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CARRIER SIGNALING SYSTEM

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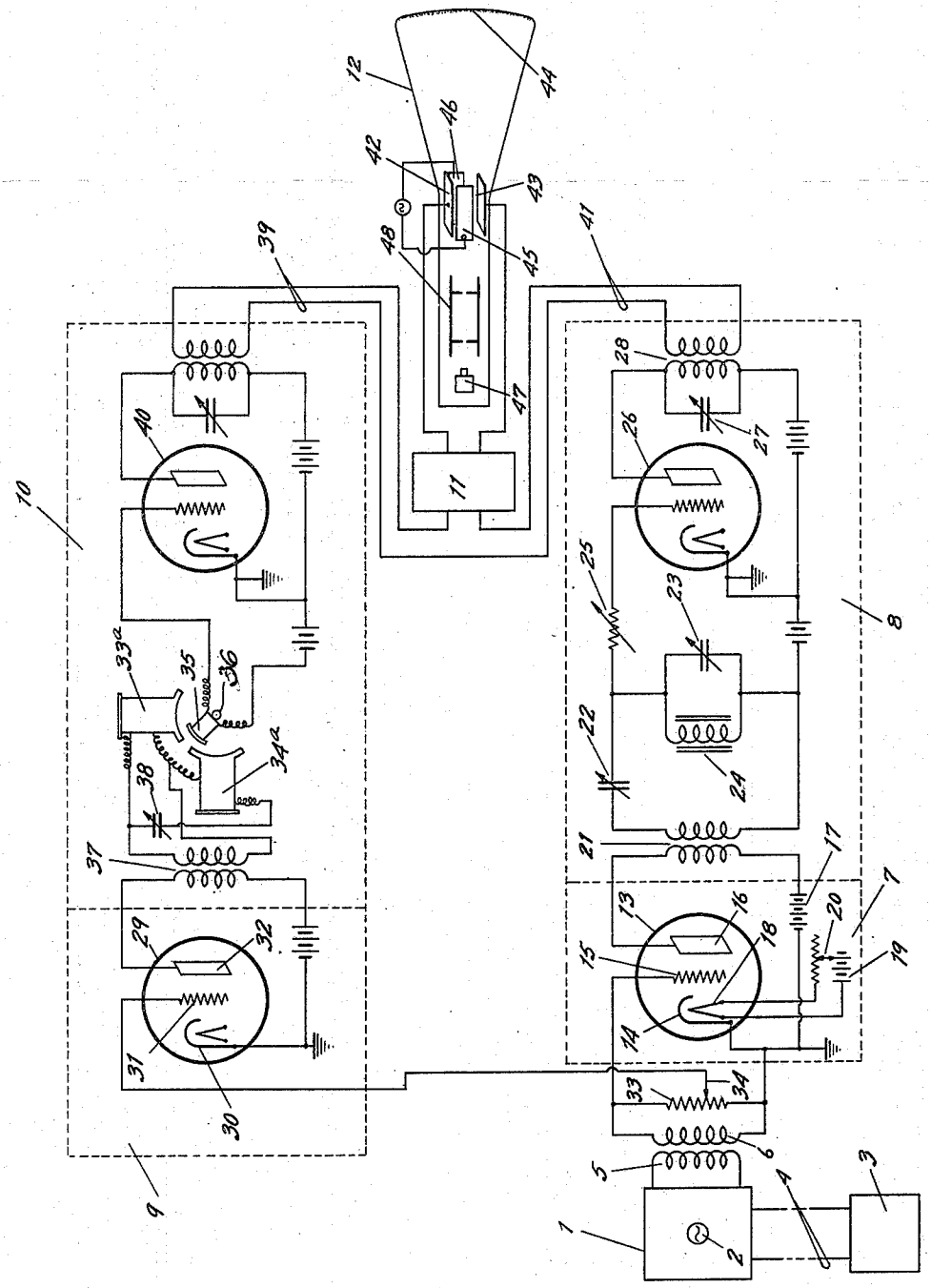

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CARRIER SIGNALING SYSTEM

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8 Claims. (Cl. 250—17)

This invention relates to electric signaling systems and more particularly to systems for signaling by currents of a sustained predetermined frequency.

In certain types of signaling systems, particularly where the signals are transmitted through the intermediary of a carrier wave, it is extremely important that the carrier wave itself be of sustained steadiness as regards amplitude. This is especially so in the case of systems for transmitting visual representations such as in phototelegraphy, picture transmission, television and the like. As a matter of fact while a certain degree of unsteadiness is permissible in ordinary telephone communication where the message is to be reproduced audibly, the same degree of unsteadiness is highly objectionable in systems for reproducing messages visually, for example in telephoto systems and the like.

Furthermore while a pronounced unsteadiness in the carrier amplitude may be detected by audible means, it is very difficult to detect slight conditions of unsteadiness by audible means. Furthermore where the unsteady condition varies at a very low rate, for example below sixteen cycles, even though it is of appreciable magnitude, it is very difficult to detect by audible reproducing means, and there is a certain level below which even visual detectors such as oscilloscopes are ineffective. I have found that these low frequency or low magnitude disturbances in the carrier amplitude while difficult of detection by ordinary means may still mar to a considerable extent a visual reproduction which would otherwise be of high quality. Accordingly, it is one of the principal objects of the present invention to provide apparatus and circuit arrangements whereby these low frequency or low magnitude disturbances in the carrier amplitude can be detected.

Heretofore the usual method of detecting and locating the source of unsteadiness in a carrier telephoto system has involved a trial transmission. Thus a short length of the picture is transmitted, reproduced, developed and examined in an effort to determine the source of the unsteadiness, and then appropriate adjustments of the carrier equipment are made. In many cases the first adjustment does not clear up the trouble and it is necessary to repeat the trial transmission and re-correct after each such trial transmission. As there are a great many possible sources of variation, many of which depend for their elimination on delicate adjustments, it is obvious that these usual methods of detecting unsteadiness in the carrier are very slow.

Accordingly, it is one of the principal objects of the invention to provide a visual detector and associated circuit arrangements preferably at the transmitter, whereby these small disturbances in the carrier may be instantaneously observed without the necessity of reproducing and developing a trial section of the picture.

A feature of the invention relates to a circuit arrangement in the nature of a modulation expander whereby the ratio of the disturbances to the carrier may be increased, thus enabling very slight disturbances to be reproduced on a cathode ray oscilloscope or similar device.

Another feature relates to the novel organization, arrangement and relative location and interconnection of parts which constitute an improved apparatus and method for directly and visually determining very small unsteadiness or disturbance in a carrier wave or the like.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

While the invention will be described herein in connection with a system of telephoto transmission, it is equally well applicable to other types of carrier transmission systems. When a carrier wave with disturbing variations therein, such for example as commutator ripple or the like, is amplified, the final ratio between the disturbances and the carrier proper is substantially the same as before amplification. In accordance with the present invention the steady carrier is suppressed in whole or in part whereby the ratio of the disturbing variations to the remaining carrier, if any, becomes large. The resultant can then be amplified while retaining this large ratio, and the amplified current is applied to an oscilloscope, preferably of the cathode ray tube type.

In the drawing, which represents one preferred embodiment of the invention, the numeral 1 represents schematically, any well-known form of apparatus for producing a modulated carrier wave and including a device 2 for generating the carrier or sustained alternating current proper. In as much as the invention finds its primary utility in telephoto systems and the like, the apparatus 1 may be any well-known form of picture analyzing and translating equipment for converting the shade values of successive elemental areas of the picture, or other visual representation, into a correspondingly modulated carrier wave of the carrier frequency 2. As an example of such an arrangement reference may be had to Patent No. 2,015,742, granted to Austin G. Cooley, Oct. 1, 1935. Preferably the apparatus 1 is equipped with a switch (not shown) whereby a portion of the carrier currents from device 2 may be taken off either in modulated or unmodulated form. As pointed out hereinabove, in order that the picture may be reproduced faithfully at the receiving point 3 over the transmission channel 4, it is necessary that the carrier per se, be substantially free from unsteadiness, particularly where the

unsteadiness is at a regular rate. For a detailed description of a suitable picture receiving and reproducing equipment reference may be had to said Patent No. 2,015,742 it being understood that the channel 4 may be a wire, carrier, or radio channel.

The unsteadiness in the carrier may result from a number of causes either in the carrier generating equipment itself, or by reason of interference from outside sources. Usually however the unsteadiness is of such small magnitude as to be completely masked, by the carrier, against detection by ordinary amplifying and audible reproducing means. Consequently before the actual transmission of the picture-current modulated carrier to the apparatus 3, it is necessary to make certain that these small disturbances are substantially non-existent. For this purpose part of the unmodulated carrier output is impressed in any suitable manner on the primary winding 5 of a suitable coupling transformer. The output of the secondary 6 is divided, part flowing through the current limiting arrangement 7 and signal shaping network 8; part flowing through the amplifier 9 and phase adjusting network 10. The arrangements are such that the current limiter smooths out the carrier impressed thereon so that there is present in the output of devices 7, 8, a carrier of uniformly steady amplitude. The part of the carrier that passes through devices 9 and 10 is adjusted so that the carrier in the output of device 10 is 180 degrees out of phase with that in the output of device 8. The combined output of devices 8 and 10 is then impressed upon a suitable amplifier 11 the output of which controls the deflection of the cathode ray beam of a suitable cathode ray oscilloscope 12. Preferably the relative strengths of the signals leaving devices 8 and 10 are adjusted so that when the signal from device 10, which contains the amplitude variation to be detected, is at a minimum it is equal to or slightly stronger than the steady signal from device 8. Thus when the signal from device 10 is at a minimum the two signals will neutralize each other. Consequently when a variation or disturbance causes the signal from device 10 to increase, substantially the entire increase is passed on to the oscilloscope 12 through amplifier 11. Consequently while the variation or disturbance at the source 2 may amount to only a relatively small proportion of the carrier per se, at the input of amplifier 11, the variation may be substantially the entire signal. By means of the oscilloscope 12 and amplifier 11 any change or disturbance in the carrier at source 2 is instantaneously visible on the oscilloscope screen.

While any well known form of current limiting device and phase adjusting device may be employed, a typical arrangement is shown in the drawing. The device 7 may comprise a grid controlled vacuum tube 13 including an electron emitting cathode 14, a control grid 15 and an anode 16. While the drawing shows a tube of the indirectly heated cathode type, it will be understood that a filamentary cathode may be employed. The current limiting tube 13 is preferably operated at saturation by reducing the emission from the cathode and employing a suitable potential from source 17 on anode 16, so that the output consists of sustained carrier waves of uniformly limited amplitude. The emission of the cathode may be regulated to the saturation point of the plate current characteristic, by connecting the heater wire 18 to an adjustable source of heating current, represented schematically by the battery 19 and the variable resistor 20. One explanation of the manner in which the carrier waves are uniformly limited as to amplitude is as follows: Should the carrier frequency generated by device 2 contain any amplitude variations as described above, these variations or irregularities are impressed upon the grid 15. The tube 13 and its circuits are adjusted so that the output on the conductors 41 consists of non-modulated carrier waves of the carrier frequency and of substantially uniform maximum wave amplitude. This is accomplished by the device 7 which clips off the peaks of the carrier waves. Consequently, the carrier frequency waves transferred by transformer 21 have a uniformly limited or maximum amplitude. They are then passed to the tuned circuits 23, 24, where the waves are smoothed out to substantially sinusoidal form. The carrier frequency is then amplified by tube 26 and further smoothing is accomplished by the tuning of the transformer 28 by condenser 27.

The output of tube 13 is then impressed by means of a coupling transformer 21 on a signal shaping network of any well-known character, comprising for example the series condenser 22, shunt condenser 23, shunt impedance 24 and resistor 25 some or all of which are variable so as to insure that the waves impressed on amplifier tube 26 are substantially sinusoidal, it being understood that tube 26 may be of any well-known construction such as ordinarily employed in audio and radio amplification. Preferably, although not necessarily, the output circuit of tube 26 is tuned to the carrier frequency by a condenser 27 in parallel with the transformer winding 23. Likewise, if desired, the various coupling circuits may also be tuned to the carrier frequency. Preferably the over-all gain of the devices 7 and 8 is such that the output signal amplitude of tube 26 is equal to or slightly less than the minimum signal amplitude from device 10.

The device 9 comprises an amplifier tube 29 which may be similar to tube 26 having an electron emitting cathode 30, a control grid 31 and an anode 32. The gain of the carrier waves impressed upon the control grid 31 is adjustable by means of a shunt resistance 33 and a potentiometer arm 34. The amplified output of tube 29 is applied to any well-known form of phase adjusting network, which may comprise a pair of stator coils and a rotor coil 35 which is pivoted for rotation at point 36. The stator coil 33^a is fed with current directly from the secondary winding of the coupling transformer 37, while the stator coil 34^a is fed with current from the secondary 37 through the condenser 38 which is tuned so as to place the phase of the current in stator 34^a ninety degrees out of phase with that in stator 33. The rotor or pickup coil 35 is arranged to be positioned in any desired phase relation with respect to the stator coils. The resultant field induced in coil 35 from the stator coils can be adjusted by the position of coil 35 so that the currents in the output conductors 39 of amplifier 40 are 180 degrees out of phase with the currents in the output conductors 41 of amplifier 26. Consequently when the signal from tube 37 is at a minimum, it will be completely neutralized by the signal from tube 26.

The combined output of tubes 26 and 40 is then applied to a suitable amplifier 11 the amplified output of which is applied to a pair of coordinate deflecting plates 42, 43 of the cathode-ray tube

12 having the usual fluorescent screen 44. It will be understood of course that tube 12 is provided with another set of deflecting plates 45, 46 energized from a local alternating or pulsating current source so as to deflect the beam in one coordinate direction at a predetermined rate. It will also be understood that tube 12 contains any well-known form of electron gun 47, and one or more focusing and accelerating electrodes 48. Instead of employing deflecting plates, deflecting magnets may be employed as is well-known to those skilled in the cathode-ray tube art.

When the various gains and phase relations are adjusted as above described there is produced on the screen 40 a pattern determined by the frequency of the carrier, and as long as the carrier is steady the pattern likewise is steady. If the carrier contains ripples or other disturbances these are indicated immediately on the screen 44 and the necessary adjustment of the source 2 can be made until the reproduced pattern is of a steady form. With this arrangement, it is possible to check the carrier either before or during the transmission of the picture and since the adjustment is made at the transmitter no time is lost in the trial transmissions which have ordinarily been required for this purpose. While the invention has been described as applied to an expander for increasing the ratio of the disturbances to the carrier, it will be understood that the circuit arrangements may be employed in any situation where an increase in apparent ratio between a carrier and its modulations is desired, thus enabling the device to be used as a level or modulation expander to increase the apparent percentage of modulation in a modulated carrier wave, particularly where a great increase of an otherwise weakly modulated carrier is desired.

While specific apparatus and circuit arrangements have been described and illustrated, it will be understood that the invention is not necessarily limited thereto and that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What I claim is:

1. The method of indicating a modulation in a carrier which includes the steps of passing one portion of the carrier through one channel and another portion of the carrier through another channel, limiting the amplitude of the carrier in one channel, adjusting the phase of the carrier in one channel to phase opposition with the carrier in the other channel, combining the output of the two channels, and applying the resultant to a signal reproducing device.

2. The method of increasing the apparent ratio between the normal amplitude of a carrier and a slight variation therein which includes the steps of passing the carrier through two channels, acting on the carrier in one of the channels to limit its amplitude below the amplitude of the carrier in the other channel, adjusting the phase of the carrier in the other channel to phase opposition with the carrier in the first channel, combining the outputs of the two channels, and applying the resultant to a signal reproducer.

3. The method of detecting carrier flutter which is difficult of detection by direct amplification of the carrier which includes the steps of passing the carrier through two channels, limiting the carrier in one channel to an amplitude of the same order as the minimum carrier amplitude in the other channel, adjusting the carriers in the two channels to phase opposition, combining the output of the two channels, and applying the resultant output to a signal reproducer.

4. The method of detecting minute flutters in an otherwise constant amplitude carrier which flutters are difficult of detection by direct amplification of the carrier which includes the steps of passing the carrier through two channels limiting the waves in one channel to an amplitude of the same order as that of the unlimited carrier in the other channel, combining the outputs of the two channels in phase opposition, and applying the resultant to a visual signal reproducer.

5. In a system for detecting minute disturbances in an otherwise steady source of carrier waves, means to pass the waves through two channels, means to limit the amplitude of the waves in one channel to an amplitude of the same order as the minimum amplitude of the unlimited waves in the other channel, means to combine the waves from the two channels in phase opposition, and a visual reproducer for indicating the instantaneous resultant of the combined waves.

6. In a system for detecting minute disturbances in an otherwise steady source of carrier waves, means to pass the waves through two channels, means in one chanel to limit the amplitude of the waves therethrough to a value below the waves in the other channel, a correcting network for restoring the limited waves to substantially their original wave shape, means in the other channel to adjust the phase of the waves therein to phase opposition with the corrected waves in the first channel, means to combine the opposed waves, means to amplify the resultant of the combined waves, and a cathode ray tube controlled by the amplified resultant.

7. In a system for detecting minute variations in an otherwise steady source of carrier waves, means to pass the waves through two channels, a current limiting tube and a wave correcting network in one channel, an amplifier tube and a phase adjusting network in the other channel, means to adjust said adjusting network to bring the waves in the two channels into phase opposition, means to combine the waves from the two channels, means to amplify the resultant of the combined waves, and a visual indicator for indicating the instantaneous amplitude of the amplified resultant.

8. In a system for transmitting signals by means of a carrier current, the method of monitoring to determine the presence of undesired disturbances in the carrier which includes diverting part of the carrier, prior to modulation by the signals, into two paths; limiting the amplitude of the waves in one path to a magnitude very much lower than the average amplitude of the waves in the other path; adjusting the waves in the two paths to phase opposition; combining the waves from both paths; amplifying the resultant; producing an instantaneous visual indication of the amplitude and wave shape of said amplified resultant; and from said visual indication determining the presence of disturbances in the carrier.

AUSTIN G. COOLEY.