

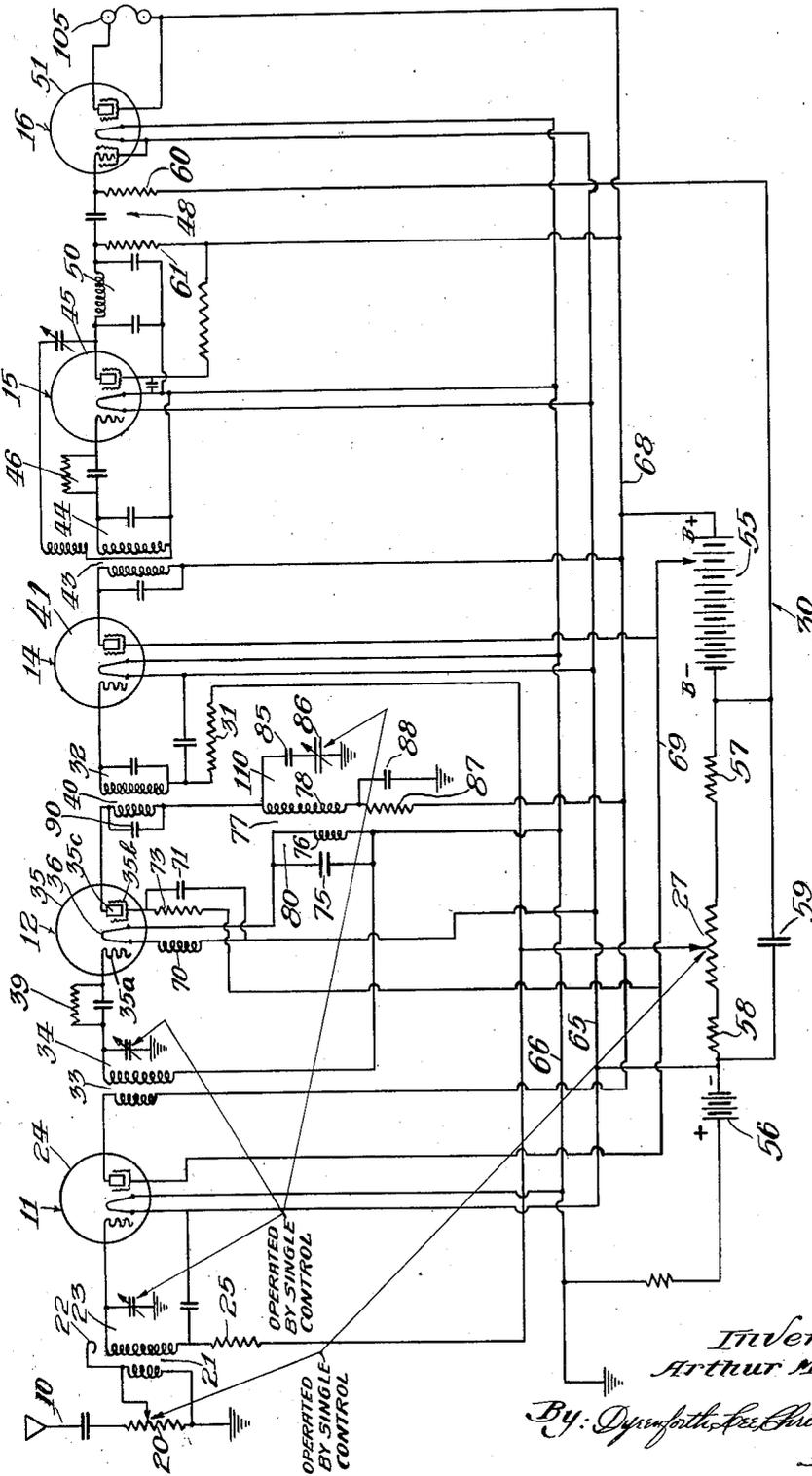
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RADIO APPARATUS

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# UNITED STATES PATENT OFFICE

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## RADIO APPARATUS

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2 Claims. (Cl. 250—20)

The invention relates to radio apparatus and is particularly adapted to be embodied in radio receivers but the invention is limited to this use only to the extent indicated in the appended claims.

A particular object of the invention is to provide an improved radio receiver which will operate efficiently and economically with a power supply of uni-directional current such as a plurality of dry cells or storage batteries providing "A", "B" and "C" voltages.

Another particular object of the invention is to provide an improved heterodyning stage in radio apparatus of the heterodyning type.

Another particular object of the invention is to provide improved radio apparatus wherein a single vacuum tube which utilizes the filament as a cathode will function efficiently and economically as a detector and an oscillator.

Still another object of the invention is to provide radio receivers operated by power supplies of dry cells or storage batteries and having a high degree of sensitivity comparable with that of radio receivers having more stages of amplification and having power supplies operated by alternating current supplied by central stations.

Other objects and advantages will become apparent as the following detailed description progresses, reference being had to the accompanying drawing, the figure in the drawing being a circuit diagram of a superheterodyne radio receiver which embodies the invention.

Referring to the drawing, wherein a preferred embodiment of the invention is illustrated, the reference character 10 designates the antenna circuit of a radio receiver of the heterodyne type which also comprises a stage 11 of tuned radio frequency, a combined first detector and oscillator stage 12, a stage 14 for amplifying the intermediate frequency, a second detector stage 15 and an audio power amplifying stage 16.

The antenna circuit 10 is of a conventional type and preferably comprises a potentiometer 20 and the primary winding of a transformer 21, the primary winding of the transformer 21 being provided preferably with a single turn 22 which is wound around the outer side of the secondary winding of the transformer 21.

The radio frequency amplifying stage 11 preferably comprises a tuned grid circuit 23, a screen grid tube 24 and a resistor 25, the resistor being connected in series between the secondary winding of the transformer 21 and a grid bias potentiometer 27 which forms part of a power

supply designated generally by the reference character 30. It will be noted that the grid bias potentiometer 27 is also connected to a resistor 31 interposed between the potentiometer 27 and a tuned grid circuit 32 forming part of the intermediate frequency amplifying stage 14.

The potentiometers 20 and 27 are operated preferably by a single control and form a volume control.

The radio frequency amplifying stage 11 is connected operatively to the combined first detector and oscillator stage 12 by a transformer 33, the secondary winding of which is part of a tuned grid circuit 34 forming part of the stage 12. The stage 12 comprises a screen grid tube 35 which has a filament 36, the filament 36 being the cathode of the tube. The grid of the tube 35 is connected operatively to the tuned grid circuit 34 through a conventional grid leak and a condenser which are illustrated at 39.

The combined first detector and oscillator stage 12 is connected operatively to the intermediate frequency amplifying stage 14 by a transformer 40, the secondary winding of which forms part of the tuned grid circuit 32. The stage 14 preferably comprises a screen grid tube 41 which may be of the same type as the screen grid tube 35 although in some instances it may be preferable to employ tubes of other types such as a pentode tube.

The stage 14 is connected operatively to the second detector stage 15 by a transformer 43, the secondary winding of which forms part of a tuned grid circuit 44. The control grid associated with the tuned circuit 44 is part of a screen grid tube 45 which, in this instance, is of identical construction with the tube 35 described above. The grid of the tube 45 is connected to the tuned circuit 44 through a conventional grid leak and a condenser which are shown at 46.

The second detector stage 15 is connected operatively to the audio power amplifying stage 16 by resistance coupling means 48, the plate circuit of the tube 45 being provided with a filter 50 to prevent the transfer of radio frequencies from the stage 15 to the stage 16.

The stage 16 is of a conventional type and preferably comprises a pentode tube 51. In this instance the stage 16 comprises a sound reproducing device 105.

The power supply 30 preferably comprises a "B" battery 55 formed of a plurality of dry cells or storage batteries. The negative terminal of the "B" battery 55 is connected to the negative

end of an "A" battery 56 through resistors 57 and 58 and the resistor of the potentiometer 27. The battery 55 preferably comprises a plurality of dry cells or a storage battery. A condenser 59 interposed between the negative terminals of the batteries 55 and 56 and connected in parallel with the resistors 57 and 58 and the resistor of the potentiometer 27 functions as a by-pass for audio frequencies. The negative terminal of the "B" battery 55 is connected to the control grid of the tube 51 through a resistor 60 which forms part of the resistance coupling 48, the other resistor of this resistance coupling being identified by the reference character 61. Obviously, the connection between the negative terminal of the battery 55 and the control grid of the tube 51 provides the grid bias for the tube 51.

The negative terminal of the "A" battery 56 is connected to a negative filament bus 65 which is common to the tubes described above. The positive terminal of the battery 56 is connected to a positive filament bus 66 which is common to the tubes described above.

The positive terminal of the battery 55 is connected to a bus 63 which is connected operatively to the plates of the tubes described above. The screen grids of the tubes 24, 35 and 41 are connected operatively to a bus 69 connected to the battery 55 to provide the desired voltage. The screen grids of the tubes 45 and 51 are connected operatively to the bus 63. The space charge grid of the tube 51 is connected to the filament of the tube.

For convenience, the elements of the tube 35 are designated as follows: The filament is 36, the control grid is 35a, the screen grid is 35b and the plate is 35c. The negative end of the filament 36 is connected to one end of a radio frequency choke coil 70 which has its other end connected to the negative filament bus 65 and also to one terminal of a condenser 71 adapted to by-pass radio frequencies from the screen grid 35 back to the filament 36. The other terminal of the condenser 71 is connected to the screen grid 35b. The screen grid 35b is also connected to one end of a resistor 73 which has its other end connected to the screen grid bus 69. The positive end of the filament 36 is connected to one terminal of a condenser 75 and to one terminal of a primary winding 76 forming part of a transformer 77 having a secondary winding 78. The other terminals of the condenser 75 and the primary winding 76 are connected to the positive filament bus 66 and to the tuned circuit 34.

The plate 35c is connected to one end of the primary winding of the transformer 40, which primary winding has its other end connected to one end of the secondary winding or coil 78 and to one terminal of a fixed condenser 85 which has its other terminal connected to one terminal of a variable condenser 86, the remaining terminal of the condenser 86 being grounded. The remaining terminal of the secondary winding 78 is connected to one end of a resistor 87 and to one terminal of a condenser 88 which has its other terminal grounded. The remaining terminal of the resistor 87 is connected to the bus 63. The primary winding of the transformer 40 is preferably shunted by a fixed condenser 90, the condenser 93 and the primary winding associated with it having constants of such value that they form a circuit tuned to the intermediate frequency. It may be mentioned at this point in the

description that the circuit 32 is also preferably tuned to the intermediate frequency.

The resistor 87 is provided to prevent the transfer of radio frequencies from the oscillator to the power supply 30. The secondary winding 78 and the condensers 85 and 86, and to a slight extent the condenser 89, constitute a tuned circuit 110 for the oscillator. The circuit 110 being tuned preferably to the oscillator frequency. The rotors of the variable condensers provided in the tuned circuits 23 and 34 and the rotor of the variable condenser 86 are mounted preferably on a single shaft to be controlled by a single dial. The radio receiver is tuned to various frequencies by displacing the rotor of the condenser 86 and the rotors of the condensers in the tuned circuits 23 and 34.

It will be readily understood that the tuned circuit which comprises the condenser 93 and the primary winding of the transformer 40 offers a large impedance to the intermediate frequency but relatively little impedance to the oscillator frequency. Therefore, there will be a relatively large transfer of energy at the intermediate frequency from the primary winding of the transformer 40 to its secondary winding as there will be a relatively large drop in the intermediate frequency potential across the primary winding. It is also readily understood that the tuned circuit 110 in the plate circuit of the tube 35 offers a large impedance to the oscillator frequency, but relatively little impedance to the intermediate frequency. This construction insures that there will be a large transfer of energy at the oscillator frequency from the winding 78 to the primary winding 76 which may be designated as a pick-up coil. The radio frequency choke 70 insures that the potential developed at oscillator frequency across the terminals of the winding 76 will not be shorted through the power supply. The condenser 75 and the winding 76 are preferably tuned to the oscillator frequency and this tuned circuit is designated by the reference character 80.

The tuned circuit 110 co-operates with the tube 35 and the primary winding 76 to generate the local oscillations. When an incoming signal at radio frequency is impressed upon the grid 35a, the signal will heterodyne with the oscillator frequency and provides the intermediate frequency which is transferred from the primary winding of the transformer 40 to the secondary winding thereof.

It will be readily apparent to those skilled in the art that the stage 12 may be employed in a superheterodyne circuit in such manner that the oscillator tube 35 will amplify the intermediate frequency.

In some embodiments of the invention, I contemplate employing a variable condenser 75. When the condenser 75 is a variable condenser, the rotor thereof will be operated preferably by the same control which displaces the rotors of the condenser 87 and the rotors of the condensers in the tuned circuits 23 and 34. However, as indicated above, the preferred embodiment of the invention comprises a fixed condenser 75 which tunes the circuit 80 to the order of the oscillator frequency, the rotors of the condenser 86 and the rotors of the condensers in the tuned circuits 23 and 34 being actuated by a single control.

A feature of the invention is the sensitivity of the improved circuit, which sensitivity permits the use of dry cells as "A", "B" and "C" power supplies.

While I have shown and described certain em-

5 bodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims, in which it is my intention to claim all novelty inherent in my invention as broadly as possible, in view of the prior art.

I claim:

10 1. In a radio receiver of the heterodyne type, adapted to be battery operated; a vacuum tube including a grid, a plate, and a directly heated filament serving as a cathode; grid, plate, and filament circuits connected to said grid, plate, and filament, respectively; a tuned circuit and a radio frequency choke coil in series with said directly heated filament, said tuned circuit being in the grid circuit of said tube; two tuned circuits in series in the plate circuit, said circuits being tuned to different frequencies, and one of said circuits being tuned to substantially the same frequency as the first mentioned tuned circuit and inductively coupled thereto, whereby said tube generates local oscillations of a frequency

substantially equal to the frequency of said coupled tuned circuits; and means in said grid circuit for impressing radio frequency signals on said tube to heterodyne with the local oscillations.

2. A radio receiving circuit of the heterodyne type, adapted to be battery operated, including; a vacuum tube having a grid, a plate, and a cathode; grid, plate, and cathode circuits connected to said grid, plate, and cathode, respectively; a tuned circuit in said grid circuit, said tuned circuit comprising an inductance and a fixed condenser; a second tuned circuit in said plate circuit, said second tuned circuit comprising an inductance and a variable condenser, said second tuned circuit being tuned to substantially the same frequency as said first tuned circuit; a third tuned circuit in said plate circuit in series with said second circuit and tuned to a different frequency and means whereby said two first-mentioned tuned circuits are inductively coupled, whereby said tube generates local oscillations of a frequency substantially equal to the frequency of said coupled tuned circuits.

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