, i. e., at approximately 15 milliseconds after the last train of C and L triggers at the completion of the azimuth display.

Another specific object of the present invention therefore is to provide an improved relay gate forming means of this character which has features described in the preceding paragraph.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 shows the composite video train which is applied to the circuit embodying features of the present invention for forming a relay gate of relatively long duration in accordance with the amplitude modulation of the C and L triggers in such train;

Figure 2 shows in block diagram form apparatus embodying features of the present invention for producing the above mentioned results;

Figure 3 is a schematic representation showing in more detailed form some of the circuitry shown in block diagram in Figure 2;

Figure 4 shows a series of triggers and waveforms which are present in different portions of the circuit shown in Figures 2 and 3.

The C and L triggers in the composite video train shown in Figure 1, having amplitudes 12-volts during azimuth antenna beam scanning and 24-volts during elevation antenna beam scanning, are used to produce the relatively long relay gate, using the apparatus shown in block form in Figure 2, which apparatus is shown more specifically in Figure 3. For this purpose, the composite video train is applied through coupling condenser **74** to the relay gate forming channel having the input terminal **75** and the output terminal **76**.

Briefly, the operation of this gate generating channel is as follows. The negative-going gate **77** appearing at the output terminal **76** is produced during the time the elevation antenna beam is scanning, i. e., during the period when the C and L triggers have their maximum amplitudes of 24-volts. During the time the azimuth antenna is scanning, these C and L triggers have an amplitude of 12-volts. It is desired that both the leading and trailing edges of the negative-going gate **77** be accurately spaced in relationship to the azimuth and elevation antenna beam scanning periods, and for that purpose, special compensatory arrangements described in detail hereinafter are provided. In general, the negative-going gate **77** is produced by integrating effectively the series of C and L triggers occurring during the elevation scanning period. However, since some time is required in the step detector or integrating networks described hereinafter, the leading edge of the negative-going gate is necessarily delayed a period too long for operation of the system as intended. To counteract such undesirable delay, the leading edge of the negative-going gate otherwise delayed is advanced by control voltages developed during the preceding azimuth beam angle scanning period.

More specifically, the composite video train is applied to the input resistance **78**, which has an adjustable tap connected to the input terminal of the amplifier stage **79**. It should be noted at the outset that this relay gate forming circuit is amplitude selective in that the same will not respond to triggers or pulses having an amplitude appreciably less than 12-volts. In other words, the much smaller reference and data triggers, as well as the range marks, cursor pulses and video signals, are ineffective to operate this relay gate forming channel. This is true since the elevation blocking oscillator stage **80** and azimuth blocking oscillator stage **81**, coupled respectively to the amplifier **79** through condensers **82** and **83**, are operated only when the triggers applied thereto have amplitudes in the order of 24 and 12-volts, respectively.

During the elevation beam scanning period, when the C and L pulses have an amplitude of 24-volts, the elevation blocking oscillator stage **80** is operated to produce a sharp pulse in accordance with each one of the C and L triggers. The relationship of these C and L pulses during the elevation scanning period, and the resulting pulses produced at the output of the blocking oscillator **80**, is shown in Figure 4 at *a* and *c*, respectively. These pulses thus produced in the blocking oscillator **80** are integrated in the step detector circuit **84**, the output of which appears as shown at *d* in Figure 4. The output of the step detector **84** is applied to the gate control stage **85** which, insofar as the elevation channel itself is concerned, is an inverter which inverts and shapes the pulse applied from stage **84**. The output of stage **85** is applied to the first cathode follower stage **86** which, in turn, is coupled to the second cathode follower stage **87** having the output terminal **76**. It is noted that a regenerative feedback circuit **88** extends from the output of the cathode follower stage **86** to the gate control stage **85** for purposes mainly of obtaining a fast and unsluggish response, particularly in the transitional period between the end of an azimuth scanning period and the start of the next succeeding elevation scanning period. The output, in the form of a negative gate **77**, which corresponds with the negative-going gate without compensation shown in Figure 4 at *g* is produced.

In order to more fully understand Figure 4, it is observed that the groups of triggers appear in the order indicated at *a* in Figure 4, and with the time axis thus established, the line or edge **89** defines the leading edge of the negative-going gate, while the full line **91** represents the trailing edge of the same gate. It is desired that the leading edge **89** be shifted forwardly with respect to time to the position indicated by the dotted line or edge **90**. In such case, the leading edge **90** occurs in the desired transitional period between the azimuth and elevation scanning periods. In such case, a composite gate indicated at *g* in Figure 4 corresponds with the desired gate shown at *b* in Figure 4.

The means whereby such leading edge **89** is shifted forwardly in time to obtain the leading edge indicated at **90** is now described generally, and such compensatory means includes generally the azimuth blocking oscillator stage **81**, the step detector **92**, the inverter stage **93**, the cathode follower stage **94**, differentiating network **95**, a portion of the gate control circuit **85**, and a connection **96** extending from the cathode follower stage **87** to the input of the blocking oscillator stage **81** for purposes of preventing operation of the azimuth blocking oscillator stage **81** during the time that the negative gate is present in the cathode follower stage **87**, i. e., during the elevation scanning period.

The azimuth blocking oscillator stage **81** is coupled through condenser **83** to the amplifier **79**, but is rendered ineffective during the elevation scanning period by the negative gate **97** applied over the lead **96** from the cathode follower stage **87**. Thus, only during the azimuth scanning period, the azimuth blocking oscillator stage **81** is operated to produce corresponding output pulses shown at *e* in the Figure 4. These pulses are step detected in detector stage **92** to produce the waveform shown at *f* in Figure 6. After this waveform is inverted in inverter and shaper stage **93**, it is applied to the cathode follower stage **94**. The output of the cathode follower stage **94** is thus a negative-going gating voltage **98**, which of course is developed only during the azimuth scanning period. Such negative-going gate **98**, represented also at *h* in Figure 4, is differentiated in the differentiating network **95** to produce the differentiated output voltage represented at *i* in Figure 4. This differentiated output voltage is applied to the gate control **85**, and as described in greater detail hereinafter, effectively serves to shift forwardly in time the leading edge of the gate **77**, which ultimately appears at the output terminal **76** in the manner indicated at *g* in Figure 4.

For a more detailed description of the relay gate forming channel described in relationship to the block diagram in Figure 2, reference is made to Figure 3. Corresponding tubes in Figures 3 and 2 are denoted by the same numbers.

The negative-going composite video, including the C and L triggers, are developed across the input potentiometer resistance **78**, the adjustable tap of which is connected to the control grid of the amplifier tube **V–318A**. The output voltage appearing on the anode of this tube is coupled, on the one hand, through condenser **82** to the control grid of the trigger tube **V–319A** of the oscillator stage **V–319A**, **V–319B**; and, on the other hand, for purposes described later, through condenser **83** to a similar but azimuth blocking oscillator stage **V–323A**, **V–323B**. The adjustable tap on resistance **78** is adjusted so that only the C and L triggers, having a magnitude of 24-volts, are effective to fire the blocking oscillator stage **V–319A**, **V–319B**. The trigger tube **V–319A** is, in its quiescent state, normally nonconducting, but a positive C or L trigger applied to such control grid causes the oscillator tube to fire, to thereby produce elevation triggers at its cathode output terminal **101**, of the character shown at *c* in Figure 4. These elevation triggers, which comprise triggers corresponding both to C and L triggers, are applied through condenser **102A** to the step detector stage which includes the tube **V–320A**, a diode. The anode of tube **V–320A** is connected to the condenser **102**, while the cathode is connected to the ungrounded terminal of the condenser **103**, having a capacity in the order of 10,000 $\mu\mu$f. The cathode of tube **V–320A** is likewise returned to the negative ungrounded terminal of voltage source **104** through resistance **105**. Resistance **106** is connected between the anode of tube **V–320A** and the negative terminal of source **104**. The resistance **105** may have a value of 1 megohm, and the resistance **106** may be 100,000 ohms. The voltage thus developed on condenser **103** is of the form shown at *d* in Figure 4, and such voltage is applied through resistance **107** to the control grid of tube **V–321A** in the gate control stage **85**.

It is observed, at this time, that the tube **V–321A** and tube **V–321B** have their anodes and cathodes connected respectively, and that both of such tubes are used to couple voltages to the cathode follower tube **V–322A**, the control grid of tube V–321A, however, being sensitive only to elevation voltages, while the control grid of tube V–321B is sensitive only to azimuth voltages, for the aforementioned purpose of shifting the leading edge **89** of the negative-going gate **77** forwardly in time to the position indicated at *g* in Figure 6.

Neglecting for the present any azimuth voltage applied to the control grid of tube V–321B, the amplified elevation voltage developed on condenser **103**, after amplification in tube V–321A, is applied to the control grid of cathode follower tube V–322A in inverted form. The cathode of the tube V–322A is coupled through resistance **108** to the control grid of the second cathode follower stage V–322B. In order to increase the quickness of response, a regenerative feedback circuit including resistance **109** extends from the control grid of tube V–322B to the cathode of tube V–321A.

Thus, under the assumption that no azimuth voltage is applied to the control grid of tube V–321B, a negative-going gate is produced at the output terminal **76** having the form shown at *g* in Figure 4, such negative-going gating voltage having the leading edge **89** and trailing edge **91**.

During this period of time, when the negative-going gates are developed at output terminal **76**, the azimuth blocking oscillator stage including tubes V–323A and V–323B is rendered inoperative by the negative voltage applied from output terminal **76** to the control grid of trigger tube V–323A through resistances **110** and **111**. Thus, by this expedient, the azimuth oscillator stage fed with C and L pulses through condenser **83**, is rendered operative to fire only during the azimuth beam scanning period.

During the azimuth scanning period, the C and L triggers have a lessened amplitude, namely, are only 12-volts, an amount insufficient to fire the elevation blocking oscillator stage V–319A, V–319B, but sufficient to fire the azimuth blocking oscillator stage V–323A, V–323B. As a result, azimuth triggers or pulses are developed across the cathode load resistance **112** of the form shown at *e* in Figure 4, and such triggers are applied through condenser **113** to the step detector or accumulating stage **92**, which includes the diode tube V–320B and condenser **114** for purposes of developing a voltage across such condenser **114** of the form shown at *f* in Figure 6.

For this purpose, the condenser **113** has one of its terminals connected to the anode of tube V–320B, the cathode of such tube being connected to the ungrounded terminal of condenser **114**, which may have a magnitude of 10,000 $\mu\mu$f. Resistance **115**, having a magnitude of 1 megohm, and resistance **116**, having a magnitude of 100,000 ohms, are serially connected between the anode and cathode of tube V–320B. The junction point of resistances **115** and **116** is connected to the negative ungrounded terminal of the voltage source **118**. The voltage thus developed on the condenser **114** is applied through resistance **119** to the control grid of the inverting, amplifying and wave-shaping tubes V–324A and V–324B. The voltage thus developed on the cathode of tube V–324B is applied through a differentiating network **95** comprising condenser **121** and resistance **122**, to the control grid of tube V–321B through resistance **124**. It is noted that the cathodes of tubes V–324A and V–324B are interconnected by resistance **125**, and that the cathode of tube V–324A is returned to the negative terminal of source **118** through resistance **126**. Condenser **121** may have a magnitude of 0.25 μf. and resistance **122** may have a magnitude of 1 megohm.

This differentiating network **121**, **122** is thus effective to differentiate the azimuth output gate represented at *h* in Figure 4 into the form shown at *i* in Figure 4. The differentiation is such that a positive voltage appears on the grid of tube V–321B during the transitional period between an azimuth scanning period to the succeeding elevation scanning period. This in effect causes the voltage developed at the output of tubes V–321A, V–321B to be depressed sooner, therefore causing the leading edge of the resulting negative-going gate **89** in Figure 4 at *g* to be shifted forwardly in time.

It is observed further that a means is provided herein for "timing out" the relay gate midway between the elevation and azimuth scans. This timing out is determined by the time constant in the step detector circuit comprising tube **84**, condenser **103**, and resistance **367**. These components may be adjusted that the trailing edge of the negative gate **77** may be made to occur at any time between elevation and azimuth scans.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

We claim:

1. In an arrangement of the character described wherein it is desired to produce a relatively long gating voltage in accordance with two groups of trigger pulses with the trigger pulses of one group being of different amplitude than the trigger pulses in the other group, one of said groups of trigger pulses having relatively large amplitudes and the trigger pulses of the other group having, in relationship to trigger pulses of said one group, a relatively small amplitude, a first channel receptive to trigger pulses of said relatively large amplitude but not receptive to said trigger pulses of said relatively small amplitude, a second channel receptive to both said large and small amplitude trigger pulses, means coupling said first channel to said second channel for rendering said second channel inoperative while said first channel is being receptive to said large amplitude trigger pulses, said first channel including a step detector arranged to produce a first substantially constant voltage in accordance with reception of said relatively large amplitude trigger pulses, an output circuit common to both said first and second channels and controlled by said relatively constant voltage developed in the first channel, said second channel including a step detector for developing a second relatively constant voltage during reception of said relatively small amplitude trigger pulses, and a differentiating network for differentiating said second voltage and for coupling said second channel to said common output circuit.

2. In an arrangement of the character described wherein it is desired to produce a relatively long gating voltage in accordance with two groups of trigger pulses with the trigger pulses of one group being of different amplitude than the trigger pulses in the other group, a first one of said groups of trigger pulses having relatively large amplitudes and the trigger pulses of the other group having, in relationship to the amplitude of trigger pulses of said one group, a relatively small amplitude, a first channel receptive to said first group of trigger pulses but not receptive to the trigger pulses of said second group of trigger pulses, a second channel receptive to both said first and second groups of trigger pulses, means coupling said first channel to said second channel for rendering said second channel inoperative while said first channel is being receptive to said first group of trigger pulses, said first channel including a step detector arranged to produce a first substantially constant voltage wave in accordance with said one group of trigger pulses, an output circuit common to both said first and second channels and controlled by said first relatively constant voltage wave developed in the first channel, said second channel including a step detector for developing a second relatively constant voltage wave in accordance with reception of said second group of trigger pulses, and a

differentiating network coupling said second channel to said common output circuit.

3. In an arrangement of the character described, a first channel receptive to relatively large amplitude trigger pulses only, a second channel receptive to relatively small amplitude trigger pulses which are small in relationship to said relatively large amplitude trigger pulses, a source of triggering voltages coupled to said first and second channels, said source being effective to impress upon both of said channels two groups of trigger pulses recurrently, with the trigger pulses in one of said groups being of said relatively large amplitude to which said first channel is receptive, and the trigger pulses of the other of said groups being of said relatively small amplitude to which said second channel is receptive, said one and other group of trigger pulses being time spaced, apparatus, including said first and second channels, for developing a gating voltage having a leading edge which occurs after the cessation of said other group of trigger pulses and before the initiation of said one group of trigger pulses, and which has a trailing edge which occurs after the cessation of said one group of trigger pulses and before the initiation of the other group of trigger pulses, an output circuit common to both of said channels, said first channel including a step detector for developing a first relatively constant voltage wave having a time duration commensurate with the time of reception of said first group of trigger pulses, said second channel having a step detector for developing a second relatively constant voltage wave having a duration commensurate with the reception of said trigger pulses of said second group of trigger pulses, and a differentiating network coupled between said second step detector and said common output circuit.

4. In apparatus of the character described, a source of recurrently appearing two groups of trigger pulses, the trigger pulses in one group being of substantially the same amplitude but being relatively large in relationship to the amplitude of trigger pulses in the other of said groups, the trigger pulses in said other group being of substantially the same amplitude but being relatively small in relationship to the amplitude of trigger pulses in said one group, said first and second groups of trigger pulses being time spaced an appreciable distance which is appreciably greater than the spacing between trigger pulses in either said one group or in said other group, a first channel receptive to said one group of trigger pulses but not receptive to said other group of trigger pulses, a second channel receptive to said one and other groups of trigger pulses, means coupled between said first channel and said second channel to disable said second channel in accordance with reception by said first channel of said one group of trigger pulses, said first channel including means for deriving from said one group of trigger pulses a first relatively constant voltage wave, the duration of which is commensurate with the duration of said one group of trigger pulses, said second channel including means for deriving from said other group of trigger pulses a second relatively constant voltage wave, the duration of which is commensurate with the duration of said other group of trigger pulses, a common output circuit common to both said first and second channels, means coupling said first voltage wave to said output circuit, and means coupling said second voltage wave to said output circuit.

5. In an arrangement of the character described, a first channel receptive to relatively large amplitude trigger pulses, said first channel comprising, in order: a first blocking oscillator stage operated only by said relatively large amplitude trigger pulses, a first step detector coupled to said first blocking oscillator stage for developing a relatively continuous voltage during and in accordance with reception of said relatively large intensity trigger pulses, a utilization network, first means coupling said first step detector to said utilization network; a second channel receptive to relatively small amplitude trigger pulses which are of small amplitude in relationship to said large amplitude trigger pulses, said second channel comprising: a second blocking oscillator stage operated by said relatively small amplitude trigger pulses, a second step detector coupled to said second blocking oscillator stage for developing a substantially constant voltage during and in accordance with trigger pulses developed in said second blocking oscillator stage, means including a differentiating network for coupling said second step detector to said utilization network for altering the wave shape of the voltage applied by said first channel to said utilization network.

6. The arrangement set forth in claim 5 in which means are provided for coupling the output of said first step detector to said second blocking oscillator stage to render the same inoperative in accordance with voltage developed in said first step detector.

References Cited in the file of this patent

UNITED STATES PATENTS

2,497,411	Krumhansl	Feb. 14, 1950
2,529,666	Sands	Nov. 14, 1950
2,534,337	Canfora et al.	Dec. 19, 1950
2,538,028	Mozley	Jan. 16, 1951
2,634,368	Johnson	Apr. 7, 1953