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RECTIFIER SYSTEM FOR CARRIER-SIGNAL RECEIVERS

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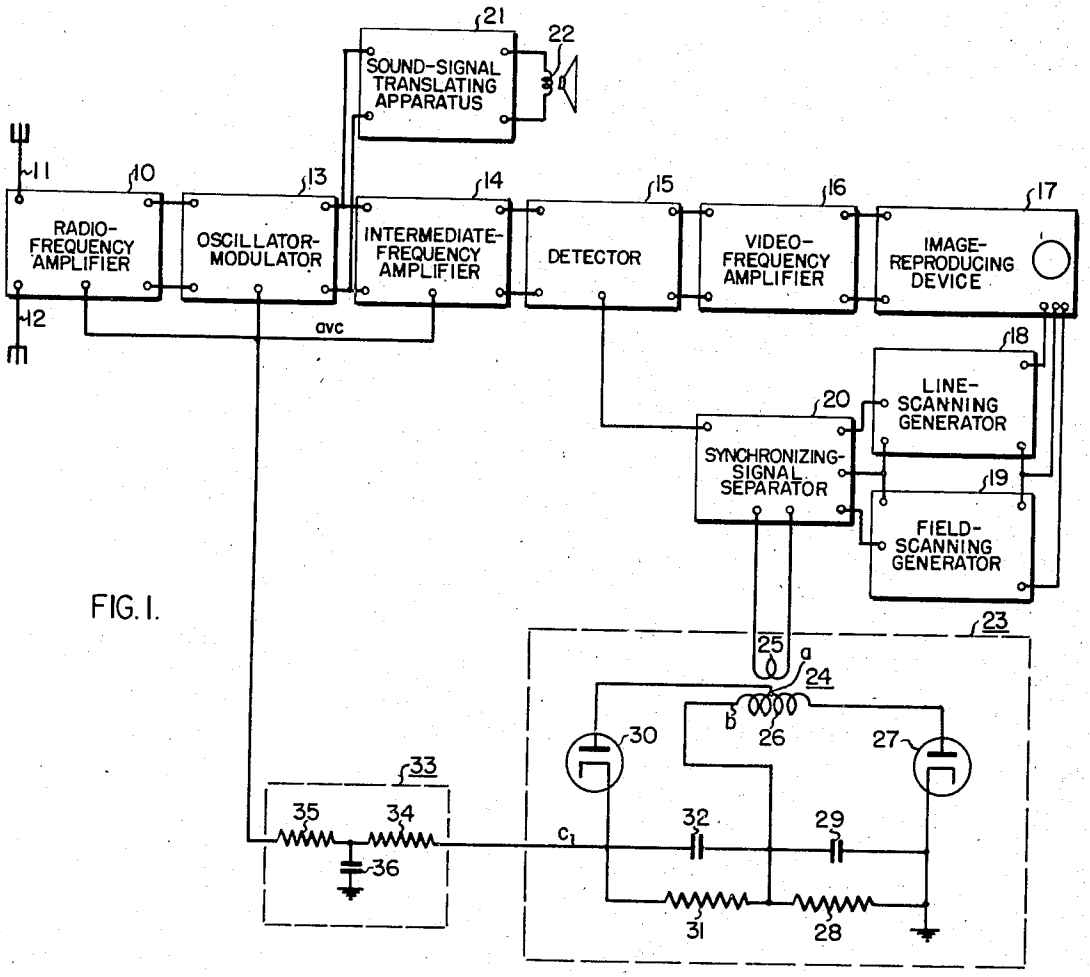


FIG. 1.

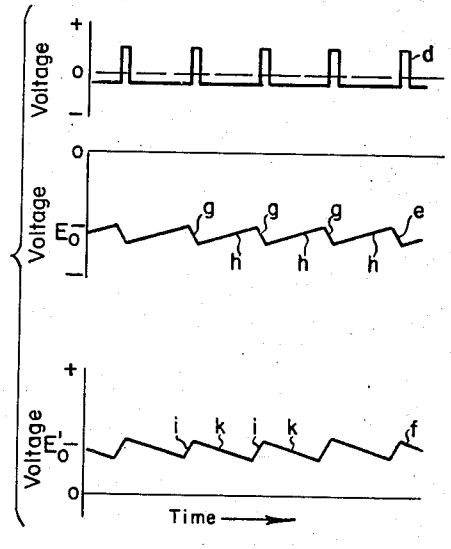


FIG. 2.

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RECTIFIER SYSTEM FOR CARRIER-SIGNAL RECEIVERS

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9 Claims. (Cl. 178—5.8)

This invention relates to rectifier systems of the type wherein periodic potentials are converted to unidirectional potentials, and particularly to such systems of this general type which include arrangements for reducing the ripple voltage components which frequently appear in the developed unidirectional potential. While the invention is of general application, it has particular utility in the automatic amplification control system of television receivers in which synchronizing-signal components of a television signal are rectified to develop a unidirectional automatic amplification control bias. The invention, therefore, will be described in connection with a television receiver wherein the invention is used to aid in attaining exceptionally fast-acting automatic amplification control.

Automatic amplification control is commonly accomplished in television receivers by peak rectification of the synchronizing components of a received signal and by the utilization of the rectified signal to control the amplification of the signal-translating channel of the receiver inversely in accordance with the strength of the received signal. In those receivers adapted to receive a carrier wave negatively-modulated with video-frequency components and line-synchronizing and field-synchronizing components of standard wave form now in use, it is necessary that the peak-rectifier circuit have a time constant which is long with respect to the period of the field-synchronizing components in order to provide a relatively steady automatic amplification control bias which, when used to control the amplification of the signal-translating channel of the receiver, does not produce undesirable shading effects in the reproduced picture or undesirable irregularities at the field-scanning frequency in the operation of the automatic amplification control system. It is, therefore, customary to provide in such automatic amplification control systems time constants of the order of many times the period of the relatively low-frequency field-synchronizing components and this period, for the standard television signal now in use, is 1/60 of a second so that a time constant of the order of one second is commonly used. Television receivers provided with automatic amplification control systems having such time constants have the characteristic that the automatic amplification control system responds slowly to changes in the peak amplitude of the received signal.

While, in general, automatic amplification control systems having long time constants of this nature operate satisfactorily in those installations which are relatively free from disturbing noise, their operation is greatly impaired in those installations subject to high noise levels. Received noise effectively increases the amplitude of the received signal to a value which may be several times its normal unmodulated value, and is thus effective to reduce the amplification of the receiver to a relatively small value, the amplification being restored to normal only after an appreciable period of time dependent upon the time constant of the peak-rectifier circuit. Repeated noise components separated by a time less than the time constant of the peak-rectifier circuit may thus effectively completely paralyze the receiver by the action of the automatic amplification control system, while sporadic noise components may cause either a complete or partial paralysis for an objectionable period of time.

It is an object of the invention, therefore, to provide a television signal receiver comprising an improved automatic amplification control rectifier system which avoids one or more of the above-mentioned disadvantages of such receivers of the prior art.

It is a further object of the invention to provide a television signal receiver comprising an automatic amplification control rectifier system which possesses extreme sensitivity and great rapidity of control action and which, therefore, materially reduces the effect of noise disturbances on the operation of the receiver.

It is an additional object of the invention to provide a television signal receiver having an automatic amplification control rectifier system which not only responds rapidly to control the amplification of the signal channel of the receiver but, in addition, has little or no tendency during operation to produce shading effects or other irregularities in the reproduced image due to the presence of field-synchronizing or line-synchronizing components.

In accordance with a feature of the invention, a rectifier system in a carrier-signal receiver comprises an input circuit adapted to have ap-

plied thereto periodic potentials to be rectified, an output circuit having circuit elements including a pair of energy-storage devices, and a pair of rectifying means individually coupling the input circuit to the devices to develop two pulsating unidirectional potentials. The devices and the circuit elements associated therewith are so proportioned that the ratio of the amplitudes of the unidirectional potentials is independent of amplitude variations of the periodic potentials and the unidirectional potentials are unequal in the output circuit while the undesired pulsation components of the unidirectional potentials are of the same order of magnitude in the output circuit. Means are included in the output circuit for combining the unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of the undesired potential pulsation components.

Also in accordance with a feature of the invention, a television receiver adapted to receive a television signal having video-signal components and periodic synchronizing-signal components has included therein an automatic control rectifier system comprising an output circuit including a pair of time-constant circuits, and means responsive to the amplitude of the synchronizing-signal components for developing in each of the time-constant circuits a pulsating unidirectional potential. The circuit elements of the output circuit and the amplitude-responsive means are so proportioned that the ratio of the amplitudes of the developed potentials is independent of amplitude variations of the periodic components and the unidirectional potentials vary unequally and proportionally with the amplitude of the received signal and independently of its vision-signal components while the undesired potential pulsation components of the developed unidirectional potentials are of the same order of magnitude. The output circuit includes means for combining the developed unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of the undesired potential pulsation components.

In a preferred form of the invention, there is provided a pair of rectifying systems each having a time-constant load circuit, the time constant of one of the load circuits being greater than that of the other, and the magnitude of the synchronizing-signal components applied to that one of the rectifying systems which has the greater time-constant load circuit is larger than that applied to the other of the rectifying systems.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a circuit diagram, partly schematic, of a complete television receiving apparatus embodying the invention; and Fig. 2 is a graph illustrating the wave forms of periodic voltage waves developed at different points in the system of Fig. 1 and is used as an aid in explaining the operation of the invention.

Referring now more particularly to Fig. 1 of the drawing, there is represented schematically a complete television signal receiver of a conventional design embodying the present invention in a preferred form. In general, the receiver includes a tunable radio-frequency amplifier 10 having its input circuit connected to an antenna system 11, 12, and having its output circuit connected to a tunable oscillator-modulator 13. Connected in cascade with the oscillator-modulator 13, in the order named, are an intermediate-frequency amplifier 14 of one or more stages, a detector 15, a video-frequency amplifier 16, and an image-reproducing device 17, preferably of the cathode-ray tube type. A line-scanning generator 18 and a field-scanning generator 19 are also coupled to the output of detector 15 by way of suitable synchronizing-signal separating apparatus 20, the output of the scanning generators 18 and 19 being coupled to the respective line-scanning and field-scanning elements of the image-reproducing device 17. Connected also to the output of the oscillator-modulator 13 is a sound-signal translating apparatus 21 which may include, in the order named, a sound-signal intermediate-frequency amplifier, a detector, an audio-frequency amplifier, and a sound reproducer 22.

The stages or units 10–22, inclusive, may all be of conventional well-known construction so that detailed illustrations and descriptions thereof are unnecessary herein. Referring briefly, however, to the operation of the system described above, television signals and their accompanying sound signals are intercepted by the antenna system 11, 12 and are selected and amplified in radio-frequency amplifier 10 and applied to the oscillator-modulator 13, wherein they are converted to intermediate-frequency vision signals and intermediate-frequency sound signals.

The intermediate-frequency sound signals are applied to the sound-signal translating apparatus 21, wherein they are amplified, detected, amplified at audio frequency, and applied to the sound-reproducing device 22 for reproduction.

The intermediate-frequency vision signals are applied to the intermediate-frequency amplifier 14 for further amplification and are thereafter applied to the detector 15 to derive the video-frequency modulation components of the vision signal. The modulation components are amplified by the video-frequency amplifier 16 and are applied in the usual manner to a brightness-control electrode of the image-reproducing device 17. The intensity of the electron beam of tube 17 is thus modulated or controlled in accordance with the video-frequency voltages impressed on its control electrode in the usual manner.

The modulation components of the vision signal are also applied to the synchronizing-signal separating apparatus 20 wherein the synchronizing components are separated from the vision-signal components and the line-synchronizing components and field-synchronizing components are separated from each other and applied, respectively, to the line-scanning generator 18 and field-scanning generator 19. Saw-tooth current or voltage scanning waves are generated in the line-scanning and field-scanning generators 18 and 19, respectively, in synchronism with the synchronizing components applied to the generators and the scanning waves so generated are applied to the scanning elements of the cathode-ray tube 17 to produce electric scanning fields, thereby to deflect the electron beam of the tube in two directions normal to each other so as to trace a rectilinear scanning pattern on the screen of the tube to reconstruct the transmitted image.

Referring now more particularly to the portion of the system of Fig. 1 embodying the present

invention, for the purpose of developing a control-bias voltage proportional to the amplitude of the received television signal and independent of its vision-signal components, there is provided an automatic amplification control rectifier system **23** preferably coupled to that output circuit of the synchronizing-signal separating apparatus **20** to which the line-scanning generator **18** is connected to derive only line-synchronizing components therefrom. The automatic amplification control system **23** comprises an input circuit adapted to have applied thereto periodic potentials to be rectified. The input circuit includes a transformer **24** having a primary winding **25** connected, as previously stated, to the output of the synchronizing-signal separating apparatus **20**, and having a secondary winding **26** across the terminals of which is connected a first rectifier system. This system comprises a diode rectifier **27** and an energy-storage device which may be a condenser **29**. A resistor **28** is connected in parallel with the condenser **29** to provide a discharge path for the latter. A portion *a*—*b* of the transformer secondary winding **26** also constitutes the coupling to a second rectifier system comprising a diode rectifier **30**, a resistor **31**, and an energy-storage device comprising a condenser **32**. The condensers **29** and **32** and their respective parallel connected resistors **28** and **31** form two time-constant load circuits **28**, **29** and **31**, **32** one for each of the described rectifying systems. The load circuits are effectively connected in series opposition, one terminal being grounded and the other being connected to the A. V. C. circuit of the receiver through a filter network **33**, comprising series-resistor arms **34**, **35** and an interposed shunt condenser arm **36**. The automatic amplification control or A. V. C. circuit is connected to the control grids of one or more of the tubes of the oscillator-modulator **13**, the radio-frequency amplifier **10**, and the intermediate-frequency amplifier **14**. The time constants of the time-constant circuits **28**, **29**, **31**, **32**, and the filter network **33** are preferably of the order of several periods of the line-synchronizing components, for example, five to twenty line periods.

In considering the operation of the portion of the television system constituting the present invention, it will be assumed that there is being received a television signal of the standard wave form now in general use, that is, a carrier wave negatively-modulated with vision-signal components and periodic line-synchronizing and field-synchronizing components of the amplitude range outside the amplitude range of the vision-signal components. The demodulation components of the received television signal are derived in the detector **15** and are applied to the synchronizing-signal separating apparatus **20**. Here, the periodic synchronizing-signal components are separated from the vision-signal components and the line-synchronizing components thereof are separated from the field-synchronizing components and are applied to the transformer **24** as periodic pulses having the wave form illustrated by the curve *d* of Fig. 2.

These periodic pulses appear in the secondary winding **26** of the transformer and are rectified by the diode rectifier **27** to develop across the time-constant circuit **28**, **29** a pulsating unidirectional potential represented by the curve *e* of Fig. 2, which is shown as having a negative polarity with respect to ground. Similarly, the potential pulses appearing in the portion *a*—*b* of the transformer secondary winding **26** are rectified by the diode rectifier **30** to develop in the time-constant circuit **31**, **32** a pulsating unidirectional potential represented by the curve *f* of Fig. 2, this potential having a positive polarity with respect to ground. If either of the developed potentials *e* or *f* of Fig. 2 were alone applied through the filter network **33** to the automatic amplification control or A. V. C. circuit of the receiver to control the amplification thereof, the pulsations of saw-tooth wave form occurring in these potentials would so change the instantaneous amplification that undesirable shading effects would occur in the reproduced image, thereby impairing the quality of the image. However, by combining these potentials with opposing polarity, the pulsations occurring in one of the unidirectional potentials opposes the pulsations occurring in the other and the differential unidirectional potential developed between the point *c* and ground is relatively free of undulations, if the time-constant circuits are properly proportioned in a manner presently to be considered, and varies in magnitude with the strength of the received signal and independently of its vision-signal components. This differential potential is applied through the filter network **33** to vary the amplification of the units **10**, **13**, and **14** inversely in accordance with the amplitude of the received signal and independently of its vision-signal components.

The time constants of the time-constant circuits **28**, **29**, **31**, **32**, and of the filter network **33** are less than the field-scanning period, being of the order of several line-scanning periods, so that the effect of received noise disturbances is at most only to reduce the amplification of the receiver during the occurrence of the noise disturbances and for a relatively short interval, for example, ten line-scanning periods, after the noise disturbances have passed.

The proper proportioning of the time-constant circuits **28**, **29** and **31**, **32** with relation to each other and to the potentials applied to the diode rectifiers **27** and **30** is important. Since the periodic line-synchronizing components have the rectangular wave form represented by the curve *d* of Fig. 2, and since the time constants of the time-constant circuits **28**, **29** and **31**, **32** are several line-scanning periods, the pulsations occurring in the unidirectional potentials developed in the time-constant circuits **28**, **29** and **31**, **32** have a saw-tooth wave form as represented by the curves *e* and *f* of Fig. 2. Each saw-tooth pulsation of the curve *e* has relatively short exponential portions *g* with interposed relatively longer exponential portions *h*. Similarly, the saw-tooth pulsations of curve *f* have relatively short exponential portions *i* with interposed relatively longer exponential portions *k*. If the slopes of the exponential portions *g* and *h* of curve *e* are numerically equal but of opposite senses to the respective slopes of the exponential portions *i* and *k* of curve *f*, the pulsations exactly oppose when the developed potentials of the time-constant circuits **28**, **29** and **31**, **32** are combined with opposing polarities, the unidirectional differential potential appearing between point *c* and ground being, therefore, substantially free of any pulsation.

The magnitudes of the ripple components of the developed voltages *e* and *f* of Fig. 2 are approximately proportional to the voltages applied to the two rectifying systems and inversely proportional to the time constants of the respective rectifier

systems. It can be shown mathematically that the ripple components have equal amplitudes and equal slopes and therefore exactly oppose each other when developed with slopes of opposite senses and differentially combined, when a relation approximately as follows exists between the voltages and the circuit constants of the system 23:

$$E_1/C_1R_1=E_2/C_2R_2 \quad (1)$$

where,

E=the amplitude of the applied periodic potential;

C=the capacitance of the time constant circuit; and

R=the resistance of the time-constant circuit, and the subscripts 1 and 2 refer to the time-constant circuits 28, 29 and 31, 32, respectively.

It is evident from Equation 1 that the time constants of the rectifier circuit elements should bear the same ratio to each other as the ratio of the voltages applied to their respective rectifiers in order that the ripple voltage components of the rectified voltages shall be equal. In this connection, it may be pointed out that this type of ripple compensation is approximately independent of the frequencies of the ripple voltage components of the rectified voltages, this fact making it possible to compensate ripple voltages of sawtooth wave form which have a large number of frequency components.

In practice, the transformer secondary winding 26 may be center tapped so that the periodic voltage applied to the diode rectifier 27 is twice that applied to the diode rectifier 30. In this event, either the two condensers 29 and 32 may be equal or the two resistors 28 and 31 may be equal, as desired; in either case the time constant of the resistor 28 and condenser 29 being twice the time constant of the resistor 31 and condenser 32.

It will be apparent from the description above that the input circuit of the control system comprises means for applying the line synchronizing-signal-components to the rectifying systems wherein they are peak-rectified. The rectifiers 27, 30 and the input circuit thus comprise means responsive to the amplitude of the synchronizing-signal components for developing a pulsating unidirectional potential in each of the time-constant load circuits 28, 29 and 31, 32. The time-constant circuits are connected in series opposition to form means included in the output circuit of the automatic control rectifier system for combining the developed unidirectional potentials. The circuit elements of the output circuit and the amplitude-responsive means are so proportioned that the ratio of the amplitudes of the developed unidirectional potentials is independent of amplitude variations of the periodic synchronizing-signal components and the unidirectional potentials vary unequally and proportionally with the amplitude of the received signal but independently of its vision-signal components. Their proportioning is also such that the undesired potential pulsation components of the unidirectional potentials are of the same order of magnitude in the output circuit, whereby the derived differential unidirectional potential is substantially free of undesired potential pulsation components.

From the foregoing description of the invention and its operation, it will be evident that the important considerations are that the unidirectional potentials developed across the resistors 28 and 31 shall be unequal and that the time constants of the rectifier systems shall bear a predetermined relation to each other and to the amplitudes of the applied periodic potentials. When the circuit elements of the output circuit and the rectifying systems are proportioned in the manner outlined, the ratio of the amplitudes of the unidirectional potentials developed across the resistors 28 and 31 are independent of amplitude variations of the applied periodic potentials. Further, the unidirectional potentials vary unequally and proportionally with the amplitude of the television signal and independently of its vision-signal components, while the undesired periodic potential pulsations of the developed unidirectional potentials are of the same order of magnitude. The differential unidirectional potential is thus free of any undesirable pulsations of line-scanning or field-scanning frequency.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a carrier-signal receiver, a rectifier system comprising, an input circuit adapted to have applied thereto periodic potentials to be rectified, an output circuit having circuit elements including a pair of energy-storage devices, and a pair of rectifying means individually coupling said input circuit to said devices to develop two pulsating unidirectional potentials, said devices and the circuit elements associated therewith being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic potentials and said unidirectional potentials are unequal in said output circuit while the undesired pulsation components of said unidirectional potentials are of the same order of magnitude in said output circuit, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

2. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, an output circuit including a pair of time-constant circuits, and means responsive to the amplitude of said synchronizing-signal components for developing in each of said time-constant circuits a pulsating unidirectional potential, the circuit elements of said output circuit and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

3. In a television receiver adapted to receive a

television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, an output circuit including a pair of time-constant circuits, and means for rectifying said synchronizing-signal components to develop in each of said time-constant circuits a pulsating unidirectional potential, the circuit elements of said output circuit and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its video-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

4. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, a pair of rectifying systems each having a time-constant load circuit, means for applying said synchronizing-signal components to said rectifying systems to develop in each of said time-constant load circuits a pulsating unidirectional potential, the circuit elements of said rectifying systems and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for connecting said load circuits in series with opposite polarity so that said potential pulsation components are of opposite phase, whereby said unidirectional potentials are combined to derive in said output circuit a differential unidirectional potential substantially free of said undesired potential pulsation components.

5. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, a pair of rectifying systems each having a time-constant load circuit, the time constant of one of said load circuits being greater than that of the other, means for applying said synchronizing-signal components to said rectifying systems to develop in each of said time-constant load circuits a pulsating unidirectional potential, the magnitude of the synchronizing-signal components applied to the one of said rectifying systems having said one load circuit being larger than that applied to the other and the circuit elements of said time-constant load circuits and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, and an output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

6. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, an output circuit including a pair of time-constant circuits each having a time constant equal to several periods of said synchronizing-signal components, and means responsive to the amplitude of said synchronizing-signal components for developing in each of said time-constant circuits a pulsating unidirectional potential, the circuit elements of said output circuit and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

7. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components consisting of line-frequency and field-frequency synchronizing pulses, an automatic control rectifier system comprising, an output circuit including a pair of time-constant circuits each having a time constant greater than the line-frequency periods but less than the field-frequency periods of said synchronizing-signal components, and means responsive to the amplitude of said synchronizing-signal components for developing in each of said time-constant circuits a pulsating unidirectional potential, the circuit elements of said output circuit and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

8. In a television receiver adapted to receive a television signal including vision-signal components and periodic line-synchronizing-signal components, an automatic control rectifier system comprising, an output circuit including a pair of time-constant circuits, and means for peak-rectifying said line-synchronizing-signal components to develop in each of said time-constant circuits a pulsating unidirectional potential, the circuit elements of said output circuit and said means being so proportioned that the ratio of the amplitudes of said unidirectional potentials is independent of amplitude variations of said periodic components and said potentials vary

unequally and proportionally with the amplitude of said received signal and independently of its vision-signal components while the undesired potential pulsation components of said unidirectional potentials are of the same order of magnitude, said output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said undesired potential pulsation components.

9. In a television receiver adapted to receive a television signal including vision-signal components and periodic synchronizing-signal components, an automatic control rectifier system comprising, a pair of time-constant circuits, one of which comprises resistance R_1 and capacitance C_1 and the other of which comprises resistance R_2 and capacitance C_2, means responsive to a potential E_1 proportional to the amplitude of said synchronizing-signal components for developing in said one time-constant circuit a pulsating unidirectional potential, means responsive to a potential E_2 proportional to the amplitude of said synchronizing-signal components for developing in said other of said time-constant circuits a pulsating unidirectional potential, the ratio of the amplitudes of said potentials E_1 and E_2 being independent of amplitude variations of said components and the circuit elements of said time-constant circuits being proportioned in accordance with the expression

$$E_1/R_1C_1=E_2/R_2C_2$$

and an output circuit including means for combining said unidirectional potentials with opposite polarities to derive a differential unidirectional potential substantially free of said potential pulsation components.

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