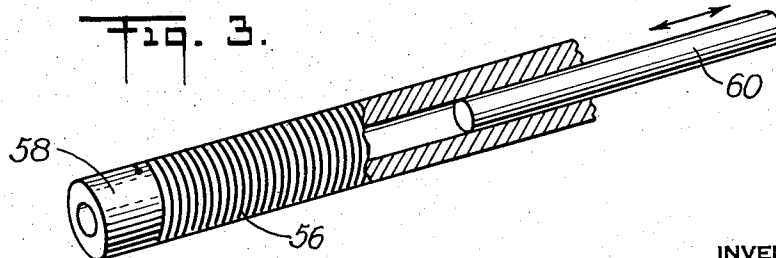
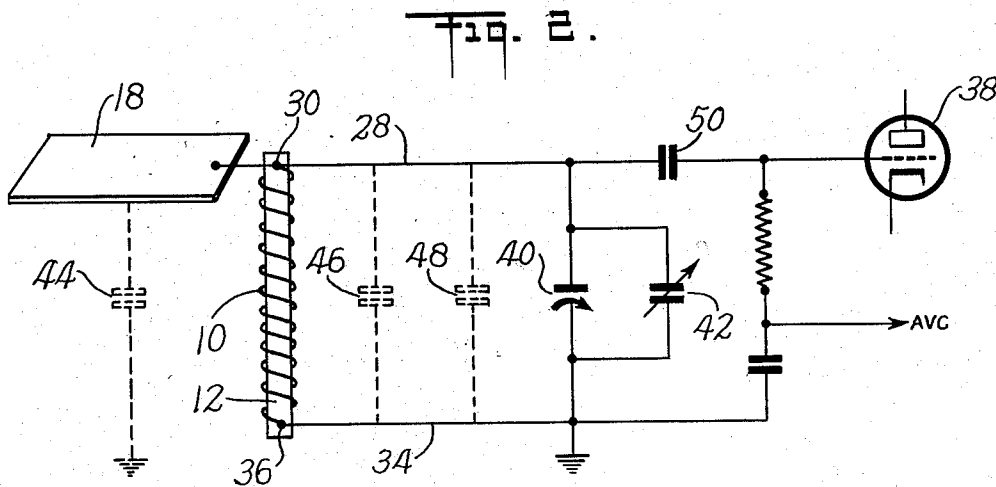
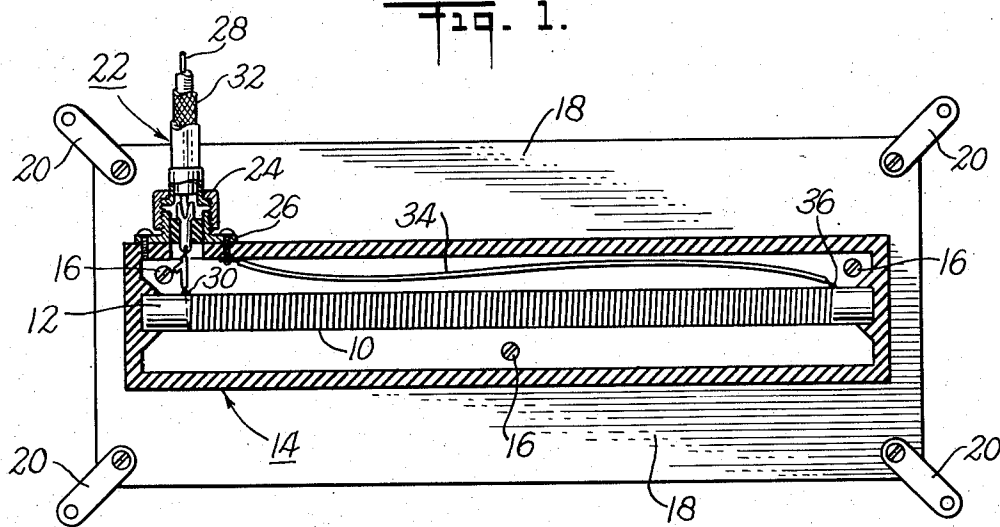


July 14, 1959

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MOBILE RADIO ANTENNA

2,895,129

Filed Jan. 30, 1956



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2,895,129

MOBILE RADIO ANTENNA

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Application January 30, 1956, Serial No. 562,077

6 Claims. (Cl. 343-717)

This invention relates to antennas for mobile radio receivers and particularly concerns an automobile antenna of substantially omni-directional characteristics.

Heretofore the type of automotive radio antenna in most common use has been the metal "whip," which is formed of stiffly resilient tubing in a plurality of telescoping sections, vertically oriented and extensible to a length of three or four feet. The "Q" of such an antenna is limited by the quality of the insulation in its supporting bases and in the coaxial transmission line which is used to connect them to the input of the automobile radio receiver.

In the radio receiver, the input circuit has conventionally been tuned by a variable powdered iron core inductor forming part of a parallel resonant circuit. Such inductors necessarily have a low Q because of the presence of the chassis of the radio receiver and other adjacent metallic structures. As a practical matter, it has been impossible to achieve Q values of an order substantially exceeding 10, and the low Q of the antenna circuitry has seriously limited the overall gain of the receiving system.

Whip-type antennas have been generally regarded as detracting from the aesthetic appearance of the automobile. Moreover, they have often been damaged by collision with garage doors, trees and other objects, and their telescoping action, if not their electrical efficacy, has been impaired.

In our copending application Serial No. 533,939, filed September 13, 1955, now abandoned, there is disclosed a magnetic antenna comprising a core of high-permeability, high-Q magnetic material with a coil of wire wound helically around it, the coil being connected in parallel with a condenser in the input circuit of the radio receiver to form a circuit resonant at the frequencies to be received. Thus, the antenna coil has served not only as a pick-up device but also as part of the tuned input circuit of the receiver. This has eliminated the necessity of an input inductance within the receiver and has made it possible to achieve Q values of the order of a hundred or more.

Despite the small physical size and resulting unobtrusiveness of the antenna disclosed in the aforementioned co-pending application Serial No. 533,939, it has an average gain comparable to or superior to that of a conventional, fully extended metal whip. However, the antenna is most efficient when mounted in the horizontal plane so that the long axis of the core is parallel to the "H" or magnetic component of a vertically polarized broadcast signal. When the antenna is so oriented, it exhibits a definite directional characteristic, the pick-up of the antenna being maximum when the long axis of the core is oriented parallel to the wave front of the broadcast signal—i.e., broadside to the direction from which the signal emanates. While the automatic volume control action of a conventional automobile radio receiver is sufficient to overcome this undesirable directional characteristic to a large extent, the sensitivity of the antenna, when unfavorably oriented, is something less than that of a fully extended whip. In poor receiving locations,

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for example locations at a considerable distance from the transmitting station in what is sometimes termed "fringe" areas, the directional effect of the antenna is therefore quite noticeable to the listener as the automobile is turned.

It is therefore among the objects of the present invention to provide a magnetic type automobile radio receiving antenna which is substantially omni-directional in its characteristics. Another object of the invention is to provide such an antenna which is sufficiently sensitive to permit it to be mounted beneath the automobile or in other inconspicuous locations where the field intensity is low. A further object of the invention is that of providing such an antenna which is practical and economical in construction and which is well adapted for conditions of actual use. A still further object is that of providing such an antenna which includes means for varying its inductance and thereby changing the resonant frequency of the tuned circuit in which it is incorporated.

In the drawings:

Figure 1 is a top plan view of an antenna embodying features of the invention, with portions of the antenna being shown in section to reveal its inner construction.

Figure 2 is a schematic diagram of the input circuit of a radio receiver including the antenna of Figure 1.

Figure 3 is a somewhat diagrammatic perspective view, partly broken away, of an alternative embodiment of this invention which includes means for varying the inductance of the antenna.

As may be seen in Figure 1, the antenna includes a helical coil 10 which is wound on an elongated cylindrical core 12 of a high-permeability, high-Q magnetic material such as a ferrite of the type sold by Henry L. Crowley and Co. under the designation "Croloy CR-20" or by General Ceramics Corporation under the designation "Ferramic Q." In the particular embodiment illustrated, the core 12 is approximately 15 inches in overall length and $\frac{5}{8}$ inch in outside diameter; it is tubular in form having a hollow axial bore approximately $\frac{1}{4}$ inch in diameter. The coil 10 comprises approximately 47 turns of No. 28 A.W.G. double silk covered wire which is wound directly on the core and spaced so as to occupy substantially the full length of the core.

The core 12 is supported at its ends in slots in a housing 14 which, for example, is molded of a thermosetting phenolic resin. The housing 14 completely encloses the core 12 and coil 10 and protects them from physical damage as well as from dirt and moisture.

The housing 14 is secured by means of screws 16 on a plate 18. The plate 18 is suitably formed of aluminum $7'' \times 17'' \times \frac{1}{32}''$, although these dimensions are not at all critical. The core 12 and coil 10 are supported so that the axis of the core 12 is parallel to the plate 18, with a spacing of approximately $\frac{3}{4}''$ between the plate and the adjacent side on the core. The plate 18 is provided at its four corners with mounting straps 20, of a suitable insulating material such as polystyrene, which are used to secure the plate 18 and the attached housing 14 in position beneath the automobile body.

Electrical connection is made to the antenna through a conventional coaxial transmission line 22, the terminal fitting 24 of which cooperates with a complementary fitting 26 secured to the housing 14. The center conductor 28 of the coaxial line 22 is connected through the fittings 24 and 26 with one terminal 30 of the coil 10, and also to the plate 18 through one of the screws 16. The outer braid 32 of the coaxial line 22 is connected through a lead 34 with the opposite terminal 36 of the coil 10.

Figure 2 is a schematic electrical diagram of an illustrative circuit by which the antenna may be connected to the input of an automobile radio receiver. As may be seen in this figure, the plate 18 and the terminal 30

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of the coil 10 are connected through the central conductor 28 of the transmission line and through a coupling capacitor 37 to the grid of the input tube 38 of the automobile radio receiver. The other terminal 36 of the coil 10 is connected through the outer braid 32 of the coaxial line to the grounded chassis of the radio receiver.

Mounted within the radio receiver and connected between the central conductor 38 and ground and thus in parallel with the coil 10, is a variable tuning condenser 40 with a padding condenser 42 connected in parallel with it for tracking purposes. The effective capacitance of the circuit includes not only the lumped capacitances of the tuning condenser 40 and padder 42, but also the distributed capacitance of the circuit including the capacitance between the plate 18 and ground, as indicated in broken lines at 44, the distributed capacitance of the coil 10, as indicated in broken lines at 46, and the capacitance of the coaxial transmission line as indicated in broken lines at 48. All of these capacitances, of course, must be taken in consideration in determining the proper value of inductance of the coil 10 and capacitance of the condensers 40 and 42. It has been found that a tuning condenser 40 having a capacitance range of 14 to 540 mmf. will properly tune the broadcast band with a plate and coil of the characteristics hereinabove described.

From a study of the circuit of Figure 2, it can be seen that the coil 10 and capacitance 40, in combination with the padder 42 and the distributed capacitances 44, 46 and 48, form a parallel circuit which is resonant at the frequencies to be received. Since the coil 10 is mounted externally of the radio receiver and is inherently a high Q device, it is possible to achieve Q's of the order of 100 or more. This gives the circuit a high "EQ product" and an excellent signal sensitivity.

The antenna unit, as illustrated in Figure 1, is preferably mounted with the plate 18 in a horizontal plane. This orients the long axis of the core 12 broadside parallel to the "H" or magnetic plane of a vertically polarized signal. Where the long axis of the core 12 is oriented broadside to the direction from which the received signal emanates, the pickup of the coil 10 is at a maximum and the sensitivity of the antenna is many times greater than that of a conventional fully extended whip. The amplitude of signal pickup by the coil 10 falls off where the long axis of the core 12 is oriented parallel to the direction from which the received signal emanates. However, the plate 18 serves as a pickup device which is substantially omnidirectional, and the signal picked up by it is always additive to that induced in the coil 10. Thus, even at the most unfavorable orientation of the antenna, its overall sensitivity is markedly superior to that of a fully extended whip. While the field sensitivity pattern of the antenna is not uniform in all directions, in its poorest orientation, it is better than a fully extended whip. The variation in signal pickup as the automobile is turned will usually be within the range of compensation of the receiver's automatic volume control, so that no variation in signal volume is observed by the listener as the car is turned.

The sensitivity of the antenna is sufficient that it may even be mounted beneath the automobile. When so mounted, it is preferably oriented so that the housing 14 is on the upper side of the plate 18. As one example of a suitable location, the antenna may be mounted so that the plate 18 is approximately $\frac{1}{4}$ inch below the lower edge of the skirt of the car body with the lower edge of the coil 10 approximately $\frac{1}{2}$ inch above the skirt. Although the coil 10 is actually above the lower edge of the car body, its coupling is apparently enhanced by the presence of the plate 18 which is located slightly below the lower edge of the car body and acceptable pickup is obtained. In one successful embodiment, the antenna is located with the long axis of the plate 18 aligned with the long axis of the car, with the leading edge of the plate spaced approximately 15 inches rearwardly of the

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center post of the car (a four-door sedan), and with the left-hand edge of the plate 18 spaced approximately 9 inches inwardly from the adjacent left-hand edge of the car body.

The antenna as thus mounted is entirely inconspicuous and does not interfere with the streamlining of the car. Its sensitivity is so great that even though mounted beneath the car it gives superior performance as compared to a conventional fully extended whip in all orientations of the automobile relative to the direction of the received signal.

Figure 3 illustrates an alternative embodiment of the invention which includes means for varying the inductance of the coil. As may be seen in this figure, the coil 56 is wound on a tubular core 58 which has slidably received in one end thereof an auxiliary core 60 of comparatively small diameter. By moving the auxiliary core 60 inwardly (toward the left as viewed in Figure 3) so that more of its length is received within the bore 58a of the main core 58, the inductance of the coil 56 may be increased, and vice versa. This feature of variability, in combination with the padding condenser 42, allows tracking of the input circuit so that the tuning condenser 40 may be ganged for simultaneous tuning with one or more additional condenser sections connected in various circuits within the receiver.

From the foregoing description, it will be understood that the present invention provides an antenna which is simple and economical in construction and which is substantially omnidirectional in its characteristics, and which is sufficiently sensitive to permit it to be mounted underneath the automobile or in some other inconspicuous location. It will therefore be appreciated that the aforementioned and other desirable objectives have been achieved. However, it should be emphasized that the particular embodiments of the invention which are described and shown herein are intended as merely illustrative rather than as restrictive of the invention.

We claim:

1. A mobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in electrically insulated relation to a vehicle, an elongated core of high-permeability, high-Q magnetic material, means for supporting said core in a generally horizontal plane and in spaced relation to said vehicle, a coil wound on said core, and means for electrically connecting said coil and said sheet to the input circuit of a radio receiver in said vehicle.

2. An automobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in a generally horizontal plane beneath the body of an automobile and in electrically insulated relation thereto, an elongated core of high-permeability, high-Q magnetic material, means for supporting said core in a generally horizontal plane beneath said automobile body and in electrically insulated relation thereto, a coil wound on said core, and means for electrically connecting said coil and said sheet to the input circuit of a radio receiver in said vehicle.

3. An automobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in a generally horizontal plane beneath the body of an automobile and in electrically insulated relation thereto, an elongated core of high-permeability, high-Q magnetic material, means for supporting said core in a generally horizontal plane on top of said sheet member and in spaced, generally parallel relation thereto, a helical coil wound on said core, and means for electrically connecting said coil and said sheet to the input circuit of a radio receiver in said vehicle.

4. A mobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in electrically insulated relation to a vehicle, an elongated core of high-permeability, high-Q magnetic material, means for supporting said core in a generally horizontal

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plane and in spaced relation to said vehicle, a coil wound on said core, means connecting said metallic sheet member to one end of said coil, and means to connect said coil across a variable condenser in the input circuit of a radio receiver in said vehicle to form with said condenser and the distributed capacitance of the circuit a tuned circuit resonant at the frequencies to be received.

5. An automobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in a generally horizontal plane beneath the body of an automobile and in electrically insulated relation thereto, an elongated core of high-permeability, high-Q magnetic material, means for supporting said core in a generally horizontal plane on top of said sheet member and in spaced, generally parallel relation thereto, a helical coil wound on said core, and a coaxial transmission line, one end of the inner conductor of said transmission line being connected to one end of said coil and to said metallic sheet member, and the other end of said inner conductor being connected to one set of plates of a variable condenser in the input circuit of a radio receiver and one end of the outer braid of said coaxial transmission line being connected to the other end of said coil and being grounded to said automobile body and the

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other end of said outer braid being connected to the other set of plates of said condenser to form a parallel tuned circuit resonant at the frequencies to be received.

6. A mobile radio antenna comprising a metallic sheet member, means for supporting said sheet member in electrically insulated relation to a vehicle, a core assembly including a main core of high-permeability high-Q magnetic material and an auxiliary core of similar material mounted adjacent said main core and movable relative thereto to vary the effective overall size of said core assembly, means for supporting said cores in spaced relation to said vehicle, a coil wound on said main core, and means for electrically connecting said coil and said sheet to the input circuit of a radio receiver in said vehicle.

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