

Nov. 19, 1940.

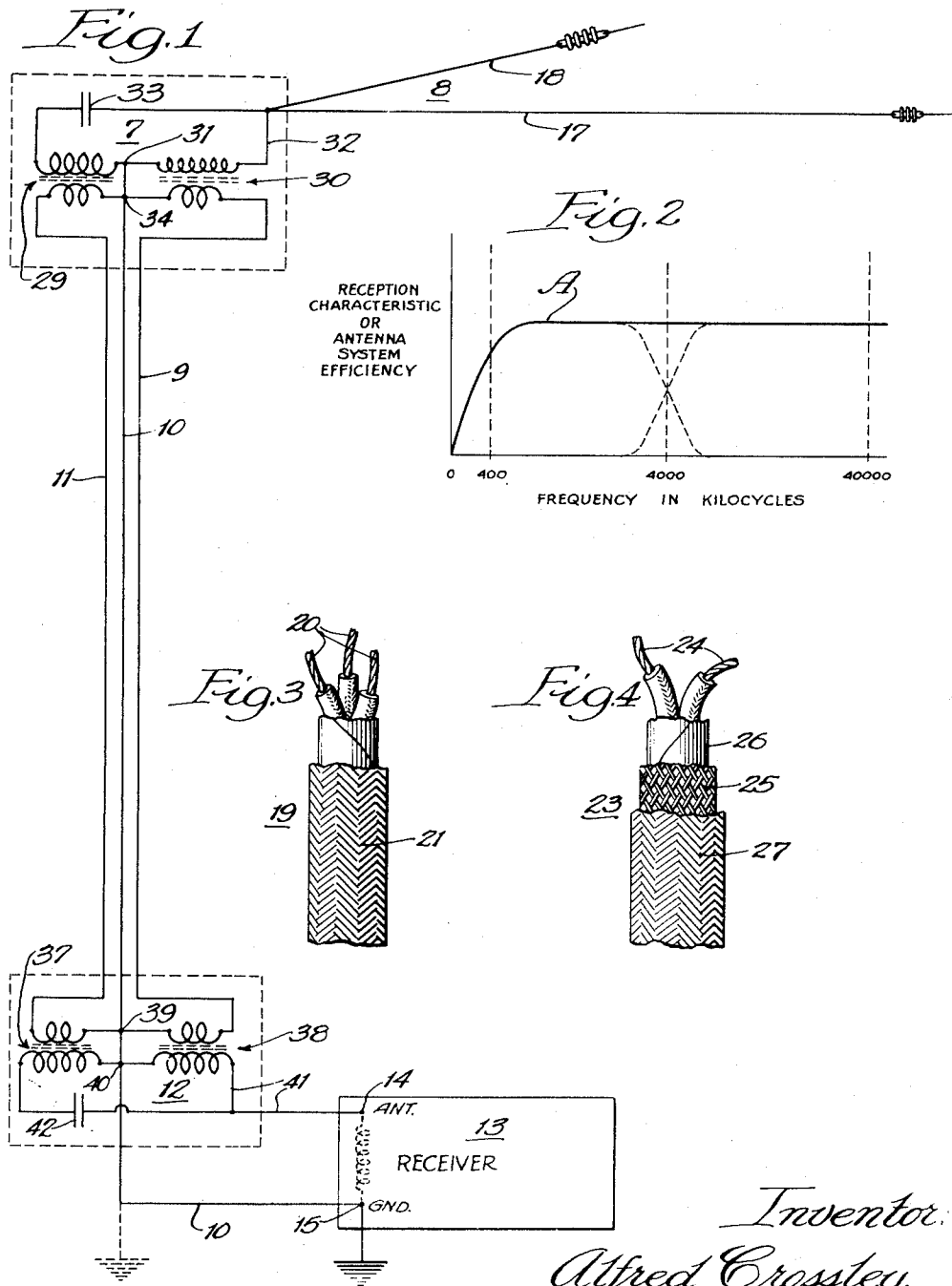
A. CROSSLEY

2,222,406

ELECTRICAL APPARATUS

Filed Aug. 31, 1938

2 Sheets-Sheet 1



Inventor:
Alfred Crossley,

By *Fisher, Clapp, Seams & Pond*
 Attorneys.

Nov. 19, 1940.

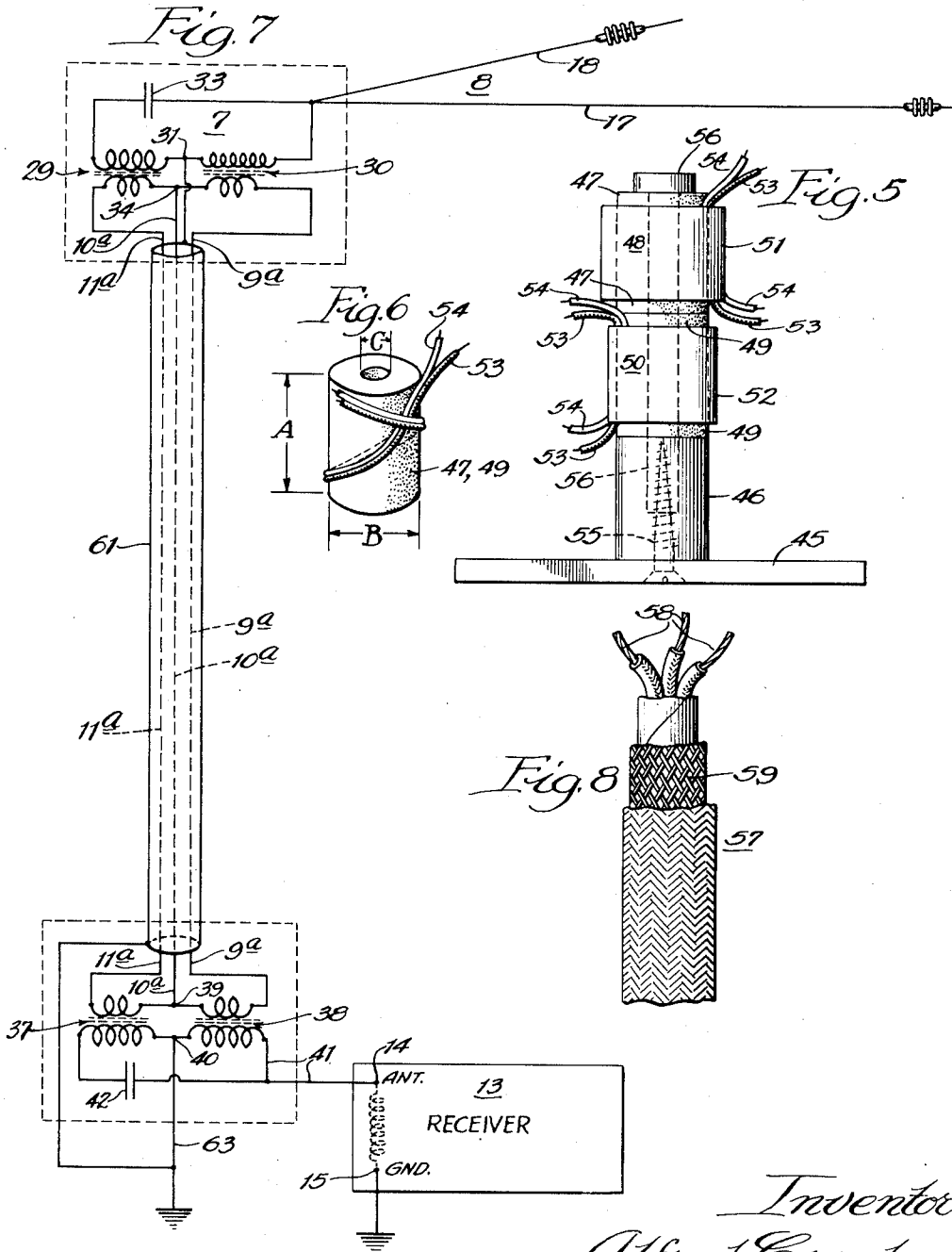
A. CROSSLEY

2,222,406

ELECTRICAL APPARATUS

Filed Aug. 31, 1938

2 Sheets-Sheet 2



Inventor:
Alfred Crossley,

By Fisher, Clapp, Seams & Pond
Attorneys.

UNITED STATES PATENT OFFICE

2,222,406

ELECTRICAL APPARATUS

Alfred Crossley, Chicago, Ill., assignor to Belden
Manufacturing Company, Chicago, Ill., a cor-
poration of Illinois

Application August 31, 1938, Serial No. 227,604

13 Claims. (Cl. 250—33)

My invention relates to the art of radio communication, and has for its principal object the provision of an improved antenna system for use in connection with receiving sets adapted to receive signals in a multiplicity of wave bands, as for example, receiving sets adapted to receive either long or short wave signals.

Other objects of my invention are to provide an improved antenna system for use with multiple wave band receiving sets which shall include a separate metallic circuit for conducting the signal energy of each wave band from the antenna to the set; to provide an improved antenna system for multiple wave band receiving sets which shall effectively eliminate local interference noise during the operation of the set by preventing energy from local interference sources from reaching the receiving set, while at the same time transmitting the signal energy from the antenna to the receiving set at a very high efficiency; and to provide an antenna system for multiple wave band receiving sets, especially receiving sets adapted to receive either long or short wave signals, which shall have a uniformly high reception characteristic over the entire reception range of the set, i. e., which shall be free from dead spots or bands of impaired reception such as are inherently present in many of the antenna systems now on the market.

The manner of accomplishing these objects and the various novel features and important advantages of my invention will be made more apparent in the following description of certain embodiments of my invention taken in conjunction with the accompanying drawings. In the drawings—

Figure 1 is a circuit diagram of an antenna system embodying the features of my invention;

Figure 2 is a curve illustrating the reception characteristics of the antenna system illustrated in Figure 1;

Figure 3 is a fragmentary elevational view illustrating one form of downlead conductor suitable for use in the antenna system of Figure 1;

Figure 4 is a fragmentary elevational view similar to Figure 3 illustrating a second form of downlead conductor;

Figure 5 is an elevational view of one type of transformer particularly suitable for use in the antenna system of my invention;

Figure 6 is a fragmentary perspective view illustrating certain of the constructional details of the transformer illustrated in Figure 5;

Figure 7 is a circuit diagram, similar to Figure

1, illustrating a modified form of the antenna system of my invention; and

Figure 8 is a fragmentary elevational view, similar to Figures 3 and 4, of a downlead conductor particularly intended for use in the antenna system of Figure 7.

While the principles of the present invention are applicable to antenna systems for use in conjunction with receiving sets adapted to receive signals in more than two wave bands, the principal present use for the invention is in connection with ordinary home receiving sets which are adapted to receive long wave signals (in the broadcast band) and ordinary short wave signals. In view of this, the embodiments of the invention illustrated in the drawings and described herein comprise antenna systems for use in connection with receiving sets which are adapted to receive signals in two wave bands, particularly the relatively long wave broadcast band and the ordinary short wave band. It is my intention, however, that this disclosure of an antenna system for merely a two band range in particular portions of the wave spectrum shall not be deemed to limit the invention in any way. Tests have shown that antenna systems in accordance with my invention may be advantageously used for more than two wave bands and in practically any portion of the wave spectrum.

As illustrated diagrammatically in Figure 1, an antenna system in accordance with my invention comprises a transformer unit 7 adapted to be located adjacent the antenna 8, a plurality of downlead conductors 9, 10, and 11, and a second transformer unit 12 intended to be located adjacent the receiving set 13. The transformer units 7 and 12 are arranged to cooperate with the antenna 8 and the downlead conductors 9, 10, and 11 in such manner that a rise or fall in the potential of the antenna with respect to ground due either to long wave broadcast signals or to short wave signals will produce a corresponding signaling potential across the antenna and ground terminals of the receiving set, indicated at 14 and 15, respectively. The signaling potentials due to long wave length signals are, however, conducted from the antenna to the set over a different circuit than the signaling potentials due to short wave signals.

By this arrangement I obtain what I prefer to designate as "free channel reception." In other words, the signal energy of each band is conducted from the antenna to the set by a separate conducting channel. The arrangement makes for extremely high efficiency in the antenna sys-

tem, particularly when certain types of very closely coupled transformers are used in the transformer units 7 and 12. In fact, tests indicate that at least 90% of the energy impinging upon the antenna can be transmitted to the set by the system of my invention, as compared with maximum transmission efficiencies of about 32.5% in the systems now used in the art. Moreover, this free channel circuit arrangement makes possible the complete elimination of trap circuits in the antenna system which might tend to produce impaired reception at certain wave lengths, a disadvantage which is to be found in most of the antenna systems of this character now known in the art.

The antenna 8 used in the system of my invention probably may be of any of the conventional types, such as a flat-topped L, inverted L, T type, doublet, etc. However, I prefer to use a composite, flat-topped antenna having a long branch 17 of the L type and a short branch 18, or half doublet, the two branches being angularly disposed relative to one another, as is illustrated diagrammatically in Figure 1. For ordinary short wave and broadcast bands, i. e., in bands of 4,000 to 22,000 kilocycles, and from 400 to 4,000 kilocycles, particularly satisfactory results will be obtained with an antenna the longer branch of which is about 60 ft. long and the shorter branch of which is about 22 ft. in length, the two branches being connected at one end to form the apex of an angle of about 30° or 40°.

The signal energy is conducted from the antenna to the receiver by a sufficient number of download conductors to provide a separate circuit for the signal energy in each wave band. Thus, for a two band system the minimum number of download conductors is three, as illustrated at 9, 10, and 11 in the drawings, the download 10 being common to both circuits. These downloads may comprise a triplex cable 19 consisting of three insulated wires 20 twisted together and enclosed in a protective fabric outer sleeve 21, as is illustrated in Figure 3; or three separate conductors insulated from one another; or preferably a cable 23 consisting of two insulated wires 24 which are enclosed in a sleeve conductor 25 of metal braid, or the like, as is illustrated in Figure 4. In this last mentioned structure the two insulated wires 24 are preferably wound about each other to form a twisted pair, insulation 26 is interposed between the wires 24 and the metallic sleeve 25, and a protective insulating covering 27, which may be waterproof, is placed over the sleeve 25.

Regardless of which of these three types of download is used, the download conductor designated as 10 in the circuit diagram of Figure 1 is permanently connected to ground. If the conducting sleeve construction of Figure 4 is used, the sleeve 25 will be employed as the grounded download conductor 10, since the sleeve 25 will then serve to shield the other two downloads 9 and 11 and effectively prevent interference energy from local sources from being conducted to the receiving set 13.

The antenna transformer unit 7 comprises a short wave step down transformer 29 and a long wave step down transformer 30. One end of the primary of each of the step down transformers 29 and 30 is permanently grounded, as by being connected to the grounded download conductor 10 at 31. The other end of the primary of the

step down long wave transformer 30 is connected directly to the antenna 8, as by the conductor illustrated at 32, and the other end of the primary of the step down short wave transformer 29 is connected to the antenna through a condenser, as illustrated at 33.

The electrical constants of the step down transformers 29 and 30 and the condenser 33 are such as to provide a low impedance path from the antenna to ground for long wave signals through the primary of the long wave transformer 30, and a low impedance path for short wave signals from the antenna to ground through the primary of the short wave transformer 29, while at the same time providing a high impedance path for short wave signals through the primary of the long wave transformers 29 and a high impedance path for long wave signals through the primary of the short wave transformer 29.

One end of each of the secondaries of the long and short wave step down transformers 29 and 30 is grounded, as by being connected to the grounded download conductor 10 at 34. The other end of the secondary of the step down long wave transformer 30 is connected to the download conductor 9, and the other end of the secondary of the step down short wave transformer 29 is connected to the download conductor 11.

It will be evident that the result of this arrangement is to provide a circuit wherein any change in the potential of the antenna 8 with respect to ground due to a long wave signal will impress a signaling potential across the download conductor 9 and the grounded download conductor 10. Likewise, any change in the potential of the antenna 8 relative to the ground due to a short wave signal will impress a signaling potential across the other download conductor 11 and the grounded download conductor 10. While the ground lead 10 is common to both circuits, an independent channel is provided in the download arrangement for both types of signal energy.

The other transformer unit 12 is similar to the antenna transformer unit 7 and includes a short wave step up transformer 37 and a long wave step up transformer 38; one side of the primary of each of the step up transformers 37 and 38 is grounded, as by being connected to the grounded download 10 at 39. The other side of the primary of the long wave step up transformer 38 is connected to the long wave download 9, and the other side of the primary of the short wave step up transformer 37 is connected to the short wave download 11.

One side of the secondary of each of the step up transformers 37 and 38 is likewise grounded, as by being connected to the grounded download 10 at 40. The other side of the secondary of the long wave step up transformer 38 is directly connected by metallic conductors 41 to the antenna terminal 14 of the receiver 13. The other side of the secondary of the short wave step up transformer 37 is connected to one of the conductors 41 through a condenser 42. The condenser 42 permits the obtaining of an impedance in the short wave side of the set transformer unit 12 which substantially prevents any circulating of the lower frequency, long wave energy, while at the same time the inherently high inductance of the secondary of the long wave step up transformer 12 effectively prevents any loss of short

wave energy by virtue of the shunt relation of the two secondaries.

The individual long and short wave transformers 29, 30, 37, and 38 used in the transformer units 7 and 12 may be of any conventional type. However, the inherent advantages of the circuit of the present invention are fully realized only when transformers having the maximum possible coupling are used in these units, the minimum permissive limit, consistent with full realization of the advantages of the invention, being about 75% coupling. Because of this characteristic of the system, my invention makes possible, and in fact almost requires, the use of metallic core transformers, such as iron dust core transformers, in the transformer units.

Iron dust transformer cores, as is well known in the art, comprise mixtures of very finely divided, individually insulated particles of iron dust or magnetic oxide, and a binder which serves to support the individual particles. These mixtures may be molded into any convenient form, and it is customary to wind the transformer coils directly upon the core. With a metallic core of this type it is readily possible to secure couplings in excess of 90% whereas the maximum coupling obtainable with an air core transformer is about 57%, and since the efficiency of energy transfer is a function of the coupling, it will be apparent that the ability of the system of the present invention to use closely coupled transformers it is a most important feature of the invention.

A type of closely coupled transformer unit which I have found particularly satisfactory in the system of my invention is illustrated in Figures 5 and 6. This transformer unit includes a base 45 of suitable dimensions, which may be cut from a sheet of insulating material, and a cylindrical core support 46 also of insulating material which serves as a support for the core 47 of the long wave transformer 48 and the similar core 49 of the short wave transformer 50. The cores 47 and 49 are of the iron dust or magnetic oxide type and preferably have the form illustrated in Figure 6. The transformer windings 51 and 52 preferably comprise bifilar wound, honeycomb coil units, i. e., windings wherein the primary and secondary windings of each transformer are wound simultaneously in parallel turns, as illustrated in Figure 6, where the first turn 53 of a primary winding is shown with shading and the first turn 54 of the cooperating secondary winding is shown unshaded.

To obtain the maximum coupling in the transformer unit as a whole, the two cores 47 and 49 are preferably mounted coaxially upon the support 46 and may be held in place by a headed wooden dowel pin 56 and screw 55, as illustrated in Figure 5. This type of transformer unit while merely illustrative is one which has proven particularly satisfactory in actual service.

In order to obtain maximum efficiency in the system, it is very desirable that the long and short wave transformers 29, 30, 37, and 38 shall be of the matched impedance type. In other words, the transformer turns ratio and coupling should be such that the low impedance transmission is substantially matched to the antenna and the radio receiver input circuit.

In a specific embodiment of the invention which gave particularly satisfactory results, the condensers 33 and 42 had a capacity of 80 m. m. f. The short wave step down transformer 29 of the antenna transformer unit 7 had a 20 turn pri-

mary and a 5 turn secondary, and the associated long wave transformer 30 had a primary of 100 turns and a secondary of 20 turns. The primary of the short wave step up transformer of the set transformer unit 12 had a 5 turn primary and a 22 turn secondary, and the primary of the associated long wave step up transformer 28 had a 20 turn primary and a 78 turn secondary. Each of the individual transformers was wound on a molded, oxide dust core having a dimension A in Figure 6 of about $\frac{1}{2}$ ", a dimension B of about $\frac{3}{8}$ " and a dimension C of about $\frac{1}{8}$ ", A. W. G. #36 enameled wire with one layer of silk insulation used for all windings. The coils were bifilarly wound in honeycomb form.

When the system of the present invention is used for the reception of very short wave signal energy, it will be found that a downlead cable of the type shown in Figure 4 will have a tendency to pick up certain types of noise energy due to the natural inductance of the shield 25 providing appreciable coupling impedance at these very high frequencies. However, if the system of Figure 1 is modified as shown in Figure 7 and a downlead conductor 57 having three insulated wires 58 enclosed within a braided conducting sleeve 59, as illustrated in Figure 8, is used this difficulty will be obviated.

The system of Figure 7 is substantially identical with the system of Figure 1, except in the following respects: One, the secondaries of the antenna unit transformers 29 and 30 and the primaries of the set unit transformers 37 and 38 are ungrounded in the Figure 7 system. Two, the three downlead conductors 9^a, 10^a, and 11^a connecting the secondaries of the antenna unit transformer and the primaries of the set unit transformers are likewise ungrounded in the Figure 7 system. Third, the downlead conductors 9^a, 10^a, and 11^a of the Figure 7 system are shielded by a grounded conducting sleeve 61 (which will comprise the sleeve 59 if a cable such as is illustrated in Figure 8 is used); this sleeve 61 is connected at its upper end to the interconnected primaries of the antenna unit transformers at 31 whereby it serves as the ground connection for that unit. And, four, the connection between the points 39 and 40 of the Figure 1 system is eliminated in the Figure 7 system, the interconnected secondaries of the set unit transformers being directly grounded by a connection 63.

The net result of these differences is merely to provide a grounded shield for the downlead conductors which is insulated from those conductors and the transformer windings which they connect. This arrangement, while providing a satisfactory path to ground for the primaries of the antenna unit transformers in order that changes in potential of the antenna with respect to ground shall provide corresponding changes in the potential across the downleads, serves to provide a complete shielding of the downlead circuit which prevents pick up of noise or interference energy. Except for this shield and the manner in which it is connected into the circuit, the system of Figure 7, as stated previously, is substantially identical with the system of Figure 1 and operates in precisely the same manner.

As stated above, tests of the antenna system of my invention have fully established its remarkable efficiency and its freedom from the disadvantages of the prior art arrangements. Outstanding among these advantages is the remarkable electrical efficiency of the system which

permits substantially twice as much of the energy at any particular frequency incident upon the antenna to be transmitted to the set terminals as was obtainable with previous types employing air core coupling. Moreover, the system of my invention is free from dead spots or bands of decreased reception efficiency and gives uniformly excellent reception over the full wave band. This characteristic is illustrated in Figure 2 where the curve labeled A represents a plot of the ratio of energy impinging upon the antenna to energy delivered by the antenna system to the receiver over the operative frequency band, i. e., the electrical efficiency of the antenna system.

At the transition point—about 4,000 kilocycles—it will be found that some of the energy is transmitted to the set from both the long wave and the short wave sides of the system. Because of this, it is possible to obtain a flat reception characteristic in the region of this frequency. In many of the prior art systems a marked decreased efficiency is encountered in this range.

The important advantages of the system of my invention are believed to be due to the fact that a separate circuit is provided for conducting the short wave and long wave energy from the antenna to the set, i. e., the provision of a free channel for each type of signal. The marked elimination of local interference noise without impairment or reduction of the signal energy is also believed to result in part from this free channel circuit arrangement since that arrangement particularly lends itself to complete shielding of the downleads, preferably by the use of the conducting sleeve cable constructions disclosed in Figures 4 and 6, although reasonably satisfactory shielding may be obtained by the triplex cable construction illustrated in Figure 3 because of the presence of grounded conductor 10 and the low impedance of such conductor.

It will be apparent to those skilled in the art that various types of antenna systems embodying the principles which I have disclosed in the foregoing may be constructed. For instance, if it should be desired to provide an antenna system for three or four wave band reception instead of two wave bands, additional units may obviously be added to the system disclosed. It is my intention, therefore, that the accompanying claims shall be accorded the broadest reasonable construction consistent with the language appearing therein and the prior art.

I claim the following as my invention:

1. In a radio receiving system; a receiving set for long and short wave signals; an antenna; an antenna transformer unit comprising a step down transformer for long wave signals and a step down transformer for short wave signals; three downlead conductors which are insulated from each other and are enclosed within a conducting sleeve; said sleeve being insulated from said downlead conductors and being permanently connected to ground; one side of the primary of each of said step down transformers being connected to said grounded sleeve; the other side of the primaries of said step down transformers being electrically connected to said antenna; one side of the secondary of both of said step down transformers being connected to a single downlead conductor; the other side of the secondary of each of said step down transformers being connected respectively to one of the other two downlead conductors; a set transformer unit comprising a step up transformer for long wave

signals and a step up transformer for short wave signals; one side of the primary of each of said step up transformers being connected to said first mentioned downlead conductor; the other side of the primary of said long wave step up transformer being connected to the downlead from the secondary of the long wave step down transformer, and the other side of the primary of said short wave step up transformer being connected to the downlead from said short wave step down transformer; one side of the secondary of said short wave step up transformer and said long wave step up transformer being grounded, and the other side of each of said secondaries of said step up transformers being electrically connected to said receiver.

2. In a radio receiving system; a receiving set for long and short wave signals; an antenna; an antenna transformer unit comprising a step down transformer for long wave signals and a step down transformer for short wave signals, both transformers being of the matched impedance type; three downlead conductors which are insulated from each other and one of which is permanently grounded; one side of the primary of each of said step down transformers and one side of the secondary of each of said step down transformers being connected to said grounded downlead conductor, the other side of the primary of said long wave transformer being connected directly to said antenna and the other side of the primary of the short wave transformer being connected to said antenna through a capacitance, the other side of the secondary of each of said step down transformers being connected respectively to one of the two ungrounded downlead conductors; a second transformer unit comprising a step up transformer for long wave signals and a step up transformer for short wave signals; both transformers being of the matched impedance type, one side of the primary of each of said step up transformers and one side of the secondary of each of said step up transformers being connected to ground, the other side of the primary of said long wave step up transformer being connected to the downlead from said long wave step down transformer, and the other side of the primary of said short wave step up transformer being connected to the downlead from said short wave step down transformer, the other end of the secondary of said long wave step up transformer being directly connected to the antenna terminal of said receiving set, and the other side of the secondary of said short wave step up transformer being connected to the antenna terminal of said receiving set through a condenser.

3. A radio receiving system for receiving signals in two different wave bands comprising an antenna, means, including three separate downlead conductors, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each of said wave bands, one of said downlead conductors being common to both of said downlead transmission circuits, and means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either wave band cause like potential fluctuations to be set up only in the downlead transmission circuit provided for that wave band.

4. A radio receiving system for receiving signals in two different wave bands comprising an antenna, means, including three separate downlead conductors, two-conductor, downlead trans-

mission circuit from said antenna to the receiving set with which said system is used for each of said wave bands, one of said downlead conductors being permanently connected to ground and being common to both of said downlead transmission circuits, and means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands cause like potential fluctuations to be set up only in the downlead transmission circuit provided for that wave band.

5. A radio receiving system for receiving signals in two different wave bands comprising an antenna, means including a pair of downlead conductors which are enclosed within a conducting sleeve and which are insulated from each other and from said sleeve, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each of said wave bands, said conducting sleeve being permanently connected to ground and constituting a common conductor of both of said downlead transmission circuits, and means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands causes like potential fluctuations to be set up only in the downlead circuit provided for that band.

6. A radio receiving system for receiving signals in two different wave bands comprising an antenna, means, including three separate downlead conductors, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each of said wave bands, one of said downlead conductors being permanently connected to ground and being common to both of said downlead transmission circuits, and means, including a step-down transformer having a coupling of at least 75% interposed between the antenna end of each of said downlead transmission circuits and said antenna and a step-up transformer also having a coupling of at least 75% interposed between the set end of each of said downlead transmission circuits and the receiving set with which said system is used, whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands causes like potential fluctuations to be set up only in the downlead transmission circuit provided for that band.

7. A radio receiving system for receiving signals in a plurality of different wave bands comprising an antenna, means, including three separate downlead conductors, providing a separate, low impedance, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each wave band which is to be received, one of said downlead conductors being permanently connected to ground and constituting a common conductor of both of said downlead transmission circuits, and means, including a step-down transformer interposed between the antenna end of each of said downlead transmission circuits and said antenna and a step-up transformer interposed between the set end of each of said downlead transmission circuits and the receiving set with which said system is used, whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands causes like potential fluctuations to be set up only in the downlead transmission circuit provided for that band.

8. A radio receiving system for receiving sig-

nals in two different wave bands comprising an antenna, means, including a pair of downlead conductors which are enclosed within a conducting sleeve and which are insulated from each other and from said sleeve, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each of said wave bands, said sleeve being permanently connected to ground and constituting a common conductor of both of said downlead transmission circuits, and means, including a step-down transformer having a coupling of at least 75% interposed between the antenna end of each of said downlead transmission circuits and said antenna and a step-up transformer having a coupling of at least 75% interposed between the set end of each of said downlead transmission circuits and the receiving set with which said system is used, whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands causes like potential fluctuations to be set up only in the downlead transmission circuit provided for that band.

9. A radio receiving system for receiving signals in two different wave lengths comprising an antenna, means, including three separate downlead conductors, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each wave band which is to be received, one of said downlead conductors being common to both of said downlead circuits, and means, including a step-down, iron core transformer interposed between the antenna end of each of said downlead transmission circuits and said antenna and a step-up, iron core transformer interposed between the set end of each of said downlead transmission circuits and the receiving set with which said system is used, whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands causes like potential fluctuations to be set up only in the downlead transmission circuit provided for that band.

10. A radio receiving system for receiving signals in a plurality of different wave lengths comprising an antenna, means, including three, separate, downlead conductors, providing a separate, two-conductor, downlead transmission circuit from said antenna to the receiving set with which said system is used for each wave band which is to be received, one of said downlead conductors being common to both of said downlead circuits, means, including a step-up transformer interposed between the antenna end of each of said downlead transmission circuits and said antenna, whereby fluctuations in the potential of said antenna with respect to ground due to signals in any of said wave bands cause like potential fluctuations to be set up only in the circuit provided for that wave band, and a step-up transformer interposed between the set end of each of said downlead transmission circuits and the receiving set with which said system is used, the electrical constants of both said step-up and said step-down transformers being such that substantial matching of impedances is obtained in each of said downlead transmission circuits.

11. A radio receiving system for long wave and short wave signals comprising a flat top, V-type antenna, one of the arms of which is much longer than the other, means, including three separate downlead conductors, two-conductor, downlead transmission circuit from said antenna

to the receiving set with which said system is used for each of the two wave bands which is to be received, and means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands cause like potential fluctuations to be set up only in the circuit provided for that band.

12. A radio receiving system for long or short wave signals comprising a flat top, V-type antenna, the two arms of which are of different lengths and are respectively adapted for the reception of long wave and short wave electromagnetic energy, means, including three separate download conductors, providing a separate, two-conductor, download transmission circuit from said antenna to the receiving set with which said system is used for each wave band which is to be received, one of said download conductors being permanently connected to ground and constituting a common conductor in both of said download transmission circuits, and means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands cause like potential fluctuations to be set up only in the download transmission circuit provided for that wave band.

13. A radio receiving system for long or short wave signals comprising a flat top, V-type an-

tenna, the two arms of which are of different lengths and are respectively adapted for the reception of long wave and short wave electromagnetic energy, means, including three separate download conductors, providing a separate, two-conductor, download transmission circuit from said antenna to the receiving set with which said system is used for each wave band which is to be received, one of said download conductors being permanently connected to ground and constituting a common conductor in both of said download transmission circuits, means whereby fluctuations in the potential of said antenna with respect to ground due to signals in either of said wave bands cause like potential fluctuations to be set up only in the download transmission circuit provided for that wave band, said last mentioned means including a step-down, iron core transformer interposed between the antenna end of each of said download transformer circuits and said antenna, and a step-up, iron core transformer interposed between the set end of each of said download transformer circuits and the receiving set with which said system is used, the electrical constants of said transformers being such that substantial matching of impedances is obtained in each of said download circuits.

ALFRED CROSSKEY

CERTIFICATE OF CORRECTION.

Patent No. 2,222,406.

November 19, 1940.

ALFRED CROSSLEY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 11, for "wace" read --wave--; page 3, first column, line 32, strike out "it"; page 4, second column, line 75, and page 5, second column, line 74, claims 4 and 11 respectively, before "two-conductor" insert the words and comma --providing a separate,--; page 5, first column, line 27, claim 5, for "bet" read --be--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of January, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.