Antenna for Mobile Communications

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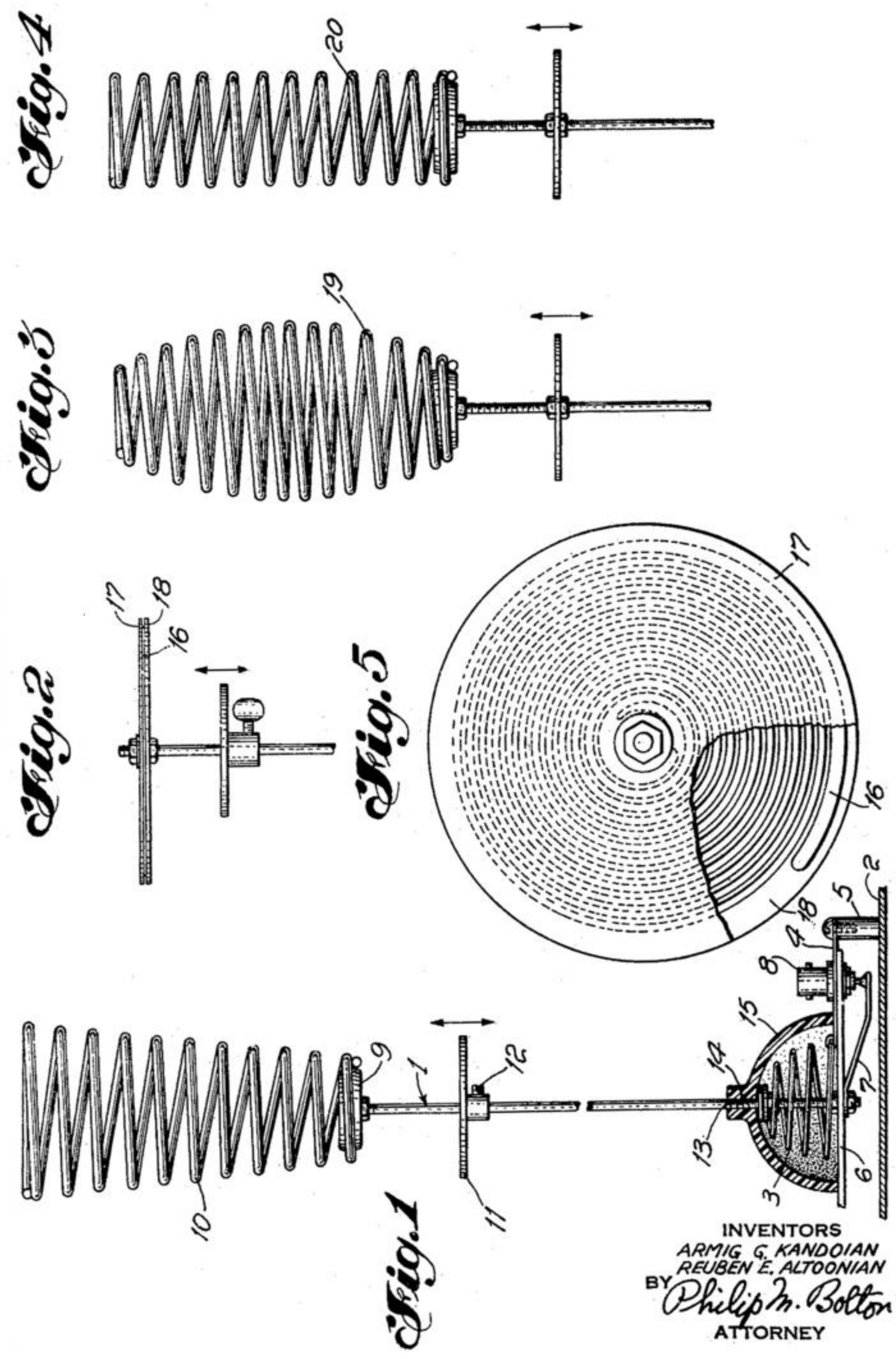

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4 Claims. (Cl. 343—752)

This invention relates to antennas for use on mobile equipment and particularly vertical grounded antennas using top loading.

Vertical antennas on mobile equipment, such as for example automobiles, tend to be so long around frequencies of 20 to 50 megacycles that they are difficult to mount. For example, in the 30 to 50 mc. band, vertical grounded antennas of 70 to 90 inches are standard. It has been the practice to mount such antennas on the fender or rear deck of the automobile and off-center with respect to the body metal which acts as the ground plane. The result of this has been to adversely affect the desired omni-directional characteristics of such antennas.

It has heretofore been suggested that the physical length of vertical antennas could be decreased by using "top loading." This consists essentially of adding lumped circuit elements to the top of the antenna. In the prior art, these elements have consisted of the combination of a lumped-constant coil inductance plus the capacitance of a separate body, which had the form of a sphere or disk. Antennas of these types are described in The A. R. R. L. Antenna Book, 1949 edition, published by The American Radio Relay League, page 61, and in the copending U. S. application of A. G. Kandoian for "Antenna," filed June 21, 1954, bearing Serial No. 438,222.

Such top-loaded antennas have not been adopted to any appreciable extent and this in part may be attributed to the complexity of such antennas and the mechanical difficulties in constructing them. Such antennas must be quite rugged and designed to present a minimum of wind resistance. At the same time, they must be relatively inexpensive. It is also important to provide some means for tuning such antennas and some means to match the antenna impedance to its load or source.

An object of the present invention is the provision of an improved vertical grounded antenna of the top-loaded type for use in mobile equipment. Some of the features of this antenna include its simplicity, high Q, and compactness. The length of one example of the present invention, operating in the 30 to 50 mc. band, is 16 to 18 inches, as opposed to 70 to 90 inches for the standard vertical ground plane antenna.

Another object of the present invention is the provision of an antenna of the type hereinbefore described having simple means for tuning said antenna.

Another object of the present invention is the provision of an antenna of the type hereinbefore described which presents small wind resistance and is rugged in structure.

In carrying out one aspect of the present invention, the top loading of the antenna is produced solely by a single spiral coil (which may be a flat or helical spiral) which provides both inductance and a substantial capacitance-to-ground. In accordance with a further feature of the

present invention, the antenna is tuned by changing the position of a disk mounted on the vertical portion of the antenna and below the spiral so as to vary the loading effect of the spiral.

Other and further objects of the present invention will become apparent, and the foregoing will be better understood with reference to the following description of embodiments thereof, reference being had to the drawings, in which:

Fig. 1 is a schematic diagram of a vertical grounded antenna according to the present invention;

Figs. 2 through 4 are similar views of modified portions of the antenna arrangement of Fig. 1; and

Fig. 5 is a schematic top plan view of the top portion of the antenna illustrated in Fig. 2.

Referring now to the embodiment illustrated in Fig. 1, the tuned dipole antenna system or vertical antenna illustrated there comprises a vertically disposed conductive tube or rod **1** which serves as the radiator. The vertical radiator **1** is terminated to ground **2** through an impedance matching inductance **3**, connector strap **4** and conductive supporting post **5**. The bottom of rod **1** is fixed in an insulating plate **6** and connected via a lead **7** to the inner conductor of a coaxial cable connector **8**, the connector in turn connecting the antenna to a transmitter or receiver (not shown). The ground plane or base **2** may be the top of an automobile or other mobile equipment with the antenna mounted at the geometrical center thereof. The length of the vertical radiator **1** from its top, to the top of coil **3** is considerably less than a quarter wavelength and to effectively render this antenna a quarter wavelength, "top loading" is employed. For this purpose the top of the vertical radiator **1** has a mounting disk **9** on which a tapered helical spiral **10** is supported whose outer configuration is in the form of a truncated inverted cone, the central vertical axis of the cone being aligned with vertical radiator **1**. The spiral is made of heavy gauge wire which may be as thick as the vertical radiator **1**, or preferably at least half the diameter of the vertical radiator **1**, so as to provide a rugged structure. Moreover, the spiral **10** is made of relatively large dimensions so that not only does the spiral provide inductance, but it also provides a relatively large capacitance-to-ground. In this embodiment, unlike that of the prior art, no separate means is required to provide the desired capacitance.

In accordance with another feature of the present invention, the antenna described in Fig. 1 is tuned by means of a conductive plate or disk **11** surrounding the vertical radiator **1** and extending transversely thereto. The disk **11** is adjustable along the length of the radiator **1** and is held in position by simple means, such as a set screw **12**. Varying the position of disk **11** varies the resonant frequency. This provides an extremely simple way of adjusting the resonance of the antenna to the mid-frequency of the band over which it is to operate.

In the example referred to hereinabove, a disk having a diameter of 2" was employed. It is to be noted that this is considerably less than the maximum diameter of the spiral measured in its width. The thickness of the disk need only be sufficient for mechanical strength.

The vertical radiator **1** may be additionally supported in any suitable way. For example, the vertical conductor **1** may be provided with a threaded portion **13** feeding into the complementary thread **14** of a dielectric member **15** in the form of a hemisphere, which member **15** is mechanically supported above the ground plane by suitable means, such as legs and screws or the like (not shown). Other forms of support for the antenna will be obvious.

Typical dimensions for one embodiment of the antenna of Fig. 1 for use at 30 to 50 mc. are as follows:

	Inches
Height of spiral	4
Maximum diameter (width) of spiral	3
Height of vertical rod **1** from top thereof to top of hemisphere **13**	10½
Distance from point **13** to base	1½

Referring now to the embodiment illustrated in Figs. 2 and 5, this structure differs from that described in Fig. 1 in that the top-loading spiral is a flat spiral **16**, as can be seen clearly in Fig. 5, and is supported between two dielectric sheets **17** and **18**. The spiral **16** and sheets **17** and **18** extend transversely to the vertical radiator 1. The overall dimensions of this antenna may be approximately the same as those of Fig. 1 although the diameter of the spiral may be a little larger, for example 4″. Tuning of the antenna and the other details thereof outside the spiral configuration are the same as in Fig. 1. It is to be noted that no additional capacitance is required with spiral **14** providing all the desired capacitance-to-ground. The spiral may be made of flat wire flattened at the top and bottom with the width of the wire extending in the same plane in which the spiral lies. The width of the spiral wire is preferably at least half that of the vertical radiator so as to provide a substantial capacitance-to-ground. The outermost turn of the spiral **14** may be made wider than that of the other turns to provide additional top capacity.

In the embodiment illustrated in Fig. 3, a helical spiral **19** is employed whose outer configuration is in the form of a prolate spheroid whose capacitance-to-ground and inductance serve to load the antenna. On the other hand, in Fig. 4, the spiral **20** which serves to load the antenna is cylindrical in outer configuration. The thickness of the wire of these spirals is preferably the same as that of the spiral of Fig. 1 and the diameter of each of these spirals is preferably at least 3″. In all the embodiments shown, no additional capacitance-to-ground element is necessary. The transverse disk tuning means is employed in each and the base coil for matching the impedance of the antennas is provided in each antenna unit.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the objects thereof and in the accompanying claims.

We claim:

1. An antenna system comprising a vertically disposed radiator, means for coupling a transmission line to said radiator, impedance matching means coupled to said vertical radiator, means positioned near the top of said vertical radiator for increasing the effective electrical length of said vertical radiator, and means for tuning said antenna system comprising a planar conductor mounted beneath said antenna loading means and adapted to be moved vertically.

2. An antenna system acording to claim 1, wherein said planar conductor comprises a disk mounted on said vertical radiator and extending transversely thereof.

3. An antenna system comprising a vertically disposed radiator, means for coupling a transmission line to said radiator, impedance matching means coupled to said radiator, means for increasing the effective electrical length of said vertical radiator comprising solely a spiral coil disposed toward the top of said vertical radiator with one end attached to the vertical radiator, said coil having a substantial inductance and being dimensioned to have a substantial capacitance-to-ground, and means for varying the tuning of the antenna system comprising a planar conductor slideably mounted on said vertical radiator for vertical movement towards or away from said spiral coil.

4. An antenna system according to claim 3 in which said planar conductor is in the form of a disk through which said vertical radiator passes, said disk extending transversely to said radiator.

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Armig G. Kandoian (S'35–A'36–SM'44) was born in Van, Armenia, on November 28, 1911. He received the B.S. degree in 1934 and the M.S. degree in electrical communication engineering in 1935, both from the Harvard University. Since 1935, Mr. Kandoian has been with the International Telephone and Telegraph Corporation and associated companies. His work has been primarily developments dealing with antennas, radiation, measurements, link communication, and air navigation. He is at present head of the radio and radar components division of Federal Telecommunication Laboratories.

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Mr. Kandoian received the honorable mention award in the Eta Kappa Nu recognition of outstanding young electrical engineers for 1943. He is a member of Tau Beta Pi, Harvard Engineering Society, and the American Institute of Electrical Engineers.