

April 7, 1953

T. J. JOHNSON
DECODING OF ANGLE VOLTAGE TRIGGERS
IN COMPOSITE VIDEO SYSTEMS

2,634,368

Filed Sept. 21, 1951

2 SHEETS—SHEET 1

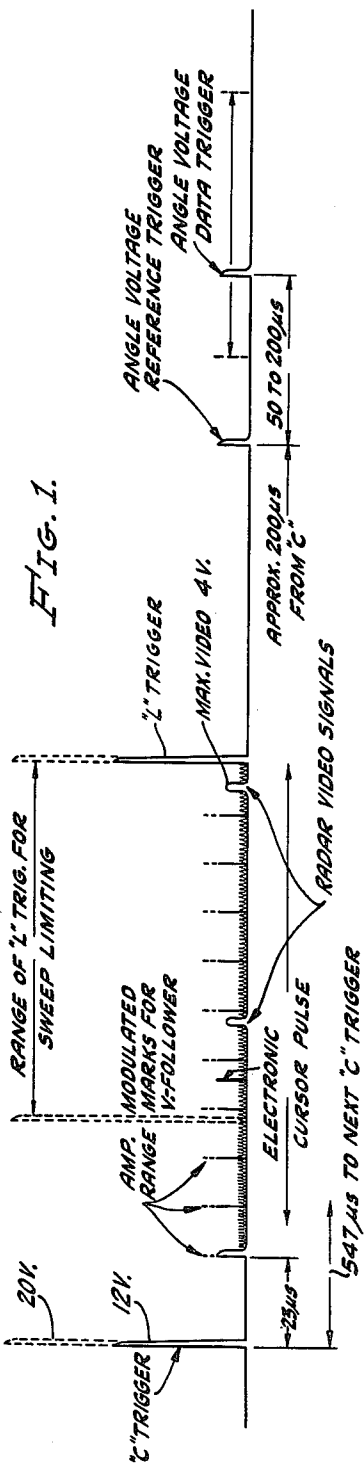
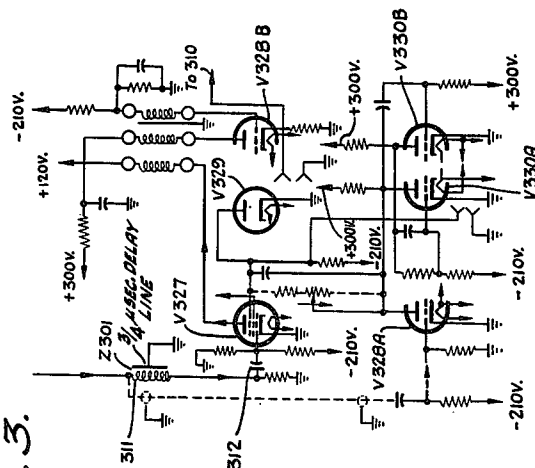
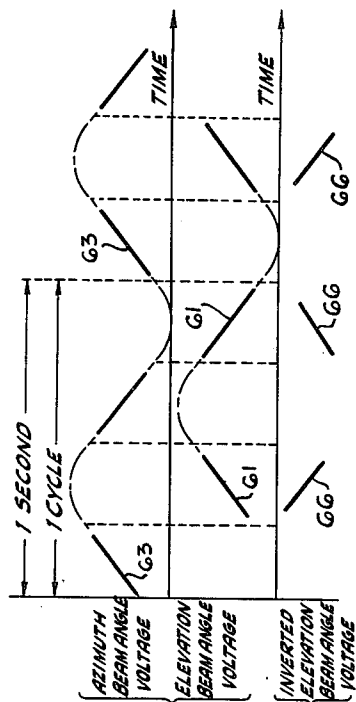


FIG. 3.



INVENTOR.
THOMAS J. JOHNSON
BY *Lyons & Lyons*
ATTORNEYS.



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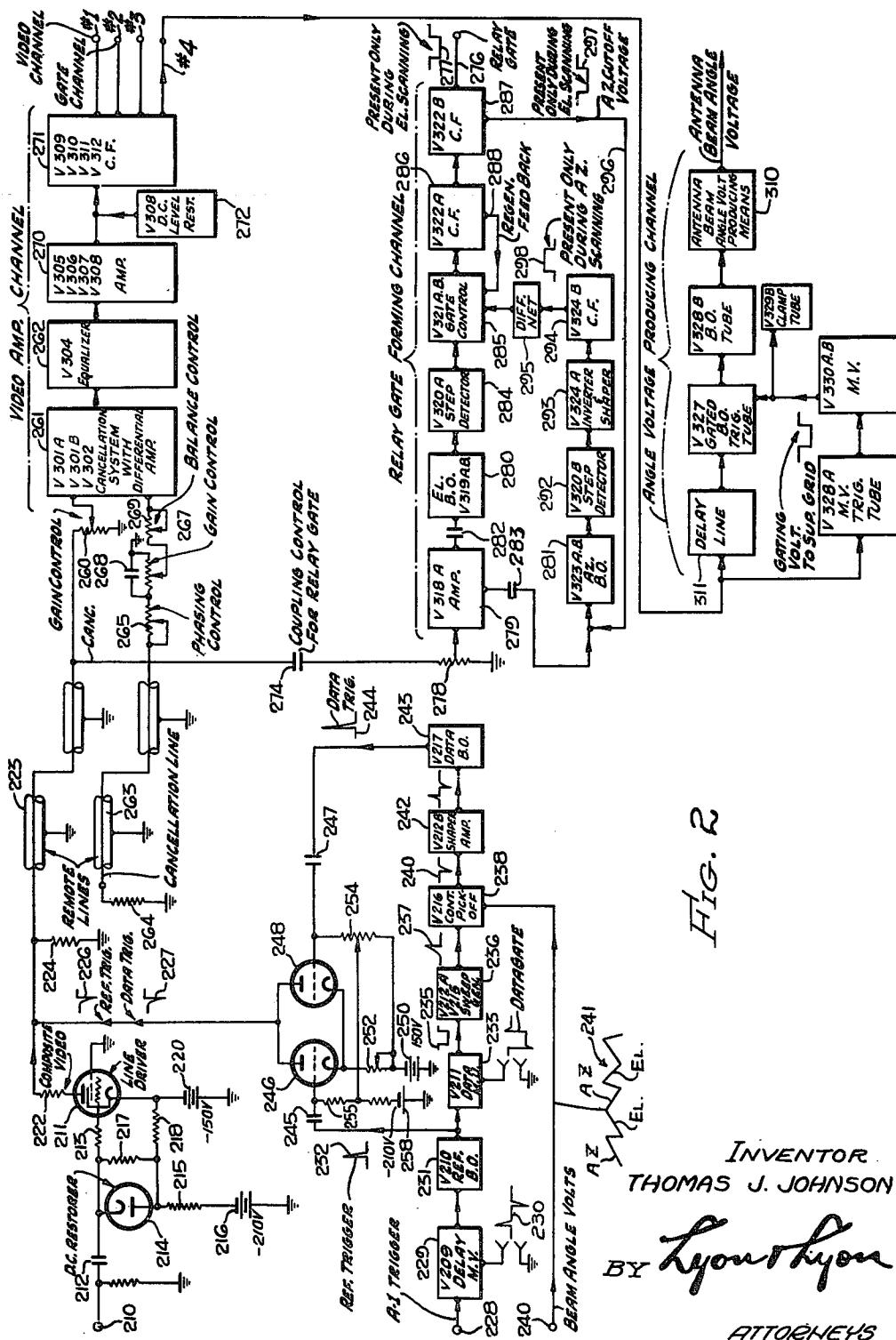


FIG. 2

INVENTOR
THOMAS J. JOHNSON

BY *Lyon & Lyon*

ATTORNEYS

UNITED STATES PATENT OFFICE

2,634,368

DECODING OF ANGLE VOLTAGE TRIGGERS
IN COMPOSITE VIDEO SYSTEMSThomas J. Johnson, Los Angeles, Calif., assignor
to Gilfillan Bros., Inc., Los Angeles, Calif., a
corporation of California

Application September 21, 1951, Serial No. 247,615

5 Claims. (Cl. 250-27)

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The present invention relates to improved techniques and means particularly useful in cathode ray tube indicators of the type such as found in the so-called precision section of G. C. A. (ground control approach) radar aircraft landing systems, but of course is not necessarily limited to use of such equipment.

More specifically, the present invention relates to improved techniques and means particularly useful in a remote location for decoding or unscrambling various trigger voltages representative of so-called antenna beam angle voltage from a composite video train of the character developed and used in the system described in my co-pending patent application with Landee, et al., Serial No. 247,616, filed September 21, 1951, and assigned to the same assignee.

In the system described in the aforementioned co-pending application, a composite video train is developed in which the spacing between so-called reference and data triggers serves as a measure of the magnitude of the angular position of an antenna radar beam while scanning through space. Such reference and data triggers form a part of such composite video train, the other part of the composite video train includes the so-called C and L triggers, between which is disposed various signals used in producing visible indications on the face of a cathode ray tube. Such composite video train as shown and described in the aforementioned co-pending application is developed at a local station and transmitted to a remote station at which the reference and data triggers are required to be separated from the remaining portion of the composite video train. The present application is directed to specific features of the means and techniques used at the remote station for effecting such separation of the reference and data triggers from the composite video train and is directed also to other related features.

For other objects and advantages of the present arrangement, reference is made to the aforementioned co-pending application, the disclosure of which is incorporated herein by this reference thereto.

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 time relationship between various triggers, range marks, cursor pulses and

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echo signals in the composite video train which is developed by the apparatus described in the aforementioned copending application, Serial No. 247,616, filed September 21, 1951, and applied to the designated terminals of the apparatus shown in the succeeding figures;

Figure 2 shows circuitry embodying features of the present invention;

Figure 3 shows in more detailed form circuitry in the angle voltage producing channel shown in block diagram in Figure 2, and in particular, the specific means embodying features of the present invention whereby the reference and data triggers are separated from the composite video train; and

Figure 4 shows the cyclical variation of azimuth and elevation beam angle voltages in relationship to the related position of the corresponding radiated azimuth and elevation antenna beams, such voltage variations being applied to the designated terminal in the apparatus shown in the preceding figures.

With reference to Figure 1, the present invention is directed to means and techniques whereby both the angle voltage data triggers are separated from the composite video train, illustrated in that figure, for purposes of recreating from such reference and data triggers a corresponding variation of azimuth and elevation beam angle voltages of the character illustrated at 241 in Figure 2 and also illustrated in Figure 4. Such azimuth and elevation beam angle voltages which appear recurrently, vary in amplitude from, for example, 2 to 52 volts in accordance with the angular position of the antenna beam radiated from the azimuth and elevation scanning antennas, as the case may be.

In accordance with the techniques described in the aforementioned copending application of Landee et al., Serial No. 247,616, filed September 21, 1951, there are provided two antennas, i. e., an azimuth and an elevation antenna for scanning respectively in azimuth and in elevation. First the azimuth antenna scans through space and a voltage variation represented as 63 in Figure 4 is developed to serve as a measure of the angular position of such antenna beam. Subsequently, after the azimuth antenna completes its scan, the elevation antenna beam scans through space and contemporaneously therewith an elevation beam angle voltage variation represented as 61 in Figure 4 is developed to serve as a measure of the angular position of the radiated antenna beam. Then, after the elevation antenna completes its scan, the azimuth antenna scans in a reverse direction to return to its initial position and after completion of such azimuth scan,

the elevation antenna beam is scanned so as to return to its initial position.

These beam angle voltage variations 63 and 61 when combined on a single line appear as the variations represented at 241 in Figure 2.

The apparatus shown in Figure 2 serves to develop the reference and data triggers illustrated in Figure 1, from such variation 241 with the spacing between the reference and data triggers serving as a measure of the instantaneous amplitude of the azimuth and elevation beam angle volts, as the case may be. It is observed, that these reference and data triggers appear as a pair, and appear at a repetition rate of the radar system which may, for example, be in the order of 2,000 per second, whereas, as indicated in Figure 4, the beam angle voltages vary at a much lower rate, i. e., the beam angle voltage varies from 2 to 52 or, conversely, from 52 to 2 volts in approximately one quarter of a second.

The particular means whereby such reference and data triggers are produced with the spacings which vary in accordance with the amplitude of such voltage variations 61, 63, is described more fully and claimed in my copending application with Alvin Guy Van Alstyne, Serial No. 203,304, filed December 29, 1950, and assigned to the same assignee as the present application. Furthermore, such copending application, Serial No. 203,304, describes and claims means at a remote location whereby the reference and data triggers are used for recreating the voltage variations 61, 63. As alluded to above, the present invention is directed to means and techniques whereby such reference and data triggers illustrated in Figure 1 are separated from the composite video train and applied to beam angle re-converting circuitry of the character mentioned in such copending application, Serial No. 203,304, without interference produced by the other triggers, pulses or signals in the composite video train.

In general, the composite video train illustrated in Figure 1 is useful in providing a visible display on a cathode ray tube, such display including an azimuth versus range picture and a corresponding elevation versus range picture. For this purpose, the pair of C and L triggers are used to gate the transfer of the radar video signals to an intensity control electrode of the cathode ray tube, i. e., for example, the cathode. The gate produced by such C and L triggers have a time length commensurate with the spacing between such triggers, whereby the various range mark pulses, cursor pulses and radar video signals may serve to intensify the cathode beam to produce corresponding visual indications during the duration of such gate. Furthermore, a so-called relay gate is developed from such composite video train, the relay gate having a duration commensurate with the time required for development of the azimuth versus range picture. The purpose of such relay gate is to cause the electrical center of the azimuth versus range on the one hand and elevation versus range pictures on the other hand to be shifted alternately since it is noted that both of these pictures are produced by a cathode tube having a single electron gun structure, and that the azimuth and elevation pictures are presented on a time sharing basis. In other words, first the azimuth picture is presented with the relay gate operative to shift the electrical center of the cathode ray tube and after the azimuth picture is developed, the relay gate is no longer present and the elevation pic-

ture is presented with cathode beam sweeps radiating from a different electrical center. Furthermore, as alluded to above, an antenna beam angle voltage, which varies in accordance with the angular position of the radiated antenna beam, i. e. azimuth or elevation beam as the case may be, is developed and used to modulate the cathode beam sweeps to thereby change their radial position to effectively produce pivoting of the sweeps about the different adjusted electrical centers.

In recreating the azimuth and elevation displays at the remote station, the C and L triggers are transmitted to the remote station, but the C and L triggers are modulated in amplitude for purposes of developing the aforementioned relay gate. In other words, the relay gate as such is not transmitted to the remote location but is developed in accordance with amplitude modulation of the C and L triggers.

The manner in which the C and L triggers and the pulses, signals and triggers between such C and L triggers in Figure 1 are placed on the composite video train is described in detail in the aforementioned patent application of Landee et al., Serial No. 247,616, and for that reason need not be repeated here. For remoting purposes that part of the composite video signal, i. e., that portion between and including the C and L triggers, is applied to terminal 210 in Figure 2, which terminal is coupled to the control grid of the line driver tube 211 through coupling condenser 212 and resistance 213. On the other hand, as described in detail later, the reference and data triggers 226 and 227 are applied to the composite video train from the anodes of tubes 246 and 248, respectively.

The junction point of condenser 212 and resistance 213 is connected to the cathode of the D.-C. restorer tube 214, which has its anode connected through resistance 215 to the negative ungrounded terminal of voltage source 216. The diode tube 214 is shunted by the resistance 217 and the anode of tube 214 is connected through resistance 218 to the cathode of tube 211. This cathode is connected to the negative ungrounded terminal of the voltage source 220. The screen grid of the pentode driver tube 211 is grounded, while the anode of tube 211 is connected through resistance 222 to the central conductor of the transmission line 223, which has its sheath grounded. Such central conductor is returned to ground through the loading resistance 224. Also applied to such central conductor is the pair of reference and data triggers 226, 227, respectively (indicated also in Figure 1), which occurs periodically at the repetition rate of the system, which, for example, may be in the order of 2,000 pulses per second. Such pair of reference and data triggers is, in fact, developed by the radar system trigger applied to the input terminal 228 of the apparatus shown in block diagram herein, but described specifically and claimed in the copending application of Thomas J. Johnson, Jr., et al., Serial No. 203,304, filed December 29, 1950, and assigned to the same assignee as the present application. The disclosure in such Johnson et al. application is incorporated herein by this reference thereto.

Briefly, this reference and data trigger developing circuit may be described as follows. The system trigger A1 applied to the terminal 228 is coupled to the trigger tube of a conventional delay multivibrator stage 229. The voltage developed in the multivibrator is differentiated so

as to appear in the form shown at 230. This differentiated waveform 230 is applied to the reference blocking oscillator stage 231 to develop a sharp positive reference trigger 232 at one of the output terminals thereof. This reference trigger 232 is coupled to the internal conductor of the transmission line 223 in accordance with the means developed herein and described later.

The reference trigger 232 is applied likewise to the data multivibrator stage 233 to produce a negative-going gating voltage 235. This gating voltage 235 is applied to the sweep generator stage 236 to develop positive-going sawtooth waves of the form shown at 237, which are applied to the pickoff stage 238, such stage 238 being controlled in accordance with antenna beam angle voltage applied at the terminal 240 and having the general waveform indicated at 241.

It is noted that the variation of the beam angle voltage applied to terminal 240 is at a relatively slow rate, it being remembered that it requires approximately one-quarter of a second for either the azimuth or the elevation voltage to change from one of its extreme values to the other of its extreme values. On the other hand the sawtooth waves 237 are applied at a relatively large rate, namely, a rate in the order of 1800 per second. The output of the pickoff stage 238 appears as a negative-going pulse 240 delayed in time in accordance with the instantaneous magnitude of the beam angle voltage applied to the stage 238. Such negative-going wave is shaped in the amplifier stage 242, the output of which is applied to the data blocking oscillator stage 243. The output of this stage 243 is the data trigger 244, which is coupled to the transmission line 223 in the manner described presently.

The reference trigger 232 is applied through condenser 245 to the control grid of tube 246. Likewise, the data trigger 244 is coupled through condenser 247 to the control grid of tube 248. The anodes of tubes 246 and 248 are jointly connected to the internal conductor of transmission line 223, while the cathodes of tubes 246 and 248 are jointly connected to the negative ungrounded terminal of voltage source 250 through adjustable resistance 252. Such negative terminal of source 250 is connected to the control grid of tube 248 through resistance 254, which has a tap thereon connected to a tap on resistance 255. The resistance 255 is connected between the control grid of tube 246 and the negative ungrounded terminal of source 258.

Thus, by the means described above, the entire composite video train, including the reference and data triggers shown in Figure 1, are applied to the internal conductor of the transmission line 223, but it is noted that instead of being positive-going triggers and pulses, as shown in Figure 1, they are inverted, i. e., all of the same being negative-going.

Apparatus at remote station

The entire composite video train thus transferred over the transmission line or cable 223 is applied to the ungrounded terminal of the gain control resistance 260, which has its adjustable tap coupled to the stage 261 labeled "Cancellation System With Differential Amplifier." The general purpose of such stage 261 and the apparatus therein is described and claimed in the copending application of Green, et al., Serial No. 224,972, filed May 7, 1951, and assigned to the same assignee as the present application.

Briefly, such stage 261 is used to substantially

reduce or eliminate pickup voltages induced electrostatically and/or electromagnetically in the extended transmission line 223, and to compensate for differences in ground potential between the local station and the remote station. The stage 261 depends for its operation on the use of a similar parallel extending cancellation line 263 terminating at the local station in the resistance 264, and being connected at the remote station to stage 261 through an adjustable phasing control resistance 265, an adjustable gain control resistance 267 shunted by the condenser 268, and the adjustable balance control resistance 269.

The composite video train appearing at the output of stage 261 is applied to the equalizer stage 262, which serves effectively to restore the high frequency components of the composite video train which is lost in transmission over the extended transmission line or cable 223. The output of the equalizer stage 262 is applied successively to the amplifier stage 270 and cathode follower stage 271, the D.-C. level of the composite video train being controlled by the D.-C. level restoring stage 272. The output of the cathode follower stage 271 is applied to the input terminals in video amplifiers at the remote location of the type shown in Figures 10 and 4.

Relay gate producing means at remote location

Certain means described under this heading is described and claimed in the copending patent application of James R. Deen, Serial No. 230,646, filed June 8, 1951, and assigned to the same assignee.

The C and L triggers in the composite video train shown in Figure 1 having amplitudes of 12 volts during azimuth antenna beam scanning and 20 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. For this purpose, the composite video train is applied through coupling condenser 274 to the relay gate forming channel having the input terminal 275 and the output terminal 276.

Briefly, the operation of this gate generating channel is as follows. The negative-going gate 277 appearing at the output terminal 276 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 20 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 277 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 277 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 278, which has an adjustable tap connected to the input terminal of

the amplifier stage 279. 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 280 and azimuth blocking oscillator stage 281, coupled respectively to the amplifier 279 through condensers 282 and 283, are operated only when the triggers applied thereto have amplitudes in the order of 20 and 12 volts, respectively.

During the elevation beam scanning period when the C and L pulses have an amplitude of 20 volts, the elevation blocking oscillator stage 280 is operated to produce a sharp pulse in accordance with each one of the C and L triggers. These pulses thus produced in the blocking oscillator 280 are integrated in the step detector circuit 284. The output of the step detector 284 is applied to the gate control stage 285 which, in so far as the elevation channel itself is concerned, is an inverter which inverts and shapes the pulse applied from stage 284. The output of stage 285 is applied to the first cathode follower stage 286 which, in turn, is coupled to the second cathode follower stage 287 having the output terminal 276. It is noted that a regenerative feed-back circuit 288 extends from the output of the cathode follower stage 286 to the gate control stage 285 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 277, is produced.

The azimuth blocking oscillator stage 281 is coupled through condenser 283 to the amplifier 279, but is rendered ineffective during the elevation scanning period by the negative gate 297 applied over the lead 295 from the cathode follower stage 287. Thus, only during the azimuth scanning period the azimuth blocking oscillator stage 281 is operated. These pulses are step detected in detector stage 292. After this waveform is inverted in inverter and shaper stage 293, it is applied to the cathode follower stage 294. The output of the cathode follower stage 294 is thus a positive-going gating voltage 298, which of course is developed only during the azimuth scanning period. Such positive-going gate 298 is differentiated in the differentiating network 295 to produce the differentiated output voltage. This differentiated output voltage is applied to the gate control 285 and effectively serves to shift forwardly in time the leading edge of the gate produced by stage 284.

Angle voltage channel at remote location

The antenna beam angle voltage, either azimuth angle voltage or elevation angle voltage, as the case may be, depending upon whether the azimuth antenna beam is scanning in azimuth or whether the elevation antenna beam is scanning in elevation, is represented as mentioned previously by the spacing between the reference and data triggers in the composite video train in Figure 1. The particular means whereby the difference in spacing of these two triggers is used to produce the original angle voltage is shown herein in block form at 310 in Figure 2. The apparatus 310 and teachings for accomplishing this

result is shown, described and claimed in the aforementioned application of Johnson, et al., Serial No. 203,304. The present arrangement, however, concerns itself generally with unscrambling of the various triggers, pulses and signals, and in particular with the manner in which such succeeding pairs of reference and data triggers are extracted from the composite video train and applied to the antenna beam angle converting means 310.

For this purpose the composite video train appearing at the output terminal in Figure 2 is fed through a $\frac{3}{4}$ microsecond delay line 311 (Figures 2 and 3) and condenser 312 to the control grid of tube V-327, a gated blocked oscillator trigger tube. When the suppressor grid of this tube is at zero volts the bias on the control grid is adjusted so that triggers of approximately 4 volts will cause this tube V-327 to trigger operation of the blocked oscillator tube V-328B. In other words this particular channel is also sensitive to voltages only above a predetermined threshold value so that it may be receptive only to the reference and data triggers and is not operated by voltages having intensities appreciably less than the amplitudes of such reference and data triggers.

The bias on the multivibrator trigger tube V-328A is adjusted so that such tube triggers the multivibrator stage V-330A, V-330B, when triggers of 14 volts or higher are applied to its grid. When triggers are of sufficient amplitude to start this multivibrator V-330A, V-330B, a negative gate is applied to the suppressor grid of tube V-327, thereby rendering tube V-327 insensitive to any triggers which in the interim may be applied to its control grid. The diode tube V-329 is used to prevent the suppressor grid from being driven positive by the plate of the multivibrator V-330A, V-330B. The duration of the gate as applied to this tube V-327 is approximately 160 microseconds. This means that a trigger above the minimum amplitude necessary to trigger the multivibrator V-330A, V-330B causes the gated tube V-327 to be insensitive for a period of approximately 160 microseconds. The trigger which causes the multivibrator V-330A, V-330B to be operated does not pass through the gated stage V-327, because the delay line 311 interposes sufficient delay to allow first the development of the negative gating voltage on the suppressor grid of tube V-327.

More specifically, as delivered to this channel by cathode follower 271, the angle voltage triggers are approximately 8 volts in amplitude. The amplitude of C and L triggers is approximately 20 volts. If only the 8-volt angle triggers are present they are passed through V-327 and trigger blocked oscillator tube V-328B. Whenever a "C" trigger is applied, tube V-328A causes the multivibrator V-330A, V-330B to be triggered and gate V-327 off for the period of 160 μ s. This means that none of the video signals which follow the C trigger in the normal sequence of operation pass through V-327. In fact, V-327 is not returned to its normal condition until after sufficient time has elapsed for the L trigger to have passed. During the period between the L trigger and the next C trigger this channel is open to pass the angle voltage triggers, i. e. the reference and data triggers in Figure 1.

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.

I claim:

1. In an arrangement of the character described, a source of video trains, each train comprising video signals bracketed by a pair of time spaced control triggers, and a pair of reference and data triggers following the last of said control triggers, means for producing a voltage representative of the spacing between said reference and data triggers, means coupling said voltage producing means to said source, said coupling means comprising a serially connected delay line and a gated blocking oscillator stage, for application thereto of a gating voltage, so as to render the same ineffective, gate forming means comprising a multivibrator stage coupled to said source and sensitive to the first of said control triggers for developing a gating voltage having a time duration somewhat greater than the time interval between said control triggers and means applying said gating voltage to said gated blocking oscillator to render the same ineffective to pass that portion of the video train other than the reference and data triggers.

2. In an arrangement of the character described, a source of video trains, each train comprising video signals of relatively small intensity bracketed by a pair of time spaced control triggers of relatively large intensity, and with a pair of reference and data triggers of relatively small intensity following the last of said control triggers, means for producing a voltage representative of the spacing between said reference and data triggers, means coupling said voltage producing means to said source, said coupling means comprising a gated channel with means for delaying the passage of the video train through said channel, and gate forming means coupled to said source and sensitive only to said relatively large intensity triggers for developing a gating voltage having a time duration greater than the spacing between said C and L triggers, and means applying said gating voltage to said channel to render the same ineffective during the presence of said gating voltage.

3. In an arrangement of the character described, a source of video trains, each train comprising video signals bracketed by a pair of time spaced control triggers, the last of said control triggers being followed by a pair of time spaced reference and data triggers, means for producing a voltage representative of time spacing between said reference and data triggers, a channel connecting said voltage producing means to said source, said channel incorporating delay means and being normally operative to pass said reference and data triggers as well as said control triggers, gating voltage producing means coupled to said source for producing a gating voltage having a time duration beginning substantially contemporaneously with the first of said control triggers and ending an appreciable time interval after the second control trigger, said channel incorporating means sensitive to said gating voltage for rendering said channel inoperative for the duration of said gating voltage and means applying said gating voltage to said channel.

4. In an arrangement of the character described, a source of video trains, each train comprising video signals of relatively small intensity

bracketed by a pair of time spaced control triggers of relatively large intensity, the last of said control triggers being followed by a pair of time spaced reference and data triggers, means for producing a voltage representative of the time spacing between said reference and data triggers, a channel interconnecting said voltage producing source, said channel including a delay line coupled to said source and a gated blocking oscillator trigger tube coupled to the output of said delay line, said blocking oscillator stage being normally effective to allow passage of the control triggers through said channel, said blocking oscillator incorporating means sensitive to the presence of a gating voltage for rendering the same ineffective during the duration of said gating voltage, gating voltage producing means comprising means coupled to said source and sensitive only to said relatively large intensity control triggers for developing a gating voltage having a time duration which begins substantially contemporaneously with the first of said control triggers and which ends an appreciable time after the second of said control triggers, and means applying the gating voltage to said blocking oscillator stage to render the same ineffective during the duration of the gating voltage.

5. In an arrangement of the character described, a source of video trains, each train comprising video signals of relatively small intensity bracketed by a pair of time spaced control triggers of relatively large intensity, the last of said control triggers being followed by a pair of time spaced reference and data triggers, means for producing a voltage representative of the time spacing between said reference and data triggers, a channel interconnecting said voltage producing means with said source, said channel including a delay line coupled to said source and a gated blocking oscillator stage coupled to the output of said delay line, said reference and data triggers having amplitudes larger than the amplitudes of said video signals, said blocking oscillator stage being normally effective to allow passage of triggers through said channel having amplitudes larger than said video signals, said blocking oscillator incorporating means sensitive to the presence of a gating voltage for rendering the same ineffective during the duration of such gating voltage, gating voltage producing means comprising means coupled to said source and sensitive only to said relatively large intensity control triggers for developing a gating voltage having a time duration which begins substantially contemporaneously with the first of said control triggers and which ends an appreciable time after the second of said control triggers, and means applying the gating voltage to the blocking oscillator stage to render the same ineffective during the duration of the gating voltage.

THOMAS J. JOHNSON.

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