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D. E. FOSTER ET AL

2,268,812

PROGRAM DISTRIBUTION SYSTEM

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2 Sheets-Sheet 1

**Fig. 1**

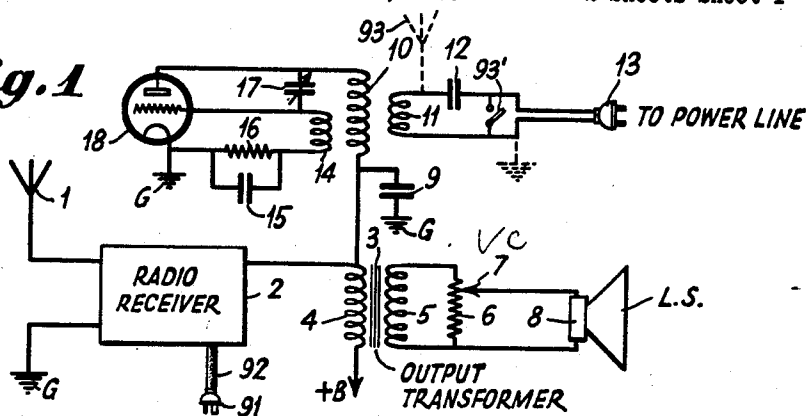


**Fig. 2**

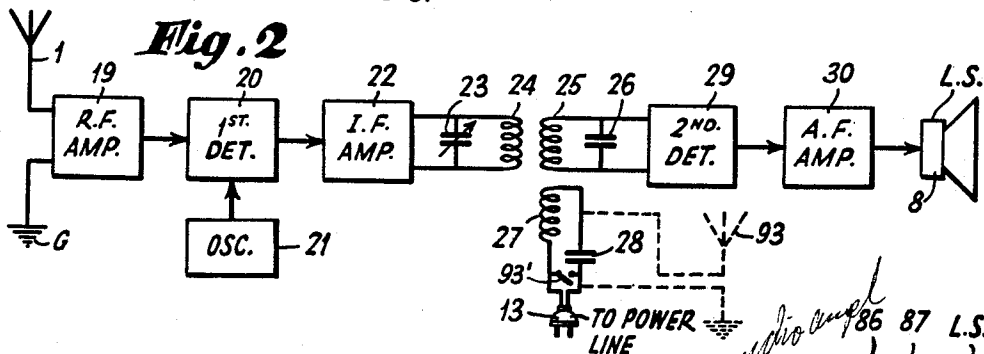
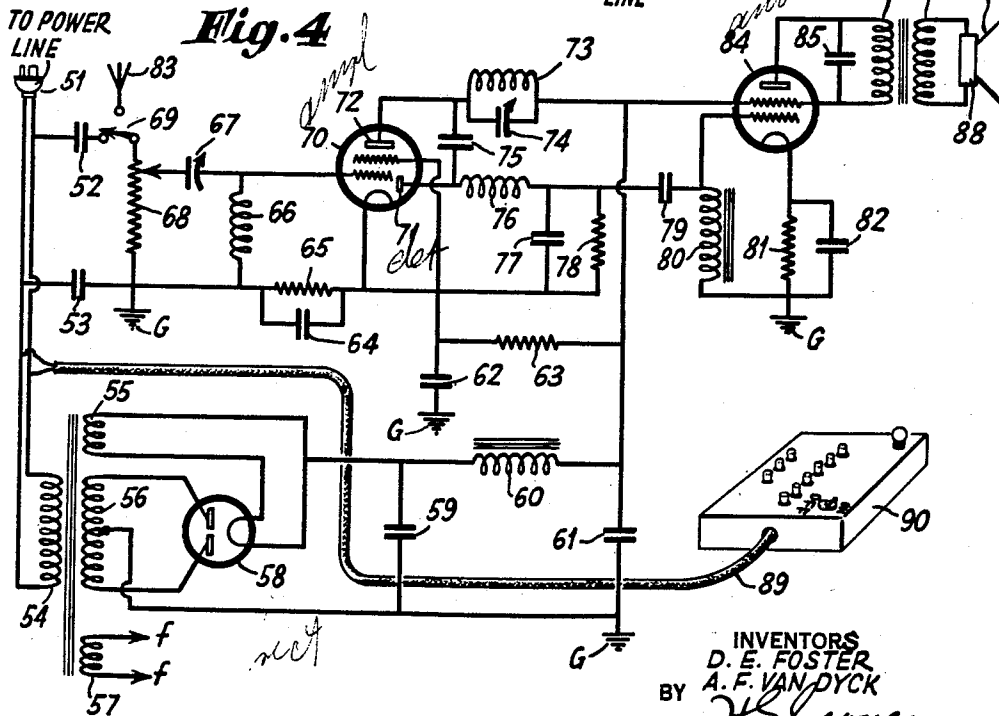


**Fig. 4**



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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## PROGRAM DISTRIBUTION SYSTEM

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6 Claims. (Cl. 250—20)

The present invention relates generally to an arrangement for transmitting radio programs from a central receiver to any point of a house or apartment and is especially adapted for use in conjunction with remote control devices of various types.

It is obvious to anyone that there is not much use in having a device which will operate a radio receiver located let us say, in the living-room of a house, from a remote point, say, an upstairs bedroom, if the received program cannot be heard at all or at best heard only indistinctly from the bedroom.

The present invention obviates this disadvantage by providing an arrangement whereby signals representing the received program are transmitted from the receiver to all points of the house or apartment. These signals may be intercepted at various remote points in the house or apartment and translated by means of suitable apparatus.

It is believed that the broad features of the present invention will be understood by anyone skilled in the art by considering the three systems for transmitting the signals throughout the house or apartment herein described. In one of these systems, oscillations are generated by means of a local oscillator and modulated by a portion of the audio energy available for instance, at the output transformer of the receiver. The modulated oscillations may then be impressed upon the power supply line and picked up at any remote point by simply plugging into an available power supply line outlet. The modulated oscillations may be transmitted also as electro-magnetic waves and picked up at a remote point by a suitable pick-up device. However, it is thought that piping the signals through an already available power supply line is preferable.

In another system where a superheterodyne receiver is employed, the use of an auxiliary oscillator may be avoided since with that type of receiver a portion of the intermediate frequency energy may be transmitted or piped as desired. In the third system a portion of the intermediate frequency energy of a superheterodyne receiver is combined with locally generated oscillations, its frequency changed to a more convenient value and then impressed upon the power line or otherwise transmitted.

To receive the signals from anyone of the aforesaid modifications there is provided a suitable detecting arrangement and possibly an amplifying device which acts to bring the signal energy up to the desired level. In a modification of the re-

ceiver which will be described hereinafter, the signals are first impressed upon an amplifier and the output fed to a suitable detector and then the resulting audio frequency is amplified in a suitable audio frequency amplifier and the output fed to a loudspeaker. A receiving unit in combination with a remote control unit makes it possible for one to go from room to room in a house or apartment and not only control the remote radio receiver located, let us say, in the living-room or the cellar, but also actually receive the program in such a way as to provide real enjoyment.

The invention will be understood more readily from a consideration of the following detailed specification when read in conjunction with the appended drawings.

This arrangement permits reception of a program economically at a multiplicity of points in the same house or apartment, since the program distribution takes place at a fixed frequency, variable tuning thus being unnecessary at the remote receivers.

In the drawings,

Figure 1 illustrates schematically an arrangement for distributing a received program over a power supply line or over the air through an arrangement wherein the audio frequency output of a radio receiver modulates the output of a local oscillator;

Figure 2 illustrates in schematic form a modification of the invention wherein a received program is distributed by transmitting a portion of the intermediate frequency energy of a superheterodyne receiver over the air or over the power supply line;

Figure 3 is a schematic representation of a modification of the invention wherein the frequency of a portion of the intermediate frequency energy of a superheterodyne receiver is altered to some convenient value and then transmitted;

Figure 4 illustrates diagrammatically a receiving arrangement in combination with a remote control unit; and,

Figure 5 illustrates schematically a portable control and receiving unit constructed in accordance with the present invention.

Referring more specifically to Figure 1 there is shown therein an antenna 1 and ground G arrangement associated with the input of a radio receiver 2, to the output transformer 3 of which is connected a loudspeaker 8. The output transformer 3 is provided with a primary winding 4 and a secondary winding 5 and across the latter is provided a volume control resistor 6 having a

variable tap 7. The loudspeaker 8 is connected between the variable tap 7 and one end of the resistor 6. To vary the volume at the receiver the sliding tap 7 may be operated along the resistor 6. The receiver 2 may be connected to a suitable power supply line by means of cable 92 and plug 91.

It is to be understood that the plug 91 and cable 92 not only supplies the radio receiver 2 with power for energizing the tubes and other elements but also picks up from the power line the control signals sent out from a remote point which determine the operation of the receiver. A remote control arrangement suitable for this purpose is shown and described in U. S. patent application Serial No. 215,731, filed June 25, 1938. In Fig. 4b of said copending application the controlling signals may be received from the power supply line through plug 19 in the event that the signals are transmitted over the power line or by means of the antenna A in the event that the control signals are transmitted over the air. A suitable remote control unit is shown in Fig. 3c of said copending application.

Referring again to Fig. 1, the local oscillator includes an electronic tube 18 having a grid coil 14 and a plate coil 10 coupled together. The usual grid leak 16 and condenser 15 is provided between the grid coil and the cathode of the tube. For tuning the oscillator a variable condenser 17 is connected between the plate and grid of the tube 18 and is thereby effectively shunted across the plate coil 10. In order that the audio frequency in the output of the radio receiver may be impressed upon the oscillator so as to modulate the oscillations generated by tube 18, plate coil 10 is connected to a point of the primary 4 of output transformer 3, thus providing a circuit for applying plate potential to the tube 18. The connection between the plate coil 10 and the primary 4 is by-passed to ground by a suitable condenser 9.

From the connections thus far described it will be evident that the oscillations generated by the tube 18 are modulated by the audio output of the radio receiver 2. These modulated oscillations are preferably impressed upon the power line by inserting the plug 13 into a suitable power line receptacle, it being noted that the plug 13 is coupled to the plate coil 10 through the winding 11 and the condenser 12. The size of the condenser 12 should be such as to prevent current from the power supply line to be impressed across the winding 10 and yet it should permit the modulated energy to pass freely through it and on to the power line. For this purpose it has been found that a condenser of the order of .01 microfarad is suitable. If it is desired to transmit the signals over the air, this may be accomplished by providing suitable means such as an antenna 93 shown in dotted lines. In which case plug 13 is not inserted into the power line, but is short circuited as shown by the dotted lines.

Referring now more particularly to the superheterodyne type receiver shown in Fig. 2, it will be seen that the antenna 1 is coupled to a radio frequency amplifier 19 the output of which feeds into a first detector arrangement shown generally at 20. For convenience there has been shown a separate local oscillator 21 which also feeds into the detector circuit 20. As is well known the arrangement 20 acts to change the frequency of the incoming signal energy to a suitable inter-

mediate frequency. In the case shown the intermediate frequency is fed to an intermediate frequency amplifier 22 in the output of which there is provided a circuit tuned to the intermediate frequency. This circuit includes a condenser 23 in shunt with the primary 24 of an intermediate frequency transformer, the secondary 25 of which forms with tuning condenser 25 the input circuit of a second detector 29. The output of the second detector is fed through a suitable audio frequency amplifier 30 to a loudspeaker 8.

A portion of the intermediate frequency energy present in the output of the intermediate frequency amplifier 22 is fed to the power line through the coupling coil 27 and series condenser 28, it being noted that the plug 13 is for the purpose of plugging into a suitable power line outlet. The purpose of the condenser 28 is similar to that of the condenser 12 in Fig. 1. It is obvious from a study of Fig. 2 that the arrangement avoids the use of the auxiliary oscillator necessary in the system shown in Fig. 1. As in the case of Fig. 1 if desired, the energy may be transmitted over the air instead of over a power line by means of antenna 93 and short circuiting of plug 13.

In some instances, as when it is desired to avoid excessive interference, it may be desirable not to impress the intermediate frequency upon the power line but to change its frequency to some other value which is less likely to interfere with other receivers and the like. An arrangement for changing the frequency of a portion of the intermediate frequency is illustrated in Fig. 3 wherein a superheterodyne receiver is schematically shown as comprising an antenna 1 coupled to a radio frequency amplifier 19, the output of which is combined with the output of a local oscillator 21 in a first detector 20 to produce intermediate frequency. The output of the detector 20 is fed to an intermediate frequency amplifier 22. Part of the output of amplifier 22 is fed to the frequency changer 34 and part of it is fed to the second detector 29 of the superheterodyne receiver. The output of the second detector 29 is amplified in audio frequency amplifier 30 and then fed to a loudspeaker 8.

Coupling between the output of the intermediate frequency amplifier 22 and the tube 34 is provided by a coupling condenser 32 which is connected between the output of 22 and the third grid of the tube 34 by means of a conductor 31 having a grounded shield 33. The second grid of tube 34 is connected to B+ through the coil 39 and resistor 40 in series, it being noted that the connection between the coil 39 and resistor 40 is by-passed to ground through a by-pass condenser 41. The first grid of the tube 34 is connected to the cathode thereof through a condenser 36 and a tuned circuit comprising coil 38 which is coupled to the coil 39 and shunted by a condenser 37. The cathode is grounded through resistor 42 and a leak resistance 35 is provided between the first grid and the cathode.

In the connections thus far described it will be noted that the second grid acts as the plate of a triode the grid of which is the first grid of the tube. The coupling between 38 and 39 produces oscillations of a frequency which is determined by the tuned circuit made up of the coil 38 and condenser 37. These oscillations are combined with the intermediate frequency oscillations impressed upon the third grid of tube 34 from which

2,268,812

3

combination there is produced the desired frequency to which the circuit comprising coil 47 and condenser 46 is tuned. The new frequency may be impressed upon the power line through coupling of the coils 47 and 49 and plug 13 or again it may be fed to antenna 93 if it is desired to transmit the new frequency over the air.

A representative receiver which may be used for receiving the energy transmitted by any one of the systems shown in Figs. 1, 2 and 3, is illustrated schematically in Fig. 4. In such a receiver the plug 51 is inserted into a suitable receptacle of the power supply line and the program signals impressed upon the power line are fed through condensers 52 and 53 and impressed across the resistor 68, one end of which is grounded. The two condensers 52 and 53 are arranged and are of the proper size to permit only the desired signals to be impressed across resistor 68 and thus exclude the power supply current. For this purpose it has been found that condensers of .01 microfarad are suitable. Resistor 68 is provided with a slider 69 through which a resonant circuit which includes condenser 67 and coil 66 is connected across any desired portion of the resistor 68. This resonant circuit is tuned by means of the variable condenser 67 to the frequency of the energy which is impressed upon the power line by any one of the systems shown in Figs. 1, 2 and 3. To amplify the energy there is provided a tube 70 having a cathode, a first grid, an auxiliary grid, a main anode 72 and a diode anode 71. The tuned circuit 66, 67 is connected between the first grid and the cathode. A grid leak resistor 65 shunted by a condenser 64 is in the connection between the tuned circuit 66, 67 and the cathode of tube 70. The signals impressed upon the first grid of the tube 70 from the tuned circuits 66, 67 which appear in amplified form on the main plate 72 are fed to the diode anode 71 through a coupling condenser 75.

The power supply means for the receiving unit includes a full wave rectifier tube 58, the plates of which are connected across a secondary 56 of a power transformer, the primary 54 of which is connected to the power supply line through the plug 51. A secondary 57 is provided for the purpose of supplying the heating circuits of the tubes with heating current and a secondary 55 supplies the cathode of tube 58 with heating current. The proper voltage for the anode 72 of tube 70 is provided by the connection from anode 72, tuned circuit 73, 74 (tuned to the same frequency as tuned circuit 66, 67) filter choke 60 to the cathode of rectifier tube 58. The usual filter condensers 59 and 61 are connected between the ends of the filter choke 60 and ground. The center tap of secondary 56 is also grounded thus completing the return circuit. The diode anode 71 is connected to the cathode of tube 70 through coil 76 and resistor 78 in series, the latter being shunted by a condenser 77. From the connection of the diode 71 with respect to the main anode 72 it will be seen that the signals which are fed from the tuned circuit 66, 67 to the first grid of the tube 70 are rectified in the diode portion of the tube 70 and the audio frequency signals representing the program appear in the output of the diode circuit.

It is usually necessary to amplify the audio frequency and for this purpose there is provided an amplifier tube 84 having a cathode, a first grid, an auxiliary grid and an anode. The first grid is connected to a point of the diode circuit

intermediate the coil 76 and resistor 78 through a coupling condenser 79 thus the audio frequency energy is impressed upon the first grid of the tube 84. The condenser 79 is preferably of small capacity so that the 60 cycle component which may be present due to the connection of the system across the power line may be eliminated from the first grid of tube 84. This grid is also connected to ground through a choke coil 80. The grid circuit of tube 84 is completed by connection of the cathode thereof to ground through the bias resistor 81 which is by-passed by condenser 82 in shunt with resistor 81.

From a consideration of the power supply circuit previously described it will be seen that the right hand side of the filter choke 60 can be considered as the positive terminal of the power supply means and that ground to which the center point of secondary 56 is connected may be considered as the return circuit. The anode of the tube 84 is connected to the positive terminal of the power supply system, that is, to the right hand side of filter choke 60 through the primary 86 of an output transformer, across the secondary 87 of which is connected the loudspeaker 88. The primary 86 of the output transformer is shunted by a condenser 85. In order to provide a suitable positive potential for the auxiliary grid of the tube 84 there is provided a connection between said auxiliary grid and the right hand end of the choke coil 60. It should also be noted that the auxiliary grid of the tube 70 is also connected to the right hand end of the filter choke 60 through a resistor 63 the grid end of which is connected to ground through a by-pass condenser 62. Associated with the receiving unit there is provided a remote control device 90 which may be connected to the power line by a suitable cable 89 and plug 51.

The remote control unit 90 may take the form of the remote control unit described in a technical paper appearing in the July, 1938, issue of the Proceedings of the Institute of Radio Engineers, starting on page 813, it being noted that Fig. 7 of said article illustrates the remote control unit and that Fig. 8 illustrates the circuit of a receiver control unit.

In actual practice, the arrangement shown in Fig. 4 including the remote control unit 90 may be mounted in a single container and carried around from room to room of a house or apartment and utilized to control a remote radio receiver and receive the signals picked up by the remote radio receiver. In order to adapt the receiving arrangement shown in Fig. 4 for any one of the systems shown in Figs. 1, 2 and 3 it is only necessary to tune the resonant circuits 66, 67 and 73, 74 to the frequency which is transmitted by the transmitting receivers. In the event that the receivers transmit the signals over the air, as, for instance, indicated by the antenna 93 shown in dotted lines in Fig. 1 then, of course, it is necessary that a receiving antenna be provided for the receiver shown in Fig. 4. Such an arrangement has been shown in Fig. 4 by the antenna 83. To receive the program from the antenna 83 it is only necessary to operate switch 69 in such a way that the top end of resistor 68 is disconnected from condenser 52 and connected to antenna 83.

Referring now to Fig. 5 wherein there is illustrated a portable controlling and receiving unit, B is a box or container for the unit. The box B is provided with a handle H which may be grasped similar to a suitcase handle when carry-

ing the unit about. LS represents the loud-speaker, S is the "on and off" switch, PL the pilot light, PB the push buttons for controlling the receiver, P the plug for plugging the unit into a power supply line outlet and C the connecting cord. It is obvious when considering Fig. 5 that a person going from room to room in a house or apartment may plug into the power supply line and control the receiver and at the same time receive the signals which are received by the remote receiver through the loud-speaker LS.

Comparing the device shown in Fig. 5 with the circuit arrangement shown in Fig. 7 of the I. R. E. technical paper above referred to, it will be seen that the pilot light PL corresponds to the pilot light which is connected to the top secondary winding in Fig. 7 of said I. R. E. paper, the "on and off" switch S of Fig. 5 corresponds to the switch SW of Fig. 7, the top row of buttons PB correspond to station selector buttons 1 through 6 of said paper and the lower three buttons PB of Fig. 5 correspond to the off, on volume up, and volume down buttons of Fig. 7 of said paper. The plug P of Fig. 5 corresponds to the polarized plug of Fig. 7 of said paper.

It will be obvious to anyone skilled in the art that various changes in structure and relationship may be made without departing from the scope of the invention as defined by the appended claims.

We claim:

1. In a signalling system, the combination with a main radio receiver the operating controls of which are adapted to be operated by means of characteristic control signals transmitted to the receiver from a remote point, of a transmitter connected with the main receiver for transmitting a carrier modulated in accordance with signal energy characteristic of the program received by the receiver, a control signal generator and transmitter adapted to be located at a remote point for generating and transmitting control signals for controlling the operation of the receiver and an auxiliary receiver at said remote point for receiving the modulated carrier transmitted by the transmitter connected with the main receiver, said auxiliary receiver including a demodulator device for demodulating the received modulated carrier to derive the signals therefrom.

2. In a signalling system including a commercially available electric power supply line, a radio receiver connected to said power supply line, the operating controls of said receiver being adapted to be operated by means of characteristic control signals transmitted to the receiver from a remote point over said electric power supply line, an auxiliary transmitter device connected between the supply line and the receiver for transmitting over the power supply line to the remote point, a carrier modulated in accordance with signal energy which is characteristic of the program received by the receiver in the operation thereof, a selectively operable transmitter at the remote point connected to the power supply line for producing and transmitting control signals to the receiver over the electric power supply line for controlling the operation of the receiver, and an auxiliary receiver means at said remote point connected to said power supply line for deriving therefrom and translating the program characteristic signals transmitted by said auxiliary transmitter.

3. In a signalling system which includes a radio receiver the operating controls of which are adapted to be operated from a remote point and means connected with the receiver for transmitting signal energy characteristic of any program received by the receiver in the operation thereof, a portable unit adapted to be located at a remote point, said portable unit including an auxiliary transmitter means for generating and transmitting energy for controlling the operation of the receiver operating controls and an auxiliary receiver means for receiving and translating the transmitted program characteristic energy.

4. In a signalling system, a radio receiver of the type wherein the operating controls thereof are adapted to be operated from a remote point, a commercially available electric power supply line, an auxiliary transmitter connected between the power supply line and the receiver for transmitting over the power supply line signal energy which is characteristic of any program received by the receiver in the operation thereof, a transmitter at the remote point including a selectively operable oscillation generator for generating and transmitting energy to said receiver to control the operation of the receiver from the remote point, and an auxiliary receiver at said remote point for deriving from the power supply line and translating the program characteristic signals impressed upon the power line by said auxiliary transmitter.

5. In a signalling system including a commercially available electric power supply line, a radio receiver the operating controls of which are adapted to be operated by means of characteristic control signals transmitted to the receiver from a remote point over the electric power supply line, a transmitter connected between the receiver and the power supply line for transmitting to the remote point over the electric power supply line carrier energy modulated by signal energy which is characteristic of any program received by the receiver in the operation thereof, a transmitter at the remote point including a selectively operable oscillation generator means for generating and impressing control signals upon the electric power supply line to control the operation of the receiver and an auxiliary receiver at the remote point for deriving from the power supply line the program characteristic signals impressed thereon at the receiver.

6. In a signalling system including a power supply line, a radio receiver of the superheterodyne type which is arranged so that the operating controls thereof are adapted to be operated by means of characteristic signals transmitted to the receiver from a remote point, an electrical connection between a circuit of the receiver wherein there exists intermediate frequency voltage and the power supply line for impressing upon the power supply line during operation of the receiver, signal energy which is characteristic of any program being received by the receiver, a selectively operable auxiliary transmitter means at the remote point generating and transmitting control signals to the receiver for controlling the operation thereof, and an auxiliary receiver means at the remote point for deriving from the power supply line the program characteristic signals impressed upon the power supply line at the receiver and translating said derived signals.

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