

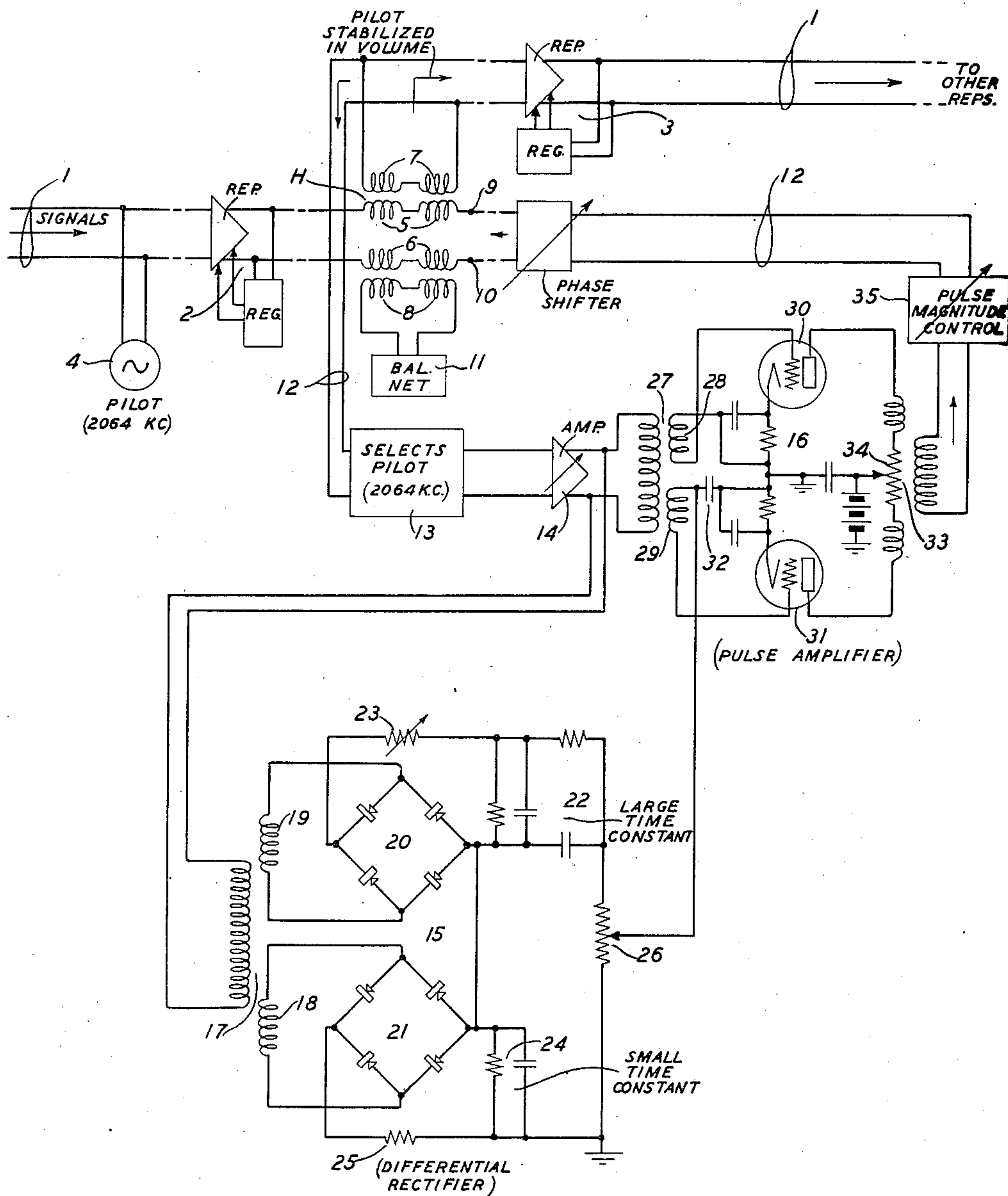
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WAVE STABILIZER

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WAVE STABILIZER

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The invention relates to electric wave stabilizers and particularly to a circuit arrangement for effectively removing transient volume variations from alternating control waves.

The invention is particularly applicable to, and will be described as applied to, automatic transmission regulating circuits such as are used in broad-frequency band repeatered carrier wave signaling systems to compensate for variations in line loss due to temperature changes or to counteract changes in the gain of the repeaters due to aging of vacuum tubes, battery variations, etc. In certain signaling systems of this type, this is accomplished by transmitting pilot waves of frequencies outside the signal frequency range and of initial constant volume over the system along with the signal waves, to control dynamic regulators associated with the signal repeaters so as to provide an adjustment of the repeater gain determined by the amplitude of the applied pilot waves. Such pilot waves in transmission over the system are subject to certain transient disturbances producing ripples in the waves tending to change the control effect on the dynamic regulators, and in a long system employing many such dynamically regulated repeaters in tandem, the operation of the regulators may cause the transient effect to build up in magnitude so as to produce a considerable transient swing in the pilot waves. This may result in intolerable violent fluctuations in the intensity level of the signals at the receiving end of the system.

An object of the invention is to stabilize the volume of alternating waves subject to transient disturbances.

Another object is to reduce the effects of transients on signal transmission in a long signaling system.

A more specific object is to prevent excessive transient effects on the operation of pilot-controlled regulators for automatically controlling repeater gain in long repeatered signal transmission systems.

These objects are attained in accordance with the invention by the use of special circuit arrangements for deriving from an alternating control or pilot wave transmitted over a transmission line, pulses proportional to the transient volume variations or ripple components in that wave, and for applying the derived pulses in proper phase and magnitude to the transmission line in such manner as to effectively neutralize or balance out the transient variations from the transmitted wave.

The various objects and features of the inven-

tion will be better understood from the following detailed description when read in conjunction with the accompanying drawing the single figure of which shows schematically the invention embodied in a long-distance repeatered signaling system employing pilot-controlled dynamic regulators for adjusting the gain of the repeaters.

In the drawing, the line designated 1 may be a transmission line in a broad frequency band multiplex carrier telephone system, for example, one employing coaxial cable and transmitting a signal frequency band extending up to 2 megacycles. Interposed in the line 1 at intervals, say five miles apart, are signal repeaters (amplifiers) with associated gain-adjusting regulators, two successive ones of which, designated 2 and 3, are illustrated diagrammatically. The regulators of the successive repeaters are arranged to be controlled in turn by a pilot wave of a given frequency, say, 2,064 kilocycles, outside the frequency range of the transmitted signals and of initial constant volume, which is supplied to the line 1 from the source 4 near its input, and is transmitted over the line concurrently with the signal waves.

The signal repeaters 2, 3 . . . may be of any suitable type and the associated regulators are of the dynamic type, such as disclosed, for example, in the patent to R. R. Blair, No. 2,179,915, issued November 14, 1939, which operates to make the gain of the associated repeater vary directly with the amplitude of the applied pilot wave in such manner as to restore the pilot amplitude in the output of the repeater to its normal constant level and thus to produce a corresponding adjustment in the amplification of the signals, the gain regulation following very quickly each change in pilot amplitude. Each repeater may be designed to compensate for the loss-frequency characteristic of the preceding section of transmission line at some predetermined line temperature, and as regulated by the associated dynamic regulator may introduce in addition a variable amount of gain, uniform over the signal frequency range of interest, to compensate approximately for changes in line attenuation due to variations of temperature from the predetermined value.

In such a system the transmitted signals and pilot waves at repeater or terminal points may have transient volume irregularities initially caused by interference of different types, such as repeater power supply variations and intermittent troubles, induced in the line or by changes in the operating characteristics of transmission apparatus, and which is evidenced by small ripples in the transmitted waves. The transient volume varia-

tions or ripple components in the pilot wave may adversely affect the operation of the dynamic regulator at each repeater point. If there is a change in the strength of the signal and pilot currents, the pilot currents will control the dynamic regulators for all of the tandem-connected repeaters and each will make a compensating gain adjustment in its associated repeater with the result that overcompensation will be effected. Thus, the operation of the regulators under control of the pilot current will produce a transient swing of the signal strength above and below normal value for a period of time, the magnitude of which will increase with the number of the regulated repeaters in tandem and may result in objectionable fluctuations in the intensities of the signals at the receiving end of the system.

Such transient effects are reduced to an unobjectionable amount in accordance with the invention by the use at one or more points in the system of a circuit arrangement such as shown schematically in the center of the drawing, for stabilizing the volume of the pilot wave.

This circuit arrangement includes a hybrid coil H having series windings 5 and 6 and branch windings 7 and 8 respectively inductively coupled to the two series windings. The conductors of the incoming portion of line 1 leading from the output of repeater 2, are connected directly through the series windings 5 and 6 of the hybrid coil H to terminals 9 and 10. The terminals of the branch winding 7 inductively coupled to series winding 5, are connected to the conductors of the outgoing portion of line 1 leading to repeater 3, and the terminals of branch winding 8 inductively coupled to series winding 6, are connected to an outgoing line impedance balancing network 11, as shown, or to a line, which may constitute a spare line. The input of a control circuit 12, the elements of which will be described in connection with the following complete description of operation of the whole circuit arrangement, is connected across the outgoing portion of line 1 near the hybrid coil H, and its output is connected to the terminals 9, 10 of the hybrid coil H.

Let it be assumed that the pilot waves of given frequency (2,064 kilocycles) and of initial constant volume generated by the source 4, and signal waves of different frequency from an input source (not shown) are being concurrently transmitted over the line 1. These waves, when they arrive at the hybrid coil H, will have small amplitude variations forming a ripple in the wave produced during transmission over the preceding section of line in the manner described above. The energy of the received signal and pilot waves will be divided between the inductively coupled windings 7 and 8, so that a portion of the signal and pilot wave energy will pass into the outgoing portion of line 1 and will pass out over that line toward repeater 3 and another equal portion into the balancing network 11.

A portion of the wave energy in the input of the outgoing portion of line 1 will pass into the input of control circuit 12 to filter 13 which is tuned to pass waves of the pilot frequency (2,064 kilocycles) and to suppress the signal frequencies. The pilot wave in the output of filter 13 will pass to the amplifier 14 which is adjusted to amplify it to the desired degree. The output of amplifier 14 is fed in multiple to the input of the differential rectifier 15 and the input of the "pulse" amplifier 16.

The differential rectifier 15 includes an input transformer 15 having two secondary windings 75

18 and 19. The input diagonal of a copper oxide rectifier bridge 20 is connected across winding 18 and the input diagonal of a second copper oxide rectifier bridge 21 is connected across winding 19. A resistance-condenser tank circuit 22 of large time constant is connected across the output diagonal of rectifier bridge through the series variable resistor 23, and the resistance-condenser tank circuit 24 of relatively small time constant is connected through the series fixed resistor 25 across the output diagonal of rectifier bridge 21. The tank circuits 22 and 24 are connected together in series opposition through potentiometer 26, which is connected to ground as shown. The circuit constants of the two sides of the differential rectifier 15 are selected so that its voltage output is zero with constant volume pilot input applied to the input transformer 17, but due to the long-time constant tank circuit on one side, the rectifier will produce a direct current voltage drop in the output potentiometer 26 proportional to any transient variations or ripple component in the input wave.

Other types of rectifiers may be used in place of the varistor type illustrated. The resistor 23 is made variable to enable the output of rectifier 20 to be balanced against that of rectifier 21 under steady state conditions so that when no transient or ripple exists in the pilot wave the voltage applied by potentiometer 26 to bias the pulse amplifier 16 in the manner to be described, will be zero.

The pulse amplifier 16 includes the input transformer 27 having two reversely wound secondary windings 28 and 29, two three-electrode amplifying vacuum tubes 30 and 31 having their control grid-cathode circuits each including a self-biasing resistor and a parallel by-pass condenser, respectively connected across the terminals of secondary winding 28 and of secondary winding 29 so that equal in-phase portions of the pilot wave applied to input transformer 27 are amplified by the two tubes, and their plate-cathode circuits connected in push-pull through respective halves of the primary winding of output transformer 33 and the potentiometer 34 in series between the two half windings, which is provided to enable an accurate adjustment of balance between the outputs of the two tubes to be made.

The direct current voltage output of the differential rectifier 15 by means of the connection of the variable arm of potentiometer 26 to the upper terminal of transformer winding 29 in the control grid-cathode circuit of amplifier tube 31 is used to bias the grid of that side of the pulse amplifier 16. The condenser 32 in the control grid circuit of amplifier tube 31 is provided to by-pass the alternating current pilot input to pulse amplifier 16 around potentiometer 26, and block direct current bias from potentiometer 26.

With constant voltage input from the output of amplifier 14 to pulse amplifier 16, the latter is balanced and its output remains zero. As stated above, any ripple component or variation in the pilot volume present in the input of pulse amplifier 16 and differential rectifier 15 causes the latter to produce a direct current voltage output proportional to that ripple or variation in pilot volume. This voltage applied as a bias to one side of pulse amplifier 16 unbalances it so that its "pulse" output, which is normally zero with constant volume input, is proportional to the ripple or variation in pilot volume at its input. The pulse output of pulse amplifier 16 is passed through the adjustable magnitude control 35 and a phase

shifter, which control the magnitude and phase of the pulses, and passes through terminals 9, 10 into hybrid coil H in which it is balanced against the incoming pilot wave at that point. If by proper selection and adjustment of the circuit elements in control circuit 12 the pulse output of the latter is properly adjusted in phase and magnitude, the ripple or variations in pilot volume introduced into the input of hybrid coil H from the incoming portion of line 1 may be substantially balanced out. The pilot output of the hybrid coil H transmitted over the outgoing portion of line 1 to control regulated repeater 3 is therefore free of the transient volume variations or ripples, and its magnitude is equal to the long-time average value of the input pilot volume.

An advantage of the wave stabilizing arrangement of the invention just described is that its failure for any cause will only result in the hybrid coil pilot output having transient volume variations or ripples equal to those at its input, and will not cause failure of the pilot-controlled regulating system.

Various modifications of the circuits illustrated and described, which are within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. In combination, a signal transmission line, means at one or more points along said line for regulating a transmission characteristic thereof, means to transmit an alternating pilot wave along said line to control said regulating means in accordance with the volume of the pilot wave at the regulating points, said pilot wave in transmission over said line being subjected to disturbances tending to produce small transient amplitude variations therein evidenced as a ripple in the wave, and means to reduce the control effect of said transient variations of the pilot wave on said regulating means, comprising means at a given point in said line for diverting a portion of the pilot wave, transforming it into pulses of magnitude and phase corresponding to those of the transient variations in the pilot wave in the line near the diverting point and applying the resulting pulses to the line to combine with the pilot wave therein in such manner as to neutralize to the required degree the transient wave variations.

2. In combination in a signaling system, a signal transmission line transmitting signal waves and subject to variations in attenuation, signal repeaters at intervals along said line, means to send a pilot wave of a frequency outside the signal frequency and of initial constant volume over said line along with the signals, regulating means at each of certain repeater points, controlled by the pilot wave received thereat to make a continuous adjustment in repeater gain in accordance with the pilot volume at that point so as to substantially compensate for the effect on the signal

of the variations in attenuation of a preceding section of said line, and auxiliary means for reducing the control effects on said regulating means of the ripple components of the controlling pilot wave caused by transient disturbances along said line, comprising means for deriving from the transmitted pilot wave at an intermediate point in said line, pulses proportional to the ripple components thereof and for combining the derived pulses with the pilot wave in said line in such manner as to effectively balance out the ripple components therein.

3. The system of claim 2, in which said auxiliary means comprises filtering means for diverting a portion of the energy of the pilot wave from the line at said intermediate point, an amplifier supplied with the diverted pilot wave energy, said amplifier being normally balanced so as to provide zero output for constant volume input, means controlled by a portion of said diverted pilot wave energy for producing a direct current voltage proportional to any ripple components therein, means to apply said voltage as a bias to one side of said amplifier to unbalance it so as to produce a pulsating amplifier output proportional to the volume variations in its pilot wave input, and means to introduce the resultant pulses in proper phase and magnitude into said line near said intermediate point in opposition to the pilot wave therein so as to effectively balance out the ripple components from that wave.

4. The system of claim 2, in which said auxiliary means comprises means to select from the waves transmitted over said line at an intermediate point therein a portion of the pilot wave and to amplify the selected wave portion, a differential rectifier having a relatively large-time constant tank circuit on one side, and a pulse amplifier, supplied in multiple with portions of the resulting amplified pilot wave, the circuit constants of said differential rectifier being such that it provides zero output with constant volume input and, due to said large-time constant tank circuit on one side, produces a direct current voltage output proportional to any ripple components in the pilot input, said pulse amplifier being normally balanced so that it provides zero output with constant volume input, and means to apply the direct current voltage output of said differential rectifier, when ripple components are present in the input thereto, as a bias to one side of said pulse amplifier to unbalance it so as to produce a pulsating output therefrom proportional to the ripple component in the pilot input, means to adjust the magnitude and phase of the resulting pulses, and hybrid coil means for balancing the pulses against the pilot wave in said line near said intermediate point so as to substantially neutralize the ripple components in the latter wave.

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