

Oct. 9, 1928.

1,686,792

H. S. BLACK

TRANSLATING SYSTEM

Filed Feb. 3, 1925

Fig. 1

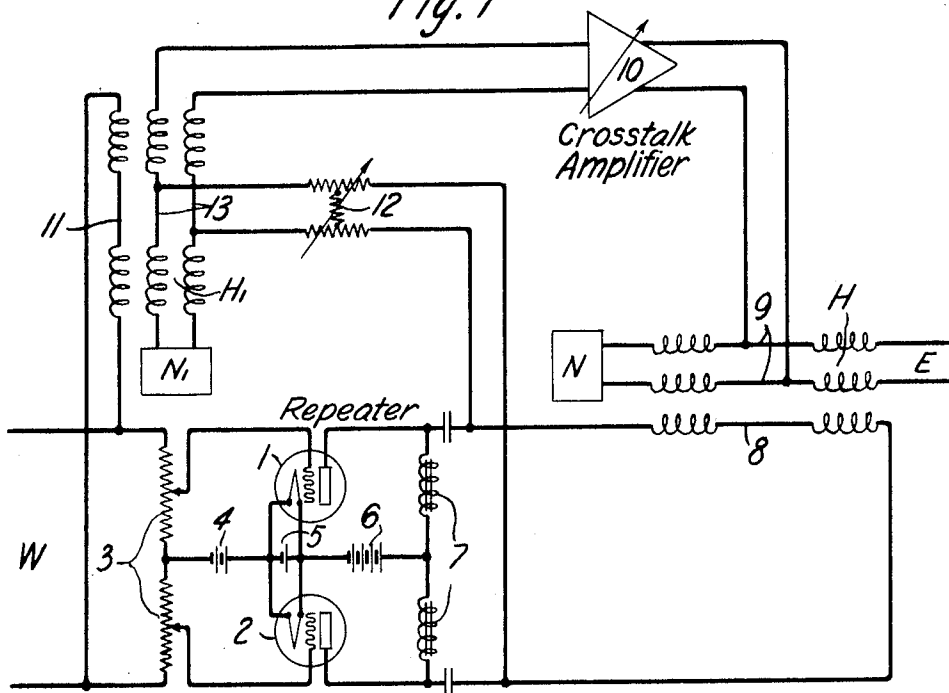
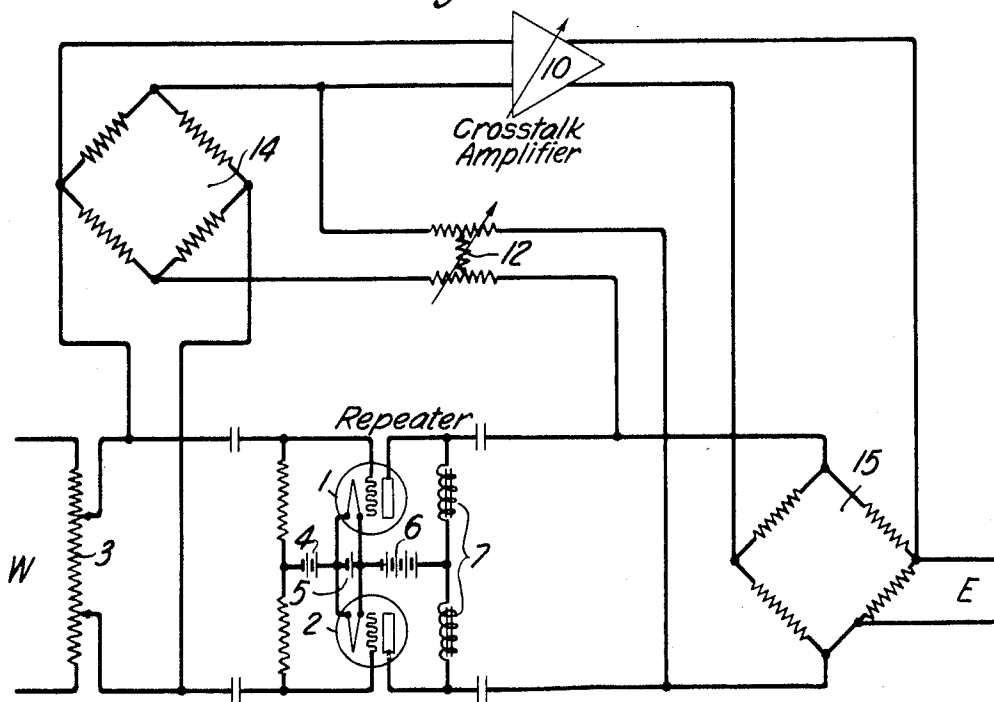


Fig. 2



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UNITED STATES PATENT OFFICE.

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TRANSLATING SYSTEM.

Application filed February 3, 1925. Serial No. 6,529.

This invention relates to translating systems, and particularly to electric wave amplification.

An object of the invention is to increase the load carrying capacity of such systems.

A related object of the invention is to repeat electrical waves without distortion.

Another object of the invention is to suppress the distortion and modulation produced in an amplifier circuit.

Another object of the invention is to facilitate the operation and maintenance of repeaters in multiplex carrier current signaling systems.

For economic reasons, it is desirable to utilize repeater amplifiers employed in carrier signaling systems to their full load carrying capacity. Whenever the waves impressed upon such an amplifier approach the load limit, however, intermodulation usually results, thereby producing cross-talk which interferes with the efficient reception of signals.

The problem of suppressing cross-talk is complicated by the fact that the cross-talk is a function of the frequency, amplifier output, and the type of modulation. The difficulties heretofore encountered are overcome in the present invention in which both odd and even order products of modulation produced in an amplifier are balanced out for all frequencies, and regardless of the output level of the amplifier.

In the preferred embodiment of the invention, a portion of the current in the input circuit of a repeater amplifier is balanced against a portion of the current in the output circuit. The balance is so adjusted that the frequencies which it is desired to amplify without distortion are balanced out and the cross-talk frequencies alone appear in the output of the balancing circuit. These cross-talk frequencies are amplified and applied to an outgoing line in such phase relation that they just balance out the cross-talk which is transmitted thereto from the repeater output.

The invention will be described as applied to a repeater for multiplex carrier current telephone or telegraph systems, but it is to be understood that it may also be applied to other places in the system than at repeater points, and to various types of systems other than multiplex carrier systems.

In the drawing, Figs. 1 and 2 are circuit diagrams illustrating two different modifications of the invention.

In Fig. 1, a one-way repeater is adapted to couple two line sections W and E. A two-way repeater may be provided by duplicating the circuit to provide a path for operation in the opposite direction.

The signaling waves incoming at the repeater from line section W are amplified in the repeater and the amplified waves are delivered to line section E.

The repeater amplifier may be of any well-known type, such as the general type of balanced amplifier disclosed in the patent to B. W. Kendall, No. 1,544,910, dated July 7, 1925.

As illustrated, the repeater amplifier comprises a pair of three-element electron discharge tubes 1 and 2. The input circuit of the amplifier includes a variable resistance 3, the adjustable taps of which are connected to the grids of the two tubes.

The usual sources of electrical energy 4, 5 and 6 are provided to properly polarize the grid electrodes, to heat the cathodes, and to furnish anode-cathode current, respectively. Each of the anode-cathode direct current circuits of the tubes contains a coil 7 which is designed to offer a high impedance to currents of the frequency or frequencies being repeated, these coils functioning to maintain the sum of the anode-cathode currents of the two tubes constant.

The output circuit of the repeater is connected to the series winding 8 of a differential repeating coil H, commonly known as a hybrid coil. The usual balancing network N is connected to the terminals of the two line windings 9 of the hybrid coil. The signaling waves originating in line section W which are amplified in the repeater, are thus transmitted through the hybrid coil H to the line section E.

Due to the distortion and modulation produced in the repeater, cross-talk frequencies are also impressed upon the line section E, and unless these undesired frequencies are eliminated they may seriously interfere with the efficient reception of the signals at the receiving station.

This invention provides a balancing circuit for eliminating the distortion and modulation frequencies which appear in the output circuit of the repeater. To accomplish

this, a portion of the currents in the input circuit of the repeater and a portion of the currents in the output circuit of the repeater are applied to a balancing circuit including a hybrid coil H_1 and its associated balancing network N_1 , the hybrid coil H_1 being connected to the input circuit of an amplifier 10, hereinafter called the cross-talk amplifier. The output circuit of the cross-talk amplifier 10 is connected to the bridge points of the line windings 9 of the hybrid coil H_1 .

The currents derived from the input of the repeater are applied to the series winding 11 of the hybrid coil H_1 , which is coupled to the line windings thereof. The currents derived from the output of the repeater are transmitted through a variable artificial line 12 and applied to the bridge points of the line windings 13 of the hybrid coil H_1 . The voltage applied across the series winding 11 of the hybrid coil H_1 is free from distortion and modulation products, while the voltage applied to the line windings 13 of this hybrid coil contains the distortion and modulation components produced in the repeater as well as the undistorted components of the amplified wave.

The amplitude and phase of the voltage which is applied to the line windings 13 of the hybrid coil H_1 are so adjusted by means of the variable artificial line 12 that the frequencies which it is desired to amplify without distortion, which are applied to the series and line windings of the hybrid coil H_1 , are exactly equal and balance each other out. Since the frequencies which are free from distortion are balanced out in the hybrid coil H_1 , the currents impressed upon the input of the cross-talk amplifier 10 are made up only of the modulation and distortion components produced in the repeater. The gain of the amplifier 10 and the poling of its output are so adjusted that the cross-talk applied to the line windings 9 of the hybrid coil H_1 just neutralizes the cross-talk applied to the series winding 8 from the repeater amplifier.

Fig. 2 illustrates a modification of the invention in which a form of Wheatstone bridge is employed in place of the hybrid coils of Fig. 1 to couple the cross-talk balancing circuit to the input and output circuits of the repeater.

The repeater in this case is similar to that shown in Fig. 1, the additional resistance elements in the input circuit of the push-pull amplifier simply being employed to secure a more perfect balance of the two sides of the circuit. The condensers in the input and output circuits of the repeater may be employed to prevent the flow of any continuous currents through the respective conductors in which they are placed.

A portion of the currents in the input and output circuits of the repeater are applied

across the ratio arms of the Wheatstone bridge 14, the arms of which contain equal resistance elements. The output circuit of the repeater and the output circuit of the cross-talk amplifier are coupled to the line section E by means of a similar bridge 15. The variable attenuator 12 may be adjusted until the voltage applied to the Wheatstone bridge 14 from the input side of the repeater is just balanced out by the distortionless components of the voltage applied across the bridge 14 from the output side of the repeater.

As in the case of the system of Fig. 1, the currents impressed upon the input of the cross-talk amplifier 10 are made up only of the modulation and distortion components produced in the repeater. By properly adjusting the gain of the amplifier 10, assuming the output to be properly poled, the cross-talk impressed upon the bridge 15 from this amplifier exactly neutralizes the cross-talk components applied to the bridge from the repeater.

A system constructed in accordance with the invention as described above is very economical to operate and maintain, particularly since the repeater can be operated at a high load level. It will be noted that both odd and even order products of modulation are balanced out, and that the balance is independent of the frequency and the output level of the repeater.

The invention set forth herein is, of course, susceptible of various other modifications and adaptations not specifically referred to, but included within the scope of the appended claims.

What is claimed is:

1. The method of suppressing even and odd order distortion components produced in an electric wave translating system and lying within the same frequency spectrum as the undistorted components which comprises isolating a portion of said distortion components from the system and reimpressing upon the output circuit of said system said isolated distortion currents in opposite phase relation to the even and odd order distortion components therein.

2. The method of suppressing distortion components in an electric wave translating system which comprises selecting a portion of the distortion and undistorted components from the output circuit of said system, balancing the undistorted part of said selected components, and reimpressing the distortion components upon said output circuit in phase opposition to the original distortion components therein.

3. The method of suppressing distortion components produced in an electric wave translating system which comprises balancing a portion of the frequencies including the distortion components in said system

against a portion of the frequencies which are free from distortion components to isolate the distortion components, and impressing said distortion components upon the output circuit of said system in opposite phase relation to the original distortion components therein.

4. The method of suppressing distortion components produced in an electric wave amplifier, which comprises balancing a portion of the distortionless current components in the input of said amplifier against a portion of the currents including the distortion components in the output of said amplifier in such phase and amplitude as to neutralize the distortionless components, and impressing the distortion components so derived upon the output circuit of said system in such phase and amplitude as to neutralize the original distortion components therein.

5. A repeater comprising an amplifying element having input and output circuits coupling incoming and outgoing transmission lines, means to shunt a part of the current in the output circuit of said repeater; means for balancing the undistorted frequencies in said shunt circuit to isolate a portion of the distortion components produced in said repeater; and means to impress said distortion components upon said outgoing line in such phase and amplitude as to neutralize the distortion components transmitted thereto from said amplifying element.

6. A repeater comprising an amplifying element having input and output circuits coupling incoming and outgoing transmission lines, means to shunt a part of the current in the output circuit of said repeater; means for balancing the undistorted frequencies in said shunt circuit to isolate a portion of the distortion components appearing in said output circuit, and means to impress said distortion components upon said outgoing line in such phase and amplitude as to neutralize the distortion components transmitted thereto from said repeater.

7. A repeater for currents of different frequencies comprising an amplifying element having input and output circuits coupling incoming and outgoing transmission lines, means for balancing a portion of the frequencies including the distortion components in said repeater against a portion of the frequencies which are free from distortion to isolate the distortion components, and means to impress said distortion components upon said outgoing line in such phase and amplitude as to neutralize the distortion components transmitted thereto from said repeater.

8. A repeater comprising an amplifying element having input and output circuits coupling incoming and outgoing transmission lines, means for balancing a portion

of the distortionless current components in said incoming line against a portion of the currents including the distortion components in the output circuit of said repeater in such phase and amplitude as to neutralize the said distortionless components, and means to impress the distortion components so derived upon said outgoing line in such phase and amplitude as to neutralize the distortion components transmitted thereto from said repeater.

9. A repeater comprising an amplifying element having input and output circuits coupling incoming and outgoing transmission lines over which signaling waves are transmitted, a balancing circuit connected to said incoming line and to the output circuit of said repeater, means in said balancing circuit to adjust the phase and amplitude of the voltage derived from the output circuit of said repeater until the voltage components which are free from distortion and modulation neutralize the voltage components derived from said incoming line, and means for impressing voltage components in the output of said balancing circuit upon said outgoing line in such phase and amplitude as to neutralize the distortion and modulation components transmitted thereto from said repeater.

10. A repeater comprising an amplifying element having input and output circuits, an incoming transmission line associated with said input circuit, a hybrid coil having line windings associated with an outgoing transmission line and a series winding connected to said repeater output circuit, a balancing circuit including a second hybrid coil having line windings and a series winding, means for applying a portion of the distortionless current components in said incoming line to the series winding of said second hybrid coil, means for applying a portion of the currents including the cross-talk components in the output circuit of said repeater to the line windings of said second hybrid coil, means for adjusting the phase and amplitude of the current components applied to the line windings of said second hybrid coil until the voltage components which are free from distortion and modulation are neutralized therein, and means for impressing the voltage components containing distortion and modulation which are isolated in said second hybrid coil to the line windings of said first hybrid coil in such phase and amplitude as to neutralize the distortion and modulation components transmitted thereto from said repeater.

11. A repeater in a multiplex system for currents of different frequencies comprising an amplifier having input and output circuits coupling incoming and outgoing transmission lines, means for shunting a portion of the current in said output circuit, means

for balancing the unmodulated current in said shunt circuit to isolate a portion of the modulation components produced in the output circuit, and means for impressing said isolated modulation components upon the outgoing line to neutralize the modulation components transmitted thereto from the amplifier.

12. A repeater in a multiplex system for currents of different frequencies comprising an amplifier having input and output circuits coupling incoming and outgoing transmission lines, means for shunting a portion of the current in said output circuit, means for balancing the unmodulated current in said shunt circuit to isolate a portion of the even and odd order modulation components produced in the output circuit, and means for impressing said isolated even and odd order modulation components upon the outgoing line to neutralize the even and odd

order modulation components transmitted thereto from the amplifier.

13. A repeater in a multiplex system for currents of different frequencies comprising an amplifier having input and output circuits coupling incoming and outgoing transmission lines, means for isolating from the unmodulated components a portion of the modulated components produced in the output circuit, part of said isolated modulated component lying within the same frequency spectrum as said unmodulated component, and means for impressing said isolated modulated components upon the outgoing line to neutralize the modulation components transmitted thereto from the amplifier.

In witness whereof, I hereunto subscribe my name this 28th day of January A. D., 1925.

HAROLD S. BLACK.