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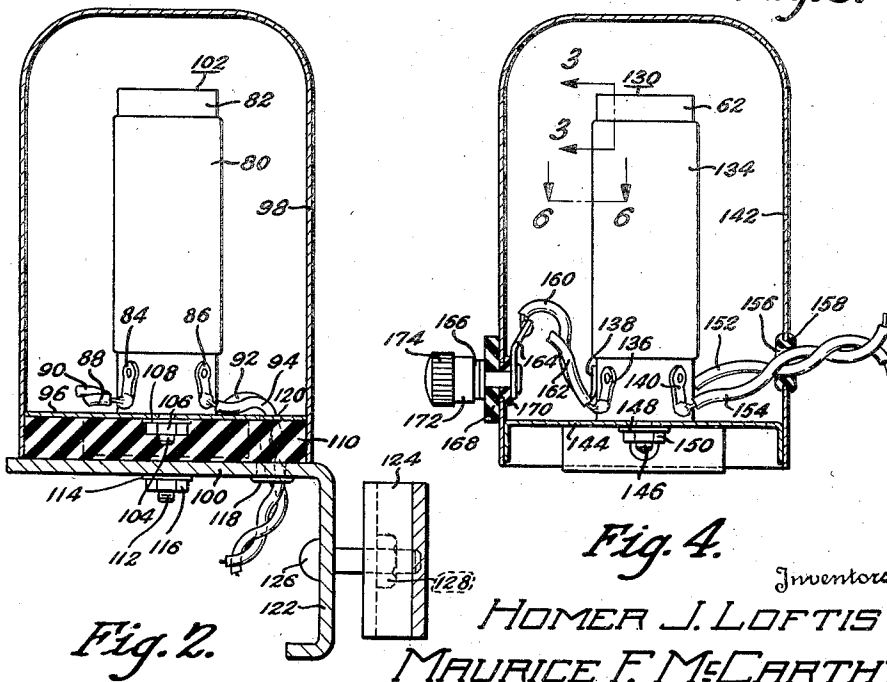
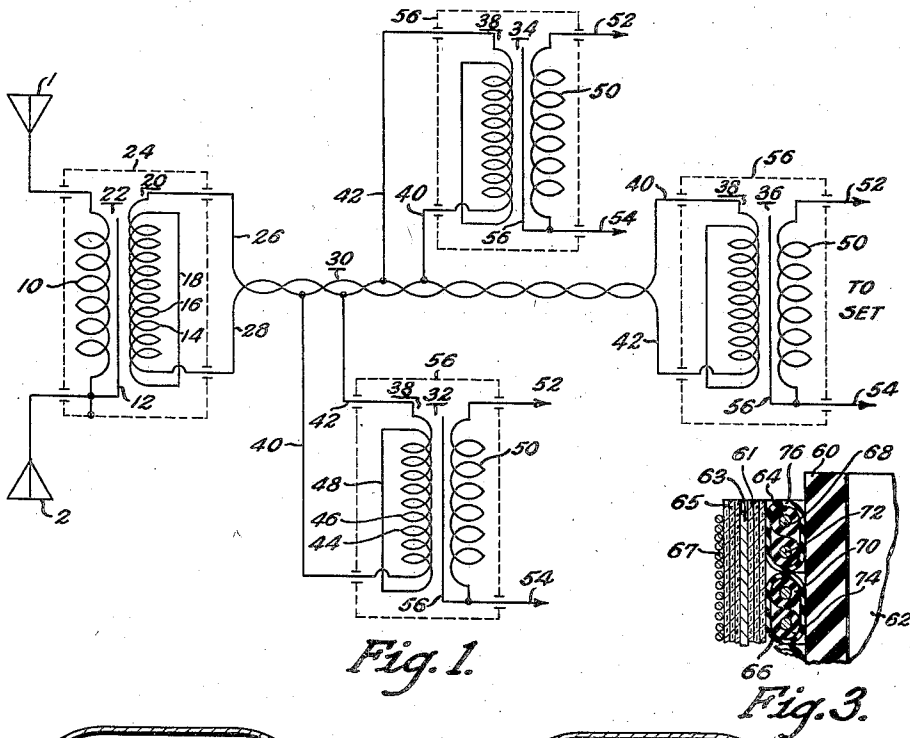
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ANTENNA SYSTEM

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2 Sheets-Sheet 1



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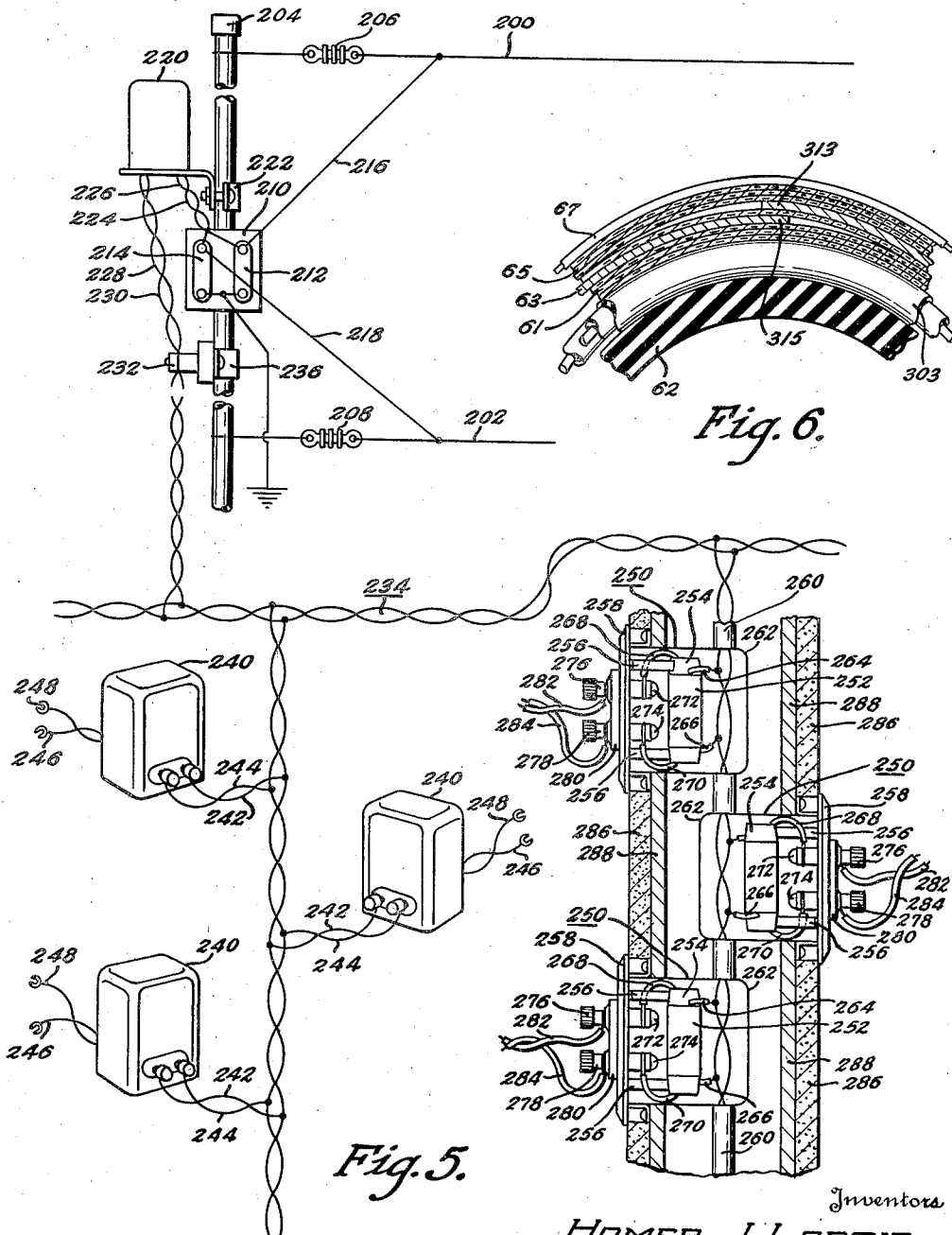
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UNITED STATES PATENT OFFICE

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ANTENNA SYSTEM

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5 Claims. (Cl. 250-9)

This invention relates to an antenna system, and more particularly to an antenna system which tends to eliminate noise and interference from local disturbances, and to which more than one receiver may be connected.

The problem of providing a good antenna for use in apartment houses or congested districts as well as the elimination of interference from street cars, elevators, electrical machinery and motors has long been a vexing one. A great many unsuccessful noise eliminating systems have been devised, and some elaborate and expensive means have been devised to solve the apartment house antenna problem. And, more economical means have been proposed to solve the antenna problem for apartment houses and hotels, but they have not done anything toward the problem of noise elimination.

A system which requires the use of booster amplifiers is expensive in first cost, and a continual expense because vacuum tubes must be replaced and power is consumed in the operation.

The systems which are economical in installation and operating cost, but which do not eliminate or even tend to eliminate stray noises are usually quite unsatisfactory in apartment houses and hotels because of the electrical apparatus usually present and utilized in and about those places.

It is an object of the present invention to provide an antenna system which may have more than one outlet. This has been accomplished by providing an antenna system having a transmission line and a coupling device connected to the transmission line for each desired outlet.

Another object of this invention is to provide an antenna system which will tend to eliminate stray signals, or interference which is picked up. This has been accomplished by close association of the conductors of the transmission line and balancing and shielding the coupling devices.

Another object of this invention is to provide an antenna system which may have a large number of receivers connected thereto and which will permit good signal reception by all of the receivers without necessitating the use of a booster amplifier. This has been accomplished by providing coupling devices to properly match the impedances of the system.

Another object of this invention is to provide an antenna system which is easy and economical to install in either a building which is being built, or one which is built and is in use.

Another object of this invention is to provide

an antenna system which requires little or no attention or expense after installation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the invention is clearly shown.

In the drawings:

Fig. 1 discloses the circuit for the coupling devices and connections for an antenna system of the type to be described in the present specification.

Fig. 2 is a sectional view showing a preferred construction for one of the coupling devices used in this system.

Fig. 3 is an enlarged fragmentary sectional view taken substantially on a line 3-3 of Fig. 4.

Fig. 4 is a sectional view disclosing the construction details of a preferred form of another type of coupling device used in the system.

Fig. 5 is a combination circuit and structural drawing showing a method of installing the system with different types of coupling devices for coupling the transmission line to a radio device.

Fig. 6 is an enlarged fragmentary sectional view taken substantially on a line 6-6 of Fig. 4.

With particular reference to Fig. 1, an inductance or winding 10 is connected in series with an antenna 1 and a counterpoise 2. Windings 14 and 16 are preferably wound parallel, coaxial and adjacent. One end of the winding 14 is connected to an end of the winding 16 through a lead 18 so that the magnetic fields of the two windings aid. A winding 20 formed by the windings 14 and 16 thus connected in series, is magnetically coupled to the winding 10. A shield 12 is interposed between the windings 10 and 20, and connected to the winding 10 intermediate that winding and the counterpoise 2. The assembly thus formed serves as a coupling or impedance matching device 22. A metallic housing 24 enclosing the coupling device 22, and connected to the winding 10 intermediate that winding and the counterpoise 2, forms a shield for the device. A transmission line 30 is formed by conductors 26 and 28, which conductors are preferably insulated and closely associated or twisted. The transmission line 30 is connected to the extremities of the winding 20, and serves to carry signal energy.

The reference numerals 32, 34 and 36 refer to coupling devices which are similar in structure, and like numerals will refer to similar parts of those devices. The extremities of a balanced

winding 33 are connected to the conductors 23 and 28 of the transmission line 30 through leads 42 and 43 respectively. The balanced winding 33 is preferably formed by two windings 44 and 46 wound parallel, coaxial and adjacent, and connected in series through a lead 43 so that their magnetic fields aid. A winding 50 is magnetically coupled with the winding 33, and adapted for connection to a radio device through leads 52 and 54, connected to the extremities of the winding. A shield 56 is interposed between the windings 33 and 50 and connected to an extremity of winding 50 intermediate that winding and the lead 54. The assembly 32 thus formed serves as a coupling or impedance matching device to couple a radio device to the transmission line 30, and preferably to match the impedance of the radio device to that of the transmission line. A housing 58 preferably forms a shield for the coupling device 32.

With particular reference to Fig. 2, the windings 80 of the coupling device are assembled on the form 82 and the extremities, or leads from the windings, are connected to soldering lugs including and similar to 84 and 86. Insulated leads 88, 90, 92 and 94 soldered to their respective soldering lugs, as shown by the lead 88 soldered to lug 86 and the lead 94 soldered to lug 86, are adapted for making necessary connections to the coupling device. In the preferred form indicated an assembly 102 thus formed is housed in a cup-shaped member 98 having a false base 96 and an outer base 100. The coil assembly 102 as formed by the form 82, the windings 80, and the lugs including 84, 86 which are fastened to the form 82, is secured to the false base 96 by a bolt 104 which is anchored to the inner surface of the form 82, and which has a cooperating washer 106 and nut 106.

A space 110 between the false base 96 and the outer base 100, and enclosed within the cup-shaped member 98 is preferably filled with an insulating material such as a heavy wax to weatherproof the unit. The outer base 100 is fastened to the cup-shaped member 98 by suitable eye bolts 112 which have cooperating washers 114 and nuts 116. The connecting leads are brought out as indicated for the leads 92 and 94 which pass through an aperture 120 in the false base 96 and through an aperture 118 in the outer base 100. To facilitate mounting, a flange 122, having a cooperating clamp member 124, is formed on the base 100. Suitable bolts 126 and nuts 128 cooperating with the flange 122 and clamp member 124, provide means for adjusting the clamp and tightening it on a suitable mounting.

With particular reference to Fig. 3, 60 refers to a section of a wall of a form 62, upon which a winding may be wound. The sectional views of conductor assemblies 64 and 66 show a preferred form of construction for the conductors used in making a winding such as the winding 38 of Fig. 1. In the assembly 64, which is similar to the assembly 66, conductors 68 and 72 are surrounded by layers of insulating material 70 and 74 respectively. An outer covering of insulating material 76 binds the two insulated conductors 68 and 72 together. By thus forming the conductor assemblies, they may be easily wound adjacent as indicated by 64 and 66 on the form 62. After the conductors are wound they may be connected in series as indicated in and described for Fig. 1. In the preferred construction, layers of insulating material 81 such as paper are wrapped over the winding formed by the conductor as-

semblies such as 64 and 66. Then the shield 63, preferably made of copper or other good conducting material, is interposed between the insulating material 81 and more insulating material 65. A winding 67 is wrapped over the insulating material 65. The winding 67 corresponds to 50 in Fig. 1.

With particular reference to Fig. 4, a form 62 having windings 134 thereon, and soldering lugs 136, 138 and 140 fastened thereto, forms a coupler sub-assembly 130. The winding connections are made to soldering lugs including the lugs 136, 138 and 140. The sub-assembly 130 is preferably enclosed within a cup-shaped housing 142 having a base 144. The sub-assembly 130 is fastened to the base 144 by a bolt 146 which is anchored inside the form 62, and which has a cooperating washer 148 and nut 150. In the preferred form, thus illustrated, the connections to the radio device, as explained for the circuit in 20 Fig. 1, are made through insulated leads 152 and 154 which are connected to soldering lugs including the lug 140, and which pass through an aperture 156 in the cup-shaped member 142. A grommet 158 protects the leads 152 and 154 from any sharp edges that may be on the material surrounding the aperture 156, and also adds additional insulation. Leads 160 and 162 soldered to lugs 136 and 138 respectively and also soldered to lugs 164 which are connected to insulatingly mounted binding posts 166 serve in making connections between the coupling device and the transmission line as illustrated in and described for Fig. 1. An insulating block 168 and a cooperating insulating piece 170 insulate the binding posts 166 from the cup-shaped member 142. A screw cap 172 having a knurled surface 174 is used to clamp a connecting wire to the binding post.

With particular reference to Fig. 5, an antenna 200 and a counterpoise 202 are supported by a mast 204. Insulators 206 and 208 insulate the antenna and counterpoise respectively, from the mast. An insulating terminal block 210 has mounted thereon conductive terminal strips 212 and 214, to which the leads 216 and 218 from the antenna 200 and counterpoise 202 respectively, are anchored. The block 210 is supported by the mast 204, and should preferably be placed about midway between the antenna and counterpoise. A main coupling device 220 which is similar to that disclosed in Fig. 3 is clamped to the mast 204 by a clamp 222. Leads 224 and 226 which are preferably insulated and twisted form a connection between the coupling device 220 and the terminal strips 214 and 212 respectively. Leads 228 and 230 form a part of the transmission line 234. A cleat 232 supported by the mast 204 by a clamp 236 grips and insulatingly holds the conductors 228 and 230, and prevents any strain in the transmission line 234 from being transmitted to the coupling device 220.

Coupling devices 240 are each similar to the device disclosed in Fig. 4. The coupling devices 240 are connected to the conductors of the transmission line 234 by leads 242 and 244. Leads 246 and 248 on the coupling devices 240 are provided for making connections with a radio device. Coupling devices 250 are similar, and like reference numerals will refer to similar parts. In this form of coupling device, the windings 252 may be similar to those used on coupling devices 32, 36, and 38 in Fig. 1, and are wound on a form 254 which is supported by brackets 256 which are fastened to wall mounting plates 258. In this

form, the transmission line 234 may be threaded through conduit pipe 260, and knock-out boxes 262 provided at the positions where the coupling devices are to be mounted. By so doing, the wall plate 258 and knockout boxes 262 form the housing and shield for the coupling device. Leads 264 and 266 form the connections between the winding of the coupling device and the transmission line 234. Leads 268 and 270 form the connection between the other winding of the coupling device and terminals 272 and 274 of the binding posts 276 and 278 respectively. The binding posts 276 and 278 are mounted on an insulating block 280 and thereby insulated from the wall plate 258. The insulating block 280 is fastened to and supported by the wall plate 258. Leads 222 and 284 connected to binding posts 276 and 278 respectively form the connections between the coupling device and a radio device. References 286 and 288 refer to wall structure of a building.

With particular reference to Fig. 6, a form of insulating material 62 has a winding 303 corresponding to the winding 38 of Fig. 1 wound adjacent thereto. Layers of insulating material 61 are interposed between the winding 303 and a shield 63. The shield 63 continues around the unit thus formed, and it should be noted that the ends 313 and 315 of that shield overlap slightly and are separated by a layer of insulating material. Hence, the shielding action produced by the shield is electrostatic rather than electromagnetic. Layers of insulating material 65 are then interposed between the shield 63 and a winding 67. The winding 67 corresponds to 50 of Fig. 1.

In receiving signals a potential difference is produced between the antenna and counterpoise by the intercepted waves due to the difference in height. That potential difference constitutes the signal voltage, and is transmitted through the coupling devices and transmission line to the radio device. It is apparent to one skilled in the art that if the impedance of the antenna and counterpoise system is matched to that of the line by a suitable coupling device that maximum power transfer will be obtained between the antenna and counterpoise and the transmission line. It is also apparent that if the impedance of the transmission line is matched to that of the radio device by a coupling device that maximum power transfer will be obtained between the transmission line and the radio device. Hence, it is preferable to have the coupling devices match the impedances which they couple. However, an installation such as that disclosed in Fig. 5, where several radio devices are coupled to the same transmission line and an antenna and counterpoise, the impedance of the windings of the coupling devices 240 which are connected to the transmission line should preferably be higher than the characteristic impedance of the line so that the group of couplers together will not tend to short circuit the conductors of the transmission line.

The preferred method of accomplishing the result is to have the sum of the impedances of the windings which are connected to the transmission line equal the characteristic impedance of the line. Another method might be to terminate the line in its characteristic impedance and have the impedances of the windings which are connected to the line so high that they will not appreciably reduce the effective terminating impedance of the line. Another factor in obtaining

high energy transfer in the coupling devices is that the coefficient of magnetic coupling between the coupled windings of the coupling devices should be kept high. Having a high coefficient of coupling prevents losses due to leakage and permits high energy transfer between the windings.

Since the noises and disturbances set up by electrical machinery, street cars, etc., do not radiate for any great distances, and are picked up to a much greater extent close to the source, it is apparent that the larger portion of the disturbances picked up by the ordinary antenna system are picked up by the lead-in and ground wires. In this modification of the present invention the counterpoise replaces the usual ground connection, and thus permits the pick-up of signal energy at a point as far as possible from the source of disturbing energy, and also permits the close association or twisting of the lead wires of the transmission line which carry the signal energy from the antenna and counterpoise. By keeping the conductors of the transmission line closely associated, such as by twisting the conductors together, the fields intercepted by the conductors are practically equal and thus equal voltages are produced in the conductors.

The balanced windings such as 20 and 38 of Fig. 1 which are connected to the transmission line permit the equal voltages set up in the conductors to buck and neutralize each other without producing a voltage in the associated windings. Having the windings 20 and 38 formed of parallel adjacent conductors connected in series as disclosed, helps to electrostatically balance the winding and reduce the electrostatic coupling between the windings of the coupling devices, to reduce the transfer of noise energy between the windings by electrostatic coupling. The shields 12 and 56 interposed between the windings of the coupling devices also reduce the electrostatic coupling and in that manner reduce noise.

Inductive coupling in the coupling devices which connect to the radio devices segregates the radio devices from the transmission line and antenna and counterpoise, so that a number of receivers may be connected to the same transmission line and antenna and counterpoise without interfering with each other when tuned to the same or different frequencies. This feature as well as others previously mentioned permits a single antenna and counterpoise system to supply energy to quite a large number of radio devices, and thus does away with the necessity of a maze of wires formerly necessary on large apartments or hotels, as well as the added feature of noise reduction or elimination.

Two types of coupling devices, 240 and 250, shown in Fig. 5 are used for the same purpose, but for different types of installation. Where it is preferable to mount the coupling devices on the radio set itself or external to the building structure, couplers of the type 240 are preferable. In a new building or in one in which the transmission line is to be threaded through conduits, couplers of the type 250 are preferable.

It is preferable for the best operation and proper balancing of the system to have the main coupling device 220 mounted near and intermediate the antenna and counterpoise. For that reason, a weather proof housing is desirable to keep moisture and corrosive atmosphere away from the windings of that coupling device when mounted outside.

While the form of embodiment of the present invention as herein disclosed, constitutes a pre-

ferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

5 1. In an antenna system, the combination including, a plurality of impedance matching devices each having a plurality of windings, one winding on each composed of a plurality of parallel helically wound conductors insulated from
10 each other and connected in series, another of said windings comprising a helical coil and having a high coefficient of coupling with the other winding, a shield interposed between said windings and connected to one of said windings and
15 a two wire radio frequency transmission line connecting said parallel wound conductors.

2. In combination in a device of the class described an antenna, a transformer having a primary winding connected to said antenna and a
20 secondary winding, a second transformer having primary and secondary windings, means connecting said last named secondary winding to a radio receiver and a transmission line having low attenuation at radio frequencies connecting the
25 secondary of said first named transformer to the primary of said second named one, the said connected primary and secondary each comprising a plurality of helically arranged turns having the same winding diameter each turn being formed of
30 two insulated conductors and an insulating covering surrounding said conductors and securing them together as a unitary structure, and a lead connecting the conductor of the top end turn with the bottom end turn of the other conductor.

35 3. In an antenna system, the combination of an antenna, a radio frequency transmission line having a characteristic impedance, a coupling device for connecting said transmission line to

said antenna, a plurality of similar coupling devices each having two windings, the total impedance of all of said windings taken together being substantially equal to the characteristic impedance of said line and leads connecting a plurality of said windings to said transmission line.

4. In a device of the class described, the combination of a long radio frequency transmission line, means for impressing a broad band of radio frequency currents across one end of said line, a plurality of transformers located at spaced apart points on said line and arranged to connect a plurality of radio receiving devices thereto, each of said transformers comprising a coil form, a primary wound about said form and consisting of two windings arranged with the turns of one winding placed between the turns of the other, a lead connecting the top turn of one winding in series with the bottom turn of the other, a layer of insulation material surrounding said primary winding and a secondary winding surrounding said insulation layer and closely coupled to said primary winding.

5. In a radio frequency transmission system, the combination of a source of modulated signal energy, a long radio frequency transmission line having a characteristic impedance, a coupling device for connecting said energy source to said transmission line, a plurality of similar coupling devices spaced apart along said transmission line and each having two windings and means connecting a plurality of said windings to said transmission line, the total impedance of said plurality of connected windings being substantially equal to the characteristic impedance of said line.

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