Nov. 27, 1945. H. W. BECKER 2,389,949

SIGNAL REPRODUCING APPARATUS

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Fig. 1

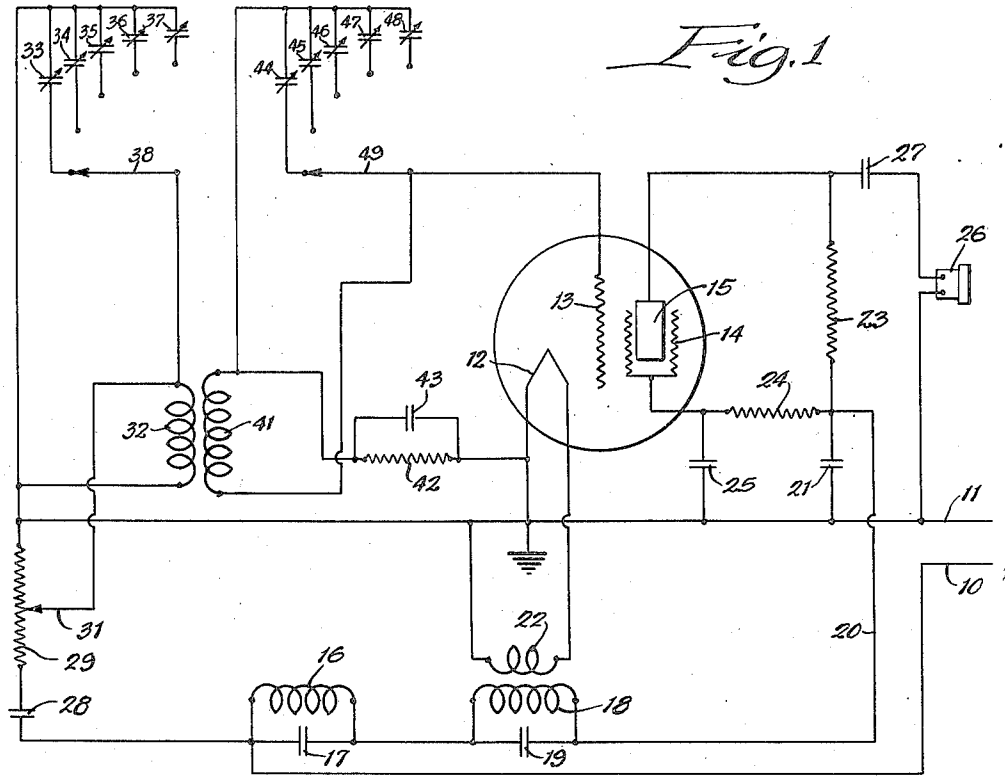
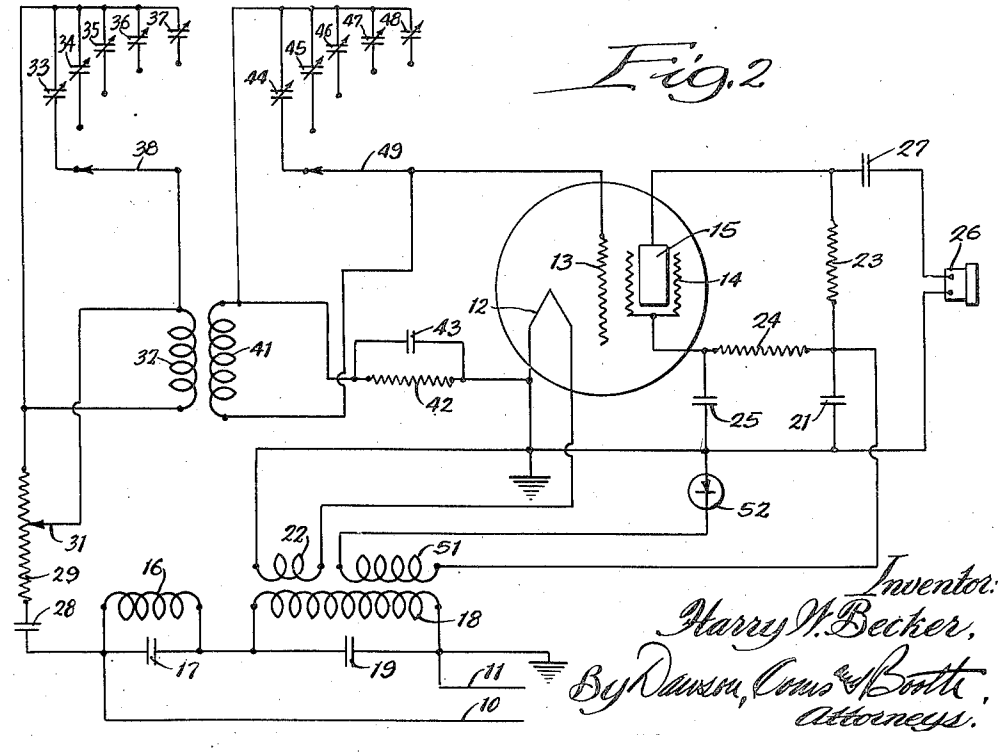


Fig. 2



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SIGNAL REPRODUCING APPARATUS

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16 Claims. (Cl. 179—1)

This invention relates to signal reproducing apparatus and more particularly to apparatus for reproducing audible signals transmitted from a distance.

One of the objects of the invention is to provide signal reproducing apparatus in which operating power and the signal to be reproduced are transmitted together so that no external power source is required at the reproducing apparatus. The invention is particularly applicable to apparatus in which the power and signal are transmitted over wires although it is not limited thereto.

Another object of the invention is to provide signal reproducing apparatus in which the operating power is transmitted at a frequency substantially higher than the signal frequency and consequently does not interfere with reproduction of the signal. In the case of audible signals the operating power is transmitted at supersonic frequency so that any vibrations produced thereby do not register on the auditory system of the listener.

Still another object of the invention is to provide a signal reproducing apparatus in which operating power and the signal to be reproduced are transmitted simultaneously over a single pair of wires. In one construction the operating power includes a high frequency alternating current to energize the filament of a tube and a direct current to energize its plate while in another construction the high frequency alternating current is rectified to provide a direct current plate voltage.

A further object of the invention is to provide apparatus including an electron discharge tube whose filament is directly heated by alternating current at a frequency substantially higher than that of the signal to be reproduced.

A still further object is to provide signal reproducing apparatus in which a plurality of signals can be simultaneously transmitted over a single pair of wires and can be selectively reproduced. According to one feature of the invention selection of the signals is effected by switching to a selected one of a series of condensers to vary the tuning of a selector circuit.

Another object of the invention is to provide sound reproducing apparatus which is small and compact and with which a selected one of a series of signals can be reproduced.

The above and other objects and advantages of the invention will be more readily apparent from the following description when read in connection with the accompanying drawing, in which—

Figures 1 and 2 are wiring diagrams of alternative forms of apparatus embodying the invention.

The apparatus of Figure 1 is adapted to reproduce any selected one of five signals transmitted over a supply circuit formed by a pair of wires 10 and 11. The signals which may be audible signals such as voice or music may be used to modulate five carrier currents of different frequency which are simultaneously transmitted over the supply circuit. In addition the supply circuit carries an operating current at a substantially higher frequency than the signal frequency and a direct current.

The apparatus includes an electron discharge tube shown as a tetrode having a filament type cathode 12, a control grid 13, a screen grid 14 and a plate 15. The supply line 10 is connected thru a resonant circuit including a coil 16 and condenser 17 in parallel to a second coil 18 having a condenser 19 in parallel therewith. The coil 18 and condenser 19 are connected thru a line 20 and a by-pass condenser 21 to the line 11. The resonant circuit 16—17 is tuned to offer a minimum impedance to the operating current but substantially to block the several carrier frequencies. The direct current can, of course, flow thru this circuit to the by-pass condenser 21.

The coil 18 serves as the primary of a transformer whose secondary 22 is connected across the filament 12. The transformer blocks the direct current so that the filament is directly heated by the high frequency operating current only.

The plate 15 of the tube is connected thru a plate load resistor 23 to the line 20. The direct voltage in the supply circuit will therefore be impressed on the plate across the load resistor, the alternating currents being by-passed back to the supply line thru the condenser 21. The screen grid is also connected to the line 20 thru a dropping resistor 24 and is by-passed to the supply line thru a second by-pass condenser 25 to eliminate any alternating components.

The output signal is reproduced thru a speaker 26 connected to the supply line 11 which is in turn connected to the filament 12 and to the plate 15 thru a blocking condenser 27 which keeps the direct current out of the speaker circuit. The speaker may be a set of earphones, a loud-speaker or any other desired signal reproducing means and may be connected to the plate circuit directly, as shown, or thru one or more amplifier stages.

The several signal currents are conducted from the wire 10 thru a blocking condenser 28 to eliminate direct current and a potentiometer resistance 29 to the line 11. Since a high impedance is offered to the signal currents by the coil 16 and condenser 17, substantially all of the signal current will flow thru the resistor 29 and develop a voltage across it. More or less of this voltage may be taken off thru an adjustable volume control wiper 31 which is connected thru a coil 32 to the wire 11.

The coil 32 may be tuned to resonance with any one of the five carrier frequencies by selectively connecting in parallel therewith one of five adjustable condensers 33, 34, 35, 36 or 37. For this purpose the condensers are connected to separate contacts which may be selectively engaged by a switch arm 38 connected to one side of the coil 32. Preferably the condensers are adjusted to tune the circuit to selected frequencies, as for example the broadcast frequencies of selected radio stations, and are not changed unless it is desired to change the setting of the apparatus.

The coil 32 is connected to the control grid 13 of the tube thru a coil 41 which is loosely coupled to the coil 32. The coil 41 is connected at one end to the grid 13 and at its other end to the filament thru a grid bias resistor 42 by-passed by a condenser 43 to keep the bias constant over several cycles. The small grid current flowing during operation develops a grid bias voltage across the resistor 42 which is sufficient for proper operation.

The coil 41 is also tuned to resonance with any one of the signal frequencies by connecting in parallel therewith any selected one of five condensers 44, 45, 46, 47 or 48 by means of a switch arm 49. The switch arms 38 and 49 are preferably interconnected to move together so that both coils 32 and 41 will always be tuned to the same frequency. This construction provides greater sensitivity of selection than when only a single tuned circuit is used.

In one apparatus embodying the invention I have employed as the tube a number 1S4 which requires a filament voltage of 1.4, a plate voltage of 90, a grid bias voltage of —7 and a screen voltage of 67.5. The supply circuit supplies the necessary D. C. voltage and in addition carries an operating current at 30 volts and 20,000 cycles. The several signal currents are supplied on carriers having frequencies of 100 kc., 140 kc., 180 kc., 220 kc. and 260 kc.

In operation the 20,000 cycle operating current passes the circuit 16—17 and energizes the filament transformer 18—22 which is so proportioned as to supply the proper filament voltage to the filament 12. The D. C. supply also flows thru this circuit thru the resistor 23 to supply the plate voltage. The screen has the D. C. voltage impressed on it across the dropping resistor 24 which reduces the D. C. supply voltage to the proper value. The signal currents flow thru the blocking condenser 28 and potentiometer resistor 29 to develop voltage across the resistor. The coil 32 is energized from the wiper 31 of the potentiometer which may be adjusted to produce a smooth volume variation from zero to maximum. The coil 32 is tuned to one of the carrier frequencies by operating the selector switch 38 to connect the desired one of the condensers 33 to 37 in circuit therewith so that only the selected carrier frequency passes thru the coil. This carrier frequency is impressed on the control grid 13 thru the coil 41 which is also tuned to the same frequency by operation of the switch 49. The output circuit terminating in the speaker 26 is therefore energized by the signal impressed on the selected carrier.

In the operation of this apparatus the 20,000 cycle operating current on the filament will produce a 20,000 cycle vibration in the output circuit in the nature of an alternating current hum. However, since this vibration is above the audible range it will not affect the auditory system of the listener in any way and will not interfere with proper reception of the audible signal. It has been found in practice that very high fidelity sound reproduction can be obtained with this apparatus. Since no external power supply is required the apparatus can be used in any convenient location to reproduce a selected one of a number of transmitted signals. The only connections required are the two supply wires 10 and 11 which carry the several signals as well as the required operating current.

Figure 2 illustrates an alternative circuit arrangement in which parts corresponding to like parts in Figure 1 are indicated by the same reference numbers. In this construction the supply line carries only the high frequency operating current and the several signal currents, the direct current being omitted. The plate circuit of the tube is energized thru a coil 51 coupled to the winding 18 and connected thru the load resistor 23 to the plate and thru the dropping resistor 24 to the screen. A rectifier 52 which may be either a tube or an oxide type rectifier is connected in circuit with the coil 51 to rectify the current in the plate circuit. This rectifier may be either a half wave or full wave rectifier but I have found that satisfactory results can be obtained by the use of a single tube or single oxide rectifier producing half wave rectification. Operation of this circuit is substantially the same as that of Figure 1 except for the difference in producing the direct plate current.

While the invention has been particularly described in connection with sound reproduction systems, operating thru wires, it will be apparent that various features thereof are applicable to other types of signal producing apparatus regardless of whether the signals are audible or are transmitted over wires or by radiation. It is, therefore, not intended that the embodiments illustrated shall be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. In a signal reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, means for supplying alternating electric current at a supersonic frequency to the filament, means for supplying an alternating signal voltage in the audible frequency range to the grid, and an output circuit connected to the plate.

2. In a signal reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying alternating current operating power at a frequency higher than the signal frequency and an alternating signal voltage, means connecting the supply circuit to the filament to impress the operating power thereon, means offering a high impedance to the operating power frequency and a relatively lower impedance to the signal frequency connecting the supply circuit to the grid, and an output circuit connected to the plate.

3. In a signal reproducing apparatus, an elec-

tron discharge tube having a filament, a grid and a plate, a supply circuit supplying alternating current operating power at supersonic frequency and a signal carrier current at a different frequency modulated by a signal at a frequency within the audible range, means connecting the supply circuit to the filament to supply operating power thereto at supersonic frequency, means including a circuit resonant at the signal carrier frequency and anti-resonant at the operating power frequency connecting the supply circuit to the grid, and an output circuit connected to the plate.

4. In a signal reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying alternating current operating power at supersonic frequency and a signal carrier current at a different frequency modulated by a signal at a frequency within the audible range, means including a circuit resonant at the operating power frequency and anti-resonant at the carrier frequency connecting the supply circuit to the filament to supply operating power thereto, means including a circuit resonant at the carrier frequency and anti-resonant at the operating power frequency connecting the supply circuit to the grid, and an output circuit connected to the plate.

5. In a signal reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying operating power at supersonic frequency and a signal carrier current at a different frequency modulated by a signal at a frequency within the audible range, means connecting the supply circuit to the filament for supplying operating power thereto and for blocking the carrier current, a potentiometer connected across the supply circuit, a circuit connected across the potentiometer resonant to the carrier frequency and anti-resonant to the operating power frequency connecting the potentiometer to the grid, and an output circuit connected to the plate.

6. In a signal reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying alternating current operating power at supersonic frequency and a signal carrier current at a different frequency modulated by a signal at a frequency within the audible range, means connecting the supply circuit to the filament to supply the operating power thereto, a circuit connecting the supply circuit to the grid and offering a relatively high impedance to the operating power and a relatively low impedance to the carrier current, a resistor in the grid circuit to develop a grid bias, and an output circuit connected to the plate.

7. In a sound reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying an alternating operating current at supersonic frequency and a signal current at audible frequencies, means connecting the supply circuit to the filament to supply operating current thereto, means connecting the supply circuit to the grid to supply signal current thereto, a load circuit connected between the plate and the filament, means to supply alternating current from the supply circuit to the load circuit, and a rectifier in the load circuit.

8. In a sound reproducing apparatus, an electron discharge tube having a filament, a grid and a plate, a supply circuit supplying an alternating operating current at supersonic frequency and a signal current at audible frequencies, a transformer coupling the supply circuit to the filament to supply operating current thereto, means connecting the supply circuit to the grid to supply signal current thereto, a load circuit connected between the plate and the filament, a transformer coupling the load circuit to the supply circuit, and a rectifier in the load circuit.

9. In a sound reproducing apparatus, an electron discharge tube having a filament, a control grid and a plate, a supply circuit supplying an alternating operating current at supersonic frequency, an alternating signal current at audible frequency and a direct current, means for substantially blocking the direct current and the signal current connecting the supply circuit to the filament to supply operating current thereto, means for substantially blocking the direct current and the operating current connecting the supply circuit to the grid to supply signal current thereto, a load circuit connected to the plate and the supply circuit, and means to by-pass alternating current across the load circuit.

10. In a sound reproducing apparatus, an electron discharge tube having a filament, a control grid and a plate, a supply circuit supplying an alternating operating current at supersonic frequency, an alternating signal current at audible frequency and a direct current, means for substantially blocking the direct current and the signal current connecting the supply circuit to the filament to supply operating current thereto, means for substantially blocking the direct current and the operating current connecting the supply circuit to the grid to supply signal current thereto, a load resistor connected to the plate and to one side of the supply circuit, a condenser connected to the line side of the load resistor and to the other side of the line to by-pass alternating currents, and a speaker connected to the plate and to the other side of the line.

11. In a sound reproducing apparatus, an electron discharge tube including a filament, a control grid and a plate, a supply circuit supplying an operating current of supersonic frequency and a plurality of signal currents superimposed on carriers of different frequencies, means for connecting the supply circuit to the filament to supply the operating current thereto while blocking the carrier and signal currents, means including a coil connecting the supply circuit to the grid, a series of condensers of different values, a switch selectively to connect the condensers in circuit with the coil to tune the coil to resonance with the carrier currents, and a load circuit connected to the plate.

12. In a sound reproducing apparatus, an electron discharge tube including a filament, a control grid and a plate, a supply circuit supplying an operating current of supersonic frequency and a plurality of signal currents superimposed on carriers of different frequencies, means for connecting the supply circuit to the filament to supply the operating current thereto while blocking the carrier and signal currents, a coil connected across the supply circuit, a series of condensers of different values, a switch selectively to connect the condensers in parallel with the coil to tune it to resonance at the frequencies of the several carrier currents, means to couple the coil to the grid, and a load circuit connected to the plate.

13. In a sound reproducing apparatus, an electron discharge tube including a filament, a control grid and a plate, a supply circuit supplying an operating current of supersonic frequency and a plurality of signal currents superimposed on carriers of different frequencies, means for con-

necting the supply circuit to the filament to supply the operating current thereto while blocking the carrier and signal currents, a coil connected across the supply circuit, a series of condensers of different values, a switch selectively to connect the condensers in parallel with the coil to tune it to resonance at the frequencies of the several carrier currents, a second coil inductively coupled to the first named coil and connected to the grid, a second series of condensers of different values, a second switch selectively to connect the second condensers in parallel with the second coil to tune it to resonance at the frequencies of the several carrier currents, and a load circuit connected to the plate.

14. In a sound reproduction apparatus, an electron discharge tube having a plate and a control grid, a load circuit connected to the plate, a supply circuit supplying a plurality of carrier currents of different frequencies each modulated by a signal voltage, a coil connected across the supply circuit, a series of condensers of different values, a switch selectively to connect the condensers in circuit with the coil to tune it to resonance at the several carrier frequencies, and means to couple the coil to the grid.

15. In a sound reproduction apparatus, an electron discharge tube having a plate and a control grid, a load circuit connected to the plate, a supply circuit supplying a plurality of carrier currents of different frequencies each modulated by a signal voltage, a variable potentiometer connected across the supply circuit, a coil connected to the potentiometer, a series of condensers of different values, a switch selectively to connect the condensers in circuit with the coil to tune it to resonance with the several carrier frequencies, and means to couple the coil to the grid.

16. In a sound reproduction apparatus, an electron discharge tube having a plate and a control grid, a load circuit connected to the plate, a supply circuit supplying a plurality of carrier currents of different frequencies each modulated by a signal voltage, a variable potentiometer connected across the supply circuit, a coil connected to the potentiometer, a series of condensers of different values, a switch selectively to connect the condensers in circuit with the coil to tune it to resonance with the several carrier frequencies, a second coil inductively coupled to the first named coil and connected to the grid, a second series of condensers of different values, and a second switch to connect the second condensers selectively in circuit with the second coil to tune it to resonance with the several carrier frequencies.

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