Oct. 27, 1936. N. M. RUST ET AL 2,058,512

RADIO RECEIVER

Filed May 11, 1935 2 Sheets-Sheet 1

Fig. 1

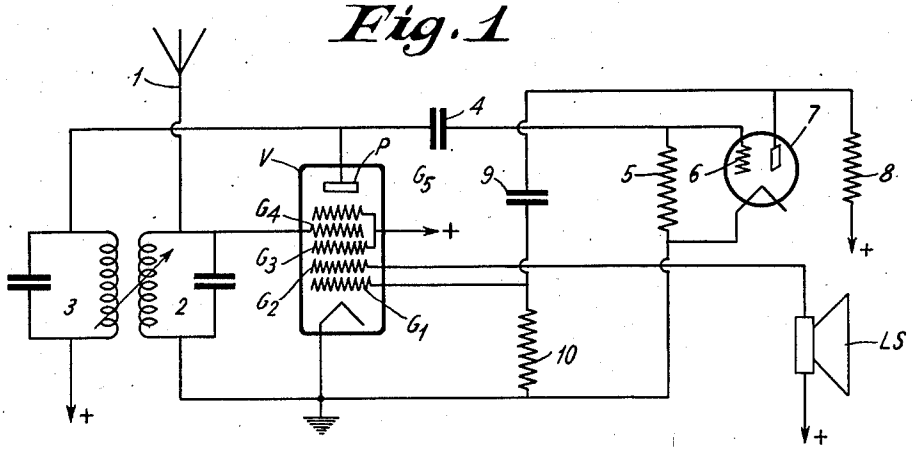


Fig. 2

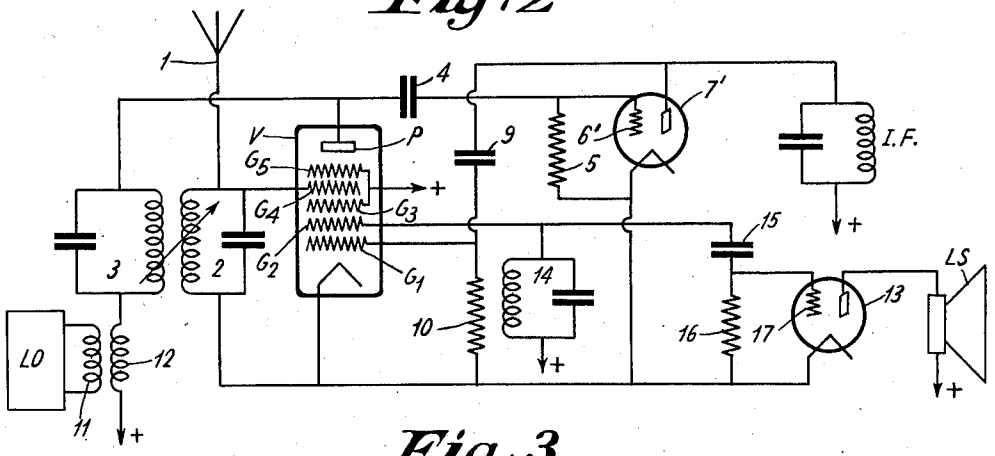
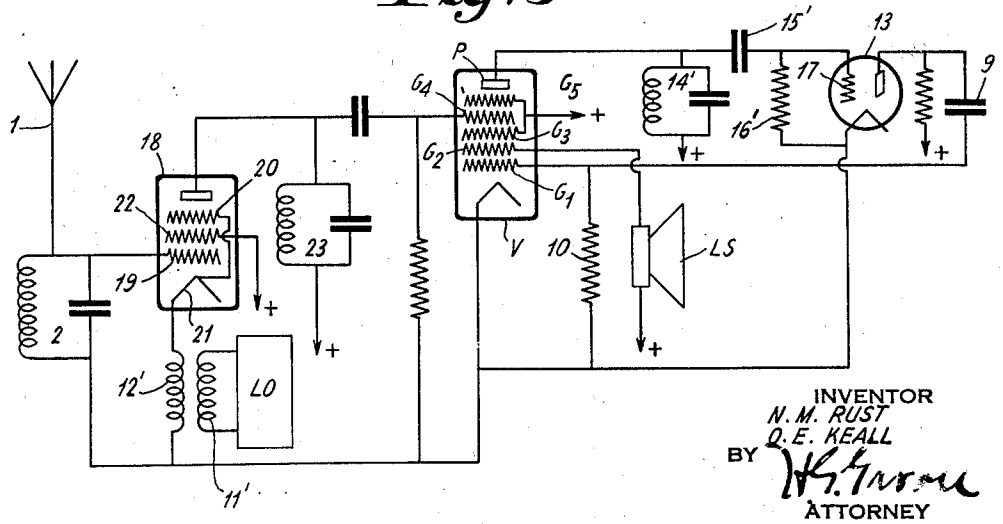


Fig. 3



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Fig. 4

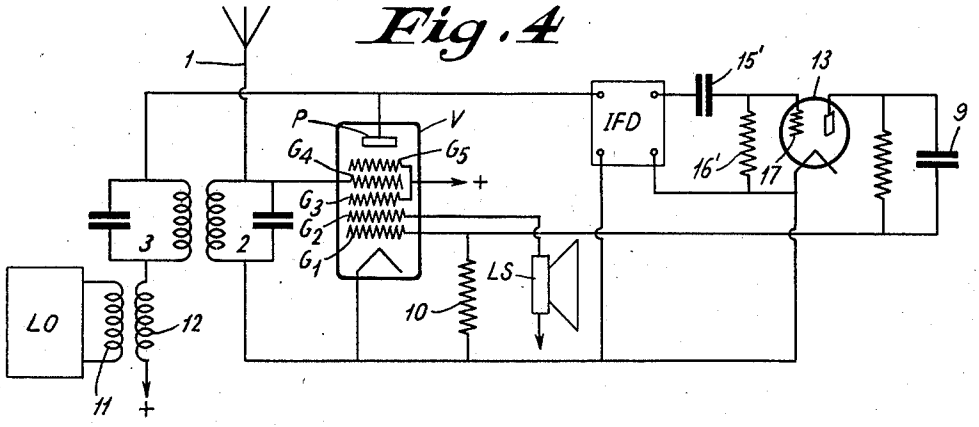


Fig. 5

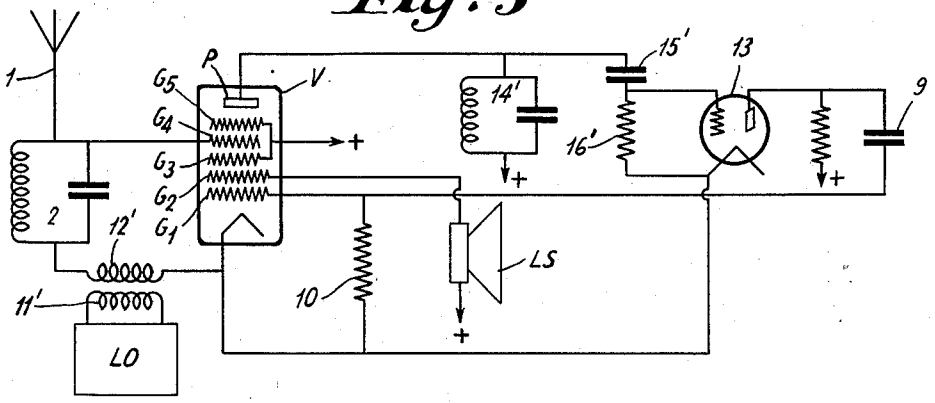
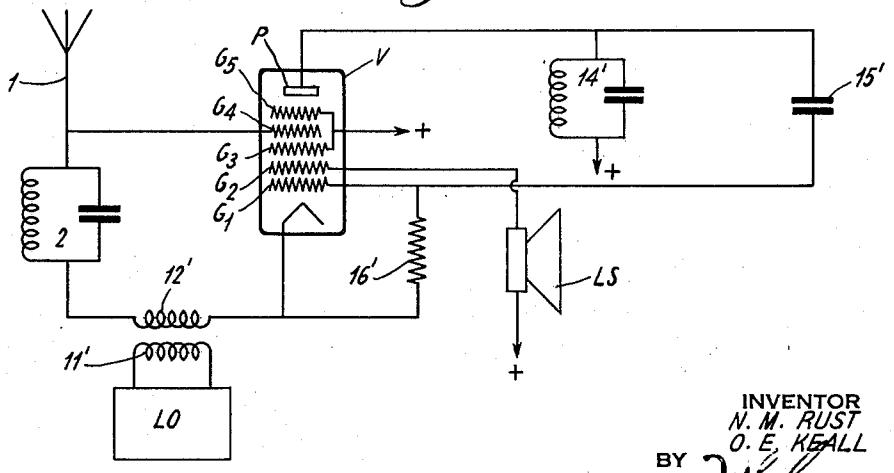


Fig. 6



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Patented Oct. 27, 1936

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UNITED STATES PATENT OFFICE

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RADIO RECEIVER

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Application May 11, 1935, Serial No. 20,914
In Great Britain May 28, 1934

12 Claims. (Cl. 250—20)

This invention relates to radio receivers and more particularly to radio receivers embodying multi-grid valves employed in reflex circuits such that one portion of the valve operates as an amplifier for energy at one frequency and another portion of the valve operates as an amplifier for amplifying energy at another frequency.

An important feature of the invention is concerned with providing an improved receiver having a reflex multi-grid valve arrangement wherein one portion of the valve amplifies modulated radio frequency carrier energy and another portion amplifies audio frequency energy derived from demodulation of said carrier energy, and wherein reaction between the audio frequency energy and the input modulated carrier energy is obtained, this feature of the invention offering the advantage of relatively distortionless high amplification from a single valve. Other features of the invention, however, reside in improved superheterodyne receivers wherein a multi-grid valve is used for reflex purposes.

In the following description of embodiments, heptode valves are referred to. By the expression "heptode valve" is meant a valve having a cathode, five grids and a plate, the grids being placed in succession in the electron stream from cathode to plate. Of the five grids, the middle grid and also the grid nearest the anode, act as screen grids and are commonly connected together within the valve envelope. A heptode valve may be regarded as consisting of a triode portion comprising essentially the cathode and the two grids nearest adjacent thereto, and a tetrode portion comprising essentially the cathode the fourth and fifth grids and the plate, the fifth grid acting analogously to the screen grid of a screen grid valve. The middle grid acts as a screen between the triode and the tetrode portions of the valve.

For a better understanding of our invention reference is made to the accompanying drawings in which:

Fig. 1 is a schematic circuit diagram of the invention as applied to a tuned radio frequency receiver, and

Figs. 2 to 6 are schematic circuit diagrams of the invention as applied to a superheterodyne type of receiver.

Referring first to Fig. 1 received modulated radio frequency carrier voltage e. g. from an aerial 1 is applied by a tuned carrier frequency circuit 2 to the fourth grid G_4 of a heptode valve V the plate circuit of which contains the usual carrier frequency tuned circuit 3 which is connected at one end to the plate P and at the other end to a suitable source of plate potential (not shown). The output from the valve V is applied to any suitable demodulator e. g. a diode, triode, or tetrode detector or crystal or similar rectifier. As shown the plate P is resistance capacity coupled by means of a condenser 4 and resistance 5 to the control grid 6 of a demodulating detector constituted by a triode 7. The anode of the valve 7 receives positive potential from a source (not shown) through a resistance 8 and is resistance capacity coupled by the elements 9, 10, back to the first grid G_1 of the heptode. The second grid G_2 of the heptode is connected through an audio frequency utilization device such as the primary of a coupling transformer feeding into a power amplifier or, as shown, through a loudspeaker LS to a suitable positive potential source (not shown) and acts as an output anode as regards amplified audio frequency. The third grid G_3 which is connected to the fifth grid G_5 (usually within the valve V) is maintained at a suitable fixed positive potential from a source (not shown) and the fourth grid G_4 to which the modulated carrier input is applied is connected through the tuned input circuit 2 already mentioned to the common negative terminal of the high tension supply source or sources which terminal may be earthed as shown. The said negative terminal may be directly connected to the cathode as illustrated but it is preferred to connect it thereto through the usual capacity shunted bias resistance (not shown).

The audio frequency reflexed on to the first grid G_1 will produce an effect on the modulated signal in the plate circuit and its sense might be chosen either so that the degree of modulation of the carrier frequency was increased or so that it was decreased. It is a feature of this invention that the latter arrangement is employed, as considerable advantage is gained by resultant decrease in audio frequency harmonics which may be caused by nonrectilinearity of the valve characteristics. Had the audio frequency been applied to the first grid in the other sense, the degree of modulation could have been increased but there would also have been considerable increase in the audio frequency harmonics and an early limit to the amplification obtainable would be reached, owing to the tendency to self-oscillation at audio frequencies that would exit. Using the circuit in the sense described above (i. e. effective reduction of modulation in the plate circuit) a far greater degree of amplification can be obtained without danger of self-oscillation at audio frequencies, especially when deeply modulated carrier frequency energy is being received.

The tuned circuit 3 in the plate circuit of the heptode V may be variably coupled as indicated by the arrow to the tuned input circuit 2 to produce reaction at the carrier frequency, and in this connection a further advantage of the invention resides in the ability to use a higher degree of reaction with stability than could have been used had the sense of the audio frequency on the first

grid been such as to produce an effective increase of the degree of modulation of the modulated carrier frequency in the plate circuit.

Fig. 2 illustrates another embodiment of the invention as applied to a superheterodyne receiver. In this embodiment received modulated radio freqency energy is applied to the input electrode of the tetrode portion i. e. to the fourth gride G_4 of a heptode valve V so that it is amplified thereby, and a locally generated oscillation from a source LO is superimposed via coupled coils 11, 12 and thus mixed with the resulting amplified energy in the plate circuit of the valve V. The "mixed" energy is coupled by elements 4, 5, to the input circuit of—and is thus detected by—a first detector 7' of any known type and shown as a triode whose input grid is marked 6'. The output energy from the first detector is, of course, of intermediate frequency and this is applied via elements 9, 10, to the input electrode of the triode portion of the heptode, i. e. to the grid G_1 the output electrode of this triode portion, i. e. the grid G_2 feeding through a demodulating detector 13 of any known type to an audio frequency utilization means LS. As shown the grid G_2 which, of course acts as an anode is coupled by the intermediate frequency tuned circuit 14 the condenser 15 and the resistance 16 to the grid 17 of a triode 13 which acts as the demodulator. IF is also an intermediate frequency tuned circuit.

In another superheterodyne receiver in accordance with this invention and shown in Fig. 3 received modulated radio frequency energy from 1 is mixed with locally generated oscillations from LO by means of pentode valve 18 whose innermost grid 19 acts as an input grid for the radio frequency and whose innermost grid-cathode circuit contains a coil 12' coupled to a coil 11' fed from the oscillator LO. The suppressor grid 20 is connected to the cathode 21, as in the usual way, the screen grid 22 receives positive potential from a source, not shown, and the anode feed circuit includes an intermediate frequency tuned circuit 23. The intermediate frequency output from the first detector valve 18 is applied to the input electrode of the tetrode portion of a heptode V i. e. to the grid G_4 the amplified output from the plate being passed e. g. by means of the intermediate frequency circuit 14' and elements 15' 16' to any known form of demodulated detector e. g. to the grid 17 of the demodulating triode 13 whose output is fed as shown, back to the input electrode G_1 of the triode portion of the heptode, the output electrode G_2 of this portion feeding into an audio frequency utilization means exemplified by the loudspeaker LS. In the arrangement of Fig. 3 carrier frequency reaction may, if desired, be provided in much the same way as in Figs. 1 and 2 (by variably coupling the appropriate coils) with like advantages. Similarly reaction may be provided in the embodiment of Fig. 4 to be described below.

In yet a further superheterodyne receiver in accordance with this invention and illustrated in Fig. 4 received modulated carrier frequency energy from 1, 2, is applied to the input electrode G_4 of the tetrode portion of a heptode valve V and the amplified energy from the anode is mixed with a locally generated oscillation from a source LO as in Fig. 2, and detected in any known first detector whose intermediate frequency output, after such amplification as may be desired, is demodulated by a demodulator valve 13 the resulting demodulated energy being applied as in Fig. 3 to the input electrode G_1 of the triode portion of the heptode, the output electrode G_2 of this portion feeding, as before, into an audio frequency utilization means LS. In Fig. 4 the first detector and intermediate frequency amplifier, if any, are not separately shown but are within the rectangle IFD.

In the superheterodyne receiver of Fig. 5 both local oscillations from LO and radio frequency oscillations from 1, 2, are impressed upon the fourth grid G_4 of a heptode V which by reason of the non-rectilinear characteristic of the tetrode portion of a heptode, acts as a first detector, so that an intermediate frequency output appears in the circuit of the plate P. This output is applied, by means of the elements 14' 15' 16' to the grid of a demodulating triode 13, as in Fig. 3, the output of which is amplified, again as in Fig. 3, by the triode portion of the heptode and fed to a utilization device such as the loudspeaker LS.

The modification of Fig. 6 differs from that of Fig. 3 principally in that the separate demodulator valve 13 is dispensed with and the intermedate frequency output from V, after such amplification as may be desired (none is shown provided for in Fig. 6) is fed back to the triode portion of the heptode which portion itself acts as the demodulating detector.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is:—

1. In an amplifying arrangement, the combination of a vacuum tube having a cathode, a signal control grid, a plate, a second and a third grid located between said cathode and plate, means for applying a modulated radio frequency signal voltage across said signal control grid and cathode, a detecting device connected to said plate, means arranged to apply the output energy of said detecting device to said second grid in such phase relationship as to decrease the degree of modulation of said signal energy and an output circuit connected to said third grid.

2. In an amplifying arrangement, the combination of a vacuum tube having a cathode, a signal control grid, a plate, a second grid and a third grid located between said cathode and plate, a circuit tuned to the incoming signal frequency connecting said signal control grid and cathode, a circuit tuned to the signal frequency connected to said plate, a feedback connection between said last named circuits, a detecting device connected to said plate, means for applying the output energy of said detecting device to said second grid and an audio frequency translating device connected to said third grid.

3. In an amplifying device, the combination of a vacuum tube having a cathode, a signal control grid, a plate and first and second grids located between said cathode and plate, a circuit tuned to a desired signal frequency connecting said control grid and cathode, means for impressing a local oscillation frequency differing from said signal frequency by a desired intermediate frequency on said plate, a first detector coupled to said plate, means for impressing the intermediate frequency output energy of said detector on said first grid, and a second detector having an input circuit coupled to said second grid.

4. In a radio receiver, the combination of a vacuum tube having a cathode, a signal control grid, a plate and a second and a third grid located between said cathode and plate, a circuit tuned to an incoming signal frequency connected between said signal control grid and cathode, a circuit

tuned to the signal frequency connected to said plate, an inductive feedback connection between said named circuits, means for causing the current between said plate and cathode to vary at a local oscillation frequency differing from said signal frequency by an intermediate beat frequency, a first detector coupled to said plate, a capacity coupling the output of said detector to said first grid, a circuit tuned to the intermediate frequency coupled to said third grid, and a second detector coupled to said third grid.

5. In a radio receiver, the combination of a detector valve having input and output circuits, means for impressing signal frequency voltage on said input circuit, means for impressing a local oscillation frequency voltage on said input circuit, an amplifier valve having a control grid, a cathode, an anode and second and third grids located between said cathode and anode, means coupling the output circuit of said detector to said control grid, a second detector coupled to said anode, means coupling the output of said second detector to said second grid and an audio frequency translating device coupled to said third grid.

6. In a radio receiver, the combination of a vacuum tube having a cathode, an anode, a signal control grid, a screen grid located between said signal control grid and anode, and third and fourth grids located between said signal control grid and cathode, a circuit tuned to a desired signal frequency connected to said signal control grid and cathode, means for causing the current between said anode and cathode to vary at a local oscillation frequency, a first detector coupled to said anode, a second detector having an anode and an input circuit, means coupling said input circuit to the output of said first detector, a capacity coupling between the anode of said second detector and the third grid of said first named tube and an audio frequency output circuit connected to said fourth grid.

7. In a radio receiver, the combination of a first detector and amplifier tube having a cathode, an anode, a signal control grid, and a second and third grid located adjacent said cathode, a screen-grid located between said signal control grid and said third grid, means for applying a steady positive potential to said screen grid, means for applying to said signal control grid a desired radio signal frequency and a local oscillation frequency, an output circuit connected to said anode, a detector coupled to said output circuit, means for impressing the detected signal variations on said second grid and an audio frequency output circuit connected to said third grid.

8. In a radio receiver, the combination of a vacuum tube having a signal control grid, a cathode, an anode and second and third grids, a circuit tuned to a desired signal frequency connected between said signal control grid and cathode, means for impressing a local oscillation frequency differing from said signal frequency by a predetermined intermediate frequency on said signal control grid, a circuit tuned to the intermediate frequency and connected to said anode, means coupling the high potential end of said last named circuit to said second grid and an audio frequency output circuit connected to said third grid, the portion of said valve comprising said cathode, second and third grids being arranged to detect the modulations of the intermediate frequency.

9. In a radio receiver, the combination of a vacuum tube having a cathode, a signal control grid, a plate and second and third grids located between said cathode and signal control grid, an input circuit connecting said signal control grid and cathode, means for impressing signal currents on said input circuit, an output circuit connected to said plate and including a feed-back connection to said input circuit, means for causing the current between said plate and cathode to vary at a local oscillation frequency, a first detector coupled to said plate, means coupling the output of said detector to said second grid and a second detector having an input circuit coupled to said third grid.

10. In a radio receiver the combination of a first detector having a cathode, a control grid, an anode and a screen grid located between said control grid and anode, an input circuit connecting said control grid and cathode, an antenna coupled to said input circuit, a source of local oscillations, means coupling said source to said input circuit, an amplifier valve having a control grid, a cathode, an anode and second and third grids located between said cathode and control grids, means coupling the anode of said first detector to the control grid of said amplifier, a second detector having an input circuit coupled to the anode of said amplifier, means coupling the output of said second detector to said second grid and an audio frequency output circuit connected to said third grid.

11. In a radio receiver the combination of a vacuum tube having a cathode, an anode, a signal control grid, a screen grid located between said signal control grid and cathode, means for applying a positive potential to said screen grid, third and fourth grids located between said screen grid and cathode, a source of signalling currents coupled to said signal control grid, means for causing the current between said anode and cathode to vary at a local oscillation frequency, a first detector coupled to said anode, a second detector having input and output circuits, means coupling said input circuit to the output of said first detector, means coupling the output circuit of said second detector to the third grid of said first named tube and an audio frequency output circuit connected to said fourth grid.

12. In a radio receiver, the combination of a vacuum tube having a signal control grid, a cathode, an anode, second and third grids and a screen grid located between said signal control grid and third grid, means for impressing a positive potential on said screen grid, a source of signal currents coupled to said signal control grid, means for causing the current between said anode and cathode to vary at a local oscillation frequency, means coupling said anode to said second grid and an audio frequency output circuit connected to said third grid, said second and third grids being arranged to detect the signal frequency modulations.

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