

**June 2, 1925.**

**1,539,820**

**E. H. ARMSTRONG**

WAVE SIGNALING SYSTEM

Filed June 8, 1922

Fig. 1,

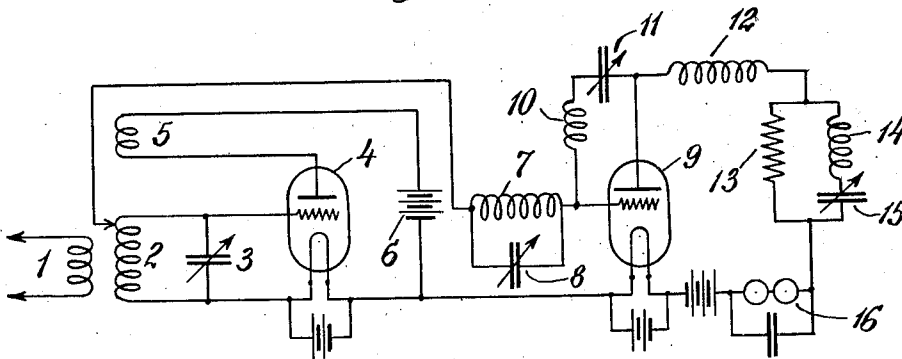
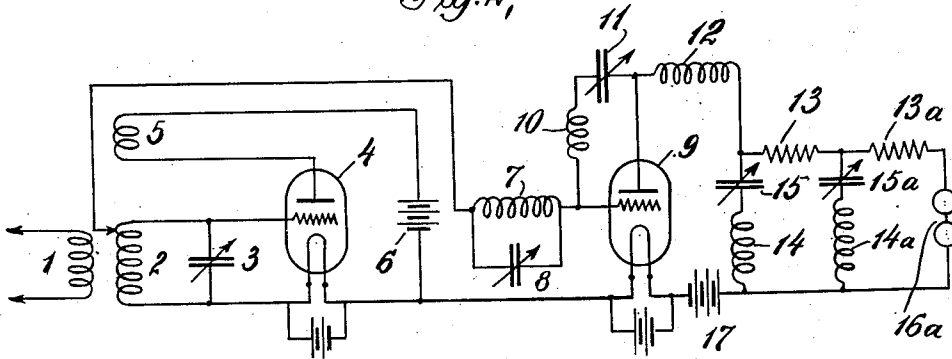


Fig. 2,



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# UNITED STATES PATENT OFFICE.

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## WAVE SIGNALING SYSTEM

Application filed June 8, 1922. Serial No. 566,682.

*To all whom it may concern:*

Be it known that I, EDWIN H. ARMSTRONG, residing at 1032 Warburton Avenue, Yonkers, in the county of Westchester, State of New York, have invented certain new and useful Improvements in Wave Signaling Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an electric regenerative system for amplifying varying electric currents, particularly radio or other high frequency signaling currents, wherein the varying potential of the current to be amplified is impressed on the system and the relation between the amount of regeneration and the degree of damping of the system is periodically varied to produce transient free oscillations proportional to the amplitude of the impressed potential and wherein the resulting free oscillations and the system are continuously maintained in this transient ordinarily unstable state to obtain super-regenerative amplification or action as described in my co-pending application, Patent No. 1,424,065, Serial No. 480,563 filed June 27, 1921.

The invention has for its object the provision of a method of and apparatus for improving the operation of super-regenerative systems employing vacuum valves, more particularly for the purpose of obtaining substantial proportionality of the response in the system and for obtaining greater amplification and improved quality of speech when such systems are employed to amplify and receive radio telephone signals or other signals of like character. To this end the characteristics of at least one of the amplifying vacuum valves in the system are modified by inserting resistance in the plate circuit of the valve thru which the direct current of the local battery flows and shunting the resistance by a capacity or a combination of capacity and inductance, which combination may be tuned to the auxiliary frequency, whereby the tendency of the super-regenerative action to become irregular and lose its proportionality to the incoming signal is overcome. A further object of the invention contemplates the extension of this idea to the provision of an electrical filter

of such character that it combines the function already described with its natural function of separating speech or signal frequency from the local auxiliary frequency which serves to periodically vary the relation between the amount of regeneration and the damping of the system.

The particular form of circuit arrangement illustrated in the drawings are preferred embodiments of the invention. By reference to the drawings and to the accompanying description a more complete understanding of the invention may be had. In these drawings:—Fig. 1 illustrates a super-regenerative system of the two-tube type with a resistance in the plate circuit of the low or auxiliary frequency oscillating system, which resistance is shunted by a condenser and inductance in series; and Fig. 2 illustrates a similar type of system in which a multi-stage filter is employed for the combined purpose of separating the voice and auxiliary frequency and increasing the amplification.

A theory of operation of this general type of super-regenerative amplifier has been described in my aforementioned patent. This invention, however, is based on the discovery of the improvement in operation of super-regenerative systems which is obtained when a resistance of the proper value shunted by appropriate values of capacity and inductance, is inserted in the plate circuit of the vacuum valve or valves producing the auxiliary frequency. The complete explanation of the mode of operation of the system is highly complicated and is unnecessary and need not be considered here because it may be easily demonstrated experimentally. The general idea of the operation of the system will be understood, however, from the following explanation:—Referring now to Fig. 1, the source 1 of the varying current to be amplified is associated with a regenerative system comprising the tuned circuit 2, 3, the vacuum valve 4, the feed-back coil 5 and the local battery 6. The regenerative system should be tuned to the wave frequency of the incoming signals present in the source 1.

Associated with the regenerative system is a feed-back oscillating and detector system similar to that described in my co-pending application 566,681 filed concur-

rently herewith. The oscillating system comprises the tuned circuit 7, 8, the valve 9, the inductance 10, the condenser 11 by means of which the oscillations in the system are controlled and maintained at the desired frequency, and the inductance 12. Of course, it is to be understood that other specific forms of oscillating circuit arrangements may be successfully employed. The elements which have been added, and which in combination constitute the basis of this invention, are the resistance 13 which is inserted in the plate circuit of the oscillating valve 9, the inductance 14 and variable condenser 15 connected in series with each other and together shunted across the resistance 13. The condenser 15 and the inductance 14 are so tuned and adjusted as to be in resonance with the auxiliary frequency produced by the vacuum valve 9 in the feed-back oscillating system. The value of the resistance 13 for the ordinary type tube should be between 10,000 and 20,000 ohms and the ratio of inductance to capacity should be fairly high. As in the usual case, the received signals are indicated by the telephones 16, which, of course, may be replaced by any of the well known forms of indicating devices.

Fig. 2 is substantially similar to Fig. 1 and like numerals have been employed to designate corresponding elements of the system. The use of the resistance 13 for the double function of improving the quality of amplification and of filtering the auxiliary currents from the speech frequency currents, is shown in the oscillating system including the vacuum valve 9. In this arrangement the filter combination comprises two resistances 13 and 13<sup>a</sup> and the two capacity inductance combinations 14, 15 and 14<sup>a</sup>, 15<sup>a</sup>. It is to be understood, however, that other forms of aperiodic filters comprising a plurality of recurrent sections of identical or varying values of resistance, inductance and capacity may be employed. The values of resistance and the ratio of inductance to capacity should preferably be as given in connection with Fig. 1. Of course, the values may be altered to take advantage of the best practice in the filter art. The telephones 16<sup>a</sup> are connected at the end of the filter and complete the path for the continuous currents supplied from the source 17 in the plate circuits of the oscillating valve 9.

It is to be understood that the present invention is adapted to receive radio signals, including radio telephone signals, when associated with an antenna, loop or other energy collecting device and to receive wired wireless signals (so-called wire carrier current transmission) when associated with the conductors of such signals. It should also be understood that modifications may be made in the specific circuit connections above

described without departing from the spirit and scope of the invention.

I claim:

1. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping, and means for periodically varying the relation between the amount of feed-back and the degree of damping of the system comprising, an oscillating system adapted to supply an auxiliary frequency to the regenerative system, and a resistance connected in said oscillating system for obtaining substantial proportionality in the response of the system.

2. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping, and means for periodically varying the relation between the amount of feed-back and the degree of damping of the system comprising, an oscillating system adapted to supply an auxiliary frequency to the regenerative system, and a resistance shunted by an inductance and capacity connected in said oscillating system for obtaining substantial proportionality in the response of the system.

3. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping, and means for periodically varying the relation between the amount of feed-back and the degree of damping of the system comprising, an oscillating system adapted to supply an auxiliary frequency to the regenerative system, a resistance connected in said oscillating system and an inductance and capacity tuned to the auxiliary frequency connected in shunt with said resistance whereby substantial proportionality in the response of said system and filtering action for separating out said auxiliary frequency is obtained.

4. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping and means for periodically varying the relation between the amount of feed-back and the degree of damping of the system comprising a feed-back oscillating circuit including a vacuum valve having grid, filament and plate elements connected in their respective circuits and a resistance connected in the plate circuit of said valve whereby substantial proportionality in the response of the system is obtained.

5. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping and means for periodically varying the relation between the amount of feed-back and the degree of damping of the system comprising a feed-back oscillating circuit including a vacuum valve having

grid, filament and plate elements connected in their respective circuits, and a resistance connected in the plate circuit of said valve, a capacity and an inductance connected in shunt with said resistance and tuned to said auxiliary frequency, all for the purpose of obtaining substantial proportionality in the response of the system and for filtering the auxiliary frequency.

10 6. An electric regenerative system adapted to produce super-regenerative action, including a feed-back circuit having a certain degree of damping and means for periodically varying the relation between the amount of

feed-back and the degree of damping of the system comprising a feed-back oscillating circuit including a vacuum valve having grid, filament and plate elements connected in their respective circuits, and a filter comprising a plurality of resistance, inductance and capacity elements connected in the plate circuit of said valve, for the purpose of obtaining substantial proportionality in the resistance of the system and for altering the auxiliary frequency.

In testimony whereof I affix my signature.

EDWIN H. ARMSTRONG.