Jan. 28, 1941. J. SCHUNACK ET AL 2,230,092

SYNCHRONIZATION SYSTEM FOR TELEVISION

Filed Aug. 9, 1938 3 Sheets-Sheet 1

Fig. 1a

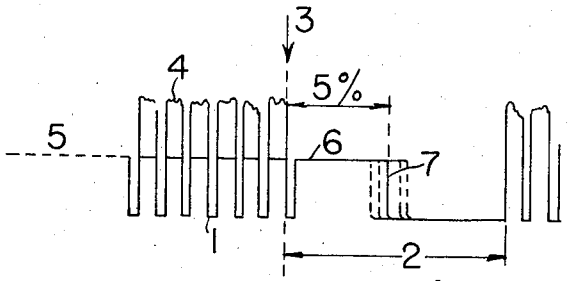


Fig. 1b

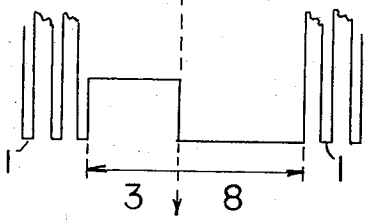


Fig. 2a

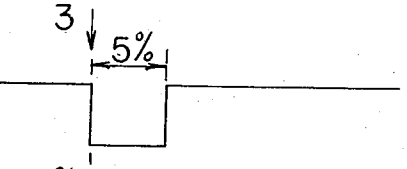


Fig. 2b

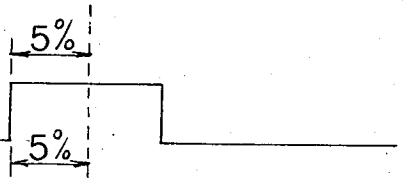
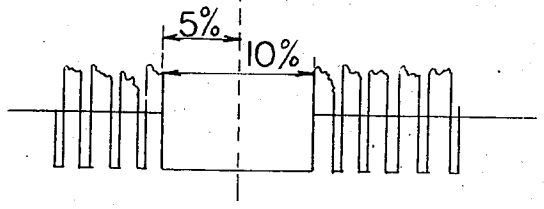


Fig. 2c



Fig. 2d



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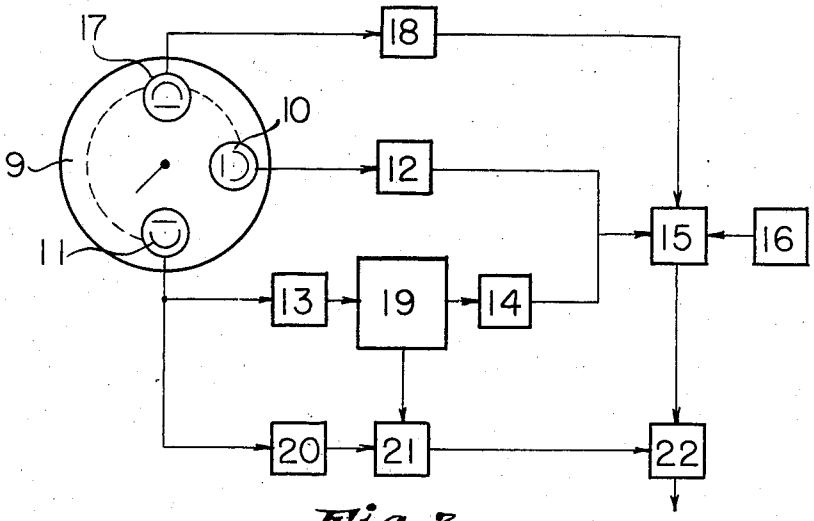


Fig. 3

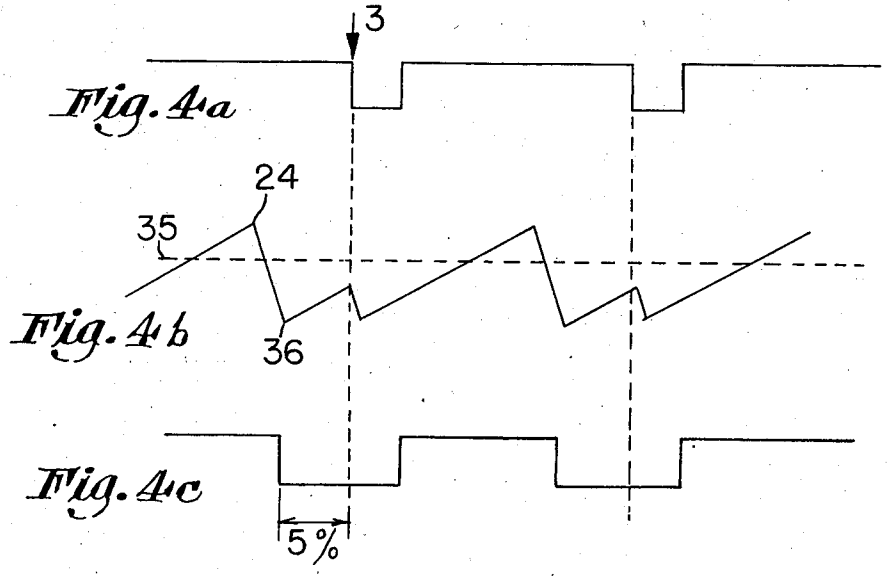


Fig. 4a

Fig. 4b

Fig. 4c

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SYNCHRONIZATION SYSTEM FOR TELEVISION

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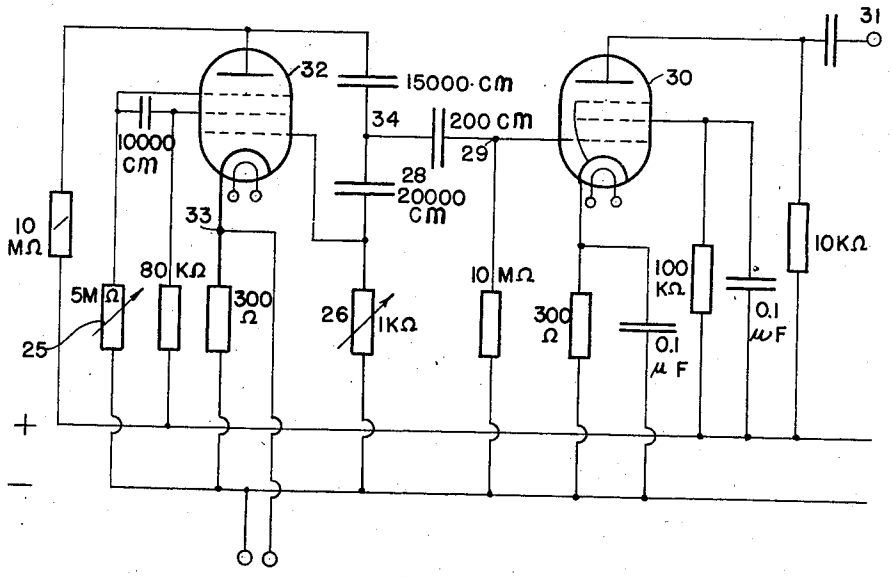


Fig. 5

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UNITED STATES PATENT OFFICE

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SYNCHRONIZATION SYSTEM FOR TELEVISION

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Application August 9, 1938, Serial No. 223,910
In Germany August 9, 1937

4 Claims. (Cl. 178—69.5)

This invention relates to systems of synchronization of television transmitters and receivers.

It is common in the art to use so-called interlaced scanning in which an image is not completely scanned in any one vertical scansion. Each partial scansion or field occurs in the interstices between the traces of the preceding scansion or scansions. It is also known to employ so-called "odd-line" interlaced scanning, in which the number of lines per television frame is an odd number, while the number of fields per frame is an even number, and whereby the number of lines in each field is a non-integral multiple of the number of fields per frame.

In such systems it is of utmost importance to maintain the vertical scanning in a predetermined fixed relationship to the horizontal scanning in respect to time. Deviations from this fixed relation cause the scanning lines of successive partial scansions not to be equidistant, but to "pair off," and in extreme cases to overlap completely, whereby, in the latter case, interlace is lost altogether and the vertical resolution of the image is reduced to one-half. A continuous shift in the time relation between vertical and horizontal scanning results in a motion of the fields with respect to each other, the so-called "line weaving" which results in an unsteady image.

It is customary in the art to employ separate scanning wave generators at the transmitter and receiver, and to synchronize both by transmission of two types of synchronizing impulses, e. g., one for vertical scanning and one for horizontal scanning. Thus, it is the accuracy of these impulses upon which perfect interlace depends. In a television system with 441 lines per full frame, 30 full frames per second and an interlace ratio of 2:1, a shift of approximately 1/30,000 second in the occurrence of the synchronizing impulses for vertical scanning, commonly referred to as the framing impulse, will cause total loss of interlace.

It is known in the art, among other methods, to derive the framing impulse from the line synchronizing frequency, or from a multiple thereof, by frequency division. The leading edge of the framing impulse will, therefore, always be in a fixed relationship to the line synchronizing impulses. It is also known to use signals, consisting of a preparatory section and a framing section proper, in order to obtain congruent framing impulses for alternate frames when using integrating networks, as is well known to those skilled in the art. In this case, the beginning of the preparatory section of the impulse is in fixed relationship to the line synchronizing impulses; actual timing of the vertical scanning generator, however, occurs at the end of the preparatory section, i. e., at the beginning of the framing section proper of the impulse. This necessitates high accuracy and uniformity in the duration of the preparatory signal; otherwise, the timing of the vertical scanning generator is subject to phase shift. However, rather great difficulties are encountered in generating preparatory signals of perfectly uniform duration.

It is the object of this invention to overcome the above-mentioned difficulties, and to provide a new method of framing impulse generation; furthermore, to provide new means for such generation.

Broadly considered, this invention is adapted to generate a framing impulse proper, directly derived from the line synchronizing frequency and in perfect synchronism therewith; to synchronize the generation of an impulse of longer duration than the framing impulse proper with the latter impulse, whereby the leading edge of the longer impulse precedes that of the framing impulse proper; to superimpose both impulses and thereby obtain a frame impulse comprising a preparatory section and a framing impulse proper, whereby the leading edge of the framing impulse proper is in perfect synchronism with the line synchronizing frequency, and to utilize the resultant impulses for synchronization.

In the accompanying drawings:

Figs. 1*a*, 1*b*, 2*a*, 2*b*, 2*c*, 2*d*, 4*a*, 4*b* and 4*c* show series of impulses;

Fig. 3 shows, in the form of a block diagram, a synchronizing system in accordance with the invention; and

Fig. 5 shows a schematic circuit diagram of one of the blocks of the system shown in Fig. 3.

The invention will now be explained in detail with the aid of the drawings. Figure 1*a* illustrates the composite television signal obtained with the prior art method. In this figure the line synchronizing impulses are indicated by the numeral 1, and are assumed to have a duration of 10% of the time required for scanning and retracing one line. The picture signal is indicated by the numeral 4, and the black level by numeral 5. The interval 2 indicates the duration of the total framing signal including the preparatory section and the framing impulse proper. The duration of the total framing signal is assumed to be 10% of the frame period, whereas the preparatory section takes up 5% thereof.

It may be understood, however, that this invention is by no means limited to framing signals of such duration and will operate just as well on signals of considerably shorter duration. The preparatory section 6 is synchronized with the line synchronizing frequency at the time indicated by the line 3. The leading edge 7 of the framing impulse proper is utilized to synchronize the vertical scanning generator. The dotted lines indicate the influence of variations in the duration of the preparatory section upon the leading edge of the framing impulse proper and, thereby, the influence upon the timing of the vertical scanning generator.

Figure 1*b* shows the composite television signal with a framing signal in accordance with the present invention. Line synchronizing impulses are indicated by numeral 1. The framing signal 8 in this case may again have a duration of 10% of the frame period. It may be seen that the leading edge of the framing impulse proper occurs at the time indicated by the line 3 and is in absolute synchronism with the line synchronizing frequency for reasons to be explained later.

Figure 3 is a schematic diagram of a synchronizing impulse generator system according to the invention. The revolving disc possesses a series of apertures through which light from a constant source is allowed to fall upon photocells 10 and 11. Photocell 17 may produce picture signals in the well-known manner of the Nipkow disc. Photocell 10 may then produce a series of impulses of line frequency, while photocell 11 may produce a series of impulses of framing frequency. These impulses may have a duration of 5% of their respective periods. The line synchronizing impulses are fed through a shaping network 12 in which their width is increased to 10% and in which they are given a square-topped shape. The framing impulses are fed through a network 13, in which their width in increased to 10%, and then to a circuit 19 which generates the preceding signal according to the invention. Circuit 19 will be explained in detail below. The output of circuit 19 is a series of impulses of the shape shown in Figure 2*b*, the duration of which is approximately 10% of the frame period, and which leads the impulse produced in photocell 11 by 5% of the frame period. This impulse is fed through an amplifier 14 and is then mixed with line synchronizing impulses. The mixed impulses are then fed to a modulator stage 15, in which a carrier generated by oscillator 16 is modulated simultaneously by the mixed impulses as well as by picture signals produced by photocell 17 and amplified by amplifier 18, to produce impulses of the shape shown in Fig. 2*a*. The framing impulse as shown in Figure 2*a*, as produced by photocell 11, is amplified by amplifier 20 and fed to a mixer stage 21. The impulse produced by circuit 19 of the shape shown in Figure 2*b* is also fed to mixer stage 21, preferably in opposite polarity, so that the resulting impulses will have a duration and phase as shown in Figure 2*c*. This impulse is modulated upon the previously modulated carrier coming from modulator 15 by a modulator stage 22, so that the resultant modulated carrier will be of the kind shown in Figure 1*b*.

Figure 5 shows a circuit which may be used to fulfill the function of circuit 19 of Figure 3. The operation of this circuit can be best explained in connection with the diagrams of Figure 4. In Figure 4*a*, the curve shows the series of framing impulses, wherein the line 3 indicates the leading edge of the impulse at which the vertical scanning generator is to be synchronized. The curve of Fig. 4*b* shows the saw-tooth voltage output of a relaxation oscillator whose natural frequency is adjusted to be slightly higher than that of the impulses of Fig. 4*a*, with which it is synchronized. Thus, it operates in such a manner that the saw-tooth voltage rises to a point 24 of the curve of Fig. 4*b*, at which point the oscillator trips and the voltage drops to point 36. Thereupon, the voltage begins to rise again until, after a fraction of the natural period of the oscillator, a synchronizing impulse, as shown in the curve of Fig. 4*a*, is injected, which causes the oscillator to trip again. The saw-tooth voltage as shown by the curve of Fig. 4*b* is fed through a phase inverter stage and is then used to synchronize a multivibrator upon the peaks indicated by numeral 36. The multivibrator then produces a series of impulses as shown by the curve of Fig. 4*c* which correspond to those in Figure 2*b*.

Figure 5 shows an embodiment of this circuit in detail. The multigrid tube 32 is in reflex oscillator connection. This circuit is self-excited and produces a saw-tooth voltage output. The frequency of the saw-tooth output can be varied by adjustment of one or both of resistors 25 and 26. The framing impulses as shown in Figure 4*a* are applied to the cathode of tube 32 at point 33 to change the cathode bias, and are thus made the cause of a premature interruption of each oscillator cycle, as shown in Figure 4*b*. The natural frequency of the oscillator circuit is so adjusted by means of resistors 25 and 26 as to be higher than that of the framing impulses so that the double-peaked saw-tooth output is produced. From point 34 of a capacitive voltage divider in the plate circuit of tube 32 the double-peaked saw-tooth voltage is applied to the control grid of another multigrid tube 30. The bias of this tube is so adjusted that the saw-tooth peak 36 of Fig. 4*b* is not cut off. Peak 36 is then used to synchronize a multivibrator of the conventional type, as is well known in the art, which is connected at point 31. This multivibrator then produces a series of impulses as shown in Figure 4*c* which correspond to those in Figure 2*b*. The duration of these impulses can be varied by variation of the multivibrator circuit constants. Thus, a series of impulses is generated, which impulses are synchronized by master impulses, whose leading edges precede those of the master impulses and whose duration is independent of that of the master impulses.

While we have described our invention in connection with mechanical means of picture signal and master impulse generation, it is obvious that these may readily be replaced by electronic means, as are well known in the art.

What we claim is:

1. Method of generating synchronizing signals possessing a preparatory section and a synchronizing impulse for television systems, comprising the steps of generating a series of master impulses at whose leading edges synchronization is to take place, deriving from said master impulses a second series of impulses whose leading edges in effect precede those of said series of master impulses and whose impulse durations are greater than those of said master impulses, superimposing said master impulses and said second impulses in opposite polarities, and

utilizing the resultant impulses for synchronization.

2. Method of generating synchronizing signals possessing a preparatory section and a synchronizing impulse for television systems, comprising the steps of generating a series of master impulses at whose leading edges synchronization is to take place, applying said series of master impulses to a saw-tooth wave generator possessing a natural frequency higher than that of said series of master impulses in such polarity and phase as to generate a double-peaked saw-tooth wave, utilizing the first one of said peaks to synchronize an impulse generator, generating by said last-named generator a second series of impulses whose leading edges in effect precede the leading edges of said series of master impulses and whose impulse durations are greater than those of said master impulses, superimposing said master impulses and said second impulses in opposite polarities and utilizing the resultant impulses for synchronization.

3. The method of deriving from a first series of impulses a second series of impulses whose leading edges in effect precede those of said first impulses, comprising the steps of applying said first impulses to a self-excited saw-tooth wave generator having a natural frequency higher than that of said first impulses in such polarity and phase as to prematurely interrupt each saw-tooth cycle and thereby producing a double-peaked saw-tooth wave, and utilizing the first one of said double peaks to synchronize an impulse generator to produce said second series of impulses.

4. The method of producing a synchronizing signal from a saw-tooth wave oscillator by application thereto of a cyclic controlling pulse, which comprises tuning said oscillator to a frequency higher than the frequency of said starting pulse, applying said starting pulse to interrupt each saw-tooth cycle after start thereof, forcing the reestablishment of said cycle after stoppage, and utilizing the double-peaked output to produce said synchronizing signal, thereby effectively advancing the leading edge of said signal ahead of the leading edge of said controlling pulse.

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