May 28, 1935. J. G. ACEVES ET AL 2,002,844

RADIO RECEIVING SYSTEM

Filed Oct. 31, 1932

FIG. 2

FIG. 1

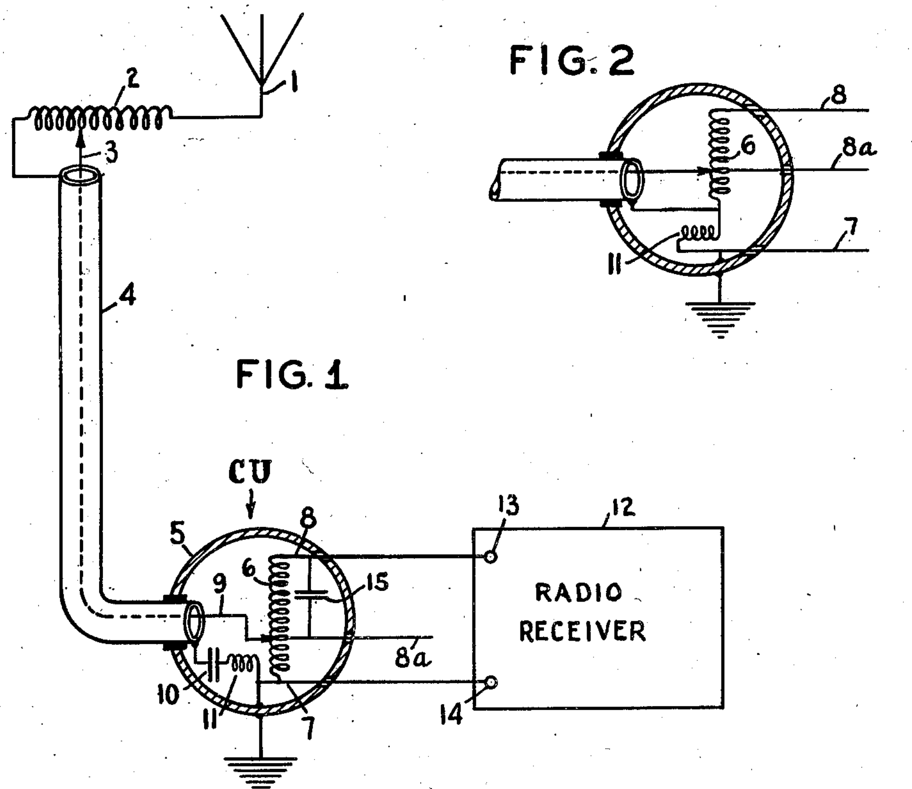
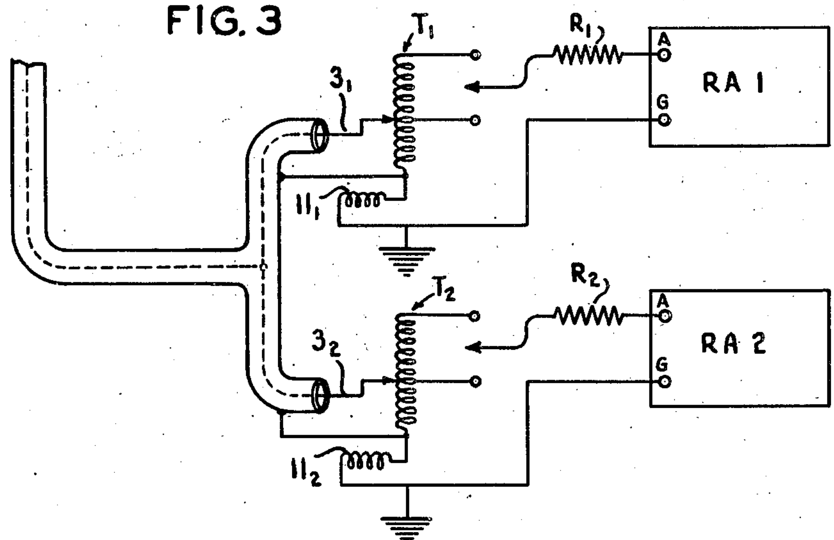


FIG. 3



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RADIO RECEIVING SYSTEM

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Application October 31, 1932, Serial No. 640,374

10 Claims. (Cl. 250—20)

This invention relates to radio receiving systems and more particularly to a system for protecting a radio receiver against extraneous electrical disturbances, such for instance as those commonly referred to as "man made static", and is an improvement upon the system disclosed in our copending United States applications, Serial Numbers 411,435, filed December 3, 1929, 628,142, filed August 10, 1932, and 634,774, filed September 21, 1932; now respectively Patents 1,976,910, issued October 16, 1934, 1,920,162, issued July 25, 1933, and 1,938,092, issued December 5, 1933.

In the operation of radio receiving apparatus, and more especially of the modern type of high gain multi-stage amplifiers, it has been found that the receiver is very sensitive to electrical disturbances in the immediate neighborhood, such for example as interference from the operation of electric motors used in operating elevators, vacuum cleaners, washing machines, refrigerators, oil burners and the like, and it has been found that in many cases such interference is picked up to a very substantial extent, if not entirely, by the lead-in or down-lead used to connect the antenna to the radio receiver.

It has been found that a very considerable improvement in the performance of such receivers in respect of decreased interference from such sources, may be obtained by enclosing the down-lead or a substantial portion of it within a grounded metallic container such as a metallic conduit, sheath or covering connected to and maintained at ground potential.

We have found that the enclosing or shielding of the down-lead within a shielding conductor as described may seriously impair the efficiency or performance of the receiver to the extent that the interchange of energy between the antenna and the receiving set is seriously interfered with as a result of changes in the constants of the down-lead and associated apparatus due to its enclosure within a shielded conductor.

We have found that it is possible to overcome this drawback and to maintain a very efficient transfer of received energy from the antenna to the radio receiver, provided the system be arranged in certain respects as will be hereinafter pointed out in accordance with our invention.

It is an object of our invention to provide a system and apparatus of the class described which shall protect the radio receiver against interference of the type above mentioned, without sacrificing efficient transfer of energy from the antenna to the receiver.

It is a further object of our invention to provide a system and apparatus of the class described which will protect the radio receiver against such disturbances as those referred to, by the use of a shielding conductor surrounding the down-lead, while at the same time preventing or minimizing the loss of signal energy picked up by the antenna, and transmitted to the set.

It is still a further object of our invention to provide simple apparatus which may be quickly and conveniently installed by the average user and operated without technical knowledge.

It is a further object of this invention to provide a transformer or coupling unit which may be interposed between the end of the down-lead and the input of the receiver, to match the impedances of the down-lead and the receiver.

It is a further object of this invention to provide such a transformer or coupling unit having taps or connections adapted to match the impedances of various types of radio receivers.

It is a further object of our invention to provide a system and apparatus which will operate satisfactorily, for the purposes described, not only on the present broadcast spectrum, but also for short waves.

Still other objects and advantages of our invention will be apparent from the specification.

The features of novelty which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its fundamental principles and as to its particular embodiments will best be understood by reference to the specification and accompanying drawing, in which

Fig. 1 indicates diagrammatically a preferred embodiment of the system according to our invention, and

Fig. 2 is a detail view indicating a modified form of connection, and

Fig. 3 is a diagrammatic representation of a system in which a plurality of radio receivers are operated off the same aerial.

Referring now more particularly to Fig. 1, 1 designates an antenna which may be of any desired or usual form and which is preferably located upon the roof of the building or in some outside space. 2 designates generically a transformer provided to match the impedance of the antenna with that of the down-lead and is preferably in the form of an auto-transformer provided with a variable tap to obtain the best results, the antenna 1 being connected to one end of coil 2, the other end of which is connected to the shield 4 and the down-lead 3 connected to the variable top.

While I have shown the antenna 1 non-adjustably connected to one end of the winding 2, it will be understood that if desired an additional variable tap may be provided for this purpose whereby the antenna to ground circuit may include any desired number of turns of the coil 2 and similarly the number of turns between the down-lead 3 and the grounded end of the coil 2 may be varied.

The down-lead 3 extends from the matching transformer 2 to the coupling unit CU which will preferably be placed adjacent the receiver or even within the cabinet or console housing the receiver. The shield 4 may be of any suitable form and may, for instance, in the case of buildings where a permanent installation is desired, be a conduit such as iron piping or BX cable. In other cases, and preferably where installations are being made in buildings already constructed, the down-lead 3 and the shield 4 may and preferably will be in the form of wire having a conducting core, an insulating covering and a final woven metallic conducting fabric covering the insulation, and adapted, when grounded, to shield the inner conductor.

This form of conductor provides the desired shielding effect and being flexible and of relatively light weight and easy to handle, may be installed without difficulty by the set user.

The component parts of the coupling unit are preferably provided within a metallic box or casing 5 of suitable form and may comprise, for example, a coil 6 provided with terminals or leads 7 and 8 extending therefrom outside of the box 7 and 8, and which are preferably taken from opposite ends of the coil. In addition, if desired, an intermediate tap 8*a* may be provided, likewise extending through the cover of the box 5.

The terminal 7 of the coil may be connected, for example, to the casing 5 which in turn is grounded.

It will be found desirable to have the shielding conductor 4 surround the down-lead 3 to the point of entry into the box 5 so that no part of the lower portion of the down-lead is unshielded. Also the shielding conductor 4 should enclose the down-lead 3 as nearly as possible to the point of contact with coil 2, and for this purpose the coil 2 and its associated apparatus may be provided with a casing and appropriate fastening means so that the same may be connected directly to the antenna, as for example by being hung thereon, as disclosed in our copending application, Serial No. 628,142, in which case the shielding of the down-lead 3 will extend directly to the casing surrounding the coil 2. Also if desired we may provide within the box 5 the radio frequency choke coil 11 and condenser 10, the functions of which will be hereinafter described.

As indicated, condenser 10 and coil 11 are included in the grounded shielding circuit, connection being made from the shield 4 to condenser 10, thence through coil 11, thence to the casing 5, and thence to ground.

By means of the apparatus thus far described the transformer formed by coil 2 may be operated as a step-down transformer reducing the voltage between down-lead 3 and the shield 4, and by the use of the apparatus within box 5, which may be operated as a step-up transformer, the desired voltage may be made to appear across the terminals 13 and 14 of the radio receiver by appropriate adjustment of the variable element.

We have found that very satisfactory results may be obtained over the present broadcast band, namely, 200 to 550 meters, without including the condenser 10 and coil 11. With such apparatus omitting the said coil and condenser, waves of the order of 50 to 100 meters may be received, but it will be found that the attenuation is large.

By the insertion of the coil 11 the operation of the system on short waves may be improved without seriously affecting its operation on broadcast waves. If the inductance of coil 11 is of the order of 6 to 10 microhenries it will offer relatively low reactance to frequencies in the broadcast band. With an inductance of about 8 microhenries the reactance of coil 11 will vary between 25 and 100 ohms over the range of 200 to 550 meters. Since the impedance of the shielded wire down-lead 3 is about 45 ohms, the impedance of coil 11 will not be excessive and the performance of the transformer 6 for broadcast wave lengths will not be materially altered by the inclusion of coil 11.

At the higher frequencies, that is to say below 100 meters, the shielding conductor 4 will begin to assume the same potential as the down-lead 3 due to their capacity, which at such frequencies offers a very small reactance. At the same time the impedance of coil 11 very greatly increases and the system will then begin to act as though the ground connection to the shield were open and the shield 4, as well as the inner conductor 3 will act as an open, unshielded down-lead, terminating in an impedance made up mostly of the choke inductance. That is to say, for relatively short waves the coil 11 acts as if it were included in the input circuit of the radio receiver while for waves of the order of 200 to 550 meters this will not be the case.

We have found that considerable advantage is gained by providing the lower unit 5 with the additional tap 8*a*. This connection is especially desirable for low impedance radio sets and is also advisable when operating the system on short wave.

We have shown a modified form of our arrangement in Fig. 2 in which the coil 11 is included in the secondary circuit of transformer 6. In this instance the ground connection 7 is made to one end of coil 11, the other end of which is connected to the lower end of coil 6.

In this arrangement if the shielding cable 4 is not connected to the box 5 which is grounded, the coil 11 will provide reception between the connections 7 and 8*a* for short waves as well as broadcast frequencies.

The construction of the coil 11 may be of any convenient or desired form except that it is desirable to avoid magnetic coupling with the coil 6. For this purpose coil 11 may be wound in the form of a figure 8 or so-called D coil and may then be placed directly over the coil 6 with relatively little coupling, or it may be made in the form of a toroid, preferably an incomplete toroid.

A further improvement in the operation of the coil 11 may be effected by means of condenser 10, of such value as to reduce the effective reactance between the shielding of the down-lead 3 and the ground connection of the radio set to a minimum for any frequency within the broadcast band. It will be understood that this effectively grounds the shielding with minimum or no reactance and thereby excludes more effectively any electrical disturbance or noise from entering the receiver through the down-lead. At the same time the reactance is appreciable for high frequencies and thereby prevents the high frequencies from being shorted to ground.

If desired an additional condenser 15 may be provided between terminals 8 and 8a to provide a better path for short wave signals to terminal 8, and thus better results will be obtained, when using a receiver of high impedance which should normally be connected to the terminal 8, without the necessity of changing the connections.

For other systems of shielded down-lead and transformer having a two conductor shielded wire, it is also possible to provide short wave reception in a similar manner as described above by the insertion of a choke coil between the shielding and ground connection of the radio receiver.

The general principle herein disclosed of interposing an impedance which is high for high frequencies and negligible for the lower frequencies such as the present broadcast wave length, so as to effectively ground the shield for broadcast frequencies while effectively insulating it for short wave or high frequencies, may be applied by anyone skilled in the art to various systems, as will be understood.

In general, when using a radio receiver having a high impedance input circuit, best results will be obtained when the turn ratios of the transformers 2 and 6 are substantially the same, when the input impedance of the receiver is the same as the impedance of the antenna. If the input impedance of the receiver is higher than the impedance of the antenna, the step-up ratio of the lower unit will preferably be somewhat greater than the step-down ratio of the upper unit; for instance, if the upper unit has a step-down ratio of 5:1, the lower unit may have a step-up ratio of 1:6 or 1:7. Using a lead-in sixty feet long, the upper and lower transformers will preferably have turn ratios of the order of 5:1—1:5 or 7:1—1:7 respectively, although good results have been obtained using turn ratios as high as 15—1.

It is possible to utilize a number of radio receivers operating from the same antenna and connected to the same lead-in. For instance, in Fig. 3 I have shown the shielded down-lead 3 as branching off at its lower end into two portions 3_1 and 3_2, the branch 3_1 being connected to a coupling unit comprising transformer T_1 and the branch 3_2 being connected to a second coupling unit comprising transformer T_2. The radio receiver RA_1 is connected between ground and the transformer T_1, and radio receiver RA_2 is connected between ground and the transformer T_2.

With certain types of radio receivers it may be desirable to interpose resistances such as R_1 and R_2, of the order of 1000 to 3000 ohms, in the connection of the receiver to its respective transformer for the purpose of preventing interaction between the receivers. With other types of receivers this resistance will not be required, for instance, with automatic volume control receivers.

In the arrangement shown in Fig. 3, the coils 11_1 and 11_2 perform the same function as coil 11 in Figs. 1 and 2. That is to say, they operate to provide a path between ground and the shielding envelope of the down-lead which has negligible impedance at broadcast frequencies but a considerably higher impedance for short waves.

While we have shown and described certain preferred embodiments of our invention it will be apparent that modifications and changes may be made within the scope of the appended claims, as will be apparent to those skilled in the art.

We claim:

1. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in from said antenna to said receiver, an impedance matching device interposed between the lower end of said lead-in and said receiver, a conducting sheath surrounding said down-lead, and a ground connection to said sheath including an impedance having a relatively low reactance to wave lengths of the order of 200 to 550 meters, and a high reactance to wave lengths of 50 to 100 meters.

2. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in from said antenna to said receiver, an impedance matching device interposed between the lower end of said lead-in and said receiver, a conducting sheath surrounding said lead-in and insulated therefrom, and a ground connection from said sheath including an impedance of such value as to have substantially no effect at frequencies from 500 to 1500 kilocycles and to offer a substantial impediment to the flow of current of frequencies substantially higher than 1500 kilocycles.

3. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in from said antenna to said receiver, a conducting sheath surrounding said lead-in, a step-down transformer interposed between said antenna and said lead-in, and a step-up transformer interposed between said lead-in and said radio receiver, and a ground connection from said sheath including an impedance, the effective value of which is relatively low for frequencies from 550 to 1500 kilocycles, and relatively high for frequencies substantially higher.

4. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in from said antenna to said receiver, a conducting sheath enclosing said lead-in, a ground connection to said sheath, a step-down transformer interposed between said antenna and said lead-in, and a step-up transformer interposed between said lead-in and said receiver, the turn ratios of said transformers being the same.

5. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in from said antenna to said receiver, said lead-in being enclosed within a conducting sheath, a step-down transformer interposed between said antenna and said lead-in and a step-up transformer interposed between said lead-in and said receiver, and a connection between said conducting sheath and ground, said connection including a reactance having substantially negligible effect for frequencies between 550 and 1500 kilocycles and being effective at frequencies substantially higher than 1500 kilocycles, to interpose a substantial impedance between said sheath and ground.

6. In a system for protecting a radio receiver from interference, in combination, an antenna, a lead-in having a conducting sheath from said antenna to said receiver, an impedance matching device interposed between said receiver and said lead-in and a ground connection to said sheath, said connection comprising inductance and capacity, the values of said inductance and capacity being so chosen as to have substantially negligible impedances to frequencies from 550 to 1500 kilocycles and to have substantial impedance for frequencies substantially above 1500 kilocycles.

7. In a system for operating a plurality of radio receivers from the same antenna, in combina-

tion, an antenna, a lead-in from said antenna to each of said receivers, a conducting sheath surrounding said lead-in, and an impedance matching unit interposed between said lead-in and each receiver, and a ground connection to said sheath, said connection comprising an impedance having substantially negligible value for frequencies from 550 to 1500 kilocycles and having a relatively large impedance for frequencies substantially higher than 1500 kilocycles.

8. In a system for protecting a radio receiver from local interference, in combination, an antenna, a lead-in from said antenna to said receiver, a grounded conducting sheath surrounding said lead-in over substantially its entire length, a step-down transformer interposed between the head of said lead-in and said antenna, and a step-up transformer interposed between the foot of said lead-in and said receiver, the turn ratios of said transformers looking toward said receiver being substantially reciprocals.

9. In a system for protecting a radio receiver from local interference, in combination, an antenna, a lead-in from said antenna to said receiver, a grounded conducting sheath surrounding said lead in over substantially its entire length, a step-down transformer interposed between said antenna and the head of said lead-in and a step-up transformer interposed between the foot of said lead-in and said receiver, the step-down turns ratio of said first transformer being somewhat less than the step-up turns ratios of said second transformer.

10. Apparatus for protecting a radio receiver against noise-producing interference, comprising, in combination, an antenna, a receiver, a double conductor leading from said antenna to said receiver, one of said conductors being grounded, a step-down transformer interposed between said antenna and said conductor for feeding signals from said antenna to said conductor, a step-up transformer interposed between said conductor and said receiver for feeding signals from said conductor to said receiver, the numerical turns ratios of said transformers being substantially the same.

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DISCLAIMER

2,002,844.—*Julius Gourgues Aceves* and *Ernest Valentine Amy*, New York, N. Y. RADIO RECEIVING SYSTEM. Patent dated May 28, 1935. Disclaimer filed September 16, 1939, by the assignee, *Amy, Aceves & King, Inc.*

Hereby enters this disclaimer to claim 9 in said specification.

[*Official Gazette October 10, 1939.*]