Dec. 15, 1936. J. G. ACEVES 2,064,400

DUPLEX RADIO AERIAL SYSTEM

Filed July 25, 1935 2 Sheets-Sheet 1

Fig. 1.

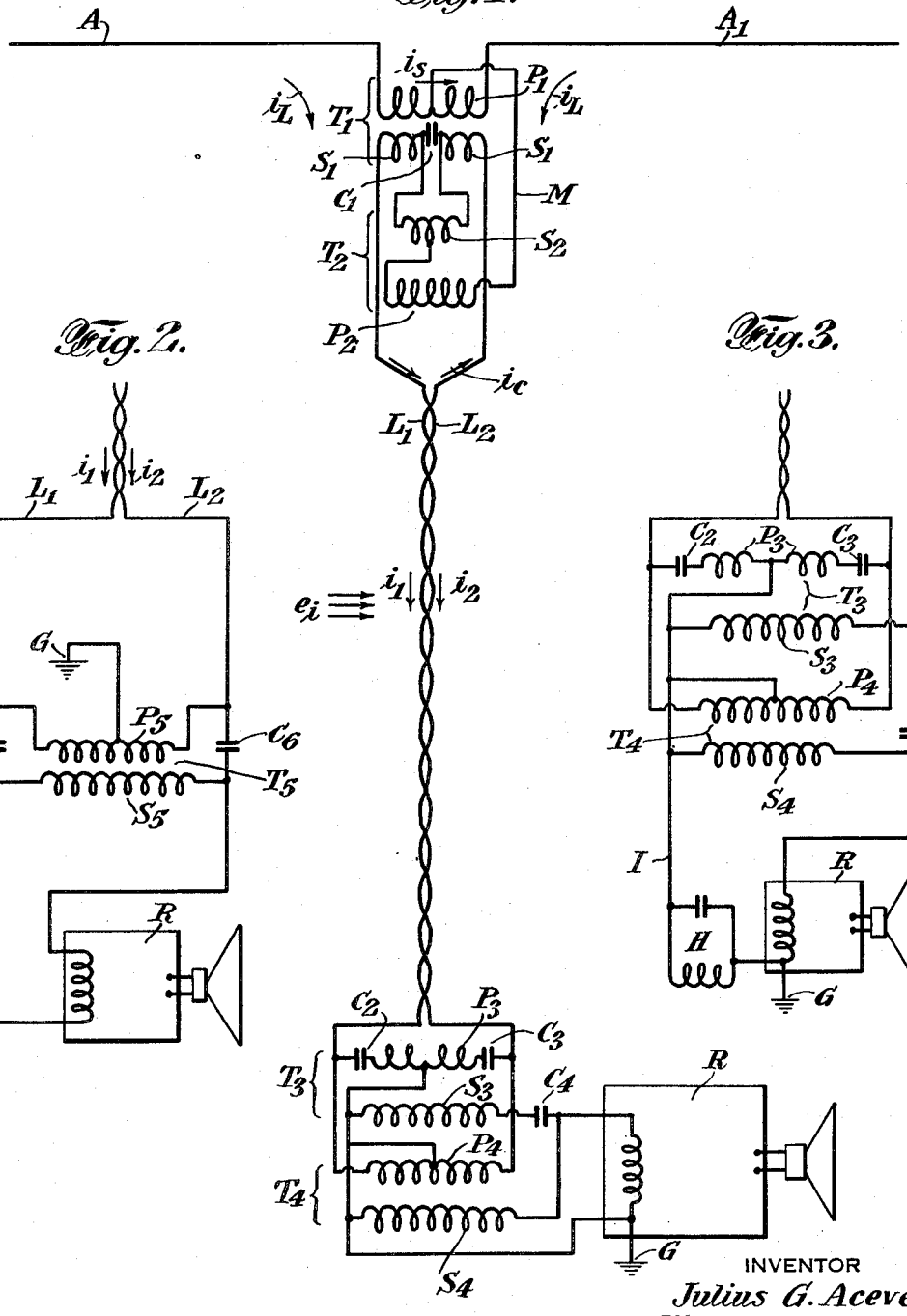


Fig. 2.

Fig. 3.

INVENTOR
Julius G. Aceves
BY
Ward, Curley & Head
ATTORNEYS

Dec. 15, 1936. J. G. ACEVES 2,064,400

DUPLEX RADIO AERIAL SYSTEM

Filed July 25, 1935 2 Sheets-Sheet 2

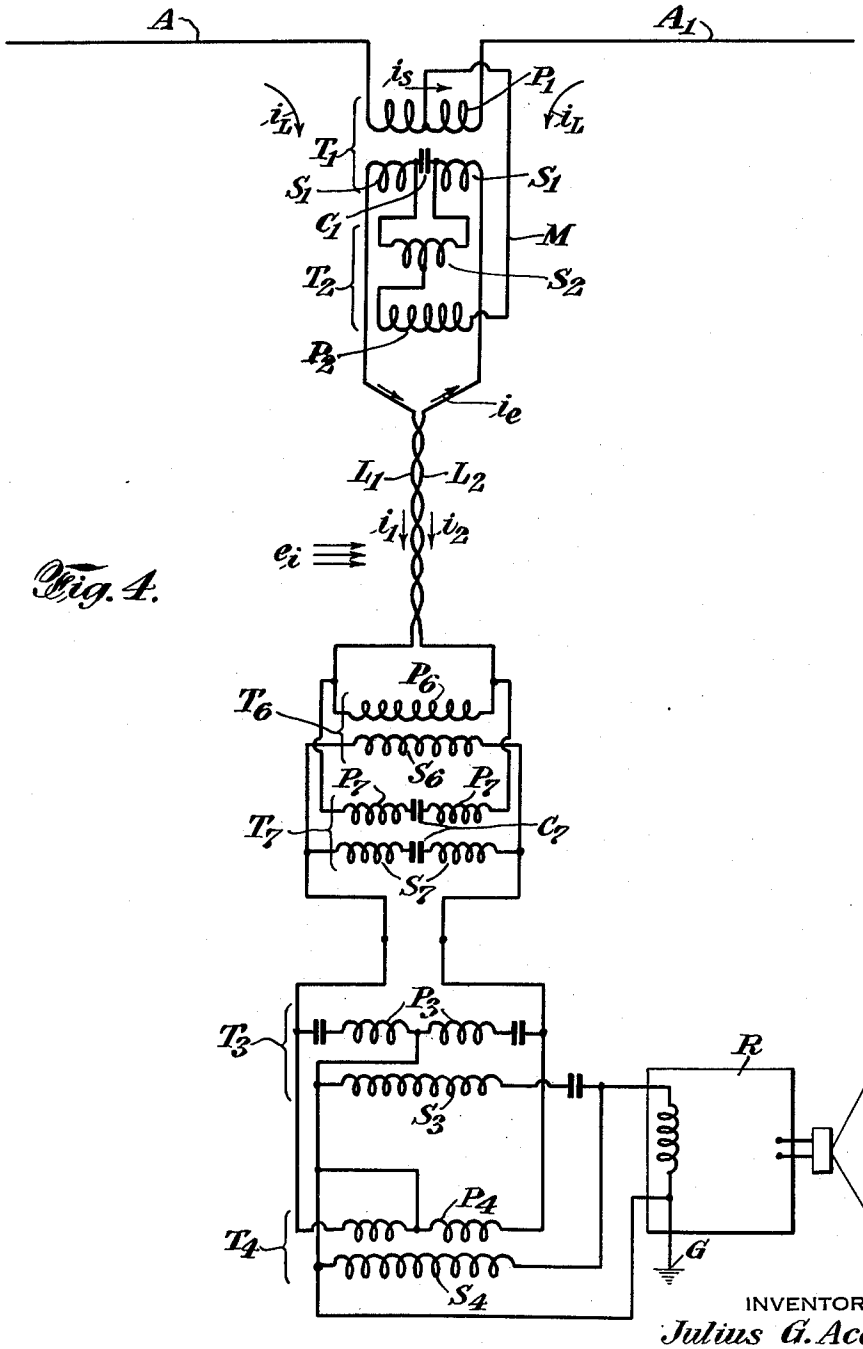


Fig. 4.

INVENTOR
Julius G. Aceves
BY
Wood, Cooley & Wood,
ATTORNEYS

Patented Dec. 15, 1936 2,064,400

UNITED STATES PATENT OFFICE

2,064,400

DUPLEX RADIO AERIAL SYSTEM

Julius Gourgues Aceves, New York, N. Y., assignor to Amy, Aceves & King, Inc., New York, N. Y., a corporation of New York

Application July 25, 1935, Serial No. 33,099

8 Claims. (Cl. 250—33)

This invention relates to radio antenna systems and associated down lead circuits for electrically coupling the antenna to a radio receiver. More particularly the invention pertains to systems of this character suitable for so-called "all wave" radio reception including the present United States and European broadcast bands, as well as the short wave range covering a total frequency band of about .15 to 23 megacycles.

An object of the invention is to provide a combined antenna and down lead system which will afford efficient radio reception within extremely wide frequency limits—such as those mentioned—without necessity for switching operations in passing from one wave band to the other. Further objects are to so arrange the down lead circuit and associated terminating couplings as to prevent interference picked up from such local equipment as sparking motors, electrical refrigerators, neon signs, etc., by the down lead conductors and ground connections from entering the radio receiver.

In Patent No. 1,965,539 issued jointly to E. V. Amy and myself, antenna and down lead systems generic to the present invention, are described together with specific embodiments thereof wherein electrostatic couplings designed for efficient short wave reception are provided between the antenna and down lead circuits, and wherein efficient reception at the longer wave lengths is secured by means of electromagnetic or transformer couplings. In the systems of the patent, local interference picked up by the down leads is prevented from entering the receiver by tapping the midpoint of the antenna transformer secondary winding through its primary winding to the antenna, and by further terminating the down lead circuit adjacent the receiver in a coil centrally tapped to ground.

The present invention provides systems basically like those of the patent but differing specifically therefrom in the provision between the antenna and down leads of electromagnetic or transformer couplings designed for short as well as for long wave reception; and in the utilization of novel couplings between the down leads and the radio receiver employing coils and condensers so arranged and proportioned as to relay signals efficiently at both long and short waves, while in cooperation with the antenna couplings preventing interference picked up by the down leads and ground connections from entering the receiver.

In the drawings:

Fig. 1 shows in the form of a circuit diagram a complete antenna and down lead circuit in accordance with the invention for automatically and efficiently relaying both long and short wave signals to a radio receiver while preventing interference picked up by the down leads from entering the receiver;

Figs. 2 and 3 are circuit diagrams of modified forms of coupling systems which may be substituted for that of Fig. 1 for coupling the down lead circuit to the receiver; while

Fig. 4 shows a modification of the Fig. 1 circuit adapted to prevent interference picked up by the ground lead as well as by the down leads from entering the receiver.

The system of Fig. 1 comprises a dipole type of antenna A, A_1 inductively coupled, in a manner to be explained, through short and long wave transformers T_1 and T_2 to down leads L_1, L_2, preferably of twisted pair, extending to a set coupler comprising short and long wave transformers T_3 and T_4, having primary windings P_3 and P_4 respectively, effectively connected in parallel between the down leads L_1, L_2, and secondary windings S_3, S_4 effectively connected in parallel to the input to a radio receiver of the "all wave" type indicated schematically at R.

Short wave reception is based on a difference of potential produced by the received signals between the portions A, A_1 of the aerial whereby a current i_s will be caused to flow in the primary winding P_1 of transformer T_1 centrally disposed in the aerial. The resulting voltage induced in the associated secondary windings S_1 having their outer terminals connected to the down leads L_1, L_2 respectively and their inner terminals connected through a short wave by-pass condenser C_1, will cause a circulating circuit i_c to flow in the down lead circuit comprising: the secondary windings S_1 and condenser C_1, referred to, down leads L_1, L_2 and the primary circuit of the set coupler transformers T_3 and T_4.

The antenna is preferably of such length that it functions substantially as a doublet antenna at short wave lengths. For short wave reception a length of approximately 20 meters for the antenna will operate effectively.

The circulating circuit i_c produced in the manner explained and flowing over the down leads L_1, L_2, will cause the short wave signals to be selectively relayed through the short wave transformer T_3 to the receiver R. This automatic selection results in part from providing relatively low inductance windings on the short wave transfomer T_3 and relatively high inductance windings on the long wave transformer T_4, and

in part from the insertion of condensers C_2, C_3, and C_4 in series respectively with the primary and secondary windings of transformer T_3. The capacities of these condensers are such that they offer small impedance to short waves whereas they substantially block the long waves. Accordingly at short wave lengths the short wave transformer T_3 presents a lower impedance between down leads L_1, L_2 than does the long wave transformer which acts substantially as a choke. Conversely at long wave lengths the long wave length transformer T_4 presents a lower impedance path owing to the blocking action of the condensers C_2, C_3, C_4 in series with the short wave transformer windings. Thus the short wave signals will pass more easily through transformer T_3 and the long wave signals more easily through transformer T_4.

At long waves the antenna A, A_1 in conjunction with the down leads L_1, L_2 operates as a horizontal T antenna. Long wave reception in accordance with the invention is based on the establishment by the received signals of a difference of potential between the antenna and, either ground or a counterpoise. For this reason the long wave antenna transformer must be so arranged as to permit signaling current to flow between the antenna and ground and to convert this current into a circulating current i_c in the down lead circuit. This is accomplished by connecting the secondary winding S_2 of the long wave transformer T_2 in shunt to condenser C_1 at the midpoint of the short wave transformer secondary S_1; by further connecting the primary winding P_2 of the long wave transformer T_2 in a connection M extending from the midpoint of its secondary winding S_2 to the midpoint of the short wave transformer primary winding P_1 in series with the antenna; and finally by connecting the midpoints of the set coupler transformer primaries P_3 and P_4 to ground at G as shown.

The capacity of condenser C_1 is such that although at short wave lengths it functions as a by-pass condenser as stated, at long wave lengths it acts as a blocking condenser, thereby in conjunction with transformers T_1 and T_2 providing efficient transfer of signaling energy between the antenna and the down lead circuit at both short and long wave lengths.

With the circuit as shown in Fig. 1, the long wave signals picked up by the antenna will produce currents i_L flowing simultaneously from the portions A, A_1 of the antenna and in inductive opposition through the halves of coil P_1 to its midpoint, thence over the midtap connection M through the primary P_2 of the long wave transformer to the midtap on the secondary S_2, where the current divides and flows in equal amounts as "parallel currents" through the down leads L_1, L_2, and thence in inductive opposition through the halves of the primary windings P_3, P_4 of transformers T_3, T_4 to ground at G of the receiver R.

These "parallel currents" will of themselves produce substantially no signal voltage in the secondary windings S_3, S_4 of transformers T_3, T_4, since these currents flow, as stated, in inductive opposition in the halves of the primary windings P_3, P_4 and hence induce no secondary voltages. However, the total current i_L, in traversing the primary winding P_2 of the long wave antenna transformer, induces a voltage in the associated secondary S_2 which establishes a circulating current i_c in the down lead circuit, which current traverses in the same direction the entire primary winding P_4 of the long wave set coupler transformer T_4, and thereby induces a signal voltage in the associated secondary S_4 which actuates the receiver R.

Consider now the effect of electrical interference, such as that caused by a sparking motor of an electric refrigerator, etc., picked up by the down leads L_1, L_2, as indicated by e_1. Waves e_1 will establish in the respective down leads L_1, L_2, currents i_1, i_2 of the same instantaneous magnitude and poled in the same direction. These parallel currents in passing to ground at G, will likewise traverse the halves of the set coupler primary transformer windings P_3, P_4, in inductive opposition with the result that no voltage will be induced in the associated secondaries, as has been explained. In this way interference picked up by the down leads will be prevented from entering the receiver.

In Fig. 1 the receiver R is provided with an input coil grounded at G as shown. Certain receivers, however, are equipped with input circuits containing "floating" coil or non-grounded primaries. For such receivers a set coupler like that illustrated in Fig. 2 is more appropriate and hence may be substituted in the circuit of Fig. 1 for that comprising transformers T_3, T_4.

In the circuit of Fig. 2 the down leads L_1, L_2 are extended through condensers C_5, C_6 respectively, to the input coil of receiver R. The capacities of condensers C_5, C_6 are such that they function as short wave by-pass condensers but as long wave blocking condensers. A step-up transformer T_5 designed for efficient long wave reception, has its primary winding connected between conductors L_1, L_2 on the antenna side of condensers C_5, C_6, and a secondary winding S_5 connected between these conductors or the receiver side of the condensers. The midtap of the primary is connected to ground at G.

For the reception of long waves the electromagnetic coupling provided by the transformer T_5 is predominately effective in relaying signals to the receiver due to the blocking action of condensers C_5, C_6 at these wave lengths. At short wave lengths on the other hand the signals are by-passed in greater part past the transformer through condensers C_5, C_6, the transformer windings then acting substantially as choke coils bridged across the line.

As regards elimination from the receiver of interfering currents induced in the down leads L_1, L_2, the circuit of Fig. 2 functions in substance like that of Fig. 1. Interfering currents i_1, i_2 directed in the same sense in conductors L_1, L_2, flow in opposite directions to ground at G through the halves of the transformer primary P_5, so that the fluxes produced therein substantially annul one another.

The circuit of Fig. 3 is similar to the set coupler T_3, T_4 of Fig. 1 except for the insertion in the connection I extending from the midpoints of the transformer primaries to ground at G, of a loading impedance H. Impedance H serves to increase the range of efficient signal reception in the long wave direction. Thus at long wave lengths the antenna and associated down lead circuit will operate as a horizontal T antenna connected to ground through the loading impedance H. Impedance H comprises a parallel resonant circuit which introduces a high impedance for frequencies in the neighborhood of .15 megacycles, in the connection I extending from the midtaps of the transformer primaries P_3, P_4

to ground at G. At appreciably higher frequencies, however, the condenser of impedance H functions as a by-pass condenser effectively grounding the midtaps of the transformer primaries P_3, P_4; with the result that, at such frequencies, the operation of the Fig. 3 circuit is the same as that of Fig. 1.

Reverting to the system of Fig. 1, interference may be introduced into the receiver by exposure to a local source of interference of an extremely long ground lead G, or one having appreciable impedance. This results from the fact that a portion of an interfering current thus induced in the ground lead will flow upward to the midtaps of the primaries P_3, P_4, thence in inductive opposition through the halves of the primary windings to the respective down leads L_1, L_2, thence upward through the down leads and in inductive opposition through the halves of the long wave antenna transformer secondary winding S_2 to the midtap thereof, thence through the associated primary P_2 in the midtap connection M, thence in inductive opposition through the halves of the short wave antenna transformer primary P_1 to the respective arms A, A_1 of the antenna and finally back to earth through the antenna-to-ground capacities.

No interference is introduced in the receiver by the flow of these currents through windings P_3, P_4, S_2, P_1, owing to the inductive opposition of the current flow in the halves of these windings. However, it will be observed that the total interfering current flows in the same direction through the primary P_2, and thus induces an interfering voltage in the associated secondary S_2, which is relayed back to the receiver along with the signal.

Fig. 4 shows a modification of the Fig. 1 circuit wherein interference picked up by the ground lead is eliminated from the receiver, by interposing in the down leads L_1, L_2 between the antenna transformers T_1, T_2 and the set coupler transformers T_3, T_4, a set of what might be termed long and short wave "isolation transformers" T_6, T_7. These transformers are designed to have extremely small inherent capacities between their primary and secondary windings P_6, S_6 and P_7, S_7, the ratio of primary to secondary turns being preferably substantially unity for each transformer T_6, T_7. Moreover, except for these extremely small and unavoidable inherent capacities the primary circuits are coupled to their associated secondaries only through their mutual inductances. Short wave by-pass condensers C_7 are connected between the inner terminals of windings P_7 and S_7 respectively.

As a result any tendency of interfering voltage induced in the ground lead G to cause interfering currents to traverse the down leads L_1, L_2 and the long wave antenna primary P_2 in the manner explained, is substantially prevented by the isolating action of transformers T_6, T_7. Such current flow as does ensue will be practically restricted to the secondary side of these transformers where the interfering currents traverse the halves of the transformer primaries P_3, P_4 in inductive opposition and likewise produce opposing effects in the secondaries S_6, S_7 of the isolation transformers T_6, T_7, in consequence of which no interfering effects are produced in the associated primaries P_6, P_7 or in the receiver R.

Instead of employing transformers T_6, T_7 having separate primary and secondary windings, an arrangement such as that shown in Fig. 2 comprising elements C_5, C_6, T_5 may be employed as the isolation circuit. As so employed, condensers C_5 and C_6 should be selected of extremely small capacity, of the order of 10 micro-microfarads each.

I claim:

1. In a radio receiving system: an antenna of the dipole type, a noise reducing downlead circuit for coupling said antenna over a pair of adjacent conductors to a radio receiver, antenna coupling means for causing received signals producing variations in potential of said antenna with respect to ground to be impressed on said downlead circuit, a connection from ground to said receiver, and means for minimizing application to said receiver of noise producing voltages introduced into said ground connection, said means including a signal relaying transformer in said downlead circuit, said transformer having separate primary and secondary windings, the capacity between which offers a high impedance to passage of noise producing currents.

2. In a radio receiving system: an antenna of the dipole type, a noise reducing downlead circuit for coupling said antenna over a pair of adjacent conductors to a radio receiver, antenna coupling means for causing received signals producing variations in potential of said antenna with respect to ground to be impressed on said downlead circuit, a connection from ground to said receiver, and means for minimizing application to said receiver of noise producing voltages introduced into said ground connection, said means including a signal relaying transformer in said downlead circuit, said transformer having separate primary and secondary windings of substantially unity ratio, the capacity between which offers a high impedance to passage of noise producing currents.

3. In a radio receiving system: an antenna of the dipole type, a two-conductor noise reducing downlead circuit for coupling said antenna to a radio receiver, a connection to ground from said receiver, means coupling said antenna to said downlead circuit for causing said downlead circuit to function as a counterpoise to said antenna to impress on said downlead circuit, signals producing variations in the potential of the antenna with respect to ground, and means for minimizing application to said receiver of noise producing voltages introduced into said ground connection, said means comprising a signal relaying transformer in said downlead circuit adjacent said receiver, said transformer having separate primary and secondary windings, the capacity between which offers a high impedence to the passage of noise producing currents.

4. In a radio receiving system, an antenna of the dipole type, a two-conductor noise reducing downlead circuit for coupling said antenna to a radio receiver, an impedance bridging said circuit thereat, a midtap connection from said impedance to ground, means coupling said antenna to said downlead circuit for impressing thereon signals producing variations in the potential of said antenna with respect to ground, and means for minimizing application to said receiver of noise producing voltages introduced into said ground connection, said means comprising a signal relaying transformer in said downlead circuit between said grounded impedance and said antenna, said transformer having separate primary and secondary windings, the capacity between which offers a high

impedance to passage of noise producing currents.

5. In a radio receiving system for reception of long and short wave signals, an antenna of the dipole type, a two-conductor downlead circuit for coupling said antenna to a radio receiver, means for causing variations in potential of said antenna with respect to ground due to long wave signals to impress a signaling voltage on said downlead circuit, means for impressing on said downlead circuit a signaling voltage derived from potential differences occurring between electrically spaced points of said antenna due to short wave signals, a connection from ground to said receiver, long and short wave signal relaying transformer means in said downlead circuit, said transformer means having separate primary and secondary windings, the capacities between which offer a high impedance to the passage of currents due to noise producing voltages introduced into said ground connection.

6. In a radio receiving system for reception of long and short wave signals: an antenna of the dipole type, a two-conductor downlead circuit for coupling said antenna to a radio receiver, an impedance bridging said circuit thereat, a midtap connection from ground to said impedance, means for causing variations in potential of said antenna with respect to ground due to long wave signals to impress signaling voltages on said downlead circuit, means for impressing on said downlead circuit signaling voltages derived from potential differences occurring between electrically spaced points of said antenna due to short wave signals, long and short wave signal relaying transformer means in said downlead circuit, said transformer means having separate primary and secondary windings, the capacities between which offer a high impedance to the passage of currents due to noise producing voltages introduced into said ground connection.

7. In a radio receiving system for reception of long and short wave signals: an antenna of the dipole type having at least a pair of arms, a two-conductor downlead circuit for coupling said antenna to a radio receiver, means coupling said antenna to said downlead circuit for causing signaling voltages occurring between the arms of said antenna due to short wave signals to be impressed on said circuit, means coupling said antenna to said downlead circuit for causing said circuit to function as a counterpoise for said antenna in impressing on said downlead circuit long wave signals producing variations in the potential of said antenna with respect to ground, a connection from ground to said receiver, and long and short wave signal relaying transformer means in said downlead circuit, said transformer means having separate primary and secondary windings, the capacities between which offer a high impedance to passage of noise producing voltages introduced into said ground connection.

8. In a radio receiving system in combination: an antenna of the dipole type, a two-conductor noise reducing downlead circuit for coupling said antenna to a radio receiver, a connection from ground to said receiver, an antenna transformer having a secondary winding included in said downlead circuit and a primary winding in a connection extending from said antenna to an intermediate point of said primary winding, and means for minimizing application to said receiver of noise producing voltages introduced into said ground connection, said means including a signal relaying transformer in said downlead circuit, said transformer having separate conductively isolated primary and secondary windings, the capacity between which offers a high impedance to passage of noise producing currents due to said ground connection.

JULIUS GOURGUES ACEVES.