MULTI-BAND MONOPLE ANTENNA WITH ADJUSTABLE TUNING

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ABSTRACT

An antenna, which has a plurality of coaxial, generally cylindrical portions interconnected by a plurality of parallel-resonant traps to enable it to transmit or receive signals at one or more relatively high frequencies, is connected to a transmission line by a fixed capacitor, a fixed inductor, and an adjustable inductor which are connected in parallel with each other. That capacitor, fixed inductor and adjustable inductor are located adjacent the lower end of that antenna; and they enable that antenna to continue to transmit or receive signals at the said one or more relatively high frequencies, while also enabling that antenna to receive or transmit signals at a lower frequency — without increasing the overall length of that antenna.

16 Claims, 10 Drawing Figures
This invention relates to improvements in antennae. More particularly, this invention relates to improvements in antennae that are intended to transmit or receive signals at relatively low frequencies as well as at one or more relatively high frequencies. It is, therefore, an object of the present invention to provide an improved antenna that is intended to transmit or receive signals at a relatively low frequency as well as at one or more relatively high frequencies. It frequently is desirable to use multi-frequency antennae, and, at the present time, a number of multi-frequency antennae are available on the market. Multi-frequency antennae, which are capable of transmitting or receiving signals in the 10 meter band, in the 15 meter band, in the 20 meter band, in the 40 meter band and in the 80 meter band, are usually very long; and hence it is difficult to erect such antennae. Also, because such antennae offer substantial resistance to wind, it is difficult to keep such antennae from being bent or broken by high winds. Further, to enable such antennae to be stiff, they must be given larger-than-usual cross sections. The overall result is that multi-frequency antennae, which are capable of transmitting or receiving signals in the 10, 15, 20, 40 and 80 meter bands, usually are expensive and are difficult to erect and maintain. To keep multi-frequency antennae short enough to enable them to be moderate in cost and to be easily erected, some manufacturers have produced and marketed multi-frequency antennae which can efficiently transmit and receive signals in the 10 meter band, in the 15 meter band, in the 20 meter band and in the 40 meter band, but which can not efficiently transmit and receive signals in the 80 meter band. However, at least one manufacturer has made a multi-frequency antenna that was relatively short and that could transmit and receive signals in the 10, 15, 20, 40 and 80 meter bands; but an inductor had to be connected between that antenna and the transmission line therefor, whenever that antenna was to be used to transmit or receive signals in the 80 meter band, and that inductor had to be disconnected or shunted whenever that antenna was to be used to transmit or receive signals in 10, 15, 20 or 40 meter bands. Consequently, it would be desirable to provide an antenna which was relatively short, which could transmit or receive signals in the 10, 15, 20, 40 and 80 meter bands, and which could be permanently connected to the transmission line therefor. The present invention provides such an antenna; and it does so by connecting a capacitor, a fixed inductor and an adjustable inductor in parallel with each other between that antenna and the transmission line therefor. Whenever the antenna provided by the present invention is transmitting or receiving signals at a relatively low frequency, the capacitor and the adjustable inductor will act as a high impedance parallel-resonant circuit; and hence the preponderance of those signals will flow through the fixed inductor. The reactance of that fixed inductor will coat with the reastance of the antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals at relatively low frequencies. Whenever that antenna is transmitting or receiving signals at a somewhat higher frequency, the reactance of the capacitor will be somewhat smaller and the reactances of the fixed and adjustable inductors will be somewhat larger; and hence the preponderance of those signals will flow through that capacitor and that fixed inductor. The reactance of the capacitor and that fixed inductor will coat with the inductance of the antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals at the said somewhat higher frequency. Whenever that antenna is transmitting or receiving signals at still higher frequencies, the reactance of the capacitor will be quite small and the reactances of the fixed and adjustable inductors will be quite large; and hence the preponderance of those signals will flow through that capacitor. The reactance of that capacitor will coat with the reactance of the antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals at said higher frequencies. In this way, the capacitor, the adjustable inductor and the fixed inductor automatically respond to changes in frequency to change the paths through which the preponderance of the signals flow to and from the antenna; and those paths provide differing values of reactance which automatically coat with the reactance of the antenna to make the effective electrical length of that antenna such that the antenna can efficiently transmit or receive signals at the desired frequencies. It is, therefore, an object of the present invention to provide an antenna which has a capacitor, an adjustable inductor and a fixed inductor that are connected in parallel with each other between that antenna and the transmission line therefor and are dimensioned so the preponderance of the signals flow through that fixed inductor at a lower frequency, so the preponderance of the signals flow through that capacitor and that fixed inductor at a somewhat higher frequency, and so the preponderance of the signals flow through that capacitor at still higher frequencies.

The capacitor, fixed inductor and adjustable inductor provided by the present invention can be marketed as parts of a multi-frequency antenna, or can be marketed as parts of a kit which can be used to convert an antenna, that is intended to transmit or receive signals at relatively high frequencies, so it can transmit or receive signals at a lower frequency as well. This is very desirable; because it enables the owners of antennae, intended to transmit or receive signals at relatively high frequencies, to easily and inexpensively convert those antennae so they can transmit or receive signals at a lower frequency as well.

Other and further objects and advantages of the present invention should become apparent from an examination of the drawing and accompanying description.

In the drawing and accompanying description a preferred embodiment of the present invention is shown and described but it is to be understood that the drawing and accompanying description are for the purpose of illustration only and do not limit the invention and that the invention will be defined by the appended claims.

IN THE DRAWING

FIG. 1 is a perspective view of one preferred embodiment of antennae provided by the present invention;
FIG. 2 is a sectional view, on a larger scale, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 2-2 in FIG. 1;
FIG. 3 is a sectional view, on the scale of FIG. 2, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 3-3 in FIG. 1;
FIG. 4 is a sectional view, on the scale of FIG. 2, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 4-4 in FIG. 1;
FIG. 5 is a partially broken-away, partially sectioned, elevational view, on the scale of FIG. 2, of the lower part of the antenna of FIG. 1, and it is taken along the plane indicated by the line 5-5 in FIG. 1;
FIG. 6 is a sectional view, on the scale of FIG. 2, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 6-6 in FIG. 5;
FIG. 7 is a sectional view, on the scale of FIG. 2, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 7-7 in FIG. 5;
FIG. 8 is a sectional view, on the scale of FIG. 2, through the antenna of FIG. 1, and it is taken along the plane indicated by the line 8-8 in FIG. 5;
FIG. 9 is a "line" drawing of the lower part of the antenna of FIG. 1, and FIG. 10 shows the equivalent circuit of that lower part.
Referring to the drawing in detail, the numeral 20 generally denotes the base of an antenna which is made in accordance with the principles and teaching of the present invention. That base is made from a suitable insulating material; and it has a securing flange 22 at the bottom thereof, has a vertically directed cylindrical passage 24 therein, has radially extending, axially directed ribs 26 which extend upwardly from the securing flange 22, and has a boss 28. The boss 28 has a recess 30 therein which opens to the right-hand face of that boss, as that boss is viewed in FIG. 6. The boss 28 also has threaded openings 32 and 34 wherein extend inwardly from that right-hand face to the cylindrical passage 24. A ground strap 36 is normally disposed in abutting relation with the right-hand face of the boss 28. A fitting 38, for a coaxial cable, normally abuts the right-hand face of the ground strap 36; and that fitting and that ground strap are normally secured to the boss 28 by screws 39. An elongated set screw 40 is disposed within the threaded opening 32, a short set screw 41 is disposed within the threaded opening 34 adjacent the inner end of that threaded opening, and a short set screw 42 is disposed within the threaded opening 34 adjacent the outer end of that threaded opening.

Screws 44 are used to fixedly hold the lower face of the securing flange 22 of the base 20 to the upper face of a mounting bracket 46. That mounting bracket can be suitably secured to a rotatable or stationary support, not shown. The numeral 48 denotes the lower portion of the antenna; and that lower portion preferably is a metal tube having an outer diameter of 14 inches. The numeral 50 denotes a part of an upper portion of the antenna; and that upper portion preferably is a metal tube having an outer diameter of 13/4 inches. That upper portion preferably supports further tube-like portions, not shown, which are coaxial and which are interconnected by parallel-resonant traps, not shown. The part 50 is normally fixedly secured to the lower portion 48 of the antenna by screws 52.

The base 20, the ground strap 36, the fitting 38, the set screw 40, the screws 39 and 44, the mounting bracket 46, the lower portion 48 of the antenna, the lower part 50 of the upper portion of the antenna, the further tube-like portions, not shown, the parallel-resonant traps, not shown, and the screws 52 can be of standard and usual design. For example, that base, that ground strap, that fitting, that set screw, those screws, that lower portion, that upper portion, those further tube-like portions, and those parallel-resonant traps can be the base, ground strap, fitting, set screw, screws, lower portion, upper portion, further tube-like portions, and parallel-resonant traps of a short 4-c antenna that is manufactured by Mosley Electronics, Inc. of Bridgeport, Missouri, or of any similar antenna.

The numeral 54 denotes an opening which extends downwardly from the upper surface of the boss 28 and which communicates with the recess 30 in that boss. The numeral 56 denotes an opening which extends through the boss 28 and which communicates with the threaded opening 34; and that opening will be horizontally directed whenever the cylindrical passage 24 in the base 20 is vertically directed. Where the base 20 is part of an antenna that is to be marketed to transmit or receive signals in the 10, 15, 20, 40 and 80 meter bands, the manufacturer of that base will form the openings 54 and 56 in that base. However, where the base 20 is part of an antenna that was marketed to transmit or receive signals in the 10, 15, 20 and 40 meter bands, but not in the 80 meter band, the owner of that antenna must form the openings 54 and 56 in that base. Before those openings 54 are formed in the base 20, that base should be separated from the lower portion 48 of the antenna; and the elongated set screw, initially supplied with the base for positioning within the threaded opening 34, should be removed. After the opening 56 has been formed in the base 28, the short set screw 41 should be threaded into the threaded opening 34.

The numeral 58 denotes an annular spacer of dielectric material which is telescoped over the lower portion 48 of the antenna; and that spacer is dimensioned so it will have a snug fit with that lower portion. The numeral 60 denotes an annular spacer of dielectric material which can be identical to the annular spacer 58. As shown by FIGS. 5 and 6, the lower face of annular spacer 58 is spaced a short distance above the upper surface of the base 20; and that distance should be great enough — at least three-eighths of an inch — to enable rain drops, melted snow, or the like to freely drain away from the recess defined by that lower face, by that upper surface, and by the portion 48 of the antenna. As shown by FIG. 4, the annular spacer 60 encircles the portion 48 of the antenna a short distance below the top of that portion. In actual practice, two further annular spacers, not shown, will encircle the portion 48 of the antenna, so that four annular spacers will encircle, and will be supported by, that portion. The lower surface of one of those further annular spacers will preferably be located 13/4 inches above the level of the upper surface of the annular spacer 58, the lower surface of the other of those further annular spacers will preferably be located 14 1/4 inches above the level of the upper surface of the first of those further annular spacers, and the lower surface of the annular spacer 60 will preferably be located 15 1/4 inches above the upper surface of the other of those further annular spacers.

The numeral 62 denotes an elongated metal tube which is telescoped over the lower portion 48 of the antenna and over the annular spacers 58 and 60 plus the two further annular spacers, not shown. The inner surface of the metal tube 62 will snugly engage, and will be supported by, the outer surface of the annular spacers 58 and 60 and the outer surfaces of the other two annular spacers, not shown. As a result, the metal tube 62 will be held stationary relative to, and in precisely fixed coaxial relation with, the lower portion 48 of the antenna. As shown particularly by FIGS. 5 and 6, the lower end of the metal tube 62 is spaced above the level of, and out of engagement with, the upper surface of the base 20.

The numeral 64 denotes a sleeve of dielectric material; and that sleeve encircles the upper end of the metal tube 62. The sleeve 64 has an annular flange which extends inwardly toward, and which engages, the outer surface of the lower portion 48 of the antenna. The engagement between the annular flange of the sleeve 64 and the outer surface of the lower portion 48 of the antenna is sufficiently intimate to keep rain, dust, snow, hail, and the like from passing downwardly between that flange and that outer surface.

The numeral 66 denotes a metal rod which is dimensioned to telescope through the opening 56 in the base 20; and the diameter of that rod is appreciably smaller than the diameter of that opening. The short set screw 41 will tightly engage the lower portion 48 of the antenna; and hence, that set screw will be electrically connected to that lower portion and will help mechanically secure that lower portion to the base 20. The short set screw 42 will tightly press the rod 66 against the head of the short set screw 41; and thus will mechanically secure that rod to the base 20, and will electrically connect that rod to the lower portion 48 of the antenna.

As shown particularly by FIGS. 5 and 8, both ends of the rod 66 are threaded; and a nut 68 is threaded onto the right-hand end of that rod. A washer 70 telescopes over the right-hand end of the rod 66 and abuts the nut 68; and a cylindrical housing 72 of dielectric material has an opening therein, adjacent the lower edge thereof, which telescopes over the right-hand end of the rod 66. A fitting 73 on the lower end of a helically wound inductor 74 also telescopes over the right-hand end of the rod 66, and a washer 78 abuts that fitting. A nut 80 is threaded onto the right-hand end of the rod 66 and abuts the washer 78 to hold the lower end of the housing 72 fixed relative to that rod; and the rod is held in its position by the fitting 73, on the lower end of the helically wound inductor 74, in electrically conducting relation with that rod.

The helically wound inductor 74 is disposed within the cylindrical housing 72; and four spacers 76 are used to assure the proper spacing between the adjacent turns of that helically wound inductor. As shown particularly by FIGS. 7 and 8, the spacers 76 are located at opposite ends of orthogonally disposed diameters of the helically wound inductor 76.
The upper end of the helically wound inductor 74 has a fitting 75 thereon with an opening therein which accommodates a screw 84. The shank of that screw passes through a washer 86, through the opening in the upper fitting 75, through an opening in the cylindrical housing 72 adjacent the upper end of that housing, through a washer 88, through two nuts 90, through a washer 92, through openings in the ends of a clamp 82, through a washer 93, through the opening in a solder lug 94, through a washer 96, and through a nut 98. The right-hand nut 90 in FIGS. 5 and 7 will coat with the washer 86 and 88 to hold the screw 84 fixed relative to the cylindrical housing 72 and relative to the fitting 75 on the upper end of the helically wound inductor 74. Also, that right-hand nut will coat with the washer 92, 93 and 96, with the solder lug 94, and with the nut 98 to firmly secure the screw 84 to the clamp 82 and to secure that clamp to the metal tube 62. Also, that left-hand nut will coat with the washers 92, 93 and 96 and with the nut 98 to electrically connect the screw 84, and thus the fitting 75, to the solder lug 94. That solder lug is soldered to the upper end of the openings 100 which extends downwardly through the opening 54 in the base 20, through the recess 30 in that base, and to the center contact of the fitting 38. As a result, when a coaxial cable is connected to that fitting, the inner conductor of that coaxial cable will be connected to the upper end of the helically wound inductor 74 by conductor 100, solder lug 94, and screw 84.

The numeral 102 denotes a cover for the cylindrical housing 72. That cover will preferably be dimensioned so it has a snug fit with the upper end of the housing 72, and thus will not be dislodged by high winds.

The numeral 104 denotes a clamp which encircles the lower part 50 of an upper portion of the antenna, as shown particularly in FIGS. 1 and 2. An elongated insulated conductor 106, which has the openings 108 and 110 therein, is secured to the clamp 104 by a screw 112 that extends into a threaded socket in the right-hand end of that insulated. Rotation of the screw 112 relative to the insulated 106 will not only firmly secure that insulated to the clamp 104, but also will firmly secure that clamp to the lower part 50 of the upper portion of the antenna. The openings 108 and 110 in the insulated 106 have the axes thereof parallel to each other. The numeral 114 denotes a clamp which encircles the lower part 50 of the upper portion of the antenna at a point below the level of the clamp 104. An elongated insulated 116 has openings 118 and 120 therein; and those openings have the axes thereof parallel to each other. A screw 122 extends through openings in the clamp 114 and screw 122 is threaded in a threaded socket in the right-hand end of that insulated. Rotation of that screw relative to that insulated will not only secure that insulated to the clamp 114, but also will secure that clamp to the lower part 50 of the upper portion of the antenna.

The spacing between the holes 118 and 120 in the insulated 116 and the spacing between those holes and the clamp 114 and preferably identical to the spacing between the openings 108 and 110 in the insulated 106 and to the spacing between the openings 108 and 110 and the clamp 104. Where that is the case, and where the insulated 106 and 116 are set in vertical registry, the openings 108 and 118 will be coaxial and the openings 110 and 120 will be coaxial.

The numeral 124 denotes a clamp which encircles the upper end of the metal tube 62; and a coupling link 126 is secured to that clamp by a screw 128, a washer 130 and a nut 132. Tightening of the screw 128 and the nut 132 will not only secure, and electrically connect, the coupling link 126 to the clamp 124, but also will firmly secure, and electrically connect, that clamp to the metal tube 62. The numeral 133 denotes a clamp which is secured to the coupling link 126 by a screw 134, a washer 136 and a nut 138.

The numeral 142 denotes a clamp which encircles the lower end of the right-hand arm of the inverted U-shaped rod 140, and the numeral 144 denotes a clamp which is secured to the clamp 142 by a screw 146, a washer 148 and a nut 150, as shown particularly by FIG. 3. A metal rod 152 has the upper end thereof encircled by the clamp 144; and tightening of the screw 146 and the nut 150 will not only secure, and electrically connect, the clamps 142 and 144 to each other, but will secure, and electrically connect, the clamp 142 to the right-hand arm of the inverted U-shaped rod 140 and will secure, and electrically connect, the clamp 144 to the rod 152. A clamp 154 encircles the lower end of the rod 152; as shown particularly by FIGS. 1 and 6; and a nut 156, washers 158 and 160, and a nut 162 secure, and electrically connect, that clamp to that lower end of that rod. The nut 156 will be set to position the clamp 154 in vertical registry with the clamp 144, and then the nut 162 will be tightened to secure the clamp 154 to the rod 66 and also to the rod 152.

The metal tube 62, the lower portion 48 of the antenna, the annular spacers 60, 66, and the two further annular spacers, not shown, constitute a fixed capacitor of relatively large capacity. In one preferred embodiment of the present invention, that metal tube, that lower portion of the antenna, and those spacers constitute a capacitor having a capacity in the range of 500 to 700 picofarads. The inverted U-shaped rod 140 and the rod 152 constitute a "trombone" adjustable inductor; and the ind读懂er 74 is a fixed inductor.

The screw 84, the washers 86, 98, 92, 93 and 96, the nuts 90 and 98, the fitting 75, the conductor 100, and the clamp 82 electrically connect the upper end of the helically wound inductor 74 to the tube 62 and to the central terminal of the fitting 38; and the clamps 124 and 133, the screws 128 and 134, the washers 130 and 136, the nuts 132 and 138, and the coupling link 126 electrically connect the tube to the right-hand arm of the inverted U-shaped rod 140. This means that one plate of the capacitor, one end of the fixed inductor, and one end of the adjustable inductor are connected together to the central terminal of the fitting 38.

The rod 66, the nuts 68 and 80, the washers 70 and 78, the fitting 73, and the short set screws 41 and 42 electrically connect the lower end of the metal tube 62 and the lower portion 48 of the antenna, the screw 40, the screws 39, and the ground strap 36 connect the rod 66 to the threaded terminal of the fitting 38, and nuts 156 and 162, washers 158 and 160, and clamp 154 electrically connect the rod 66 to the rod 152. This means that the other plate of the capacitor, the other end of the fixed inductor, and the other end of the adjustable inductor are connected together to the threaded terminal of the fitting 38.

When a coaxial transmission line is connected to the fitting 38, the inner conductor of that transmission line will be coupled to the lower portion 48 of the antenna by the parallel-connected capacitor, adjustable inductor, and fixed inductor. Whenever the signals in the 40 meter band are to be transmitted or received by the antenna, the adjustable inductor and the capacitor will act as a high impedance parallel-resonant circuit; and the preponderance of those signals will flow through the fixed inductor. The reactance of that fixed inductor will be obtainable to the reactance of that antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals in the 40 meter band. Whenever signals in the 40 meter band are to be transmitted or received by the antenna, the reactance of the capacitor will be somewhat smaller and the reactances of the fixed and adjustable inductors will be somewhat larger; and the preponderance of those signals will flow through the capacitor and the fixed inductor. The reactances of that capacitor and of that fixed inductor will be obtainable to the reactance of that antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals in the 40 meter band. Whenever signals in the 10, 15 or 20 meter band
are to be transmitted or received by the antenna, the re-actance of the capacitor will be quite small; and the preponderance of those signals will flow through the capacitor. The re-actance of that capacitor will coat with the re-actance of that antenna to make the effective electrical length of that antenna such that the antenna will efficiently transmit or receive signals in the 10, 15 and 20 meter band. As a result, the parallel-connected capacitor, adjustable inductor and fixed inductor provided by the present invention automatically respond to changes in frequency to change the paths through which the preponderance of the signals flow to and from the antenna; and those paths provide differing values of re-actance which automatically coat with the re-actance of the antenna to make the effective electrical length of the antenna such that the antenna can efficiently transmit or receive signals in the desired bands.

The capacitor, fixed inductor and adjustable inductor of the present invention can easily and economically be marketed as an antenna conversion kit. To assemble that antenna conversion kit with an antenna, the screws 52 will be removed, the set screw 46 will be loosened, the elongated set screw initially disposed within the opening 34 in the base 20 will be removed, and the lower portion 48 will be separated from that base and from the part 50 of the upper portion of the antenna. The openings 54 and 56 will then be formed in the base 20, the elongated set screw initially disposed within the threaded opening 34 will be replaced by the short set screw 41, and the short conductor initially connected to the center terminal of the fitting 38 will be replaced by the conductor 100. The lower portion 48 of the antenna will again be telescoped with the cylindrical passage 24 in the base 20, and the set screw 40 will be tightened to mechanically secure that lower portion to that base. Thereafter, the annular spacer 58 will be telescoped downwardly over the lower portion 48, the two further annular spacers, not shown, will be telescoped downwardly over that lower portion, and then the annular spacer 60 will then be telescoped over the top of that lower portion. At this time, the metal tube 62 will be telescoped downwardly over those four annular spacers. Thereupon the sleeve 64 will be disposed in the position shown by FIGS. 1 and 4.

The screw 84, the washer 86, the fitting 75 on the upper end of the helically wound inductor 74, the cylindrical housing 72, the washer 88, and the right-hand nut 90 will be used to assemble the upper end of that helically wound inductor with that cylindrical housing. The nut 68 will be threaded onto the right-hand end of the rod 66, the washer 70 will be telescoped over that right-hand end, and then that right-hand end will be telescoped through the cylindrical housing 72; and then the fitting 73 and washer 78 and nut 80 will be fixed on that right-hand end. The cover 102 will then be pressed onto the upper end of the cylindrical housing 72.

Clamp 82 will be set in the approximate position shown by FIG. 1; and then the left-hand end of the rod 66 will be telescoped through the opening 56 in the base 20, and the shank of the screw 84 — with left-hand nut 90 and washer 92 thereon — will be telescoped through the openings in clamp 82. Washer 93, solder lug 94, washer 96, and nut 98 will be set on the shank of the screw 84. The cylindrical housing 72, and hence the helically wound inductor 74, will be set parallel to the tube 62; and then the short set screw 42 will be tightened to force the rod 66 into mechanical and electrical contact with the head of the short set screw 41.

The lower part 50 of the upper portion of the antenna will then be telescoped into the upper end of the lower portion 48, and the screws 52 will be replaced — to mechanically secure and electrically connect that upper portion to that lower portion of the antenna. The clamps 104 and 114 will be assembled with the lower part 50 of the upper portion of the antenna in the approximate positions shown by FIG. 1; and the elongated insulators 106 and 116 will be loosely secured to those clamps, respectively, by the screws 112 and 122. The clamp 114 will be set in engagement with the upper edge of the lower portion 48 of the antenna, and then the screw 122 will be tightened; but the screw 112 will be left relatively loose — so that elongated insulator 106 and the clamp 104 can be moved.

The ends of the arms of the inverted U-shaped rod 140 will be passed through the openings 105 and 120 in the elongated insulator 106, and then through the openings 118 and 120 in the elongated insulator 116. The clamp 124 will be set about one inch below the upper end of the tube 62; and then screws 128 and 134, washers 130 and 136, and nuts 132 and 138 will be used to fixedly secure, and electrically connect, that clamp and the coupling link 126 to the tube 62, and to loosely secure the clamp 133 to the right-hand arm of the inverted U-shaped rod 140. Nuts 156 and 162 and washers 158 and 160 will fixedly secure, and electrically connect, clamp 154 to the rod 66 and to the lower end of rod 152; and screw 146, washer 148 and nut 150 will be used to loosely secure clamp 142 to the left-hand arm of inverted U-shaped rod 140, and to loosely secure the clamp 144 to the upper end of rod 152.

The RV-4C antenna will have radial wires — for 10 meter band, for 15 meter band, for 20 meter band and for 40 meter band operation — secured to the base 20 thereof. Where the antenna conversion kit provided by the present invention is intended to enable that antenna to efficiently transmit and receive signals in the 80 meter band, an additional radial wire will be secured to that base. That additional radial wire will have an effective length of 79 feet — and it can be buried in the ground or supported above the ground.

To tune the antenna to efficiently transmit and receive signals in the 80 meter band, the insulator 106, the clamp 104, and the inverted U-shaped rod 140 will be moved up or down relative to the clamps 133 and 142. To decrease the frequency of the signals which can be efficiently transmitted or received by the converted antenna, the insulator 106, the clamp 104, and the inverted U-shaped rod 140 will be moved upwardly relative to the clamps 133 and 142; and to increase the frequency of those signals, that insulator, that clamp, and that inverted U-shaped rod will be moved downwardly relative to those clamps. Once the desired tuning in the 80 meter band has been obtained, the screws 134 and 146 and the nuts 138 and 150 will be tightened to electrically connect coupling link 126 with the right-hand arm of inverted U-shaped rod 140, and to electrically connect the left-hand arm of that rod with the rod 152. It will be noted that no change in the connections to the helically wound conductor 74 are required, and that no taps are required for that inductor. Also, it should be noted that no change is required in the capacitance of the capacitor constituted by the tube 62, the lower portion 48, the annular spacers 58 and 60, and the other two annular spacers, not shown. All of this means that the present invention has avoided the cost, the manipulation, and the other problems that ensue from the use of an adjustable capacitor or a tapped or switched inductor.

The antenna conversion kit provided by the present invention will slightly de-tune the antenna for operation in the 40 meter band. However, by making relatively minor adjustments in that antenna, it is possible to re-tune it to enable it to efficiently transmit and receive signals in the 40 meter band as well as in 10 meter band, the 15 meter band, the 20 meter band, and the 80 meter band.

It thus should be apparent that the present invention makes it possible for the owner of a multi-frequency antenna to adapt that antenna to transmit or receive an additional frequency without any essential change in that antenna and with the addition of a minimum number of parts. Moreover, it should be apparent that an antenna conversion kit provided by the present invention can be assembled with an antenna with a minimum of time, tools and skill.

The rod 152 and the inverted U-shaped rod 140 are made with substantial cross sections and with substantial lengths to enable them to radiate large amounts of heat, and thus to enable the antenna to radiate substantial amounts of power. Also, those rods are made with substantial cross sections and with substantial lengths to enable them to be adjusted easily and without any risk of becoming bent or deformed. Specifically,
in the said one preferred embodiment of the present invention, the diameters of the rods 152 and 140 are three-sixteenths of an inch, the length of the rod 152 is 48 inches, the distance from the upper surface of the closed end of the inverted U-shaped rod 140 to the line connecting the bottom faces of the arms of that rod is 40¾ inches, and the center-to-center spacing of the arms of that inverted U-shaped rod is 3 inches. The tube 62 is 46 inches long, it has an outer diameter of 1½ inches, and it has a wall thickness of fifty-eight thousandths of an inch. The tube 62 and the rods 140 and 152 are made of aluminum, but the rod 66 is made of brass. The annular spacers 58 and 60, and the two further annular spacers, not shown, are preferably made from polyethylene. However, if desired, those annular spacers could be made from mylar, teflon or other materials that have sufficient dielectric properties and that are capable of withstanding the voltages developed between the inner and outer plates of the capacitor.

In the foregoing description, reference has been made to the 80 meter band. It should be understood that the present invention enables the antenna to transmit or receive signals in the 75 to 80 meter band. Further, it should be understood that the present invention is applicable to antennae which are intended to transmit or receive frequencies in bands other than the 10, 15, 20, 40 and 80 meter bands.

Whereas the drawings and accompanying description have shown and described a preferred embodiment of the present invention, it should be apparent to those skilled in the art that various changes may be made in the form of the invention without affecting the scope thereof.

What we claim is:

1. An antenna which comprises:
   a generally cylindrical portion,
   a plurality of annular elements of dielectric material dimensioned to telescope over, and to engage the outer surface of, said generally cylindrical portion,
   a tube of conductive material dimensioned to be generally coaxitive with, to be telescoped over, and to be spaced by said annular elements from, said generally cylindrical portion,
   said tube and said annular elements coating with said generally cylindrical portion to constitute a capacitor, an inductor,
   means for mechanically securing and electrically connecting one end of said inductor to said tube,
   an adjusting conductor and a second adjusting conductor,
   second means adjustable interconnecting the first said and said second adjusting conductors in series to constitute and adjustable inductor,
   third means for mechanically securing and electrically connecting the first said adjusting conductor to said tube,
   fourth means mechanically securing and electrically connecting the other end of said inductor to said generally cylindrical portion of said antenna,
   an electrical connection between said second adjusting conductor and said generally cylindrical portion,
   the first said means electrically connecting said one end of said inductor to said tube, and thereby connecting said one end of said inductor to one plate of said capacitor,
   said third means electrically connecting said first said adjusting conductor to said tube,
   said fourth means connecting the other end of said inductor to said generally cylindrical portion and said electrical connection connecting said second adjusting conductor to said generally cylindrical portion, thereby connecting said inductor and said capacitor and said adjustable inductor to parallel with each other,
   said tube and said one end of said inductor and said second adjusting conductor being connectable in a transmission line,
   whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, inductor and adjustable inductor.

2. An antenna as claimed in claim 1 wherein said inductor is a helically wound inductor, and wherein the first said means and said fourth means holds said inductor at one side of said tube and at one side of said generally cylindrical portion.

3. An antenna as claimed in claim 1 wherein said inductor is a helically wound inductor, wherein the first said means and said fourth means holds said inductor at one side of said tube and at one side of said generally cylindrical portion, and wherein said third means and said electrical connection hold said first said and said second adjusting conductors at the opposite side of said generally cylindrical portion.

4. An antenna as claimed in claim 1 wherein the first said means includes a clamp supported by said tube, wherein said third means includes a clamp supported by said tube and a clamp secured to said first said adjusting conductor, wherein said fourth means includes a rod, and wherein said second means includes a clamp secured to said first said adjusting conductor and a clamp secured to said second adjusting conductor.

5. An antenna as claimed in claim 1 wherein said fourth means includes a portion of a rod, and wherein said electrical connection includes a further portion of said rod.

6. An antenna which comprises:
   a generally cylindrical portion,
   a plurality of spacing elements of dielectric material dimensioned to engage the outer surface of said generally cylindrical portion,
   a tube of conductive material dimensioned to be generally coaxitive with, to be telescoped over, and to be spaced by said spacing elements from, said generally cylindrical portion,
   said tube and said spacing elements coating with said generally cylindrical portion to constitute a capacitor, an inductor,
   means for mechanically securing and electrically connecting one end of said inductor to said tube,
   an adjusting conductor and a second adjusting conductor,
   second means adjustable interconnecting the first said and said second adjusting conductors in series to constitute and adjustable inductor,
   third means for mechanically securing and electrically connecting the first said adjusting conductor to said tube,
   fourth means mechanically securing and electrically connecting the other end of said inductor to said generally cylindrical portion of said antenna,
   an electrical connection between said second adjusting conductor and said generally cylindrical portion,
   the first said means electrically connecting said one end of said inductor to said tube, and thereby connecting said one end of said inductor to one plate of said capacitor,
   said third means electrically connecting said first said adjusting conductor to said tube,
   said fourth means connecting the other end of said inductor to said generally cylindrical portion and said electrical connection connecting said second adjusting conductor to said generally cylindrical portion, thereby connecting said inductor and said capacitor and said adjustable inductor to parallel with each other,
   said tube and said one end of said inductor and said second adjusting conductor being connectable to a transmission line,
   whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, inductor and adjustable inductor,
   and
   a plurality of insulators secured to said antenna to help support said first said adjusting conductor,
   one of said insulators and said first said adjusting conductor being adjustable relative to said second means and said electrical connection to "tune" said antenna.

7. An antenna which comprises:
   a generally cylindrical portion,
   a plurality of spacing elements of dielectric material dimensioned to engage the outer surface of said generally cylindrical portion.
a tube of conductive material dimensioned to be generally coextensive with, to be telescoped over, and to be spaced by said spacing elements from, said generally cylindrical portion,
said tube and said spacing elements coating with said generally cylindrical portion to constitute a capacitor, an inductor, means for mechanically securing and electrically connecting one end of said inductor to said tube, an adjusting conductor and a second adjusting conductor, second means adjustable interconnecting the first said and said second adjusting conductors in series to constitute an adjustable inductor, third means for mechanically securing and electrically connecting the first said adjusting conductor to said tube, fourth means mechanically securing and electrically connecting the other end of said inductor to said generally cylindrical portion of said antenna, an electrical connection between said second adjusting conductor and said generally cylindrical portion, the first said means electrically connecting said one end of said inductor to said tube, and thereby connecting said one end of said inductor to one plate of said capacitor, said third means electrically connecting said first said adjusting conductor to said tube, said fourth means connecting the other end of said inductor to said generally cylindrical portion and said electrical connection connecting said second adjusting conductor to said generally cylindrical portion, thereby connecting said inductor and said capacitor and said adjustable inductor in parallel with each other, said tube and said one end of said inductor and said second adjusting conductor being connectable to a transmission line, whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, inductor and adjustable inductor, and a plurality of insulators secured to said antenna to help support said first said adjusting conductor, said insulators being disposed above the level of said tube and disposing said first said adjusting conductor at one side of said antenna, the first said means and said fourth means being disposed below the level of said insulators and angularly displacing said inductor from said first said adjusting conductor.

9. An antenna which comprises: a generally cylindrical portion, a plurality of spacing elements of dielectric material dimensioned to engage the outer surface of said generally cylindrical portion, a tube of conductive material dimensioned to be generally coextensive with, to be telescoped over, and to be spaced by said spacing elements from, said generally cylindrical portion, said tube and said spacing elements coating with said generally cylindrical portion to constitute a capacitor, an inductor, means for mechanically securing and electrically connecting one end of said inductor to said tube, an adjusting conductor and a second adjusting conductor, second means adjustable interconnecting the first said and said second adjusting conductors in series to constitute an adjustable inductor, third means for mechanically securing and electrically connecting the first said adjusting conductor to said tube, fourth means mechanically securing and electrically connecting the other end of said inductor to said generally cylindrical portion and said electrical connection connecting said second adjusting conductor to said generally cylindrical portion, thereby connecting said inductor and said capacitor and said adjustable inductor in parallel with each other, said tube and said one end of said inductor and said second adjusting conductor being connectable to a transmission line, whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, inductor and adjustable inductor, and a plurality of annular elements of dielectric material dimensioned to telescope over, and to engage the outer surface of, said generally cylindrical lower portion,
a tube of conductive material dimensioned to be generally coextensive with, to be telescoped over, and to be spaced by said annular elements from, said generally cylindrical lower portion,
said tube having a length, and said annular elements having thicknesses, which cause said tube to coat with said generally cylindrical lower portion to constitute a capacitor having a capacity in the range of hundreds of picofarads,
a fixed inductor,
means for mechanically securing and electrically connecting one end of said fixed inductor to said tube,
a substantially U-shaped conductor and an adjusting conductor,
second means adjustable connecting one arm of said substantially U-shaped conductor to said adjusting conductor and thereby connecting said substantially U-shaped conductor and said adjusting conductor in series to constitute a "trombone" adjustable inductor,
third means for mechanically securing and electrically connecting the other arm of said substantially U-shaped conductor to said tube,
fourth means mechanically securing and electrically connecting the other end of said fixed inductor to said generally cylindrical lower portion, and
an electrical connection between said adjusting conductor and said generally cylindrical lower portion,
the first said means electrically connecting said one end of said fixed inductor to said tube, and thereby connecting said one end of said fixed inductor to one plate of said capacitor,
said third means electrically connecting one end of said "trombone" adjustable inductor to said tube,
said fourth means connecting the other end of said fixed inductor to said generally cylindrical lower portion and said electrical connection connecting the other end of said "trombone" adjustable inductor to said generally cylindrical lower portion, thereby connecting said fixed inductor and said capacitor and said "trombone" adjustable inductor in parallel with each other,
said tube and said one end of said fixed inductor and said one end of said "trombone" adjustable inductor being connectable to a transmission line,
whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, fixed inductor and "trombone" adjustable inductor.
11. An antenna as claimed in claim 10 wherein a portion of an elongated rod is part of said fourth means, wherein a further portion of said elongated rod is part of said electrical connection, and wherein said elongated rod extends through the base of said antenna and is spaced from but electrically connected to said generally cylindrical lower portion.
12. An antenna which comprises:
a generally cylindrical lower portion,
a plurality of spacing elements of dielectric material dimensioned to engage the outer surface of said generally cylindrical lower portion,
a tube of conductive material dimensioned to be generally coextensive with, to be telescoped over, and to be spaced by said spacing elements from, said generally cylindrical lower portion,
said tube having a length, and said spacing elements having thicknesses, which cause said tube to coat with said generally cylindrical lower portion to constitute a capacitor having a capacity in the range of hundreds of picofarads,
a fixed inductor,
means for mechanically securing and electrically connecting one end of said fixed inductor to said tube,
a substantially U-shaped conductor and an adjusting conductor,
second means adjustable connecting one arm of said substantially U-shaped conductor to said adjusting conductor and thereby connecting said substantially U-shaped conductor and said adjusting conductor in series to constitute a "trombone" adjustable inductor,
third means for mechanically securing and electrically connecting the other arm of said substantially U-shaped conductor to said tube,
fourth means mechanically securing and electrically connecting the other end of said fixed inductor to said generally cylindrical lower portion, and
an electrical connection between said adjusting conductor and said generally cylindrical lower portion,
the first said means electrically connecting said one end of said fixed inductor to said tube, and thereby connecting said one end of said fixed inductor to one plate of said capacitor,
said third means electrically connecting one end of said "trombone" adjustable inductor to said tube,
said fourth means connecting the other end of said fixed inductor to said generally cylindrical lower portion and said electrical connection connecting the other end of said "trombone" adjustable inductor to said generally cylindrical lower portion, thereby connecting said fixed inductor and said capacitor and said "trombone" adjustable inductor in parallel with each other,
said tube and said one end of said fixed inductor and said one end of said "trombone" adjustable inductor being connectable to a transmission line,
whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, fixed inductor and "trombone" adjustable inductor,
said fixed inductor being a helically wound inductor, said fixed inductor being enclosed within a housing, said housing being adjacent the base of said antenna.
13. An antenna which comprises:
a generally cylindrical lower portion,
a plurality of spacing elements of dielectric material dimensioned to engage the outer surface of said generally cylindrical lower portion,
a tube of conductive material dimensioned to be generally coextensive with, to be telescoped over, and to be spaced by said spacing elements from, said generally cylindrical lower portion,
said tube having a length, and said spacing elements having thicknesses, which cause said tube to coat with said generally cylindrical lower portion to constitute a capacitor having a capacity in the range of hundreds of picofarads,
a fixed inductor,
means for mechanically securing and electrically connecting one end of said fixed inductor to said tube,
a substantially U-shaped conductor and an adjusting conductor,
second means adjustable connecting one arm of said substantially U-shaped conductor to said adjusting conductor and thereby connecting said substantially U-shaped conductor and said adjusting conductor in series to constitute a "trombone" adjustable inductor,
third means for mechanically securing and electrically connecting the other arm of said substantially U-shaped conductor to said tube,
electrical connection connecting the other end of said "trombone" adjustable inductor to said generally cylindrical lower portion, thereby connecting said fixed inductor and said capacitor and said "trombone" adjustable inductor in parallel with each other.

said tube and said one end of said fixed inductor and said one end of said "trombone" adjustable inductor being connectable to a transmission line,

whereby said antenna is "fed" by or "feeds" said parallel-connected capacitor, fixed inductor and "trombone" adjustable inductor,

said substantially U-shaped conductor being inverted,

said third means being connected to the lower end of said other arm of said substantially U-shaped conductor and to the upper end of said tube,

said second means being connected to the lower end of said one arm of said substantially U-shaped conductor and to the upper end of said adjusting conductor,

said electrical connection being connected to the lower end of said adjusting conductor.

14. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

15. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

16. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

17. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

18. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

19. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.

20. In an antenna which has a plurality of coaxial, generally cylindrical portions, the improvement which comprises a capacitor and a fixed inductor and an adjustable inductor that are connected in parallel with each other between one of said portions and a transmission line, said capacitor and said adjustable inductor being dimensioned to act as a high impedance parallel-resonant circuit at a relatively low frequency and thereby cause the preponderance of signals at said low frequency to flow through said fixed inductor, said fixed inductor being dimensioned so the preponderance of signals at a somewhat higher frequency will flow through said capacitor and through said fixed inductor, and the reactance of said capacitor being so low at relatively high frequencies that the preponderance of signals at said high frequencies will flow through said capacitor, whereby said parallel-connected capacitor, adjustable inductor and fixed inductor can automatically respond to changes in frequency to change the paths through which the preponderance of signals flow to and from said antenna and whereby said paths provide differing values of reactance that automatically coact with the reactance of said antenna to make the effective electrical length of said antenna such that said antenna can efficiently transmit or receive signals at desired frequencies, said fixed inductor being a helically wound inductor, said adjustable inductor being a substantially U-shaped conductor and an adjusting conductor that constitute a "trombone" adjustable inductor.