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TELEVISION AND THE LIKE TRANSMISSION SYSTEM

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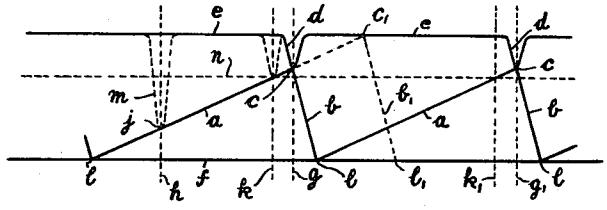


Fig. 1.



Fig. 2.

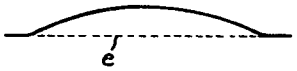


Fig. 3.

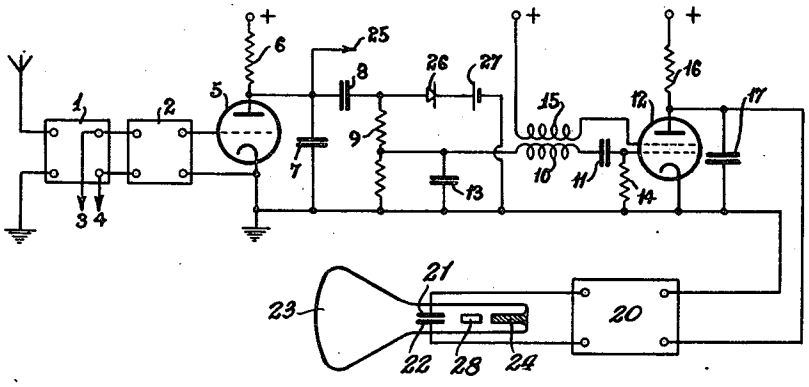


Fig. 4.

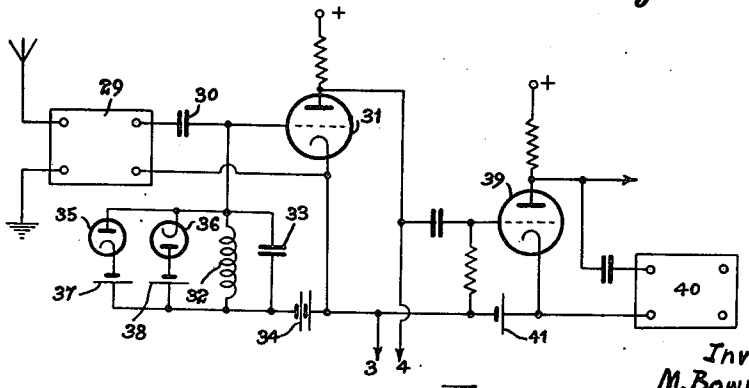


Fig. 5.

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TELEVISION AND THE LIKE TRANSMISSION SYSTEM

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The present invention relates to television and the like transmission systems in which a scanning operation at a receiving station is synchronized with a scanning operation at a transmitting station by means of a synchronizing signal.

The invention is concerned with systems of the type in which a scanning operation at the receiver is controlled by means of a voltage or current of saw-tooth wave form, that is to say a wave form which comprises a rising portion and a falling portion, the change-over from the rising portion to the falling portion and vice versa being relatively abrupt. The frequency of the scanning current or voltage is, in systems of this type, controlled by the received synchronizing signals. An example of such a system is a television transmission system in which a cathode ray tube is employed to reconstitute the transmitted image at the receiver, and in which the cathode ray beam is deflected over the fluorescent screen of the tube under the control of two voltages or currents of saw-tooth wave form. The two voltages or currents are usually of very different frequencies, known as the line and frame frequencies, and serve to deflect the ray in directions at right angles to one another. The wave form is usually unsymmetrical as shown in the diagram in Fig. 1 of the accompanying drawing (in which current or voltage is plotted as ordinate against time as abscissa) and comprises a gradually rising portion *a* followed by a relatively steeply falling portion *b*, the picture reproduction taking place during the rising portion *a*. The terms rising and falling are used in this specification purely relatively and it is immaterial whether the rise be an increase in the positive or negative sense.

In systems such as those with which the invention is concerned, the instant at which the scanning voltage or current ceases to increase in magnitude and commences to decrease, represented by *c* in Fig. 1, is determined by the arrival of a synchronizing impulse *d*, the impulse being of a certain predetermined amplitude, and having preferably a steep fronted or peaked wave form. Now, as will be explained hereinafter, the decrease in scanning current or voltage can only be initiated by a received impulse if it exceeds in amplitude a predetermined value dependent upon the phase of the cycle of oscillations *a*, *b* when the impulse occurs. This will be understood if it be assumed that a decrease in voltage only occurs when the voltage of the oscillations *a*, *b* plus the voltage of an applied impulse *d* is at least equal to the voltage represented by the distance between the datum line *e* of the impulses *d* and the datum line *f* of the oscillations *a*, *b*. Thus at the time indicated by dotted line *g* the minimum amplitude of impulse required is equal to the distance of point *c* below line *e* whereas at time *h* the required amplitude is represented by the distance of point *j* below the line *e*.

The synchronizing impulses *d* are of such amplitude that they are only capable of initiating the decrease in the scanning current or voltage over a small portion of the cycle near to the point *c*. Stray impulses such as those due to atmospherics for example may, however, considerably exceed the synchronizing signals in amplitude, and since they may occur at any time during the scanning period, they may, if they are of sufficient amplitude, cause the scanning current or voltage to commence to decrease prematurely.

Thus, fortuitous disturbances occurring in the synchronizing signal channel between the transmitter and receiver may interfere with the scanning operation at the receiver and cause distortion of the received image.

It is an object of the present invention to provide a method and means for reducing the effect of interference due to stray disturbances upon a scanning operation at the receiving station.

Accordingly, in a television or like transmission system of the type referred to in which synchronization of scanning operations at the transmitter and receiver is maintained by means of a synchronizing signal, the present invention provides a method of reducing interference with synchronization by stray impulses which comprises limiting the amplitude of said stray impulses at the receiver.

It will readily be seen that by limiting the amplitude of the stray impulses at the receiver, the part of the scanning period during which interference with synchronization may be caused is correspondingly limited.

Thus, in Fig. 1, if the amplitude of stray impulses is limited to the distance between the dotted line *n* and the line *e*, interference with synchronization by strays can only take place over the part of the cycle between lines *k* and *g*, lines k_1 and g_1 and so on, whatever the amplitude of the strays may be.

According to a feature of the invention, a television or like receiver adapted for use in a system of the type specified in which scanning is controlled by a synchronizing signal transmitted from a transmitter, comprises means for limiting the amplitude of electrical impulses oc-

curring in the synchronizing signal channel of the receiver.

When the synchronizing signal received is of substantially constant frequency and of constant amplitude, means may be provided at the receiver for limiting the amplitude of stray impulses occurring in the synchronizing channel to substantially said constant amplitude. By this means, the part of the scanning period during which interference due to the stray impulses may occur is limited to a small portion of the period close to the end thereof.

The invention will be described by way of example with reference to Figs. 2 to 5 of the accompanying drawing in addition to Fig. 1 which has already been referred to. In the drawing, Figs. 2 and 3 are diagrams showing the nature of synchronizing impulses which may be employed in the present invention and Figs. 4 and 5 are circuit diagrams of two embodiments of the present invention. It is to be understood, however, that the invention is not limited to any of these particular embodiments, but is described in its broadest aspect in the appended claims.

Referring to Fig. 4, there is shown a circuit diagram of a receiver of a television system employing a cathode ray tube to reconstitute the transmitted image. It will be assumed that the deflection of the cathode ray over the fluorescent screen of the tube is to be controlled by two voltages of saw-tooth wave form, one of which is at the line scanning frequency and serves to deflect the ray in one direction, for example horizontally, and the other of which is at the frame scanning frequency and serves to deflect the ray vertically.

At the transmitter, which is not illustrated, there are generated, in any known or suitable manner, two sets of impulses of a wave form shown diagrammatically in Figs. 2 and 3, one set of impulses shown in Fig. 2 being of the line scanning frequency and the other shown in Fig. 3 being at the frame frequency. The two sets of impulses are together caused to modulate a carrier wave of a frequency of, say, four hundred kilocycles per second; this wave will be referred to as the sub-carrier. The modulated sub-carrier and the picture signals representing the light and shade values of the image to be transmitted are together caused to modulate a main carrier wave, the frequency of which is considerably above the frequency of the sub-carrier. The modulated main carrier is then radiated from a suitable aerial system.

At the receiver shown in Fig. 4, the main carrier is received and detected in a receiver indicated by reference 1 and the picture signals are separated from the modulated sub-carrier by means of suitable selective circuits which have a sharp cut-off just above the highest picture frequency required such as a high-speed filter or pass a band of frequencies around the sub-carrier frequency such as a band-pass filter. Such a circuit is represented at 2, the picture signals passing to a picture signal channel, the commencement of which is represented by arrows 3 and 4.

The modulated sub-carrier is then fed from the output of the filter device 2 to the grid-cathode circuit of a grid-current rectifier 5, the anode of which is connected to the positive terminal of a source of high tension current through a suitable resistance 6, and to its cathode through a condenser 7. The condenser 7 is given such a value that it has a low impedance at the sub-carrier frequency, and a high impedance at the line and frame scanning frequencies, and therefore serves to by-pass currents of the sub-carrier frequency. The cathode of the sub-carrier detector 5 is earthed, and there is connected in parallel with the by-pass condenser 7 a circuit comprising a further condenser 8 in series with a potentiometer 9 comprising two resistances in series. Either or both of the resistances may be variable. The time constant of this circuit 8, 9 is arranged to be such that while potential differences at the line scanning frequency are set up across the potentiometer 9, substantially no potential differences at the frame scanning frequency are produced.

The junction of the two resistances constituting the potentiometer is connected through an inductance coil 10 and a grid condenser 11 in series to the control grid of a screened grid valve 12. The lower resistance of the potentiometer 9 is shunted by a condenser 13, and the control grid of the screened grid valve is connected, through a grid leak 14, to its cathode, which is also earthed. The screening grid of the screened grid valve is connected to the positive terminal of a source of high tension current through an inductance coil 15 which is coupled to the coil 10; the two coils 10 and 15 may comprise the primary and secondary windings of an iron-cored transformer of suitable ratio. The anode of the screened grid valve 12 is connected to the positive terminal of the high tension source through a feed resistance 16, and to the cathode through a reservoir condenser 17. The arrangement is such that the valve 12 functions as an oscillation generator, the generation of oscillations being controlled by the received line frequency impulses and a voltage of substantially saw-tooth wave form being set up across the reservoir condenser 17. The generation of the saw-tooth voltage is explained in more detail below. The saw-tooth voltage, which is at the line scanning frequency, is then applied, generally after amplification in an amplifier indicated at 20, to two deflecting plates 21 and 22 of the cathode ray tube 23, the source of the electron beam or electron gun being indicated at 24. The line frequency saw-tooth oscillation thus serves to control the horizontal deflection of the cathode ray of the cathode ray tube 23.

The sub-carrier detector 5 is coupled in a similar manner by a connection indicated at 25 to a further generator which may be of the same type, adapted to generate a saw-tooth voltage wave at the frame scanning frequency which is applied to the deflecting plates 26 which are arranged at right angles to the plates 21 and 22.

Connected in parallel with the whole of the potentiometer 9 is a circuit comprising a suitable rectifier 26 in series with a source of electromotive force 27. The rectifier 26, which may be of the copper-copper oxide type, has its negative electrode connected to the positive terminal of the source 27, which may be a suitable dry battery. The E. M. F. of the battery is made substantially equal to the potential difference set up across the potentiometer by each line impulse, and no current normally flows in the rectifier circuit. When, however, a random disturbance of an amplitude greater than that of the line impulses appears in the output circuit of the sub-carrier detector 5, a potential difference greater than that of the battery 27 tends to build up across the potentiometer 9, and current therefore passes in the rectifier circuit 26, 27. The result is that the potential difference

set up across the potentiometer 9 is always limited to a value substantially equal to the value of the potential difference set up by the line impulses.

In order that the invention may be better understood, the functioning of the oscillation generator 12 will be further explained. It will be assumed that, at the commencement of the cycle of oscillation to be considered, represented by point *l* in Fig. 1, the control grid side of the grid condenser 11 has a strong negative charge, and that the charge is leaking away to earth through the grid leak 14. During the early part of the cycle, while the control grid is still fairly strongly negatively charged, substantially no electron current flows in the valve 12. The anode-cathode path of the valve is thus substantially insulating during this part of the cycle, but a small substantially constant current, serving to charge the reservoir condenser 17 at a substantially uniform rate, flows in the anode feed resistance 16. This part of the cycle is represented by *a* in Fig. 1.

In the absence of the synchronizing impulses, the control grid potential would eventually reach a certain critical value represented by *e* in Fig. 1 at which electron current commences to flow in the screening grid and anode circuits of the valve 12. The inductive coupling 10, 15 between the screening grid and control grid circuits causes a voltage to be induced in the control grid circuit, when current begins to flow in the screening grid circuit and whenever the current in this circuit increases, the sense of the coupling being such that the induced voltage, under these circumstances, tends to drive the control grid potential still further in the positive direction. Whilst the control grid is positive it collects electrons and charges the condenser 11 negatively with respect to the grid coils 10. The current in the screening grid circuit is thus further increased, the action being cumulative and causing the screening grid current to rise rapidly. The anode current similarly rises, and the anode-cathode path of the valve ceases to be insulating; the reservoir condenser accordingly discharges through the valve. This part of the cycle is represented in Fig. 1 by b_1 and is the line followed in the absence of synchronizing impulses.

The maximum value to which the screening grid current rises is determined by the natural frequency of the screening grid circuit and its associated circuits or by saturation. When the maximum value is reached, the current ceases to increase so that the control grid is no longer held positive, the more negative grid potential causes the screen current to decrease. As soon as the screening grid current starts to fall, a voltage is induced in the control grid circuit which causes the grid potential to become more negative, and thus still further to decrease the screening grid current. The action is cumulative, until the screen current is shut off entirely. In this steady state, the potential across the coil 10 is zero and the potential of the grid is more negative than this by the potential due to the negative charge of the condenser 11 caused by the grid current. The resultant grid potential is the original highly negative value. If a synchronizing impulse of the amplitude shown in Fig. 1 arrives at any time between that represented by line *g* and that corresponding to point c_1, the discharge of the condenser 17 will be initiated thereby.

Although impulses at the amplitude of the synchronizing impulses are only effective to cause the grid potential to reach the critical value if they occur within a range of grid potentials close to the critical potential, nevertheless impulses at a greater amplitude than the synchronizing impulses, for example strays, may drive the grid potential up to the critical value even if they occur close to the beginning of the cycle, and outside the normal critical range. For example at the time *h* or thereafter an impulse of the amplitude shown at *m* will drive the grid potential up to the critical value. By limiting the amplitude of the stray impulses to the amplitude of the synchronizing impulses, or to a value not greatly exceeding this, for example to a value represented by the distance between lines *n* and *e*, the range of grid potentials over which the limited stray impulses may cause interference with the generation of the scanning voltage is limited to a range of grid potentials close to the end of the cycle of oscillation, for example the range between lines *k* and *g*.

It is found in practice that the frame scanning operation at the receiver is less liable to interference of the type in question than the line scanning operation. However, it will be apparent that if such interference does occur, it may be reduced in a manner similar to that described for the line scanning.

Clearly the arrangement of Fig. 4 is applicable to the reception of signals in which impulses of the character shown in Figs. 2 and 3 are combined with picture signals and transmitted therewith over a common channel which may be a carrier wave; that is to say the sub-carrier can be dispensed with. The picture signals are usually combined with the synchronizing impulses in such a way that the impulses of Fig. 2 occur between successive lines of the picture scanned and the impulses of Fig. 3 between successive picture frames and further so that the datum line *e* in Figs. 2 and 3 corresponds to picture black and the picture signals extend from this datum line in the opposite direction to the synchronizing impulses. Where this form of signal is to be received, the filter device 2 of Fig. 4 is omitted and the picture signals are prevented from affecting the anode current of the valve 5 for example by so biasing the grid of valve 5 that grid current flows in response to picture signals.

It is desirable to arrange that the limiting circuit of Fig. 4 should have a time constant which is short compared with the duration of any one synchronizing impulse. If any amplification is effected between the detector 5 and the limiting device it is also important to arrange either that overloading does not occur in such an amplifier with signals having an amplitude many times in excess of that required to operate the limiting device or else that the circuits of the amplifier are of such short time constant that the overloading condition cannot persist for a time longer than the duration of a synchronizing impulse.

More than one limiting device may be provided if desired and it is then usually preferable to arrange that only a part of the total limiting required is effected in an earlier limiter, the remainder of the limiting taking place in a later limiter.

Referring to Fig. 5, there is shown a circuit for a receiver in which limiting is effected at radio frequency. It will be assumed that the modulation of the carrier at the receiver by the picture signals and the impulses of Figs. 2 and 3 is effected in such a way that the synchronizing signals are represented by increases in carrier am-

plitude and the picture signals by decreases thereof.

The received signals are selected and if desired amplified in the receiver 29 and are passed through a coupling condenser 30 to a radio frequency amplifier 31. Between the grid and cathode of the amplifier 31 is connected a tuned circuit, comprising an inductance 32 shunted by a condenser 33, in series with a source 34 of bias potential. The elements of the tuned circuit 32, 33 are arranged to be of low loss and the source 34 is of low impedance. Across the tuned circuit 32, 33 are also connected two diode rectifiers 35 and 36, each in series with a source of voltage 37 and 38 respectively, the diode 35 having its anode connected to the grid side of the tuned circuit 32, 33 and the diode 36 being oppositely connected. The voltages and polarities of the sources 34, 37 and 38 are such that due to source 34 the bias of the grid of the valve 31 enables this valve to operate on a suitable part of its characteristic whilst the cathode of the diode 35 is maintained at a potential +V and the anode of diode 36 at a potential —V relatively to the grid of the valve 31 when no signal is being received, where V is the signal amplitude at the grid of the valve 31 at which limiting is required to take place. It is usually arranged that V exceeds, for example by 25%, the carrier amplitude on the grid of the valve 31 corresponding to the peak of a synchronizing impulse which may be referred to as W. Thus if any interference having an amplitude more than 1.25W appears on the grid of valve 31 current will flow through the diode 35 on one half cycle and through the diode 36 on the other half cycle. The limiting circuit described restores rapidly after the interference has passed because the diodes have a low impedance path in parallel with them through the coil 32.

The limited signals thus appear in the anode circuit of the valve 31 and are passed to a detector 39 and to a filter device 40 the output of which may be passed after amplification if desired to a generator of saw-tooth oscillations such for example as that described in connection with Fig. 4.

The valve 39 is biased by a battery 41 in such a manner that substantially no anode current flows therein with carrier amplitudes corresponding to picture signals but that the valve functions as an anode bend detector for the synchronizing signal modulation. The picture signals together with synchronizing signals are taken from leads 3 and 4 to a separate detector.

The diode 35 may if desired be omitted and the voltage of source 34 adjusted to the value V so that grid current flows in the valve 31 for the positive half cycles exceeding V in amplitude.

The filter device 40 is arranged to give a measure of frequency selection so as to reduce still further the chance of strays affecting the synchronization. It is known that a wave form of the kind shown in Fig. 2 can be resolved into a number of sinusoidal oscillations and it is found that the form of the impulses can be reproduced sufficiently accurately by a relatively small range of frequencies and the device 40 may thus with advantage be arranged as a low pass filter to suppress frequencies exceeding the aforementioned ones. If desired the device 40 may be a band pass filter so that frequencies below the fundamental frequency of the impulses of Fig. 2 are also suppressed. It is desirable to arrange as shown that the amplitude limiting takes place before the frequency selection.

The frame frequency impulses may be taken at 25 and may also be subjected to frequency selection if desired.

In the circuits so far described, limiting has been effected with the aid of diode rectifiers. It is of course possible to use other forms of rectifier such as a thermionic triode arranged to limit either at a bend of its anode current-grid voltage characteristic or by the flow of grid current.

It may be desirable to arrange that the output of the limiting device is not only limited to a certain critical value but that in response to signals exceeding a predetermined value the output falls below the critical value. One example of this type of limiter is a grid rectifier which is so biased and arranged that for small inputs it gives a rectification characterstic in which the output current is proportional to the input voltage and in which for large inputs anode bend rectification comes into operation in addition to the grid rectification and acts in opposition thereto.

We claim:

1. A television receiver having an input circuit for receiving a carrier wave modulated with synchronizing signals, a detector, means for coupling said detector with said input circuit, means for generating an oscillation of saw-tooth wave form, a scanning device, means for applying said oscillation to said scanning device to control the operation thereof, means for applying demodulated synchronizing signals from said detector to said generating means, and separate biased rectifier limiting means connected to the detector for limiting the amplitude of each synchronizing signal between predetermined values whereby the oscillations are initiated only during predetermined time intervals.

2. A television receiver having an input circuit for receiving a carrier wave modulated with synchronizing signals, a detector having an output circuit, means for coupling said detector with said input circuit, means for generating an oscillation of saw-tooth wave form, a scanning device, means for applying said oscillation to said scanning device to control the operation thereof, means for applying demodulated synchronizing signals from said detector to said generating means, and separate biased rectifier limiting means connected to the output circuit of the detector for limiting the amplitude of each synchronizing signal between predetermined values whereby the oscillations are initiated only during predetermined time intervals.

3. A television receiver having an input circuit for receiving a carrier wave modulated with synchronizing signals, a detector having an input circuit, means for coupling said detector with said input circuit, means for generating an oscillation of saw-tooth wave form, a scanning device, means for applying said oscillation to said scanning device to control the operation thereof, means for applying demodulated synchronizing signals from said detector to said generating means, and separate biased rectifier limiting means connected to the input circuit of the detector for limiting the amplitude of each synchronizing signal between predetermined values whereby the oscillations are initiated only during predetermined time intervals.

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