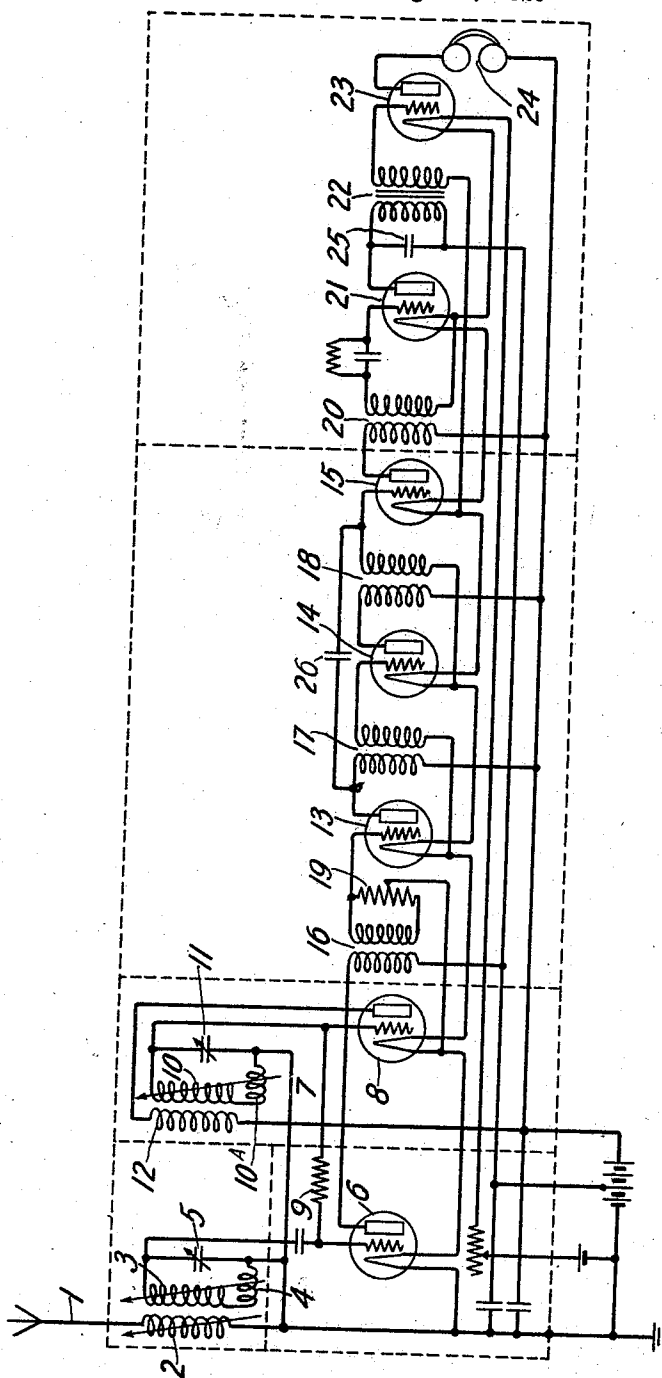


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S. E. ANDERSON
RADIO RECEIVING SYSTEM

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UNITED STATES PATENT OFFICE

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RADIO RECEIVING SYSTEM

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This invention relates to a radio receiving system and more particularly to an arrangement of this type employing successive stages of detection.

5 In radio receivers employing successive detection the incoming signal modulated wave is combined with local oscillations to produce an intermediate frequency wave modulated in accordance with signals, the intermediate frequency wave being amplified and then detected to yield the signals. In one class of systems of this type a separate oscillator is used to supply oscillations of a frequency different from that of the received wave to a detector in which the oscillations and incoming wave are combined to produce the intermediate frequency wave.

At the present time it is the general practice to employ a space discharge device having intercoupled input and output circuits, including a tuned circuit for determining the frequency of the oscillations generated, as a source for producing the locally supplied oscillations. The local source is coupled to the detector in such manner, as by a loose inductive coupling, that the tuned receiving circuit and the frequency determining circuit of the source may be adjusted independently of each other.

10 To secure a high degree of amplification and good quality reproduction of the signals, tandem circuits have been employed to amplify the intermediate frequency wave. However, owing to the tendency to produce oscillations of undesired frequencies or "singing" in the individual amplifier circuits and in the system including the tandem connected circuits, it has been the practice either to limit the amplification effected in each circuit to a low value, or to provide each circuit and the system with anti-singing arrangements. Systems employing the first mode of procedure to effect a high degree of amplification require a large number of tandem connected circuits and those employing anti-singing devices are exceptionally complicated.

The present invention provides a simple arrangement adapted to overcome the disadvantages referred to above.

In accordance with this invention the detector is provided with a high resistance leak path through which the local oscillations are supplied to the detector, and tandem connected circuits, each selective of the wave to be repeated and including a three-electrode space discharge device, have dissimilar electrodes of certain of said devices interconnected by a path including a condenser of low impedance for certain of the frequency components to be amplified, so that a frequency band of appreciable width may be amplified to a high degree by a limited number of tandem connected amplifier circuits without causing distortion of the repeated wave, with the result that good quality reproduction of the signals may be accomplished.

The preceding statement, describing in a general way one arrangement embodying the invention, is given merely for the purpose of briefly disclosing its nature and is not intended to indicate the scope of the invention. The novel features and combinations which are believed to be characteristic of this invention will be pointed out with particularity in the subjoined claims.

One object of this invention is to permit a selective receiving circuit and a local source of oscillations, including a tuned frequency determining circuit, to be coupled to a detector in such manner that there will be no interaction between the selective and frequency determining circuits.

Another object is to improve the transmission characteristics of a system including tandem connected circuits selective of the frequency band and including electric discharge devices adapted to amplify the band of frequencies.

Still another object is to selectively effect a high degree of amplification of a relatively wide band of frequencies without causing distortion, whereby the different frequency components of the band may be faithfully repeated.

For a complete understanding of the invention reference should be made to the following specification read in conjunction with the attached drawing in which the single figure

illustrates a radio telephone receiver embodying the invention.

Referring to the drawing, there is shown an antenna 1 connected through a variable inductance coil 2 to ground. Coupled to the antenna is a receiving circuit comprising a coil 3 inductively associated with coil 2, an adjustable coil 4 and a variable condenser 5. The coils 3 and 4 and condenser 5 cooperate to constitute a tuned receiving circuit selective of the incoming wave. The coupling between the antenna circuit and the secondary circuit may be varied by adjusting the coil 2. The tuning of the secondary circuit may be varied to select different frequency waves by adjusting condenser 5 or the coupling between coil 3 and coil 4 or both.

An incoming wave incident upon the antenna is impressed upon the input circuit of detector 6 through the receiving circuit 3—4—5. Local oscillations of the desired frequency will also be supplied from source 7 to the input circuit of the detector 6.

The source 7 is herein shown by way of example as comprising a space discharge device 8 having its input and output circuits intercoupled in the well known manner to generate oscillations, the frequency of which is determined by a tuned circuit comprising coils 10, 10—A and condenser 11. The frequency of the oscillations generated may be controlled by adjusting condenser 11 or the coupling between coils 10 and 10—A. Coil 10 is inductively associated with a coil 12 included in the cathode-anode circuit of tube 8.

The detector 6 is provided with a leak path consisting of a resistance 9 of the order of 2 megohms. The input circuit including the leak path may be traced as follows: From the grid of discharge device 6, through the resistance 9, coils 10 and 10—A of the oscillator feed-back coupling, cathode of detector 6 and across the space within it to its grid.

The input circuit of the detector embodies a second path through which energy is supplied to it from the antenna and secondary circuits. This path extends from the grid of tube 6, tuned circuit 3—4—5 to the cathode of 6 and the space path between its cathode and grid.

The resistance 9 in addition to operating as a leak path for the detector 6 also serves as a coupling through which oscillations are supplied from the source 7 to the input electrodes of the detector. By virtue of this mode of coupling the oscillator and detector, the tuning of the selective receiving circuit 3—4—5 and that of the frequency determining circuit 10—11 of the oscillator are rendered substantially independent of each other. In other words, the tuned receiving circuit 3—4—5 may be adjusted to select the incoming wave without reacting upon the fre-

quency determining circuit 10—11 of the oscillator and vice versa.

Let it be assumed that the incoming wave comprises a carrier current modulated by speech, that the unmodulated component and the modulation products, i. e. both side bands, are received, and that speech constitutes a frequency band of 2500 cycles. The received wave will, therefore, have a band width of approximately 5000 cycles.

As thus far described, the system operates as follows: Having adjusted the circuit 3—4—5 to select the incoming wave and frequency determining circuit 10—11 of source 7 to supply oscillations of corresponding frequency differing from the incoming wave, there will be produced in the output circuit of the detector waves modulated by speech, which corresponds to the sum and to the difference of the received frequency and the frequency of the local oscillations. As is usual in successive detection systems, especially for short wave transmission, the difference frequency is selected and amplified by the intermediate amplifier comprising three tandem connected circuits each selective of the difference frequency and including one of the space discharge devices 13, 14 and 15, respectively.

The unmodulated component of the intermediate frequency wave will be assumed to be of the order of 50,000 cycles, hence the total frequency band supplied to the intermediate frequency amplifier will extend from 47,500 cycles to 52,500 cycles, i. e. will comprise a frequency band of 5,000 cycles.

Secondary windings of the coupling transformers 16—17—18 are designed to each cooperate with the inherent reactances of the circuits, including the internal capacity between the electrodes of the tubes 13—14—15, respectively, to select the intermediate frequency wave. The voltage of the intermediate frequency wave impressed upon the input electrodes of the amplifier 13 may be controlled by the potentiometer 19 connected in parallel with the secondary winding of the transformer 16.

The amplified intermediate frequency wave is supplied through the coupling transformer 20 to the device 21, herein shown as a three-electrode space discharge device, in which it is detected to yield speech currents. These currents are impressed upon the device 23 through the transformer 22 and after being amplified by the device 23 are supplied to the receiver 24. A by-pass condenser 25 is connected across the primary of transformer 22 in order to afford a low impedance path for any intermediate frequency carrier present in the output circuit of detector 21.

In the operation of the system described above, it was found that when the intermediate frequency amplifier was adjusted to effect the desired amplification, namely, of

the order of 8,000 to 10,000, oscillations of undesired frequencies or singing sometimes occurred in this portion of the system. Even though oscillations did not occur, the regeneration or tendency toward oscillation served to accentuate certain components lying within the intermediate frequency band. This resulted in the transmission characteristic of the amplifier being very irregular and the signals reproduced by the receiver 24 were of exceptionally low quality, and in some cases almost unintelligible.

It appears probable that the inherent reactances of the amplified circuit, including the inter-electrode capacities of the tubes and inductive and capacity effects of the inter-stage transformers and connecting leads, cooperate to produce resonant paths for certain frequency components lying within the band, these resonant paths being either in the circuits individual to each amplifying device or in the intercoupled circuits comprising the complete amplifier. Under these conditions the components selected by the resonant paths were amplified to a greater extent than the other components, with the result that regeneration or oscillations occurred at the selected frequencies.

In order to overcome the above noted disadvantages, the plate of the first amplifier 13 was connected to the grid electrode of the third amplifier 15 by a path including a condenser 26 of small capacity.

When a condenser 26 of the proper capacity is employed, it has been found that the transmission characteristic of the amplifier was substantially uniform over the frequency range of the band being amplified. Further, it was found that if the capacity of this condenser was increased beyond the proper value to prevent singing in the circuit, it resulted merely in a reduction of the amplification effected. It will, therefore, be apparent that the actual value of this condenser is not very critical and hence that a capacity of fixed value requiring no adjustment, as is the case with the usual stabilizer, may be applied to the system.

What is claimed is:

1. An amplifier comprising a plurality of tandem connected circuits selective of a wave to be amplified each circuit including a three-electrode space discharge device, means for supplying to said amplifier a wave extending over a relatively wide frequency band, and means for preventing regenerative operation of said amplifier, said last mentioned means comprising a capacity element connecting an output electrode of one device with an input electrode of another device other than the adjacent device.

2. An amplifier comprising a plurality of tandem connected circuits, each selective of a wave to be amplified and including a three-electrode space discharge device, means for

supplying to said amplifier a wave extending over a relatively wide frequency band, and means for preventing distortion of said wave, said last mentioned means comprising a capacity element connecting the plate of one discharge device to the grid of a following discharge device other than the next succeeding device.

3. An amplifier comprising a plurality of tandem connected circuits each selective of a wave to be amplified, a space discharge device having a cathode, an anode and a grid included in each of said circuits, means for supplying to said amplifier a wave extending over a relatively wide frequency band, and means, connecting the anode of one of said discharge devices to the grid of a following discharge device other than the next succeeding one, for preventing distortion of the amplified wave.

4. An amplifier comprising a plurality of tandem connected circuits each including a space discharge device having a cathode, an anode and a grid, inductive means for connecting said circuits in tandem and for cooperating with the inherent capacity between the electrodes of said devices to constitute selective circuits, means for supplying to said amplifier a wave extending over a relatively wide frequency band, and means for preventing regeneration and distortion of the amplified wave band, said last mentioned means comprising a reactance element for connecting a plate electrode of one discharge device with a grid electrode of another discharge device other than the adjacent discharge device.

In witness whereof, I hereunto subscribe my name this 14th day of August, A. D., 1925.

SIDNEY E. ANDERSON.