

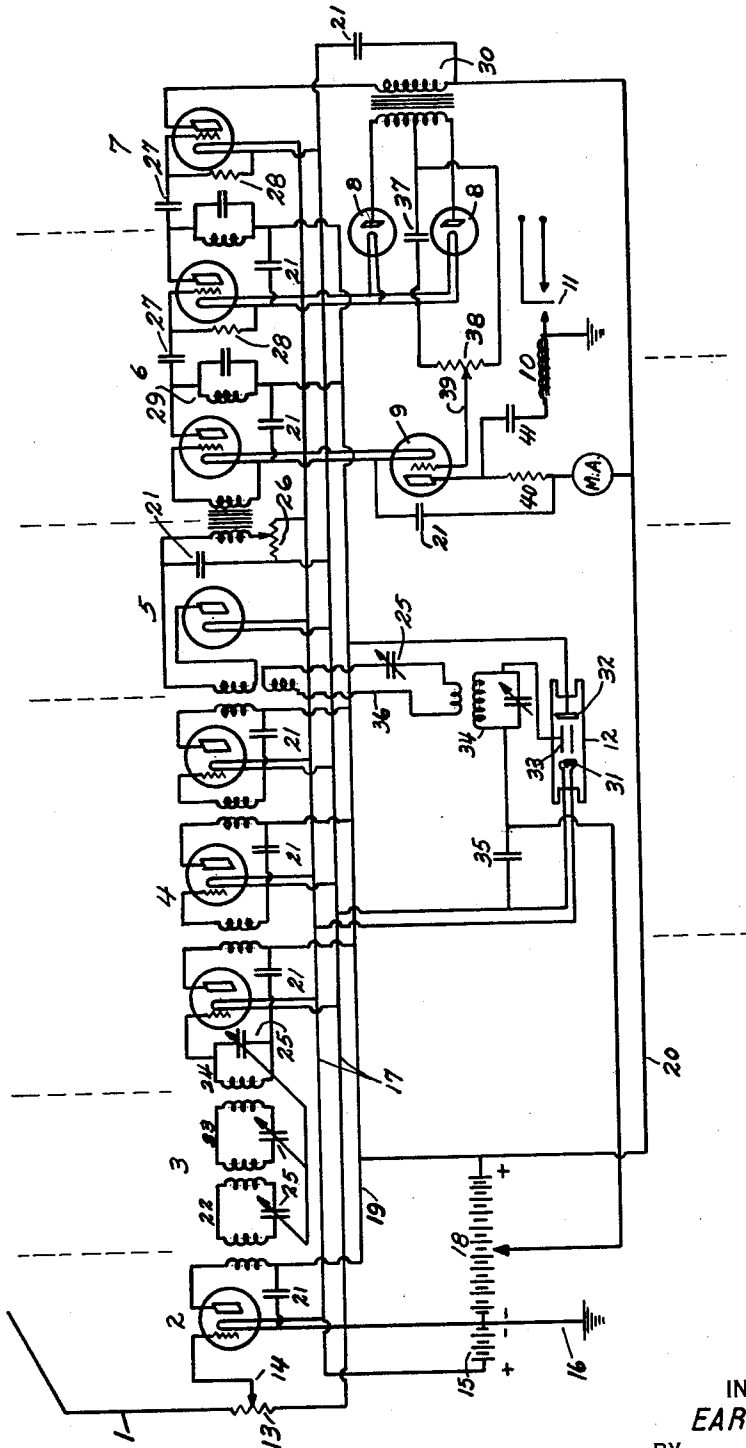
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RADIORECEIVER

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RADIORECEIVER

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6 Claims. (Cl. 250—8)

This invention relates to improvements in radio-receivers or receiving apparatus for signalling; especially receivers intended chiefly for use in radiotelegraphy.

5 An object of the invention is to provide a novel radioreceiver which is capable of operating upon the heterodyne principle; and which therefore comprises suitable circuits for the incoming oscillations, a source of local oscillations, means for
10 combining the incoming oscillations with the local oscillations, and means for actuation by oscillations of the resultant or beat frequency to enable the incoming signals to be perceived.

Another object of the invention is to provide a
15 heterodyne receiver designed to admit incoming oscillations having frequencies extending over a band of predetermined width, with a detector in which said incoming oscillations are combined with local oscillations; and suitable devices including circuits tuned to the resultant or beat frequency for the efficient operation of suitable appliances for enabling the incoming signals to be
20 perceived and understood.

A further object of the invention is to provide
25 a radioreceiver comprising selector circuits for passing a band of frequencies; devices for giving radiofrequency amplification of the incoming oscillations over a corresponding range of frequencies; said devices being coupled by aperiodic or
30 untuned circuits; additional devices for audiofrequency amplification; a suitable detector between the devices for radiofrequency amplification and the devices for audiofrequency amplification; the last named devices comprising tuned
35 circuits connected with output means; and a local oscillator coupled to the detector and adjustable to deliver oscillations differing from the incoming oscillations by a frequency substantially equal to the resonant frequency of said tuned circuits.

40 Other objects and advantages of the invention will appear from the following description taken with the accompanying drawing, which show one embodiment of this invention. But this disclosure is illustrative only, and right is reserved to
45 make changes which do not exceed the scope of the invention or the broad meanings of the terms in which the appended claims are expressed.

The drawing shows an outline of an arrangement of circuits and other elements according to
50 the invention.

The receiver circuit comprises an antenna 1, or collector connected to a suitable antenna, which may be of the directional type. The incoming oscillations reaching the antenna are passed
55 through a coupling stage 2 comprising a three-element vacuum tube; then by way of a series of coupled tuned circuits 3 to a stage of radiofrequency amplification indicated as a whole by the numeral 4. This stage includes a number of amplifier vacuum tubes in tandem, the last of which

being coupled to a rectifier and detector 5. Beyond the rectifier is an audiofrequency amplification and filter stage 6 coupled to an output stage 7. The anode current of this stage is converted into unidirectional current by a pair of
65 rectifiers 8; and by a relay coupling stage comprising a vacuum tube 9 the signals are impressed upon a relay comprising a coil 10 and a movable contact 11, which controls the circuit to the signal recorder.

The local oscillator is shown at 12 and is coupled to the anode circuit of the detector 5. This oscillator is adjusted so that the frequency thereof differs from the frequency of the incoming oscillations to give the beat frequency required.
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To afford suitable volume control the collector
75 1 includes a series resistance 13, acting as a potentiometer, and cooperating therewith is a movable contact 14 connected to the grid or control electrode of the tube in the coupling stage 2. A suitable source of electric current 15 energizes
80 the cathode of this tube; one pole of this source 15 being grounded at 16. Through a pair of main conductors 17 the same source of current supplies the filaments of the tubes of the stages
85 4, 6 and 7, the rectifier 5, the rectifiers 8 and the coupling tube 9 in parallel. At 18 is a source of electric energy of higher potential; grounded at its negative end like the source 15; and with its opposite terminal joined to a lead 19 to the
90 anodes of the tubes of the stages 2, 4 and 6, which are supplied in multiple. A similar lead 20 from the positive pole of the source 18 connects the anodes of the tubes 7 and 9 in parallel; also a branch conductor from the anode of the
95 oscillator tube 12 to the lead 19 enables the potential of the source 18 to be impressed upon this electrode also. A suitable by-pass condenser 21 is connected in the output circuit of the
100 tube in the coupling stage 2 between the anode and the filament, so that the high frequency oscillations received on the collector 1 will not reach the battery 18.

The output circuit of this tube contains a transformer coil to enable it to be coupled to the
105 stage 3 which comprises tuned circuits 22, 23 and 24. The circuit 22 contains a secondary coupled to the primary of the stage 2, and a primary in series with said secondary to couple the circuit 22 to the circuit 23. Similarly the
110 circuit 23 includes a primary coil coupled to the secondary of the circuit 24. All three of these circuits have a condenser indicated at 25 and these condensers are preferably arranged so that they can be adjusted in unison. These circuits have the effect of a band pass selector and will
115 transmit oscillations within a band or range of frequencies having a predetermined width. The last circuit 24 constitutes a multiple tuned circuit in the input circuit of the first tube of
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the radiofrequency amplification stage 4. This stage as shown comprises three amplifier tubes with the output of each coupled to the input of the next by means of aperiodic or untuned coupling transformers. Any suitable design of tubes will serve the purpose but it is preferable to use tubes of novel form with the cathodes between the anodes and grids; both the grids and the anodes being cylindrical and the cathodes having the shape of spirals and spaced farther from the anodes than from the grid. Such a tube will give an effect similar to that of a screen grid tube; and in operation the filament and the electrons emitted thereby provide a very effective screen or electrostatic shield between the anode and the grid; the control action of the grid on the electrons between the filament and the anodes being in no wise impaired.

These tubes may be of the three element screened type as more fully described in the pending application for U. S. Letters Patent, Serial No. 524,254, filed March 21, 1931. Such tubes are screened to prevent coupling between the grid and plate, as described in the application aforesaid. This type of tube requires no external neutralization and therefore none is shown herein. However, the circuit herein shown and described is not inefficient, but on the other hand is highly efficient because of the characteristics of the aforesaid tubes in combination with the circuit herein described.

Beyond the last tube of the stage 4 is the rectifier and detector, which has the form of a vacuum tube containing an anode and a heated cathode only. The anode of the last tube in the stage 4 is electromagnetically coupled to the anode circuit of the detector, and this latter circuit is also coupled to the circuit of the oscillator 12 by a tuned link as will be described later. The anode or positive electrode of the detector is supplied with current from the source 15, which impresses a relatively low potential thereon through resistance 26 connected across the leads 17; the anode of the rectifier tube being connected to this resistance through a movable terminal so that the voltage can be adjusted. In series with this movable terminal and the anode is the primary coil of an iron-core transformer by which the detector is coupled to the input of the first tube of the stage 6. The output of this tube is electrostatically coupled to the input of the second audioamplifier tube of the stage 6 through a condenser 27; and this last named tube is similarly coupled to the tube of the output stage 7. The anode circuits of both tubes of stage 6 contain parallel tuned circuits comprising inductance and condensers shown at 29; and the grid circuits of the second tube of the stage 6 and the tube of the output stage 7 contain leak resistances 28. One of the tuned circuits 29 may be dispensed with if desired and still the required selectivity could easily be obtained. Also inductive coupling instead of electrostatic coupling could be utilized.

The anode circuit of the single tube of the output stage is connected with the conductor 20 through the primary of an iron-core transformer 30. The opposite terminals of the secondary of this transformer are united to the anodes of the rectifiers 8. The cathodes of the rectifiers 8 are in parallel and the midpoint of the secondary of the transformer 30 is connected to these cathodes.

The oscillator 12 comprises an evacuated container enclosing a filament 31 connected across the lead 17 and an anode 32 connected to the

main plate conductor 19. These two electrodes are at opposite ends of the tube 12 and between them is a third electrode having the form of an open cylinder with one end presented toward the electrode 32 and the other toward the filament 31. The circuit of the electrode 33 contains a parallel tuned circuit including inductance and a variable condenser in series with the condenser 35 joined to the negative terminal of the filament 31. By means of the circuit 34 the frequency of the tube 12 can be regulated as desired. The inductance of the circuit acts as the primary of a transformer by which the circuit of the electrode 33 is coupled to the link circuit 36; which, as already described, is inductively coupled to the anode circuit of the rectifier 5. The adjustable condenser 25 enables this link circuit to be tuned to the frequency of the tube 12.

The midpoint of the secondary of the transformer 30 is joined to the negative electrodes of the rectifiers 8 through a lead containing a condenser 37 and across the terminals of this condenser is bridged a resistance 38. The two elements 8 thus give full wave rectification and supply a fluctuating voltage to the relay coupling tube 9. This tube is also of the three element variety with the grid thereof connected by a movable terminal 39 to the resistance 38, which serves as a potentiometer. Thus the input voltage of the tube 9 can be adjusted. The voltage of the anode of the tube 9 is controlled by a fixed resistance 40. The relay coil 10 is in shunt with the fixed resistance 40, being connected at one end to the ground and at the other end to the anode of the tube 9 through a fixed condenser 41 to provide neutralization of the inductance of this relay, and in consequence reducing the electrical inertia of the relay circuit. This arrangement enables the relay to operate very efficiently at high signalling speeds. The tube 9 functions as a very low frequency amplifier comparable to the speed of signalling; its output being approximately 35 cycles per hundred words per minute.

All of the tubes except the rectifier tubes 5 and 8 have by-pass condensers 21 in the output circuits thereof. The filaments and plates are all supplied from batteries; although the receiver could just as well be operated with alternating current for the filaments and rectified alternating current for the anodes. No grid bias on any of the tubes is employed except that which is inherently obtained by joining the grids of the amplifier tubes to the negative terminals of the filaments.

In practice the incoming oscillations picked up by the collector are passed through the stage 2 and the selector 3 which may transmit a band of a certain width. In the stage 4 the oscillations are amplified, and in the detector of the stage 5 the signal oscillations are combined with the oscillations delivered by the oscillator 12 which beat with the signal oscillations. The audiofrequency stage 6 by reason of the tuned circuit 29 will operate in synchronism with this beat frequency; which is passed on through the tube of the stage 7, then rectified by the elements 8 and transmitted by way of the coupling tube 9 to the key relay 10.

While the tubes of the radiofrequency amplification stage 4 are coupled by untuned transformers, the correct design of these transformers will afford a condition of approximate resonance over a band of frequencies of substantially the same width as that of the selector stage 3, and this makes possible a gain in each stage that is quite

large enough for the purposes of this invention.

The type of receiver above described is of the so-called single sub-channel variety; that is, only one sub-channel at a time can be received by reason of having only one audiofrequency filter 6, but, also it is capable of receiving any desired sub-channel by simply adjusting the heterodyne beat to conform with the resonant period of the audiofrequency filter. The choice of audiofrequency filter period is dependent to some extent upon the frequency spacing between sub-channels. For example, where the sub-channel spacing is 750 cycles the audiofrequency filter is tuned to approximately 2200 cycles; so that, to receive any desired sub-channel, the heterodyne oscillator is tuned to provide a 2200 cycle beat with the desired sub-channel. This frequency of 2200 cycles is chosen as that beat which is least susceptible to heterodyne interference between sub-channel frequencies. To explain further, let it be assumed that a separation of sub-channels of 1000 cycles is used, likewise that the audiofrequency filter is tuned to respond to 1000 cycles. It can then be seen that regardless of which sub-channel was being heterodyned by the local oscillator there would still exist in the detector circuit thousand cycle beats between adjacent channels, and obviously the audiofrequency filter stages would respond equally well to all of these beats and make impossible the selection of any one sub-channel. So then, there exists a mathematical relationship between the sub-channel separation frequency and the beat frequency farthest removed from sub-channel beats or beats from their harmonics.

This type of receiver by virtue of its flexibility has great utility, particularly for stations that do not necessarily make use of all the possible sub-channels simultaneously. For simultaneous multiple channel reception, the output of the detector tube through perhaps one additional audioamplifier would be fed into audiofrequency filter stages, one for each sub-channel, and separated by a frequency equivalent to the sub-channel frequency separation. Each filter stage output circuit would then be connected to its own relay through a rectifier and coupling system as described above.

What is claimed is:

1. A radiotelegraph receiver comprising devices and connecting circuits for giving radiofrequency amplification of incoming oscillations, devices and connecting circuits for audiofrequency amplification, an intervening detector having a cathode and an anode and a local oscillator the output of which is delivered to the anode of said detector electromagnetically via a tuned link along with said incoming oscillations, said audiofrequency devices being electrically tuned to a fixed frequency, said local oscillator having adjustable means for controlling the frequency of the generated oscillations independent of the tuning means in said link.

2. A radioreceiver comprising a vacuum tube, having an anode, elements for effecting full-wave rectification of current in the circuit of said anode, a relay, a vacuum tube to couple said relay to the rectifying elements, said tube containing an anode with a resistance in series therewith, and a condenser in series with said relay, said relay and said condenser being in multiple with said resistance.

3. A radiotelegraph receiver comprising devices for radioamplification, devices for audioamplification, an intervening detector comprising a cathode and an anode, a source of electric energy for said cathode, a resistance in parallel with said cathode, a conductor united to a movable terminal of said resistance at one end and to the anode at the other end, and a local generator of oscillations adapted to deliver via a tuned electromagnetic coupling link energy to the anode of said detector circuit for the purpose of heterodyning with incoming oscillations also delivered to the anode of said detector circuit thereby producing in said detector anode circuit a plurality of beat frequencies, said devices of audiofrequency amplification being electrically tuned to respond to only one of said beat frequencies.

4. A radiotelegraph receiver comprising devices for radiofrequency amplification, similar devices for audioamplification, an intervening diode detector, a source of local oscillation and a tuned link through which the oscillations of said source are delivered to an anode of said detector for the purpose of producing beats in said detector circuit with incoming oscillations, said audioamplification devices adapted to respond to and to amplify only one of said beats, said amplified beat being within the range of audible frequencies.

5. A radiotelegraph receiver comprising devices for producing radiofrequency amplification, a collector, a three element vacuum tube adjacent said collector, a plurality of tuned circuits between said devices and said collector, said radiofrequency amplification devices adapted to respond to a wide band of frequencies and having connected to its output a detector circuit comprising a two element rectifier, also electromagnetically coupled to the anode of said detector circuit via a tuned link, a source of local oscillation having adjustable frequency characteristics and adapted to produce difference beat frequencies in said detector circuit with incoming oscillations connected to said detector circuit, and a device for audiofrequency amplification having a fixed frequency characteristic, said local oscillation adjusted to produce a beat with the desired incoming oscillation of the same frequency as that to which said audio device is tuned.

6. A radiotelegraph receiver comprising a collector, a plurality of circuits tuned to pass incoming oscillations having frequencies extending over a band or range of predetermined width, means comprising a vacuum tube to couple said circuits to said collector, radiofrequency amplifying tubes connected by untuned circuits to which said tuned circuits deliver, a diode detector having a cathode and an anode for receiving said amplifying oscillations, a generator of local oscillations electromagnetically coupled via a tuned link to the anode of the detector, the incoming and local oscillations combining in said detector to produce oscillations of a different frequency and means for amplifying oscillations of said different frequency, said resultant different frequency lying within the audible range of frequencies and said means comprising one or more circuits tuned to said different frequency whereby oscillations of any other frequency will be filtered out.

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