

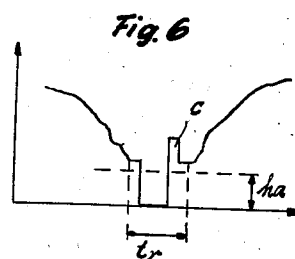
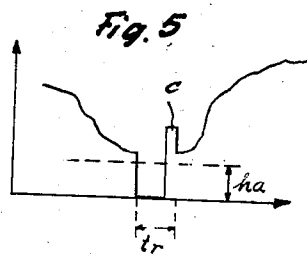
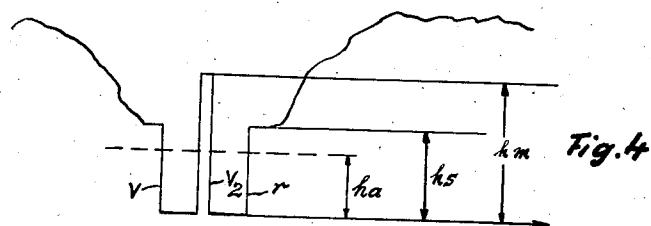
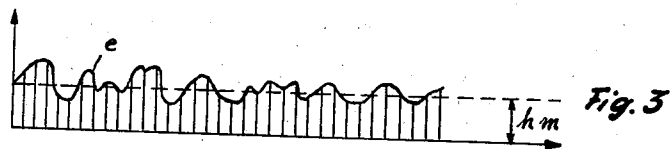
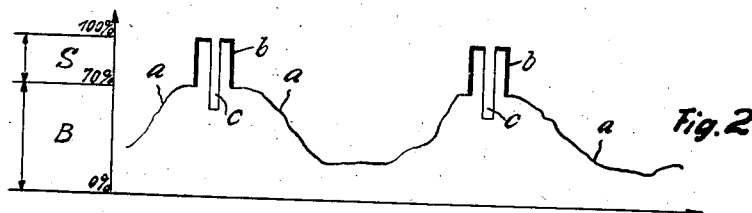
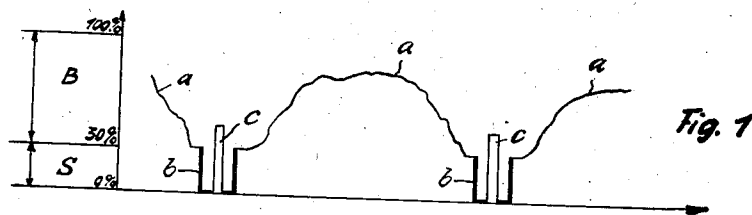
Dec. 30, 1941.

R. R. VON FELGEL-FARNHOLZ  
TELEVISION TRANSMISSION SYSTEM

2,268,001

Filed Nov. 13, 1939

3 Sheets-Sheet 1



Inventor:

Richard Ritter von Felgel-Farnholz  
by Edwin L. Martin

Dec. 30, 1941.

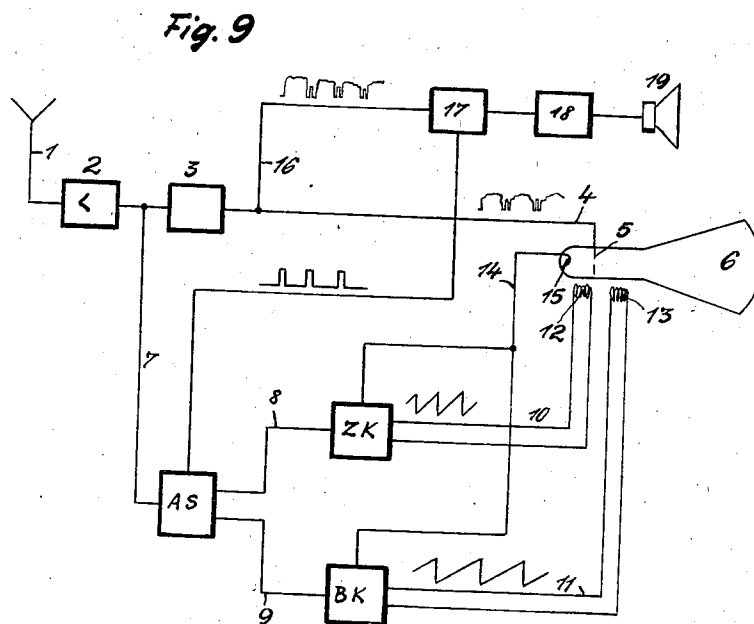
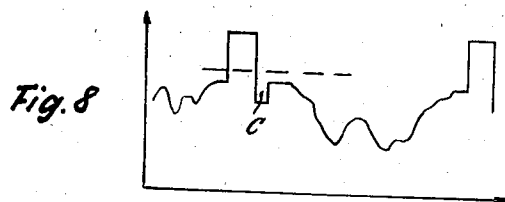
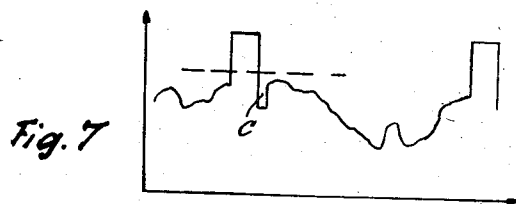
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2,268,001

TELEVISION TRANSMISSION SYSTEM

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3 Sheets-Sheet 2



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TELEVISION TRANSMISSION SYSTEM

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Fig. 10

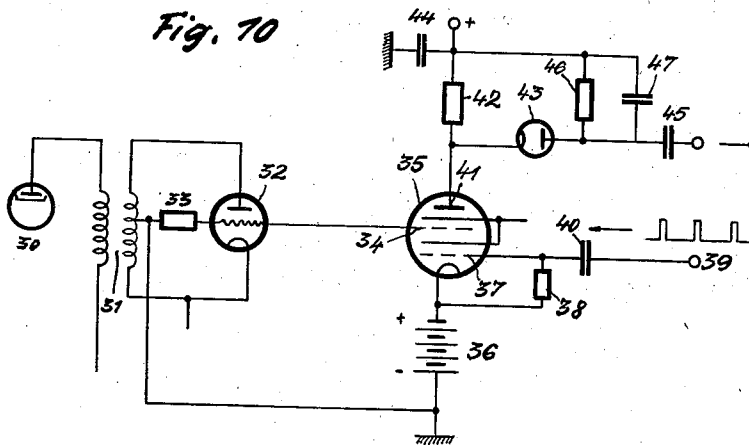
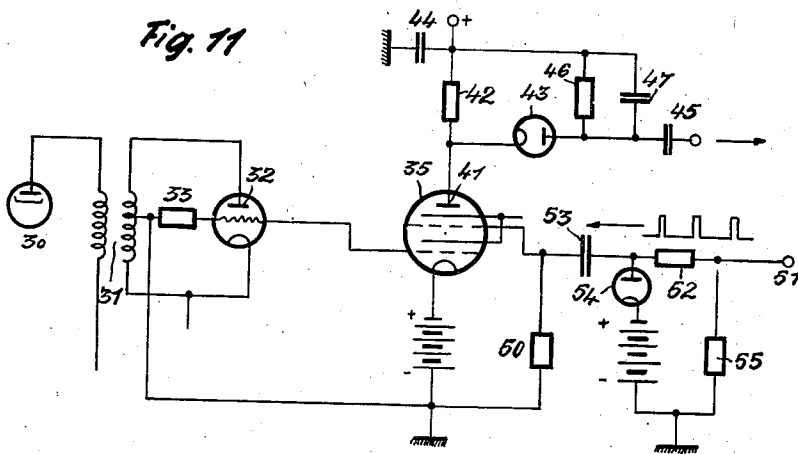


Fig. 11



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## UNITED STATES PATENT OFFICE

2,268,001

## TELEVISION TRANSMISSION SYSTEM

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2 Claims. (Cl. 178—5.6)

This invention relates to methods and means for transmitting television signals and accompanying sound signals over a single transmission channel.

It is an object of the present invention to provide a simple and workable method and arrangement which allows the transmission of the sound accompanying the image transmission in intervals of the image transmission. It is a further object to overcome difficulties arising in such transmissions when the sound occurring during the transmission of the image component is delayed, stored or compressed in order to transmit an electric wave in a short period of time which is representative of a sound wave of considerably longer duration. Methods of this kind have the drawback that at the receiver a relocation of the sound wave becomes necessary either by extending the sound wave or by shifting those parts of the sound signal into their original positions which have been delayed for the purposes of transmission. It is an object of this invention to effect a combined sound and image transmission over a single channel, preferably on a single carrier wave without utilizing delaying or shifting networks of any kind.

This invention makes use of the fact that a sound transmission can be effected also in case only a small portion of the original sound wave is transmitted, if only the frequency of the interruptions of the sound wave is sufficiently higher than the highest frequency of the sound to be transmitted. It also makes use of the observation that the eye and the ear register these two phenomena as simultaneous even if they are actually occurring alternately one after the other in sufficiently short frequency. It is therefore an object of the invention to transmit image signals and sound signals which do not occur simultaneously exactly at the same moment but which occur alternatively during different intervals of time.

According to the invention a method is used in which sound signals and image signals are transmitted as modulations of the same carrier in the same range of modulation but at different times. The transmission channel is used alternately for the transmission of image and sound oscillations. The shifting or change-over of the transmission is preferably effected by only one series of impulses. These impulses may be controlled from the transmitter and preferably the synchronizing impulses or derivatives thereof are used for this purpose.

Still other and further objects of the inven-

tion will become apparent from a consideration of the following specification and claims in connection with the accompanying drawings, illustrating preferred methods and forms of my invention, wherein:

Fig. 1 represents graphically the position of the imposed sound signals between accompanying parts of picture signals according to the German television standards.

Fig. 2 represents graphically the position of the sound signals in the television transmission according to present American standards.

Fig. 3 shows diagrammatically the curve of the accompanying sound combined from the selected strips *c* of the transmission according to Fig. 1 or Fig. 2.

Fig. 4 is a diagrammatic representation of the imposed sound signal in a larger scale.

Fig. 5 and Fig. 6 illustrate slightly modified positions of the imposed sound signals between picture signals in transmission systems according to Fig. 1.

Fig. 7 and Fig. 8 are a set of curves showing those modified positions of the sound signal in transmission system according to Fig. 2.

Fig. 9 shows a block diagram of a suitable form of a television receiver for carrying out the invention.

Fig. 10 illustrates details of the blocking device referred to in the schematic diagram of Fig. 9.

Fig. 11 shows details of another embodiment of the blocking device.

Fig. 1 illustrates the basic principles of the new method of combined sound and picture signals.

The parts *a* of the curve each represent the picture signals during the transmission of one scanning line. In the transmission system according to Fig. 1 the value white of the picture brightness corresponds to a carrier amplitude of 100% and the value black to an amplitude of 30%. Between the parts *a* of the curve there are situated the line synchronizing signals *b*. These synchronizing signals are required to synchronize the scanning devices in the receiver and these signals, or other signals derived therefrom serve also to extinguish the cathode ray during its return path. The transmission of sound signals *c* takes place only during that time, when the cathode ray tube is turned off for instance by applying a strong negative impulse to the control electrode thereof.

Fig. 2 shows the transmission of sound signals *c* in a transmission system comprising an amplitude-range from 0 to 70% for picture signals and from 70 to 100% for synchronizing signals. The

amplitudes of the sound signals  $c$  correspond to the actual amplitudes of the sound at that very same moment.

The transmission of the sound signal will in no way disturb the transmission of the picture signals and will cause no visible faults of the received image as the periodical transmission of the single signals  $c$  only takes place during the time, when there is no transmission of picture signals.

In order to receive and reproduce the sound signals special arrangements must be made in the receiver. These features will be described later in this disclosure after giving a further description of the different useful methods to combine and to transmit alternatively the picture signals and the sound signals.

Fig. 3 illustrates by a curve diagrammatically the form of the sound wave, obtained at the receiver. The single sound signals  $c$  selected by special means are fed to the sound channel of the receiver; the envelope  $e$  of the amplitudes of the adjacent sound signals corresponds to the wave form of the accompanying sound. According to a preferable embodiment of the invention the signals  $c$  are amplified in the video amplifier itself so that it is not necessary to provide special amplifier stages for the amplification, especially intermediate-frequency amplification of the sound signals. At the output of the common video and sound amplifier the output energy is impressed on the control electrode of the cathode ray tube and also on a control electrode of a sound power amplifier tube. The voltages according to the sound wave form modulate the anode current of the power amplifier tube thus producing the necessary energy for the loudspeaker. The working conditions of the power tube are preferably so chosen that the tube is always blocked except when the cathode ray is extinguished. The same black out impulses which serve to extinguish the cathode ray may serve also to actuate the blocked sound amplifier channel.

Fig. 4 illustrates in a larger scale the relationship between the amplitudes of the picture signals, synchronizing signals and sound signals. The sound signal is placed symmetrically within the synchronizing signal. The amplitude of the imposed sound signals may obtain any value within the modulation-range. It is necessary to avoid any scanning-irregularities and therefore it is desirable to avoid also any variations of the form of the synchronizing signal which is cut off by an amplitude-limiting device and fed to the scanning oscillators. If the working conditions of the amplitude limiting device are so chosen that the signals below the amplitude  $h_a$  (as indicated by the dotted line) are cut off, then it is desirable to modulate the sound signal only by such an extent that the resulting lowest sound amplitude remains above that dotted line.

The average value  $h_m$  of the unmodulated sound signal corresponds at a fixed amplification to the actual value of the field strength at the receiver. Therefore it is possible to use the amplitude  $h_m$  for controlling the amplification and thus to avoid any fading effects. Furthermore the value  $h_s$  of the leading edge  $v$  or of the following edge  $r$  can be used for controlling the amplification or the picture brightness or the black level.

The invention is in no way limited to the symmetrical position of the sound signal.

The Figs. 5, 6, 7 and 8 show other suitable po-

sitions of the sound signal. In Fig. 5 the sound signal  $c$  is so placed at the end of the synchronizing signal, that the sound signal is finished at the same time as the return period  $t_r$  of the cathode ray. If reference is now made to Fig. 6 showing a similar wave form it may be assumed that the amplitude of the carrier is maintained at the black level, e. g. by applying a so-called blackout impulse, before the beginning of the leading edge of the synchronizing signal. Fig. 7 shows a similar position of the sound signal  $c$  as Fig. 5 but applied to transmission system according to different standards (the amplitudes of the synchronizing signals are greater than the maximum picture signal amplitudes). Fig. 8 shows a slightly modified form, the only difference being that before the beginning of each synchronizing impulse the amplitude will reach the same given value. Therefore the form of the cut off signal (above respectively below the dotted line) is absolutely independent from the foregoing picture signals.

It should be understood in the consideration of this invention that for convenience of illustration square-topped waves with vertical sides have been illustrated by the various curves. Such a wave shape is substantially impossible to transmit and would, in practice, ordinarily be replaced by impulses with rounded corners and slightly sloping sides. Therefore the present illustrations must be regarded as being of rather conventional nature and serving only to indicate and set forth the principles upon which the present invention is based rather than as defining the invention in any concrete and limiting form.

Fig. 9 is a block diagram of a receiver. It may be assumed that the picture signals and sound signals are transmitted on a common carrier wave which is modulated according to the curve illustrated in Fig. 1. The signals are received by means of the antenna 1 and fed to an amplifying device. That device 2 may be of the superheterodyne type with a following intermediate frequency amplifier or it may be a multistage amplifier with regeneration. The amplified signals are demodulated in the device 3 and are then applied by way of the line 4 to the control electrode 5 of the cathode ray tube 6. From the output of the amplifying device 2 a part of the energy is branched off and fed to an amplitude selecting device AS. The selected synchronizing signals are conducted by way of the lines 8 and 9 respectively to the horizontal deflecting wave oscillator ZK and to the vertical deflecting wave oscillator BK. These deflecting wave oscillators ZK and BK generate currents of sawtooth wave form, as indicated in the figure and the currents are fed by way of the lines 10 and 11 to the deflection coils 12 and 13 respectively. These coils serve to deflect the cathode ray in horizontal and vertical direction in synchronism with the deflection of the scanning beam at the transmitter. The cathode ray is suppressed during the so-called return periods by means of black-out impulses. In a preferred embodiment of the receiver these black-out impulses are derived with positive polarity from the synchronized oscillators and are applied by way of the line 14 to the cathode 15 of the cathode ray tube 6. The output of the demodulating device 3 is connected by the line 16 with the blocking device 17. The working conditions are so chosen, that the transmission channel from the line 16 to the following sound amplifier 18 is blocked when picture signals are impressed on the cathode ray tube. The

blocking device is only unblocked during the so-called return periods of the cathode ray. The control impulses for actuating the blocking device 17 are derived from the device AS as diagrammatically indicated by the square-topped curve in Fig. 9. The control impulses may be identical with the selected line synchronizing impulses or may be derivatives therefrom, e. g. the so-called blackout impulses. So the blocking device 17 opens the sound channel 16—18—19 only during those aforesaid intervals, when there is no picture transmission and in that way only the sound signals are fed to the sound amplifier 18 and the loudspeaker 19.

Fig. 10 shows the details of one preferred form of the blocking device 17 which is diagrammatically indicated in the block diagram of Fig. 9. Valve 30 represents the last stages of the common video and sound amplifier and the output of this amplifier is fed by means of a transformer 31 to a duodiode 32. A resistor 33 is inserted between the cathode of that diode and the center point of the secondary winding of the transformer 31. The signals developed across the resistance 33 are fed to the second or outer control grid of a multigrid tube 35 which is preferably of the hexode or pentagrid type. Screen grids are provided between the two control grids of the tube 35 and also between the outer control grid and the anode. The outer control grid 34 is negatively biased by means of a battery 36 of 15 v. The battery may be replaced by any other suitable means for obtaining a biasing potential. The first control grid 37 is connected with a cathode by means of a resistor 38 of 5 megohm. In that way the valve is practically blocked as a negative blocking potential always will be derived at the resistor 38 as soon as a grid current begins to flow. The valve 35 is made conductive periodically during certain intervals which are used for the transmission of the accompanying sound signals. This is accomplished by means of special positive impulses which are applied to the control grid 37 by way of the line 39 and the condenser 40. Generally it will be useful to choose a comparatively high value of the resistor 38 and a comparatively low capacity of the condenser 40, so that only a very little amount of energy will be needed for unblocking and blocking the tube. The amplified and selected sound impulses are derived from the output of the tube 35 across a load resistor 42 of 10,000 ohm by means of a diode 43. The other end of the load resistor 42 is connected with the positive pole of an anode voltage supply of 300 v. and grounded by means of a condenser 44 of 30  $\mu$ f. The sound impulses which are taken off at the diode 43 are fed to an audio power tube, or a cable, or directly to a loudspeaker by way of the condenser 45. The anode of the diode 43 is connected to the positive pole of an anode voltage supply by means of a resistor 46 of 1 megohm and a condenser 47 of 500 cm.

If reference is now made to Figure 11 it may be assumed that the received sound signals are fed from the final stage 30 of the common video and sound amplifier to the valve 35 in the same way as in the device of Fig. 10. Corresponding parts in the Figs. 10 and 11 respectively are characterized by the same numbers. The amplified sound signals are impressed on the first (inner) control grid of the valve 35. The square-topped switching impulses for periodically rendering the valve 35 conductive are applied over the line 51, the resistor 52 and the condenser 53 of 0.1  $\mu$ f. to

the second (outer) control grid. The second control grid is connected over a resistor 50 of 100,000 ohm with a biasing potential of -15 volt, so that the valve is blocked under normal conditions and only rendered conductive for short periodical intervals, when a positive impulse is impressed on that grid. The amplitudes of the switching impulses are maintained constant by means of an amplitude limiting device comprising the biased diode 54 and the resistors 52 and 55.

If the sound or the speech is modulated on series of impulses and the frequency of these impulses is within the audible frequency-range, then it is necessary to employ low-pass filters in the sound channel. The cut-off frequency of that filter should be chosen below the frequency of these impulses (the impulses serve as a sound carrier). Then the so-called sound carrier does not disturb the reproduction of the transmitted sound or speech. It is generally desirable, that the frequency of these impulses is above the audible range.

The invention may be used especially in connection with scanning oscillators of the so-called transformer type. In these oscillators the return period commences as soon as the leading edge of the synchronizing signals arrives and then the control grid of the oscillator valve is blocked by a very strong negative potential (e. g. several hundred volts) immediately after the beginning of that return period. Therefore the second leading edge  $v_2$ , as indicated in Fig. 4, will cause no false synchronization.

In many cases it will be advantageous to use combined valves with several systems within one bulb, comprising at least one amplifying system for amplification and/or demodulation of the signals derived from the output of the common video and sound amplifier and for the periodical blocking and opening respectively of the sound channel. The diode system within the common bulb may serve for demodulation of the sound carrier or to obtain the control voltages. If the audio power tube comprises a suppressor grid, the unblocking and blocking of the sound channel is effected preferably by controlling the potential of that suppressor grid.

The tube also can be unblocked and blocked by controlling the screen grid potential. Then it is generally necessary, that the amplitude of the controlling impulses be maintained constant.

The invention is not limited only to the transmission of television signals and accompanying sound signals only and it lies within the scope of the invention to transmit also picture signals and especially colour signals (instead of the aforesaid accompanying sound) thus indicating not only the brightness but also the colour of the transmitted picture. Other useful applications of the invention will be apparent to those skilled in the art.

The system as described in the foregoing specification is especially adapted for small transmitters, e. g. sets for use in airplanes, two-way television-telephones etc.

What I claim is:

1. The method of transmitting television signals, including picture signals and synchronizing signals, and accompanying sound signals in a composite signal by way of a single transmission channel, comprising the steps of transmitting television picture signals during the useful line scanning periods, transmitting synchronizing signals and auxiliary pulses in the interval be-

tween said periods, modulating the amplitude of said auxiliary pulses in accordance with the sound waves to be transmitted to produce sound signals, and retaining a predetermined finite minimum amplitude of said auxiliary pulses independent of said sound waves, said minimum amplitude being at least as great as the portion of the synchronizing signal amplitude utilized for synchronization.

2. The method of transmitting television signals, including picture signals and synchronizing signals, and accompanying sound signals in a composite signal by way of a single transmission channel, comprising the steps of transmitting television picture signals during the useful line scanning periods, transmitting synchronizing

signals and auxiliary pulses in the interval between said periods, said auxiliary pulses extending from the maximum amplitude of said synchronizing signals in the direction of picture representative of increasing picture brightness, modulating the amplitude of said auxiliary pulses in accordance with the sound waves to be transmitted to produce sound signals, and retaining a predetermined finite minimum amplitude of said auxiliary pulses independent of said sound waves, said minimum amplitude being at least as great as the portion of the synchronizing signal amplitude utilized for synchronization.

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