Oct. 20, 1942. W. A. TOLSON 2,299,361

TELEVISION SYSTEM

Filed Dec. 29, 1939 4 Sheets-Sheet 1

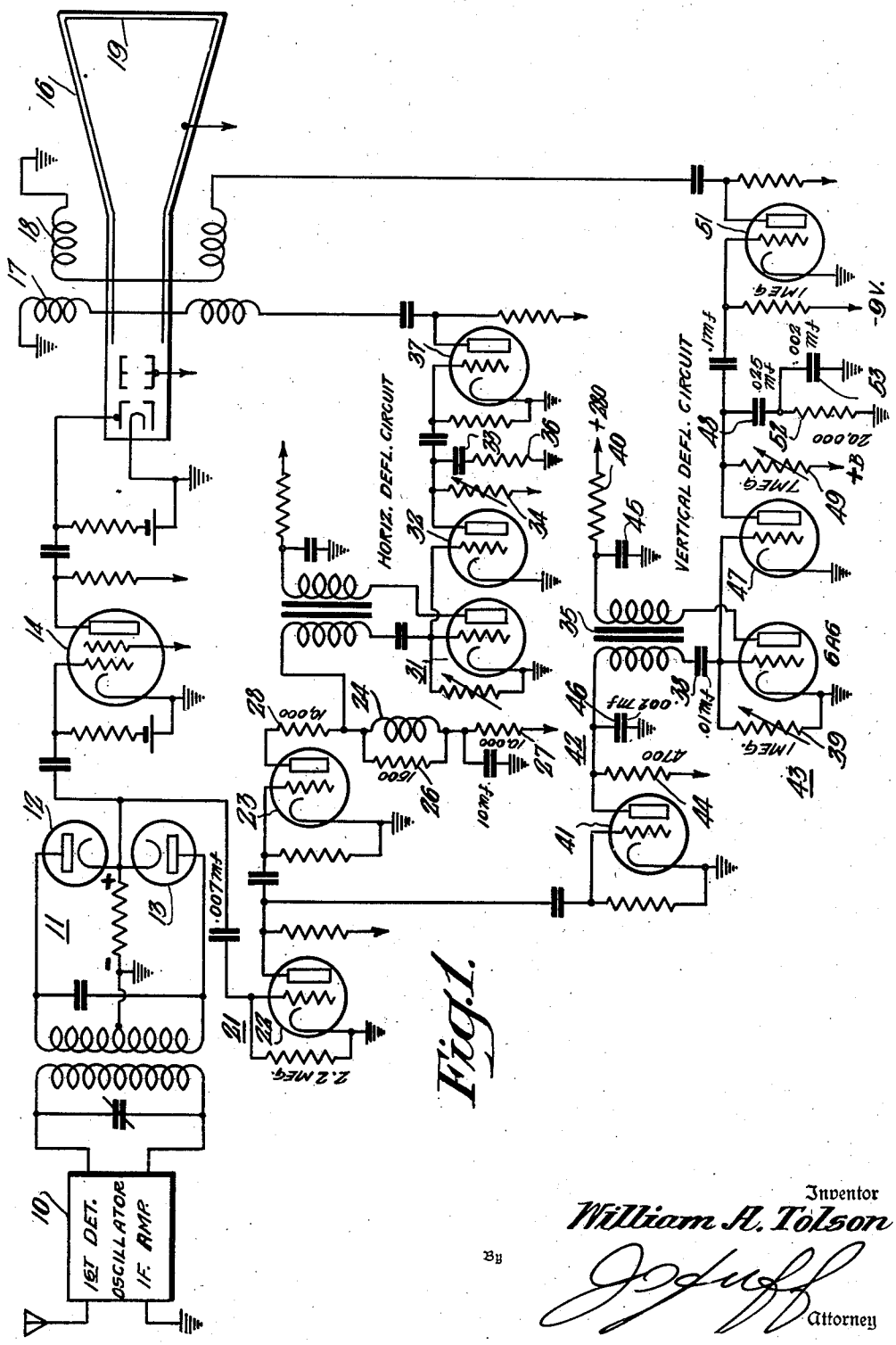


Fig. 1.

Inventor
William A. Tolson

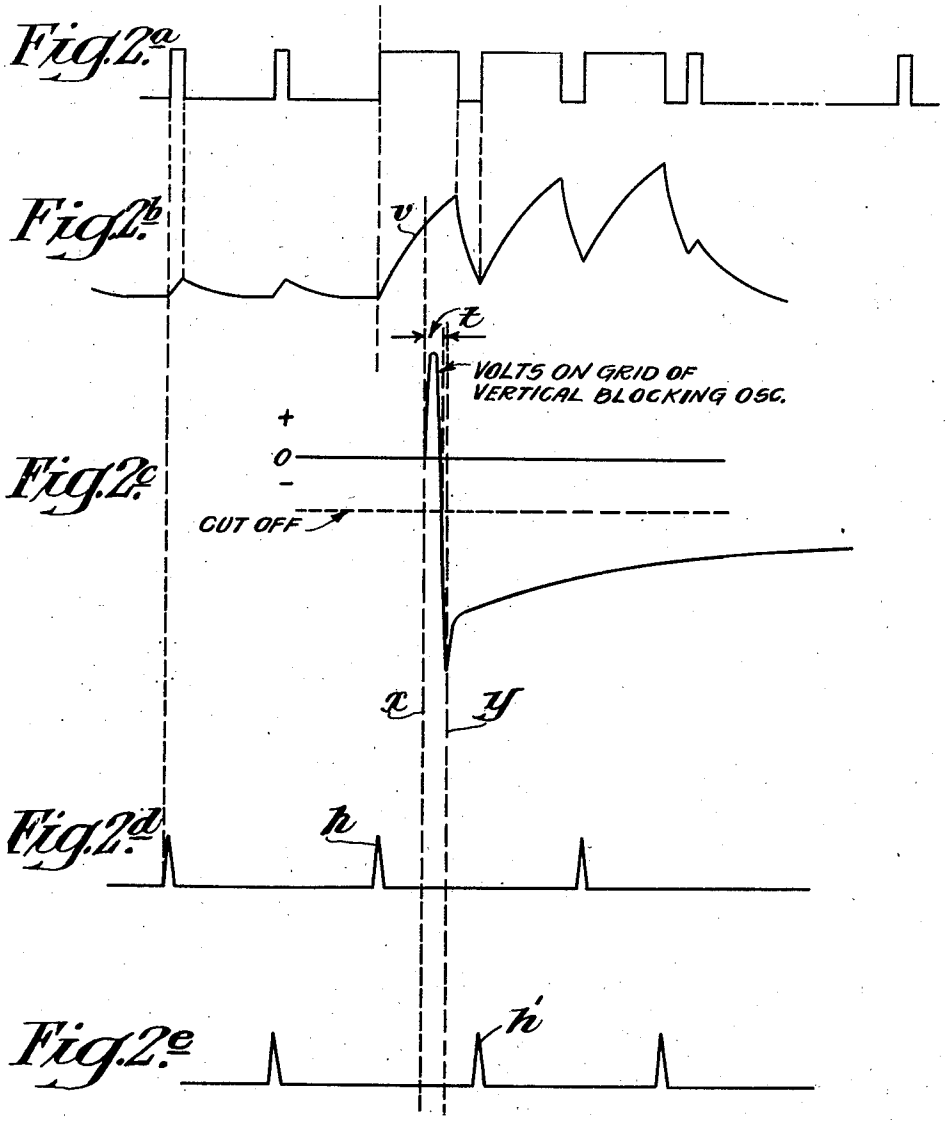
By

Attorney

Oct. 20, 1942. W. A. TOLSON 2,299,361

TELEVISION SYSTEM

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Inventor

William A. Tolson

By

Attorney

Oct. 20, 1942. W. A. TOLSON 2,299,361

TELEVISION SYSTEM

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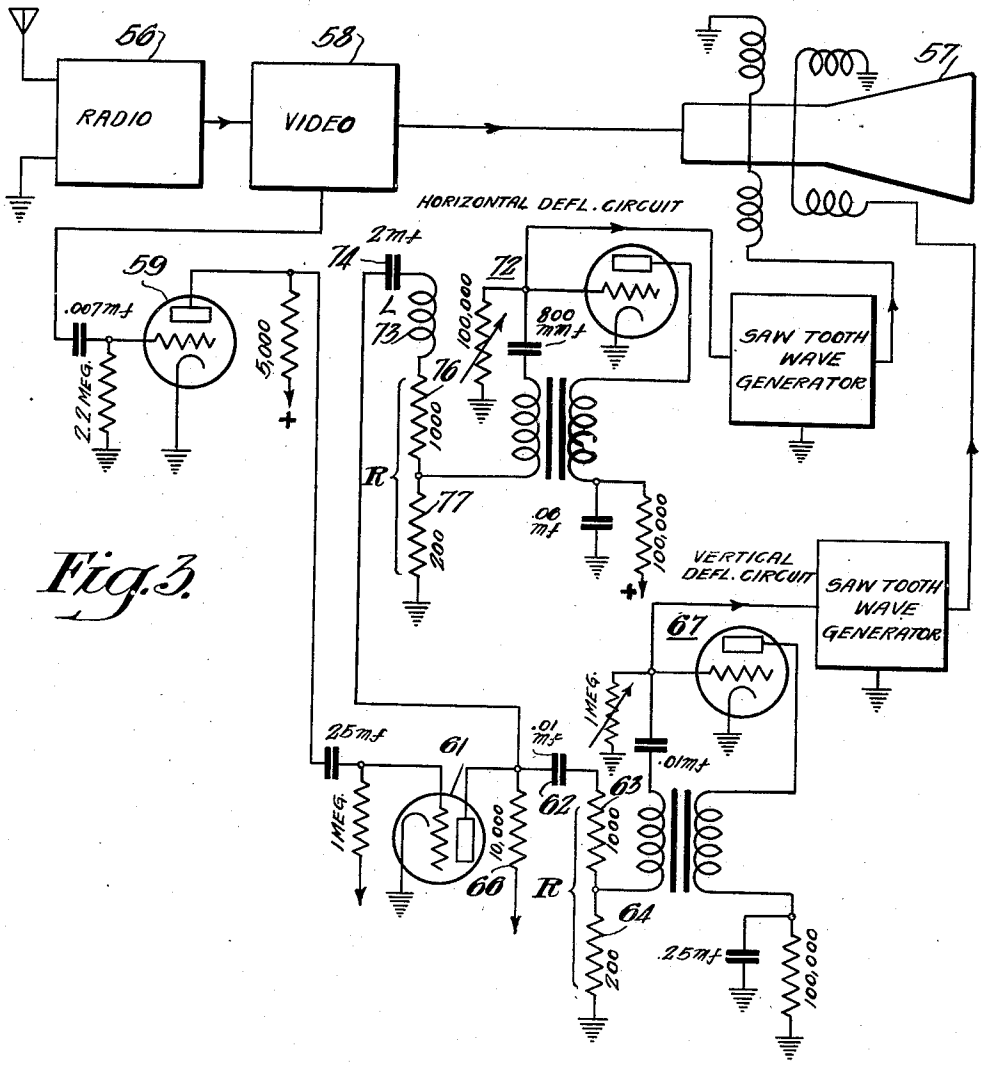


Fig. 3.

Inventor
William A. Tolson

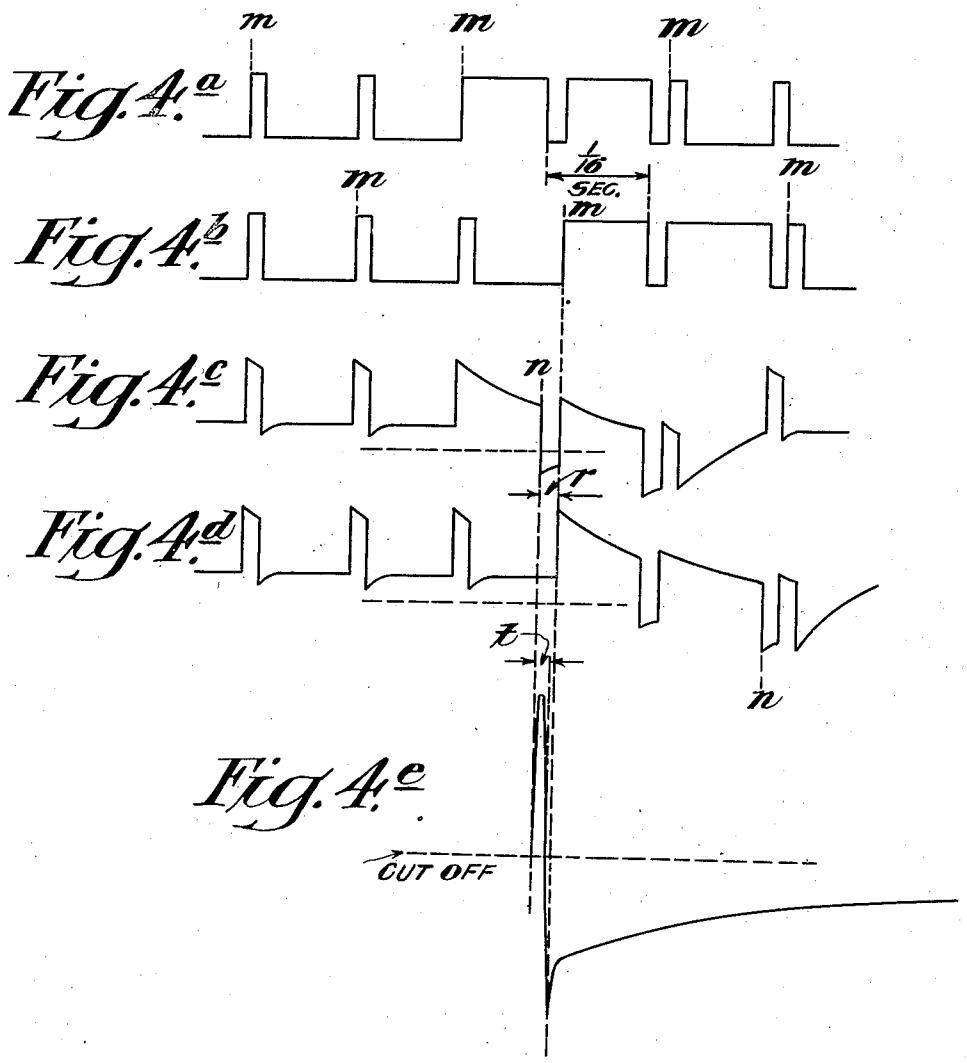
By

Attorney

Oct. 20, 1942. W. A. TOLSON 2,299,361

TELEVISION SYSTEM

Filed Dec. 29, 1939 4 Sheets-Sheet 4



Inventor

William A. Tolson

By

Attorney

Patented Oct. 20, 1942

2,299,361

UNITED STATES PATENT OFFICE

2,299,361

TELEVISION SYSTEM

William A. Tolson, Westmont, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application December 29, 1939, Serial No. 311,653

11 Claims. (Cl. 178—7.5)

My invention relates to cathode ray tube apparatus and particularly to television receivers of the type in which horizontal and vertical deflecting circuits are employed for causing a cathode ray to scan a fluorescent screen or the like.

In television receivers the cathode ray is caused to scan the screen in synchronism with the scanning at the transmitter by transmitting horizontal and vertical synchronizing pulses along with the picture signals. In the type of television system which is preferred at the present time, the synchronizing pulses are so transmitted that the scanning is interlaced by the so-called odd-line method. This method of interlacing is described in Ballard Patent 2,152,234, issued March 28, 1939, and assigned to the Radio Corporation of America.

It has been found that one of the major causes of improper interlacing is "cross talk" from the horizontal deflecting circuit into the vertical deflecting circuit. Specifically, if pulses from the horizontal deflecting circuit appear in the vertical deflecting circuit with sufficient amplitude or energy content, they will directly affect the operation of the oscillator ordinarily employed in the vertical deflecting circuit. However, these pulses from the horizontal deflecting circuit can affect the vertical deflecting circuit oscillator in this way only during its period of susceptibility. By "period of susceptibility" is meant that time during which the oscillator is drawing plate current. This is the period during which any voltage applied to the oscillator input circuit will appear directly in its output circuit.

Cross-talk between deflecting circuits may disturb the interlacing in another way in television receivers of the type wherein frequency separation of the horizontal and vertical synchronizing pulses is utilized. In such receivers the frequency separation means generally includes an integration circuit through which the vertical synchronizing pulses are fed to the vertical deflecting circuit. Such an integration circuit may carry over into the period of susceptibility the effect of some of the horizontal synchronizing pulses preceding this period. This undesirable effect usually is not serious in properly designed systems and it may be avoided entirely in certain types of systems, for example, in systems employing amplitude separation of horizontal and vertical synchronizing pulses, in systems utilizing different steepness of wave fronts of synchronizing pulses, such as that decribed in application Serial No. 180,493, filed December 18, 1937, in the name of Alda V. Bedford and assigned to the Radio Corporation of America, or in systems including the type of receiver described hereinafter in which the vertical deflecting circuit is caused to synchronize on the back edge of a vertical synchronizing pulse.

It is an object of my invention to reduce the effect of cross-talk between horizontal and vertical deflecting circuits in cathode ray tube apparatus on the vertical deflection of the cathode ray.

A further object of my invention is to provide an improved television receiver.

A still further object of my invention is to provide in a television receiver means for and a method of improving the interlacing of a reproduced picture.

In accordance with my invention I reduce the duration of the period of susceptibility of the vertical deflecting circuit oscillator to a time which is so short that a horizontal synchronizing pulse or a pulse from the horizontal deflecting circuit will not appear during this period. Therefore, the first mentioned cause of poor interlacing due to cross-talk is eliminated.

This is advantageous even though some synchronizing pulses are fed into the vertical deflecting circuit through an integrating circuit. However, if, when practicing my invention, the use of an integrating circuit is avoided, there will be no disturbance of the interlacing even though no particular care has been taken to keep the horizontal synchronizing or deflecting circuit pulses out of the vertical deflecting circuit.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

Figure 1 is a circuit diagram of a television receiver embodying my invention,

Figures 2*a*, 2*b*, 2*c*, 2*d* and 2*e* are curves which are referred to in explaining the invention,

Figure 3 is a circuit diagram of another embodiment of my invention, and

Figures 4*a*, 4*b*, 4*c*, 4*d* and 4*e* are curves which are referred to in explaining the operation of the circuit of Fig. 3.

Referring to Fig. 1, the invention is shown applied to a television receiver of the type designed, in the example illustrated, to receive television signals transmitted in accordance with the present R. M. A. standards in the United States. This signal includes horizontal synchronizing pulses which occur at the end of each scanning line and at the rate of 13,230 per

second, and framing pulses which occur at the end of each picture frame and at the rate of 60 per second, this being referred to as the field frequency. The framing pulses are of the same amplitude as the horizontal synchronizing pulses but they are of longer duration (and slotted) whereby the two groups of synchronizing pulses may be separated from each other by means of frequency discriminating circuits. The received signal has the odd line relation between the horizontal and vertical synchronizing pulses as taught by the above mentioned Ballard patent in order to produce interlaced scanning. Each slotted vertical synchronizing pulse is preceded and followed by several pulses occurring at double the line frequency.

The receiver may comprise the usual elements of a superheterodyne receiver, as indicated by the block **10**, and the usual push-pull second detector **11** including the diodes **12** and **13**. The second detector supplies the picture signal and synchronizing pulses through a video amplifier **14** to a cathode ray tube **16** of conventional construction. In the example illustrated, horizontal deflecting coils **17** and vertical deflecting coils **18** are provided for causing the cathode ray to scan the fluorescent screen **19** at the end of the tube.

Signal is also fed from the output of the second detector **11** to a suitable separating circuit **21** which may comprise a grid leak biased tube **22** for passing the synchronizing pulses to the exclusion of the picture signal.

The synchronizing pulses may be amplified by an amplifier **23** and impressed through a frequency discriminating circuit upon the horizontal deflecting circuit, this deflecting circuit producing a flow of saw-tooth current through the deflecting coils **17**. In the particular example illustrated, the frequency discriminating circuit comprises an inductance coil **24** shunted by a resistor **26** and connected in the plate circuit in series with a filter resistor **27** and a resistor **28** adjacent to the plate of the amplifier tube **23**. Since only the steep front edges of the horizontal synchronizing pulses and of the pulses comprising the slotted vertical synchronizing signal (shown in Fig. 2*a*) produce a voltage of any substantial amplitude across the inductance coil **24**, there is substantially no vertical synchronizing pulse applied to the horizontal deflecting circuit.

The horizontal deflecting circuit may be of conventional design comprising a suitable oscillator **31** such as a blocking oscillator of the type described in Tolson and Duncan Patent 2,101,520, issued December 7, 1937, and assigned to the Radio Corporation of America.

The blocking oscillator **31** produces a sharp voltage pulse of large amplitude in response to the occurrence of each horizontal synchronizing pulse (but in response to alternate pulses only where they occur at double the line frequency), and this blocking oscillator pulse is impressed upon the grid of a discharge tube **32** to discharge a condenser **33** across which a saw-tooth voltage wave is produced. It will be understood that the condenser **33** is charged through the plate resistor **34** of the discharge tube at a comparatively slow rate in the usual manner to produce the desired saw-tooth. The usual peaking resistor **36** is connected in series with the condenser **33** whereby a combined saw-tooth wave and impulse wave is impressed upon the grid of the output tube **37**. As is well known in the art, such an impulse component is desirable for the production of a good saw-tooth current wave through deflecting coils where the output tube is of the low impedance type.

In order to synchronize the vertical deflecting circuit in this embodiment of the invention, synchronizing pulses are also fed from the output circuit of the separating tube **22** through an amplifier **41** and through an integrating circuit **42** to a suitable oscillator **43** in the vertical deflecting circuit, this oscillator being of the above-mentioned blocking oscillator type in the example illustrated. The integrating circuit may comprise the plate resistor **44** of the tube **41** and a shunt condenser **46** whereby there appears across the condenser **46** a voltage wave of the character indicated in Fig. 2*b*. As is well understood in the art, when the synchronizing voltage, as represented by the curve of Fig. 2*b*, reaches a certain predetermined amplitude it "triggers off" the oscillator whereby it goes through its cycle of operation to produce a voltage on its grid having the wave shape shown in Fig. 2*c*.

During this cycle of operating the blocking oscillator tube draws plate current for the time *t*. This is the period of susceptibility previously referred to.

The blocking oscillator **43** includes the usual feed-back transformer **35**, grid condenser **38** and grid leak resistor **39**. By adjusting the resistor **39** the oscillator is made to trigger off at the proper point on the front slope of the vertical synchronizing pulse *v* as indicated in Figs. 2*b* and 2*c*.

Voltage may be applied to the plate of the oscillator tube through the usual filter resistor **40**, there being the usual filter condenser **45**.

The positive voltage pulse produced during the time *t* is impressed upon a discharge tube **47** to quickly discharge a condenser **48** which has been gradually charged in the usual manner through the plate resistor **49** of the discharge tube. Since this circuit, like the horizontal deflecting circuit, includes a low impedance output tube **51** for supplying saw-tooth current to the deflecting coils **18**, there is included a peaking resistor **52** in series with the saw-tooth condenser.

A condenser **53** is connected across the peaking resistor **52** in order to increase the length of time that the output tube is held at plate current cut off. This has been found necessary or at least desirable because of the extremely short duration of the period *t* when practicing my invention.

By referring to the curve shown in Figs. 2*a* to 2*e*, it will be seen that the period *t* of the blocking oscillator, that is, its period of susceptibility, has been made so short that if the blocking oscillator is adjusted to trigger off at the time indicated by the dotted line *x* immediately following a horizontal pulse in the horizontal deflecting circuit (pulse *h* in Fig. 2*d*, for example), the period will be terminated as indicated by the dotted line *y* before the occurrence of the next horizontal pulse (odd-line pulse *h'* in Fig. 2*e*, for example). Therefore, no horizontal pulse will occur during the period of susceptibility and the horizontal pulses may be permitted to feed into the vertical deflecting circuit with substantial amplitude without disturbing the interlacing.

The period *t* when given the duration above specified is much shorter than previously employed in vertical deflecting circuits. It will be understood that the oscillator **43** is self-oscillatory, that is, it oscillates at a certain "free run-

ning" frequency when synchronizing pulses are not being applied to it. This "free running" frequency is slightly lower than the frequency of occurrence of the horizontal synchronizing or line frequency pulses.

In order that the period t be short, the transformer of the oscillator is made with low impedance windings having small distributed capacity each winding having only two or three ohms resistance, for example. Such a transformer is similar to the blocking oscillator transformer used in the horizontal deflecting circuit and may have a natural period of the order of 150 kilocycles.

When practicing my invention it is preferable to give the integration circuit a shorter time constant than commonly employed whereby the front or leading edge of the vertical synchronizing pulse is comparatively steep as shown at v in Fig. 2*b*. In this way any variation in the time t at which the oscillator is triggered off is held to a minimum. It will be noted that the second and third triangular portions of the integrated vertical synchronizing signal are ineffective in the receiver and occur only because the standard television signal with long slotted vertical pulses is being received.

It will be understood that Figs. 2*d* and 2*e* represent primarily the timing of those pulses or voltage "kicks" occurring in the horizontal deflecting circuit which feed into the vertical deflecting circuit through wiring capacity, stray magnetic fields, etc., to give the cross-talk difficulties above-described, and that no attempt has been made to indicate accurately either the amplitude or the wave shape. The pulses in Fig. 2*d* are the "even line" pulses corresponding to the synchronizing pulses shown in Fig. 2*a* while the pulses in Fig. 2*e* are the "odd line" pulses, the corresponding snychronizing pulses not being shown.

Referring to Fig. 3, there is shown an embodiment of my invention in which the vertical deflecting circuit is synchronized on the back side of the first portion of the slotted vertical synchronizing pulse. This embodiment comprises a television receiver which may comprise the usual radio receiver **56** which supplies the demodulated picture and synchronizing signal to a cathode ray tube **57** through a video amplifier **58**.

It is assumed that the receiver is for the reception of the standard signal previously described. The horizontal and vertical synchronizing signals as they appear at successive one-sixtieth second intervals are shown in Figs. 4*a* and 4*b*, respectively, the picture signal not being indicated.

A portion of the amplified received signal is suplied to a grid leak biased separating tube **59** which supplies the synchronizing pulses only to an amplifier tube **61**. The amplified pulses are then passed through a condenser **62** and resistors **63** and **64** in series whereby, as a result of condenser **62** charging rapidly through tube **61** but discharging slowly through the plate resistor **66**, there appears across the resistor **64** the voltage waves shown in Figs. 4*c* and 4*d*. These voltage waves are, of course, produced by the synchronizing pulses shown in Figs. 4*a* and 4*b*, respectively.

The voltage appearing across the resistor **64** is applied to the oscillator **67** which, in the example illustrated, is of the blocking oscillator type and a duplicate of the oscillator **43** of Fig. 1. The voltage appearing on the grid of this oscillator, when it is triggered off by the voltage wave of Fig. 4*c*, is shown in Fig. 4*e*. In accordance with my invention, the period of susceptibility t is made less than the time r where r is the time between the instant the vertical oscillator is triggered off by the back edge of a pulse and the instant the horizontal oscillator is triggered off by the front edge of the next succeeding pulse. Thus, in this embodiment of the invention, as in the first one, the horizontal deflecting circuit pulses do not occur during the period of susceptibility of the oscillator.

It should be understood that the invention applies where oscillators other than those of the blocking type are utilized. For example, a dynatron oscillator or multivibrator may be substituted for the blocking oscillator, although the blocking oscillator is preferred.

The remaining portion of the vertical deflecting circuit is indicated by the block **71** and may be the same as the corresponding portion of the circuit shown in Fig. 1.

The horizontal deflecting circuit which includes the blocking oscillator **72** may be the same as that shown in Fig. 1. In the example illustrated, no attempt is made to prevent the vertical synchronizing pulses from being applied to the horizontal deflecting circuit.

As a refinement of the invention, the synchronizing pulses may be passed through an inductance coil **73** to accentuate the low frequency components of the synchronizing signals by the same amount they are attenuated as a result of the network **62—63—64** being across the plate circuit of the amplifier **61**. The coil **63** is in series with a blocking condenser **74** and the resistors **76** and **77**.

In order that the frequency response of the circuit be flat at the input circuit of the oscillator **72**, the circuit constants may be given the following relation for a frequency of 16,000 cycles:

$X_L=X_c=R$ at a certain frequency such as 16,000 cycles per second, where X_L is the reactance of coil **73**, X_c is the reactance of condenser **62**, and R is the resistance of resistors **76** and **77** in series and of **63** and **64** in series. The frequency of 16,000 per second is taken as the frequency at which X_L and X_c should be equal because of the following considerations: It is assumed that the condenser **62** and associated discharge circuit should have the proper values to make the condenser **62** lose approximately 60 percent of its charge in the time required for the cathode ray to traverse one scanning line. This time is less than $1/13230$ of a second (because about 20 percent of the time is used for blanking) and may be assumed to be about $1/16000$ of a second.

Merely by way of example, I have indicated the values of various circuit elements, these values being in ohms, megohms, microfarads, micro-microfarads and henrys.

I claim as my invention:

1. A television receiver for the reception of picture signals, horizontal synchronizing pulses occuring at the end of each scanning line, and vertical synchronizing pulses occurring at the end of each picture frame, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including only one oscillator, the said oscillator having a period of susceptibility which is shorter than the time between successive horizontal synchronizing pulses whereby cross-talk from the

horizontal deflecting circuit to the vertical deflecting circuit is minimized.

2. A television receiver for the reception of picture signals, horizontal synchronizing pulses occurring at the end of each scanning line, and vertical synchronizing pulses occurring at the end of each picture frame, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including only one oscillator, the said oscillator being adjusted to be self-oscillatory or free running in the absence of synchronizing pulses and having a period of susceptibility which is shorter than the time between successive horizontal synchronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

3. A television receiver for the reception of picture signals, horizontal synchronizing pulses occurring at the end of each scanning line, and vertical synchronizing pulses occurring at the end of each picture frame, said receiver comprising horizontal and vertical cathode ray deflecting circuits, each deflecting circuit including an oscillator, the oscillator in said vertical deflecting circuit being adjusted to be self-oscillatory or free running in the absence of synchronizing pulses and having a period of susceptibility which is shorter than the time between the instant the vertical deflecting oscillator is triggered off and the next succeeding time the horizontal deflecting oscillator is triggered off whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

4. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses and which has a period of susceptibility which is shorter than the time between successive horizontal synchronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

5. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses and which has a period of susceptibility which is shorter than the duration of a horizontal synchronizing pulse whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

6. A television receiver for the reception of a composite signal comprising picture signals, a horizontal synchronizing pulse occurring at the end of each scanning line and a slotted vertical synchronizing pulse occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses and which has a period of susceptibility which is shorter than the duration of a slot in said vertical synchronizing pulse whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

7. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said receiver comprising horizontal and vertical cathode ray deflecting circuits, each deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses, the vertical deflecting oscillator having a period of susceptibility which is shorter than the time between the instant the vertical deflecting oscillator is triggered off and the next succeeding time the horizontal deflecting oscillator is trigged off whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

8. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including a condenser across which a saw-tooth voltage is to appear, means for charging said condenser comparatively slowly, and means for discharging said condenser comparatively rapidly, said last means comprising an oscillator including a vacuum tube, said oscillator being so adjusted that said tube draws plate current for a period which is shorter than the period between successive horizontal syncronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

9. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said vertical pulses being slotted and of greater duration than said horizontal pulses, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses and which has a period of susceptibility which is shorter than the time between successive horizontal synchronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized, and means comprising an integrating circuit for impressing the vertical synchronizing pulses on said oscillator substantially to the exclusion of said horizontal synchronizing pulses, the charging and discharging time constants of said integrating circuit being such that the voltage thereacross rises to a comparatively large value before the occurrence of the first slot in said vertical

pulse and drops to a comparatively low value during the occurrence of said first slot.

10. A television receiver for the reception of a composite signal comprising picture signals, horizontal synchronizing pulses occurring at the end of each scanning line and vertical synchronizing pulses occurring at the end of each picture frame, said horizontal and vertical pulses occurring in odd-line relation to produce interlaced scanning, said vertical pulses being slotted and of greater duration than said horizontal pulses, said receiver comprising horizontal and vertical cathode ray deflecting circuits, said vertical deflecting circuit including an oscillator which is free running in the absence of synchronizing pulses and which has a period of susceptibility which is shorter than the time between successive horizontal synchronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized, and means for causing said oscillator to synchronize on the back edge of the first portion of the slotted vertical synchronizing pulse.

11. The method of producing an interlaced picture in a television receiver of the type including a horizontal deflecting circuit and including a vertical deflecting circuit having an oscillator therein which is free running in the absence of synchronizing pulses which method comprises receiving a signal having horizontal and vertical synchronizing pulses occurring in odd-line relation, and operating said oscillator with a period of susceptibility which is less than the period between successive horizontal synchronizing pulses whereby cross-talk from the horizontal deflecting circuit to the vertical deflecting circuit is minimized.

WILLIAM A. TOLSON.