

Feb. 27, 1940.

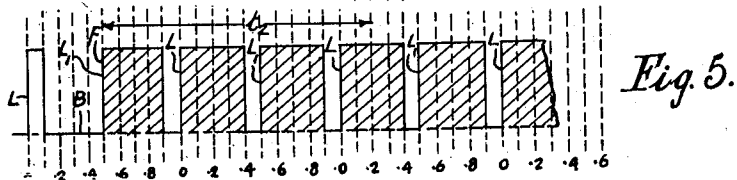
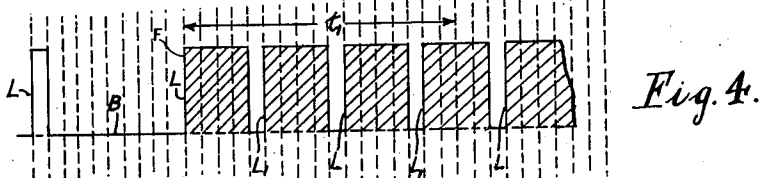
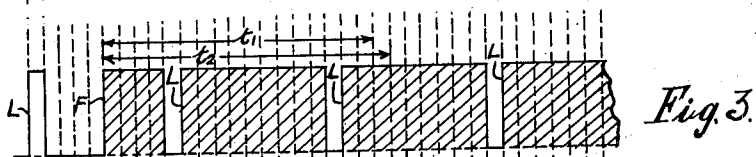
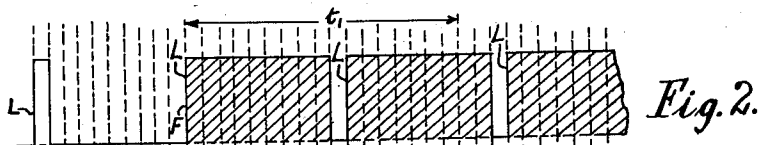
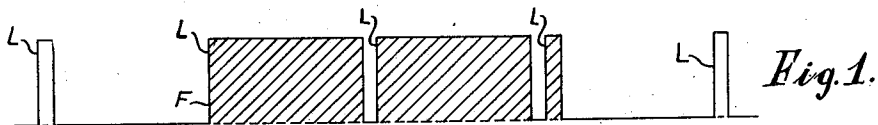
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2,192,122

SYNCHRONIZING MEANS FOR TELEVISION AND LIKE SYSTEMS

Original Filed Aug. 30, 1935

4 Sheets-Sheet 1



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SYNCHRONIZING MEANS FOR TELEVISION AND LIKE SYSTEMS

Original Filed Aug. 30, 1935 4 Sheets-Sheet 2

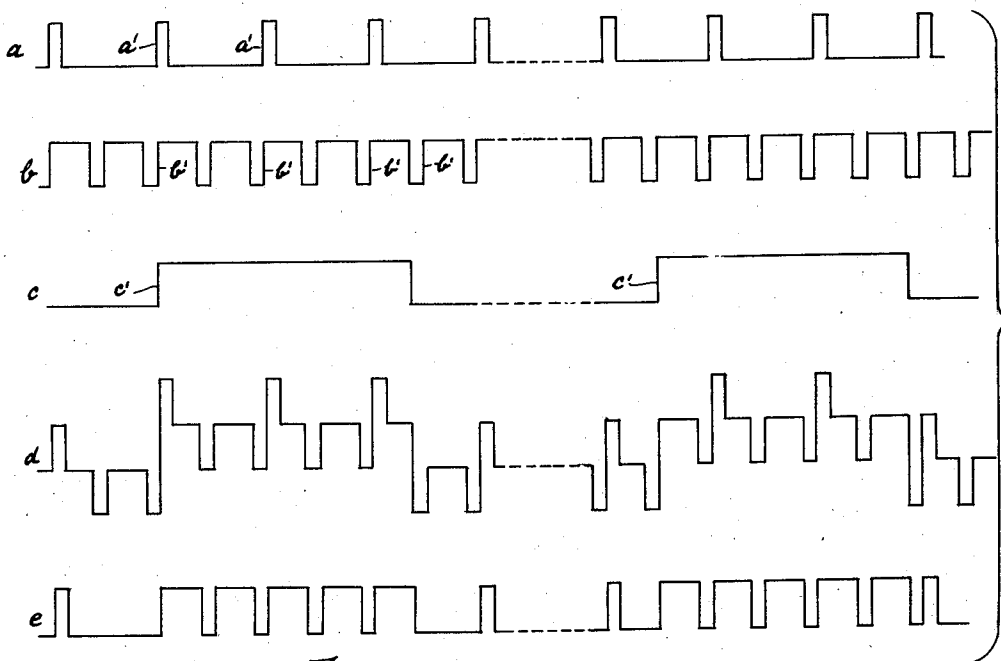


Fig. 6.

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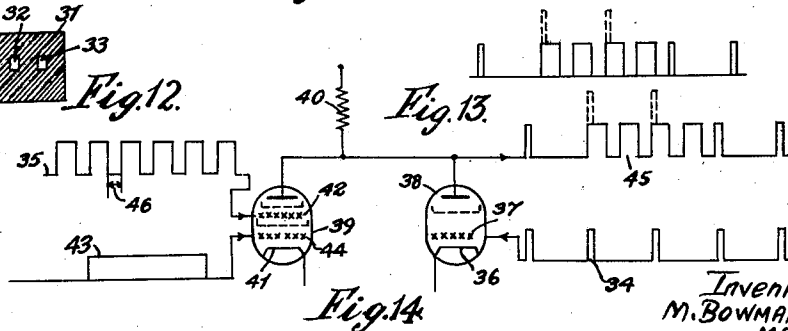
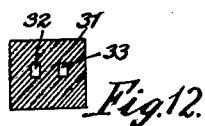
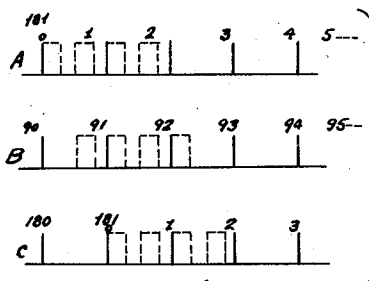
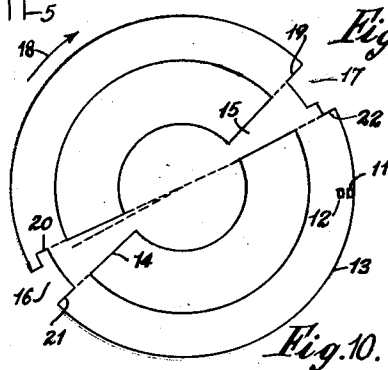
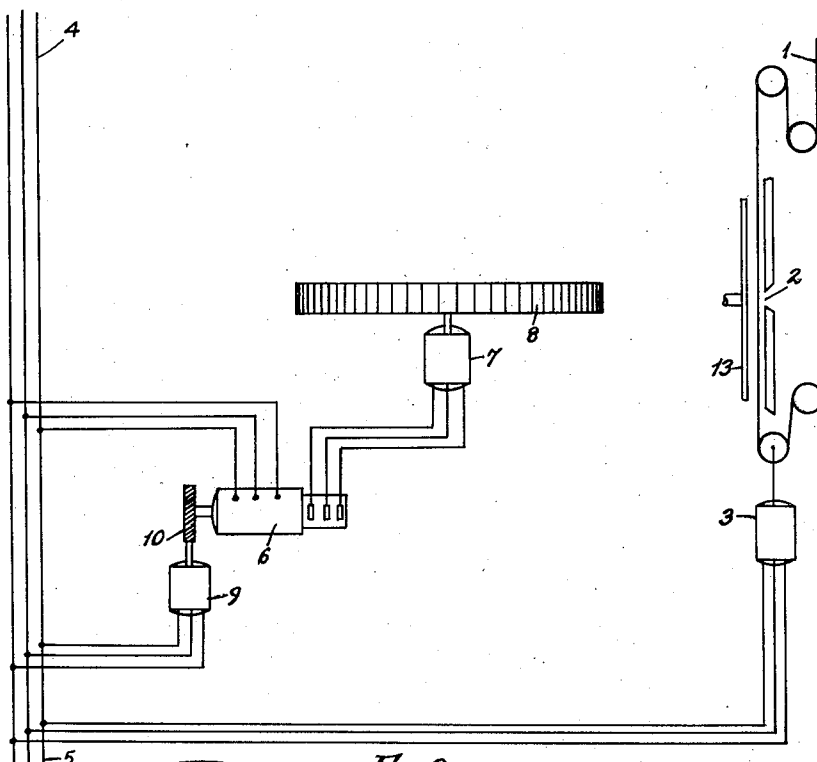
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SYNCHRONIZING MEANS FOR TELEVISION AND LIKE SYSTEMS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,192,122

SYNCHRONIZING MEANS FOR TELEVISION
AND LIKE SYSTEMS

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The present invention relates to television and like systems of the kind employing interlaced scanning.

Scanning is said to be interlaced when an object is completely scanned in a small plurality of traversals of the object, the lines scanned in one traversal being intercalated between the lines scanned in the next traversal.

In many television systems, such as those employing a cathode ray tube at the receiver, synchronization is obtained with the aid of two sets of pulses, one set known as line pulses serving to return the scanning beam (say from the right edge to the left edge) at the end of the scanning of each strip of the object and the other set known as frame pulses serving to return the scanning beam (say from the bottom edge to the top edge) at the end of each complete traversal of the object.

When interlaced scanning is employed it is necessary that one traversal of the object should occupy a whole number of lines plus a fraction of a line. Thus in the case where the object is completely scanned in two traversals, successive frame pulses will be displaced in phase relatively to one another by one half the interval between successive line pulses, and alternate frame pulses will be in the same phase.

The synchronizing signals are usually used at a receiver to control the generation of oscillations of saw-tooth wave form. The method usually consists in allowing a condenser to charge up during the scanning stroke and to be discharged on the arrival of a synchronizing pulse to give the return stroke. The discharging means may comprise a device, such as what is known as a blocking oscillator, which in the absence of synchronizing signals continues to discharge the condenser but at a later time, so that in the absence of synchronizing signals the generator runs slow. One such generator is used for each of the two frequencies required.

It is usual to transmit the synchronizing signals in the intervals between the scanning of successive lines and frames of the object and to separate the frame pulses from the line pulses at the receiver for example by frequency selection.

The synchronizing signals may be fed to the same transmission channel as the picture signals, but in the opposite or blacker-than-black sense, and in order to keep within desired low limits the maximum amplitude with which the transmission channel is required to deal, it has been found desirable to employ line and frame pulses of substantially the same amplitude. They

may then be made of different durations so that they can readily be separated from one another by a frequency selection.

Thus the frame pulses may be made to last for at least the greater part of a line interval, and preferably for more than one, for example approximately three line intervals. If the line pulses are suppressed during the frame pulse, the line frequency saw-tooth generator may get so far out of step that the next arriving line pulse is incapable of controlling the generator, which therefore remains out of step for several more lines. The disadvantage of this is obvious and to obviate it the line pulses have been arranged to persist throughout the framing interval.

An example of the above-mentioned persistence of the line pulses, where the frame signal is arranged to last for approximately two line intervals, is shown in Fig. 1 of the accompanying drawings, where signal current (or voltage) is plotted against time as abscissa. The leading edges L of the signal, Fig. 1, serve to control the "line" generator and the leading edge F indicates the beginning of the frame pulse (shown cross hatched) used to control the "frame" generator.

It will be noted that the separation of line from frame pulses when using such a signal can be effected by frequency selection and nevertheless the "line" generator is held in step throughout the framing intervals.

Although in Fig. 1 the frame pulse is shown to last only over about two line periods, it may be made to last for one line period or for a greater number than two line periods, according to circumstances.

A difficulty arises, however, when this system is applied to interlaced scanning. This difficulty will be discussed with reference to Figs. 2 and 3 of the accompanying drawings, in which the time abscissa is shown divided into tenths of a line period. Thus the line pulses, of which the leading edges are indicated by L, last for one tenth of a line interval (in the absence of a frame impulse) and the frame pulses (shown cross hatched), in the case illustrated, are shown lasting for more than two line intervals.

In Figs. 2 and 3, the leading edges L serve to control the line generator and the leading edges F indicate the beginning of the frame pulses which are used to control the frame generator. In this example it is assumed that the object is to be scanned in two traversals, so that one frame impulse, shown in Fig. 2, is displaced in

phase by one half the line interval relatively to the next, shown in Fig. 3.

A voltage has to be derived from the frame pulse in order to "fire" the frame blocking oscillator and a certain energy has to be derived from the frame pulse to develop the required voltage. Thus in Fig. 2 the energy required may be that represented by the wave form from F to a point 1.7 line intervals later. Thus the blocking oscillator will fire after a time interval indicated by t_1 from the commencement F of the frame pulse.

With the next frame pulse (shown in Fig. 3) however, the energy content of the frame pulse from F to the point 1.7 of a line period later (that is over the interval t_1) will be less than in Fig. 2 and firing will be delayed, so that in Fig. 3 the interval between F and the firing point may be that indicated by t_2 .

It is clearly undesirable that the moment of firing should depart in this way from the desired point and the present invention provides means for overcoming the difficulty.

According to the present invention, a method of providing synchronizing signals for use at a television receiver employing interlaced scanning comprises generating line synchronizing pulses in the intervals between trains of picture signals representative of lines of the object to be transmitted and frame synchronizing signals in the intervals between successive traversals of the object and transmitting said line pulses and frame signals, said frame synchronizing signals having substantially the same amplitude as said line pulses and having leading edges which occur at the frequency of said line pulses and substantially in phase with the leading edges of said line pulses and successive frame signals being arranged to commence in different phase relation with respect to said line pulses.

According to a feature of the invention, a method of providing synchronizing signals for use at a television receiver employing interlaced scanning comprises generating line synchronizing pulses in the intervals between trains of picture signals representative of lines of the object to be transmitted and frame synchronizing signals in the intervals between successive traversals of the object and transmitting said line pulses and frame signals, each of said frame signals including a plurality of pulses which provide, during at least the earlier part of each frame signal, leading edges which occur at n times the line pulse frequency (where n is the number of traversals in which said object is completely scanned), wherein it is arranged that certain of said leading edges occur in phase with the leading edges of said line pulses, so that leading edges occur at line frequency throughout said synchronizing signals.

It is to be understood that the frame signal may comprise a larger number of pulses than is necessary to provide the specified number of leading edges; that is to say, the frame signal may have a larger number of leading edges than n during each line interval.

According to a further feature of the invention, a method of providing synchronizing signals for use at a television receiver employing interlaced scanning comprises generating line synchronizing pulses in the intervals between trains of picture signals representative of lines of the object to be transmitted, generating auxiliary line pulses occurring at n times the frequency of said line pulses (where n is the number of traversals in which said object is completely

scanned) and having every n^{th} leading edge occurring in phase with the leading edges of said line pulses and transmitting said line pulses and said auxiliary line pulses alternately, said auxiliary line pulses being transmitted during the intervals between successive traversals of said object.

The pulses constituting the frame signals, or the auxiliary line pulses are preferably arranged to be of greater duration than the line pulses, and the pulses constituting the transmitted synchronizing signals are with advantage arranged all to have a substantially rectangular wave form.

The invention further provides apparatus for generating synchronizing signals in accordance with the invention.

The invention will now be described with reference to Figs. 1 to 16 of the accompanying drawings, in which

Figs. 1 to 3 show slotted synchronizing signals,

Figs. 4 and 5 show wave forms of synchronizing signals generated in accordance with the present invention,

Fig. 6 is an explanatory figure, illustrating one method of generating synchronizing signals,

Fig. 7 shows diagrammatically apparatus for generating synchronizing signals according to the invention,

Fig. 8 shows a detail of Fig. 7,

Fig. 9 illustrates diagrammatically forms of apparatus for generating synchronizing signals according to the invention,

Figs. 10 and 12 illustrate details of Fig. 9,

Figs. 11 and 13 are explanatory diagrams,

Fig. 14 is a circuit diagram of electrical apparatus for the generation of synchronizing signals,

Fig. 15 illustrates scanning apparatus for interlaced scanning employing an apertured scanning disc, and

Fig. 16 illustrates a detail of Fig. 13.

In the following description, it will be assumed for simplicity that it is desired to generate synchronizing signals for an interlacing system in which an object to be transmitted is scanned in two traversals thereof.

Reference is now directed to Figs. 4 and 5, in which there is shown an example of a form of signal according to the present invention. As in Figs. 2 and 3 the curves of Figs. 4 and 5 represent a synchronizing signal in the neighbourhood of successive frame signals (shown cross hatched), and the leading edge F in Fig. 4 is one half of the line interval out of phase with the leading edge F in Fig. 5 with reference to the line pulses. It will be observed that the difference between the signal of Figs. 4 and 5 and that of Figs. 2 and 3 is that, in Figs. 4 and 5 leading edges L and L_1 occur at double the line frequency during the frame pulse. That is to say, there have been introduced, in addition to leading edges L, further leading edges L_1 intermediate the leading edges L. The leading edges L_1 occur at such a time that they are incapable of affecting the line generator, but the effect of adding them is that the frame pulses have the same energy content over the equal intervals t_1 and t_2 in Figs. 4 and 5. Hence with wave forms of the kind shown in Figs. 4 and 5, the firing voltage will in each case be developed after the same time (t_1 , t_2) measured from F.

Where the interlacing is such that three traversals are necessary to scan the whole image, there are provided in the frame pulses leading edges which occur at three times the line fre-

quency, and so on. As has already been stated, more pulses than are necessary to provide the requisite number of leading edges may be employed if desired.

Referring now to Fig. 6 of the accompanying drawings, in which voltage is plotted throughout against time as abscissa, a series *a* of line pulses is generated in any known or suitable manner, and there is also generated a series of suppressing pulses which occur at double the line frequency, alternate suppressing pulses having leading edges *b*₁, which are in phase with the leading edges *a*₁ of the line pulses. A series of frame pulses is also generated; two successive frame pulses are shown at *c*, the leading edges of which are one half of a line interval out of phase relatively to one another.

The pulses *a*, *b* and *c* are mixed together as shown, that is, the pulses *a* and *c* are mixed in the same sense and the pulses *b* are added in the opposite sense. The resultant complex signal, which is shown at *d*, is fed to a limiting device which removes parts of the signal above and below the frame pulses, the signal in the output circuit of the limiting device having substantially the form shown at *e*.

During the mixing and limiting processes, all of the suppressing pulses with the exception of those which occur during a frame pulse are removed by the limiting device; the suppressing pulses which occur during frame pulses remain after mixing and limiting in the form of depressions in the frame pulses, and the latter thus exhibit leading edges which occur at double the line frequency.

One form of apparatus for generating synchronizing signals by the method described with reference to Fig. 6 will now be described with reference to Figs. 7 and 8. In the apparatus shown in these figures, the line and suppressing pulses are generated by causing images of a slit in a screen 64 to pass in succession over three slits 76, 77 and 79 in a screen 65 (see particularly Fig. 8). The screen 64 is associated with a light source 66, and images (one of which is shown at 78, Fig. 8) of the slit in the screen 64 are swept over the screen 65 by means of the mirrors of the mirror drum 77 which also serves to scan the object to be transmitted. A suitable optical system 80 is provided to focus light on to screen 65.

The slits in the screen 65 are arranged as shown so that as the reflected beam of light from source 66 leaves one slit, it reaches another: behind each slit is arranged a photo-electric cell 68, 69 and 81 respectively, the outputs of the cells 68 and 81 being mixed together in the same sense and with the output of cell 69 in opposition and applied through condenser 70 to the control grid circuit of a limiting valve 71. The cell 68 generates line pulses, while the cells 69 and 81 generate suppressing pulses; frame pulses are generated in any known or suitable manner and applied to terminals 72.

The control grid of valve 71 is biased relative to its cathode by means of battery 73, for example, to a point more negative than that corresponding to anode current cut-off, the arrangement being such that of the composite signal (*d*, Fig. 6) applied to valve 71 the parts lying below the frame impulses do not cause anode current to flow. Furthermore, it is arranged that the parts of the signal *d*, Fig. 6, which lie above the frame pulses cause grid current to flow in the grid circuit of valve 71; the high resistance 74 prevents

the grid potential changing substantially during these parts of the signal which, accordingly, produce substantially no effect in the anode circuit.

A signal of the form shown at *e* in Fig. 6 is derived from the output terminals 15.

Further methods of generating signals of the kind shown in Figs. 4 and 5 will now be described with reference to Figs. 9 to 14, of which Figs. 11 and 13 are explanatory graphs in which voltage is plotted against time as abscissa.

The apparatus illustrated in Fig. 9 is designed to scan a motion picture film at a rate of 50 pictures per second in 181 lines per two frames and to generate one line pulse per line scanned and one frame signal per 90½ lines scanned. The apparatus shown in broken lines is not used in the arrangement first to be described.

Referring to Fig. 9, a motion picture film 1, which is of the kind described in British Patent No. 438,905 and bears two pictures in a length of film occupied by one normal sized frame, each picture being printed twice and compressed in the direction of the film only, is moved at a uniform rate of 50 pictures (or 25 normal frames) per second past a scanning slit 2. The film is driven by a 50 cycle, 3-phase alternating current "film" motor 3 supplied with current from a mains supply 4, 5. The same mains is also used to supply an induction motor 6; the latter serves as a three-phase transformer between the mains 4, 5 and a "drum" motor 7 which drives a mirror-drum 8 at 50 R. P. S. through 1:1 gearing. Current from the mains is applied to the stator winding of the induction motor 6 and the slip rings (to which a starting resistance is normally connected) are connected to the drum motor 7.

Alternatively the drum motor may be driven by current from an alternating current motor generator; in either case, the induction motor or the motor generator serves to supply current to the drum motor at a voltage less than the mains voltage.

The mirror-drum 8 bears 90 plane mirrors symmetrically disposed upon its surface at equal angular intervals. The drum is arranged in the usual way to sweep images of successive lines of the film which appear in the slit 2, over a picture photo-cell (not shown).

If the drum were in fact rotated at 50 R. P. S., as has been described, then, since the film passes the slit 2 at 50 pictures per second, 90 lines would be scanned per picture. In order, therefore, to add on the extra half strip per frame, the stator of the induction motor 6 is rotated, or "wound", in the opposite direction to the rotating field at a rate of ½ R. P. S. (or, if a motor generator is used, the stator of the latter is rotated in the opposite direction to the rotor thereof). The stator of the motor 6 is wound by means of a "winding" motor 9, supplied from the mains 4, 5 and driving the stator through 180:1 gearing 10. The output from the motor-generator 6 is thus 50+½ cycles per second and the mirror drum 8 is driven at 50+½ R. P. S. The number of mirrors coming into operation per frame is therefore 90½.

Line synchronizing signals are generated by allowing each mirror of the drum 8 to reflect a beam of light from a stationary source of light into a photo-cell. This method, which is quite well known and is therefore not illustrated, has the advantage that any errors in the setting of mirrors upon the drum are recorded in the line synchronizing signals and thus similar errors

may be introduced into the scanning of lines at a receiver.

Frame signals are generated in a somewhat similar manner by allowing certain mirrors of the drum to reflect images of a pair of illuminated frame apertures (shown at 11, 12 in Fig. 10) on to a frame photo-cell (not shown) every 90½ lines. The frame apertures 11, 12 are disposed alongside the film and are normally obscured by a rotatable shutter 13. The shutter, which is driven at 25 R. P. S. from the film motor 3 is provided with two opaque arms 14, 15 (Fig. 10) which cover the scanning slit 2 whilst the apertures 11 and 12 are uncovered by notches 16, 17 cut in the edge of the shutter 13, two pictures being scanned per revolution of the shutter 13.

The position of the apertures 11, 12 is such that the mirror drum has to be rotated through an angle corresponding to half a mirror in order to displace the image of one aperture into the position previously occupied by the image of the other aperture. It follows that when the apertures 11, 12 are uncovered by a notch 16 or 17, each mirror of the drum sweeps a pair of images over the frame photo-cell and the spacing between the apertures is such that the pulses generated in the frame photo-cell by successive mirrors occur at equal intervals of time. The shape of the notches 16, 17 is such that only two mirrors come into operation per notch so that only four pulses are generated per notch. The wave form of four such pulses is shown in broken lines at A in Fig. 11.

The mirror drum 8 is rotated so as to sweep an image of aperture 11 over the frame photo-cell before that of aperture 12 and the notches 16 and 17 are so shaped that when the shutter is rotated, in the direction indicated by arrow 18, notch 17 uncovers aperture 11 half a line interval before it uncovers aperture 12 whilst when notch 16 comes into operation it uncovers aperture 12 half a line interval before it uncovers aperture 11. The angular separation between the back edge 19 of notch 17 and the leading edge 20 of notch 16 is equivalent to 90 mirrors and the angular separation between the back edge 21 of notch 16 and the leading edge 22 of notch 17 is equivalent to 91 mirrors.

The wave form of the frame signals generated is thus as shown in Fig. 11, where the line pulses and the leading edges of certain of the broader frame pulses are shown by full vertical lines and the remainder of the frame pulses are shown dotted; the pulses shown at A and C are generated whilst notch 17 is in operation and the pulses shown at B are generated whilst notch 16 is in operation; the numbers above the full vertical lines indicating the times at which the scanings of successive lines on the picture commence represent the numbers of the lines scanned in any pair of pictures.

Henceforth four pulses of the kind shown in broken lines in Fig. 11 will be regarded as making up a single frame signal. It will be appreciated, however, that the number of pulses to one frame signal can easily be made other than four if desired. Furthermore, it will be seen that each frame signal is interrupted by depressions which occur at double the frame frequency.

Let it now be assumed that notch 17 has allowed a first frame signal to be generated (as shown at A in Fig. 11) disposed between lines numbered 181 and 2; then after an interval of 90 mirrors from the commencement of the first frame signal, notch 16 uncovers aperture 12 and half a line later

a pulse is generated due to light from this aperture falling on the frame photo-cell, so that the second frame signal commences 90½ lines after the commencement of the first signal. After an interval of 91 mirrors from the first opening of notch 16, that is, after an interval of 90½ mirrors from the commencement of the second frame signal notch 17 again uncovers aperture 11 and a pulse is immediately generated.

Thus frame signals commence at intervals of 90½ lines, odd-numbered frame signals commencing at the beginning of lines and even-numbered at positions corresponding to half-way along lines.

Although it has been stated that each picture is scanned in 90½ lines, in fact two of these strips may be lost whilst the frame signal is generated.

The line signals are generated at times corresponding to the full vertical lines in Fig. 11 and the frame signals may be superimposed upon the line signals to give mixed signals of the wave form shown in Fig. 13. The pulses shown in dotted lines in this figure may then be removed with the aid of any known or suitable amplitude limiting device.

It will be noted that in the above described arrangement, the phase relationship between the frame and line signals is fixed because both sets of signals are generated under the control of the mirror-drum 8, the shutter 13 serving merely to determine the approximate time, with respect to the scanning of complete pictures, at which the frame signals are generated.

In a modification of the embodiment of the invention last described, which will now be discussed with reference to Figs. 9 to 12, and with particular reference to the parts shown in broken lines in Fig. 9, the shutter 13 is dispensed with, or, if present, serves merely to obscure the scanning slit 2 in between the scanning of successive pictures, and frame signals are generated with the aid of a single auxiliary mirror 23 mounted upon, and rotating with, the mirror-drum 8 and co-operating with an optical system mounted upon a rotatable disc 24.

As in the previous arrangement, the mirror-drum 8 is rotated at $50 + \frac{1}{8}$ R. P. S. whilst the film is moved past the slit 2 at the rate of 50 pictures per second. The disc 24 is rotated at $\frac{1}{8}$ R. P. S. through suitable gearing by means of a 50 cycle three-phase alternating current motor 24A supplied from the mains 4, 5, and rotates in the same direction as the drum 8.

The optical system on the disc 24 comprises a lamp 25 having a long filament, a right-angle reflecting prism 26 and lenses 27, 28 and 29. In operation, light issuing from the lamp 25 and passing to one side of the prism 26, is collected by lens 27 and projected on to the mirror 23, whence light is reflected onto the prism 26, an image of the filament of lamp 25 being focused upon the vertical face of this prism. Light is reflected upwards from the prism 26, the lens 28 serving, in co-operation with lens 29, to focus the light upon a frame photo-cell 30. Upon the vertical face of the prism 26 is disposed a mask 31, such as is shown in Fig. 12, bearing two apertures 32 and 33; lenses 28 and 29 form an image of the aperture of lens 27 upon the photo-cell 30. The cell 30 is arranged behind an aperture in a screen 30'.

Since 50 pictures are scanned per second 50 frame signals must occur per second. The mirror drum 8 revolves in one direction at $50 + \frac{1}{8}$ R. P. S. and the disc 24 revolves in the same direction at 75

$\frac{5}{8}$ R. P. S., the mask 31 is therefore illuminated 50 times per second. Each time the mask is illuminated, corresponding square-topped pulses are generated in the photo-cell 30 so that the frame signals, as before, are of the wave form shown dotted in Fig. 11. The frame signals obviously occur at $90\frac{1}{2}$ line intervals because one signal occurs per picture and $90\frac{1}{2}$ lines are scanned per picture.

It will be noted that, as before, although the frame and line signals are of frequencies which are in non-integral multiple relationship, both sets of signals are generated under the control of the one scanning member.

If the shutter 13 is used to obscure the picture gate 2 in between the scanning of successive pictures, it is preferable to drive it from the "unwinding" motor 24A, which is left running continuously. The obscuring of the film 1 can then easily be made to coincide with the generation of frame signals and the film need be framed with respect to the shutter 13 only. If desired, however, the shutter may be driven by the film motor 3, in which case it is necessary to phase the film drive with respect to the frame signals in addition to framing the film with respect to the shutter.

Also, if it be found more convenient, the unwinding motor 24A may be dispensed with and the disc 24 and the optical system carried by it may be driven through 1:1 gearing from the stator of the motor-generator 6.

Yet another embodiment of the invention will be described with reference to Fig. 14. In this embodiment the scanning drum is driven at $50+\frac{5}{8}$ R. P. S. and the film scanned, as before, in $90\frac{1}{2}$ lines per picture at a rate of 50 pictures per second, each mirror co-operating in generating a line signal for every line scanned. The wave form of the line signals is as shown at 34 in Fig. 14. Under the control of the line signals there are generated, in any known or suitable manner, auxiliary line signals of the kind shown at 35 in Fig. 14. These auxiliary line signals may be generated, for example, by means of a multi-vibrator or in any other known or suitable manner. The auxiliary line signals 35 occur at double the line signal frequency, and it is arranged that each auxiliary line signal pulse has a duration the same as that of each pulse in a frame signal and that every alternate auxiliary line signal pulse commences in phase with a line pulse.

The line pulses 34 are applied between the cathode 36 and first grid 37 of a screened grid thermionic valve 38. The valve 38 is connected in parallel with a hexode thermionic valve 39, the two valves having a common anode resistance 40. The auxiliary line signals are applied between the cathode 41 and a grid 42 of the valve 39 whilst auxiliary frame pulses, of the wave form shown at 43 are applied between a grid 44 and the cathode of the valve 39.

The auxiliary frame pulses are generated with the aid of a shutter rotating in front of the film. The shutter is provided with two opaque arms, adapted to obscure the film in between scans of successive pictures, and with two notches which allow light to fall directly from a suitable source of light into a frame photo-cell during those periods when the film is obscured. This shutter may be driven from the film-driving motor.

Referring again to Fig. 14, the grid 44 of valve 39 is biased negatively with respect to the cathode to such an extent that no anode current

flows in the valve until an auxiliary frame pulse arrives. The auxiliary frame pulses serve to "switch on" the valve 39 to allow auxiliary line pulses to pass; the current flowing through the common anode resistance 40 is therefore of the wave-form shown at 45, consisting of the line signals superimposed upon trains of auxiliary line signals which are allowed to pass by the auxiliary frame pulses. One such train of auxiliary line pulses constitutes the frame signal which is eventually transmitted. Here again each frame pulse contains depressions, and hence also leading edges, which occur at twice the line frequency.

The dotted parts of the signal shown at 45 are removed by limiting. If desired, however, in order to avoid the necessity for limiting, means may be provided for "switching off" the line pulses while valve 39 is switched on: for this purpose, valve 38 may be replaced by a hexode. The switching-on of valve 39 may be arranged to take place in any desired phase with respect to the auxiliary line pulses. It preferably takes place, however, during an interval between successive pulses, and it is also desirable that it should occur as rapidly as possible.

From a consideration of Fig. 14, it will be clear that the error in positioning of a frame signal may amount to the interval indicated at 46, between two successive auxiliary line pulses. The exact time at which a frame signal commences is thus determined by the line signals, which in turn are positioned in time by the mirrors of the scanning drum, the auxiliary frame pulses generated at a frequency independent of the motion of the drum, serving merely to determine the approximate time at which the frame signals occur.

If for any reason it is found necessary to alter the phase relationship between the line and frame synchronizing signals, this may be done, in the three modifications last described, by adjusting the positions of apertures 11 and 12, by adjusting the positions of apertures 32 and 33, or by introducing a suitable delay network between the line synchronizing signal source and the auxiliary frame pulse generator, respectively.

The synchronizing signals may also be generated with the aid of an apertured scanning disc, in a manner such as will now be described with reference to Figs. 15 and 16 of the accompanying drawings.

Referring to Fig. 15, an object 50 in the form of a motion picture film on which two pictures are printed per frame is arranged to be scanned completely in one revolution of an apertured scanning disc 51 (Fig. 14) by means of picture-scanning apertures 52, the first, third, fifth etc. lines being scanned on one picture during one half revolution and the second, fourth, sixth etc. lines being scanned on the next picture during the other half revolution. The motion of the film thus provides the second component of the scanning motion.

Arranged around the disc 51 along a track 53 separate from that occupied by the picture scanning apertures 52 are a plurality of synchronizing apertures co-operating with an apertured photo-electric cell 54 separate from the cell 55 in which the picture signals are developed. Light from a suitable source 56 can pass through the synchronizing apertures on to the cell 54 when these apertures are in certain positions. The shape and position of the synchronizing apertures is substantially as shown, so

that at the end of the scanning of each line of the object there is generated in the synchronizing cell 54 a substantially square-topped pulse to constitute a line pulse. At diametrically opposite regions 57, 58 on the disc 51, the synchronizing apertures are given a greater length in a circumferential direction (this length being, however, less than the distance between leading edges of two successive apertures 52) so that impulses of the form shown cross hatched in Figs. 4 and 5 are generated. The leading edges F in these two regions are arranged to differ in phase by one half the line interval, and the number of apertures for a given number of line intervals in the regions 57 and 58 is made double the number for the same number of line intervals elsewhere.

It is not essential that the leading edges L₁ (Figs. 4 and 5) should persist after the firing point, and the apertures 53 in the disc 51 may be so arranged as to generate elongated line pulses of the kind shown to the right of F in Figs. 4 and 5 up to the firing point or just beyond it and thereafter to generate pulses of the kind shown to the right of F in Figs. 2 and 3.

A number of ways of generating impulses of the kind shown in Figs. 4 and 5 has been described, but it is to be understood that the invention is not limited to these methods, which have been discussed by way of example. It will be clear that a framing signal according to this invention may last for any convenient number of line intervals; the invention is clearly not limited to the interlacing of two traversals only of an object, but may be applied to the interlacing of a larger number of traversals.

Many modifications of the invention within the scope of the appended claims will readily occur to those versed in the art.

We claim:

1. A method of providing synchronizing signals for use at a television receiver employing interlaced scanning, said method comprising generating line synchronizing pulses in the intervals between trains of picture signals representative of lines of the object to be transmitted, generating frame synchronizing signals having a duration greater than the interval between successive line pulses, generating suppressing pulses occurring at n times the frequency of said line pulses where n is a small integer representing the number of traversals in which said object is completely scanned, causing certain of said suppressing pulses to terminate at substantially the same moment as a line pulse commences, mixing said line pulses and frame signals in the same sense with said suppressing pulses in the opposite sense, limiting the mixed signals for removing parts thereof above and below the frame signals, and transmitting the resultant limited signals.

2. A method according to claim 1, in which said line pulses, suppressing pulses and frame signals are generated with a substantially rectangular wave form.

3. A method according to claim 1, in which said line pulses, suppressing pulses and frame signals are generated with substantially the same amplitude.

4. Apparatus for generating synchronizing signals for use at a television receiver employing interlaced scanning, said apparatus comprising means for generating line pulses in intervals between trains of picture signals representative of lines of the object to be transmitted, means for

generating frame signals having a duration greater than the interval between successive line pulses, means for generating suppressing pulses occurring at an integer multiple of the frequency of said line pulses and for terminating certain of said suppressing pulses at substantially the same moment as the initiation of a line pulse, means for transmitting synchronizing signals, a channel for conveying synchronizing signals to the transmitting point, and means including a limiting device for mixing line pulses, suppressing pulses and frame signals and feeding them into said channel.

5. Apparatus for generating synchronizing signals for use at a television receiver employing interlaced scanning, said apparatus comprising means for generating line pulses in intervals between trains of picture signals representative of lines of the object to be transmitted, means for generating auxiliary line pulses occurring at n times the frequency of said line pulses where n is a small integer representing the number of traversals in which said object is completely scanned, every n^{th} leading edge of said auxiliary line pulses occurring in phase with the leading edges of said line pulses, means for transmitting synchronizing signals, a channel for conveying synchronizing signals to the transmitting point and coupling means including a discharge device for feeding said line pulses and said auxiliary strip pulses into said channel.

6. Apparatus according to claim 5, wherein said coupling means comprise a first discharge device arranged to feed line pulses continuously into said channel, and a second discharge device arranged to feed auxiliary line pulses into said channel only during intervals between traversals of said object, means being provided in association with said channel for removing line pulses which occur during said intervals.

7. The method of generating a composite television synchronizing signal which comprises generating frame synchronizing impulses, generating line synchronizing impulses, deriving auxiliary impulses from the generated line synchronizing impulses, interrupting the generated frame synchronizing impulses by the derived impulses at time intervals at which the inception of both the frame synchronizing and derived impulses coincide to produce interrupted frame synchronizing impulses having a wave shape whose integrated area with respect to time for each interrupted frame synchronizing impulse is constant over a predetermined time interval, said predetermined time interval being greater than the time period between the generated line synchronizing impulses.

8. The method of generating synchronizing signals for an interlaced television system which comprises generating frame synchronizing impulses, generating line synchronizing impulses, deriving auxiliary impulses from the generated line synchronizing impulses, said auxiliary impulses occurring at a greater rate than said line synchronizing impulses, producing interrupted frame synchronizing impulses by adding the derived impulses to the frame synchronizing impulses, and regulating the time period at which the derived impulses are added to the framing synchronizing impulses to provide time coincidence of inception of both the derived impulses and the frame synchronizing impulses so that the interrupted frame synchronizing impulses have constant energy content at a predetermined time interval, said predetermined time interval being

at least equal to the time period between the generated line synchronizing impulses.

5 9. The method of generating synchronizing signals for an interlaced television system which comprises generating frame synchronizing im-
pulses, generating line synchronizing impulses, deriving auxiliary impulses from the generated
10 line synchronizing impulses, said auxiliary im-
pulses occurring at twice the rate of said line
synchronizing impulses, producing interrupted
frame synchronizing impulses by adding the de-
rived impulses to the frame synchronizing im-
pulses, and regulating the time period at which
15 the derived impulses are added to the frame
synchronizing impulses to provide in-phase re-
lationship between the derived and frame syn-
chronizing impulses so that the interrupted

frame synchronizing impulses have constant en-
ergy content at a predetermined time interval.

10. The method of generating synchronizing
signals for an interlaced television system which
5 comprises generating frame synchronizing im-
pulses, generating line synchronizing impulses,
deriving auxiliary impulses from the generated
line synchronizing impulses, said auxiliary im-
pulses occurring at a greater rate than said line
synchronizing impulses, producing interrupted 10
frame synchronizing impulses by adding the de-
rived impulses to the frame impulses with the
inception of both the derived impulses and the
framing impulses occurring in time coincidence.

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