This invention relates to an antenna structure particularly intended for mobile installations.

Change of the operating frequency of the antenna is accomplished by changing the inductance of an antenna loading coil. In the past, this has been accomplished by manipulation of an adjustable tap of the coil. Since antenna coils are desirably a physical part of the antenna and since the antenna is desirably mounted externally of the automobile or other mobile apparatus, changing the operating frequency heretofore necessitated stopping the mobile apparatus and manually adjusting the tap. Considerable time may be lost in accomplishing this adjustment, and inefficient operation results.

One of the objects of the present invention is to overcome these disadvantages by providing an improved remote control and remote indicating device operable, for example, from the passenger compartment of an automobile, whereby adjustment of the resonant or operating frequency of the antenna is efficiently accomplished.

Another object of this invention is to provide an improved device of this character in which the coil and casing are protected from arcing, should the coil be adjusted during operation of the radio apparatus. This is accomplished by a novel segmental switch structure that disconnects all sections of the coil until an adjusted position is achieved.

In certain frequency bands, it is desirable to change the setting of the coil only slightly. Another object of this invention is to provide a simple manner for such fine adjustment without the use of separate compensating coils.

Still another object of this invention is to provide a novel apparatus of this character in which the steps of movement of the switch structure between settings may be made equal although the particular settings are not uniformly spaced with respect to the coil. In this manner, the sensitivity and response of the moving mechanism need not be too great. Also, it is an object of this invention to provide a novel indicator useful in this organization in which the indicator is responsive to the attainment of one of the contacting positions.

Still another object of this invention is to provide a durable and compact switch structure.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a pictorial view of an antenna incorporating the present invention, the antenna being illustrated as attached, by way of example, to the rear bumper of an automobile;

Fig. 2 is an enlarged fragmentary longitudinal sectional view of the coil and switch structure forming a part of the antenna;

Fig. 2a is an enlarged fragmentary longitudinal sectional view of that portion of the antenna structure housing the means for moving the switch and for indicating the position of the switch; Fig. 2a also diagrammatically illustrates a meter forming a part of the indicator and a control circuit for the mechanism;

Figs. 3, 4, 5 and 6 are sectional views, taken along planes indicated by lines 3—3, 4—4, 5—5 and 6—6 of Fig. 2;

Fig. 7 is an enlarged sectional view, taken along the plane indicated by line 7—7 of Fig. 2a; and

Fig. 8 is a diagrammatic view showing the operation of the switch.

The antenna 10 shown in Fig. 1 comprises generally three serially connected sections, a base section in the form of a tube 11, an antenna coil assembly 14 and a whipl 12. At the bottom of the tube 11 is a housing 13 forming a part of the antenna and enclosing a driving mechanism to be described more fully hereinafter.

The antenna in this instance is shown attached to the rear bumper 15 of an automobile 16. A mounting bracket 8, to which the housing 13 is bolted, is provided for this purpose. A lead from the radio apparatus connects with the mounting bracket 8, and thus connects, through the bolt 9, with the antenna sections.

A coil 17 is supported by the aid of a plurality of polystyrene or other appropriate plastic or insulating rods 18 equatorially located along the outside of the coil. The turns of the coil 17 are partially embedded in the rods 18, thereby securing the coil against longitudinal movement. End caps 19 and 20 have flanges into which the ends of the rods 18 are frictionally received. The spacing between adjacent turns and the diameter of the wire forming the coil are both exaggerated in the drawings for purposes of clarity.

The upper end of the tube 11 projects slightly into a central opening 19a of the lower cap 19. A collar 21, secured to the end of the tube 11, as by a set screw 22, prevents downward movement of the end cap 19 with respect to the tube 11.

A nylon supporting rod 23 extends axially of the coil 17 and has a lower reduced extension 23a telescoping within the upper end of the tube 11. A shoulder 23b, formed by the reduced extension 23a, abuts the end of the tube 11. The collar 21 also holds the tube 11 about the rod extension.

The rod 23 supports the coil assembly 14 and also the whip 12. The upper end of the rod 23 has an axial recess 23c accommodating an interiorly threaded metallic insert 24. A reduced threaded extension 12a at the lower end of the whip section 12 passes through an aperture 20a in the upper cap 20 and cooperates with the insert 24. A shoulder 12b, formed by the whip extension 12a, engages the cap 20 to hold the entire coil assembly in place.

The upper end turn of the coil 17 is connected to the metallic insert 24 and thus to the whip section 12 by the aid of a screw or pin 25 extending transversely through the end of the rod 23. The pin or screw 25 forms a terminal post cooperable with a connecting wire 26 that is suitably connected to the terminal portion of the coil.

In order to connect the whip 12 and a selected portion of the length of the coil 17 to the tube 11 and to short-circuit the remaining portion of the coil 17, a sliding switch arm or bar 27 of metallic material is provided. This arm has a generally square cross-section and is
guidingly accommodated in an elongate slot or recess 23d extending longitudinally at one side of the rod 23, as shown more clearly in Fig. 4. The groove 23d terminates short of the upper end of the rod 23 to form an abrupt determining a limited upward position of the arm 27 relative to the rod 23.

A series of resilient contact arms 28, 29, 30, 31, 32, 33 and 34, carried by the rod 23 and compatible with the arm 27, are respectively connected at selected positions along the length of the coil 17 to determine the operating frequency of the antenna. The contact arms are generally arcuate in configuration, as shown most clearly in Fig. 4. They are each affixed to the rod 23 by two screws, such as 35 and 36, for the arm 29. One of the screws forms a terminal post co-axial with a connection 37, soldered or otherwise permanently affixed to one of the coil turns. The free end of the contact arm 29 over-rides the slot 23d of the rod 23 and is provided with an inwardly struck portion 29a forming an edge extending transversely of the switch arm 27.

The normal configuration of each of the contact arms is such that the downwardly struck portions extend slightly into the path of movement of the switch arm 27. Corresponding lower side walls of the inwardly struck portions form cam surfaces cooperable with the end edge of the switch arm 27 to flex the contact arms outwardly as the end of the switch arm 27 advances beneath them.

The upper contact arm 28 is connected to one of the turns of the coil 17 such that the coil length between the upper end of the coil and the contact arm 29 corresponds to that for operation of the radio equipment on a 10-meter band, for example. The lower contact arm 34 is connected to the lower end of the coil and, if only this contact arm is engaged, the coil length corresponds, for example, to a 75-meter band. The intermediate contact arms correspond to intermediate band lengths. The contact arms may be uniformly spaced for best operation of the switch, although the positions along the coil of the contact arm connections may not be uniformly spaced. The coil length between adjacent contacts may be small or large, as desired. Furthermore, successive contacts may correspond to any desired order of coil lengths.

In the position of the switch arm 27 illustrated, all of the contact arms 28 through 34 are engaged thereby. The switch arm short-circuits that length of the coil between the upper contact arm 28 and the lower contact arm 34. Assuming that successive contacts correspond to successive coil lengths, then in this position only a short length of the coil is operative, namely, that between the terminal pin 27 and the upper contact arm 28.

A small pellet 58, located in a transverse aperture 23e of the reduced extension 23f of the rod 23, is urged to engage the bottom of the switch arm 27. A compression spring 39, also located in the aperture 23f and engaging the tube 11, is provided for this purpose. An electrode conductive path is thus established between the switch arm 27 and the tube 11. In the position shown, the operative antenna length includes the upper whiff 12, the first section of the coil 17 determined by the contact arm 28, the switch arm 27, pellet 38, spring 39, tube 11 and the outer housing 13.

If the switch arm 27 is moved downwardly, the end of the arm disengages the upper contact arm 28, and that segment of the coil 27 between the contact arm 28 and the next contact arm 29 is no longer short-circuited. This in effect determines a different effective coil length and provides proper operation for the next frequency band.

Obviously the successive positions of the arm 27 correspond to successive effective coil lengths for the antenna circuit.

If the transmitter is operating substantial voltages may be induced in the coil 17. In order to prevent arcing as the arm 27 moves upwardly the short-circuit successive coil sections, a series of insulation inserts 40, 41, 42, 43, 44, 45 and 46 are provided. These inserts 40 through 46 are secured in place in corresponding recesses of the arm 27.

Referring to Fig. 8 and the full-line position of the switch arm 27 diagrammatically shown, the contact arm 30 is shown engaging the terminal portion of the contact arm 27 just above the first insert 40. Contact arms 31, etc., beneath the contact arm 30 are also engaged by the switch arm 27. The contact arms 28 and 29 above the contact arm 30 are not engaged. The coil sections 17a, 17b and 17c are operative, and the remaining coil sections 17d, etc., are disengaged. If the switch arm 27 moves upwardly, the contact arms 30, 31, etc., engage insulation inserts 40, 41, etc., and all sections of the coil will be disconnected from the transmitter.

This is illustrated by the dot-and-dash line position in Fig. 8. Upon a slight incremental movement of the arm 27 from this dot-and-dash line position, the contact arms 29 and 30, as well as the remaining contact arms 31, etc., will simultaneously engage the arm 27. Accordingly, there will be no chance of high voltages being induced in coil sections about to be short-circuited. The spacing of the insulation inserts 40 through 46 related to the contacts is such as to ensure simultaneous engagement of conductive portions of the switch arm 27 with the contact arms. The required relationship is that the spacing between the contacts 28, 29, etc., is divisible in whole numbers by the spacing between the trailing edges of the inserts 40, 41, etc., or the leading edges of the conductive portions of the bar 27.

The rod 23, being made of nylon, will not carbonize in any event.

For positioning the switch arm 27, a motor driven pulley 47 in the casing 13 is provided. The pulley 47 as well as the small reversible motor 48 and gear reduction mechanism 49 are all mounted within the casing 13.

A light endless cable passes about the driving pulley 47 in the casing 13 and also about a pulley 51 secured within the rod extension 23a. For accommodating the pulley 51, the rod extension 23a has a recess 25 extending inwardly of the rod extension 23a from the bottom of the rod recess 23f for the switch arm 27.

The pulley 51 is mounted by a transverse pin 52. A groove 23g in the bottom of the rod slot 23d provides clearance space for one lateral run 53 of the cable. A small bore 23h extends inwardly from the end of the rod extension 23a and provides clearance space for the opposite lateral run 54 of the cable. Screw 55, located near the end of the switch arm 27, secures the right-hand cable run 53 to the arm 27. Accordingly, upon rotation of the pulley 47 in either direction, the switch arm 27 moves upwardly or downwardly with the cable.

Engagement of the switch arm 27 with the end surface of the rod slot 23d causes slippage to occur between the driving pulley and the cable. Reverse movement of the switch arm 27 is limited by a stop pin 56 secured to the tube 11 and extending inwardly thereof. The reversible motor 48 is controlled by a polarly reversing switch 57 located conveniently in the driver's compartment of the mobile apparatus.

In order to permit a remote determination of the position of the switch arm 27, a meter 58 cooperates with an electrical circuit, the characteristics of which are changed in steps as the switch arm reaches successive contacting positions.

A steel round insulation support 59, located just above the casing 13 and in the tube 11, mounts a series of longitudinally spaced resistors 60, 61, 62, 63, 64, 65 and 66. Aligned recesses on one side of the flat surface of the support 59 accommodate all but the lower end resistor 66. These resistors serially connect with each other and to a connection 67 to the meter 28.

A long tube 68 of conductive material is mounted in a longitudinal slot on the other side of the support 89.
and is insulated from the antenna tube 11. The end of the tube 68 connects with a companion lead 69 for the meter 58. As the cable moves upward and downwardly, the resistors 60 through 66 are successively placed in series relationship with the meter leads 69 and 67. For this purpose, the lateral run 53 of the cable extends through the conductive tube 68 and carries a conductive pellet or bullet 70; the pellet 70 having appropriate slight clearance in the tube 68.

In the position shown, the pellet 70 is located in registry with the first of a series of longitudinally spaced slots 71, 72, 73, 74, 75, 76 and 77 in the tube 68. A resilient wire 78, 79, 80, 81, 82, 83 or 84 is provided for each of the slots. One end of the wire 78, for example, is embedded in the support 59 on one side of the tube 68. The wire 78 extends across the tube slot, and its other end is connected to the upper end of the end resistor 60. The central portion of the wire 78 is in the path of movement of the pellet 70.

In the position shown, the pellet 70 has flexed the wire 78 outwardly, causing appropriate electrical contact between the tube 68, pellet 70, wire 78, to a point in the connected resistors such as to effect a series circuit relationship between all of the resistors and the meter.

The movable arm of the meter gives a definite indication of the operating frequency of the antenna, as by a scale marking 58a. The parts are so proportioned that the pellet 70 engages the wire 78 only when the switch arm 27 is in conductive relationship with the uppermost contact arm 28, as shown in Fig. 2.

The length of the pellet 70 is sufficiently small to ensure that when the meter 58 indicates the scale marking 58a, the contact arm 28 is engaged by the conductive portion of the switch arm 27.

As the motor 48 is operated to move the arm 27 and pellet downwardly, the motor circuit is momentarily open-circuited, and no indication is given by the meter 58 unless the next resilient wire 79 is engaged by the pellet. This corresponds to the next switching position of the arm 27.

In this case, the pellet 70 establishes a circuit for the meter including all of the resistors except the upper resistor 60. This definite electrical condition causes the meter to indicate a scale marking 58b.

Further successive switching positions are indicated by the meter by providing appropriate connections for the wires 80, 81, 82, 83 and 84 between adjacent resistors. By passing appropriate values of the resistors, the meter can easily be read. Conveniently, the scale markings can be made to designate particular operating bands.

The run 54 of the cable extends through the clearance space provided between the substantially half-round support 59 and the tube 11. The arrangement illustrated provides both remote setting and indication of the position of the coil, and the coil can readily be accurately placed when the equipment upon which the radio apparatus is mounted is in motion.

We claim:
1. In an antenna structure: a coil; a plurality of contact means, respectively connected to selected portions of the coil; a movable switch member having an electrically common surface conductively engageable with all of the contact means simultaneously and movable to disengage the contact means one at a time in sequence whereby selected between the contact means engaged by the surface area are so recorded; and insulation means carried by the member for engagement by the contact means, the insulation means being so located that immediately prior to initial conductive engagement of the member with one of the contact means, conductive engagement of those contact means previously in cooperative relationship with the member is interrupted, whereby the member is simultaneously placed in conductive relationship with all operative contact means.

2. In an antenna structure: a unitary coil; a switch member movable in a path, and having alternate conductive and insulation portions spaced along the member in a direction parallel to the path the conductive portions being electrically common; and a series of contact arms respectively connected at selected positions of the coil, and spaced along the path, the member being movable to engage successive inclusive members of contact arms; the insulation portions being so located as to preclude engagement of any of the contact arms with the member immediately prior to arrival of the switch member to any contacting position.

3. In an antenna structure: a coil; a switch member movable in a path, and having alternate conductive and insulation portions spaced along the member in a direction parallel to the path the conductive portions being electrically common; and a series of contact arms respectively connected at selected positions of the coil, and spaced along the path, the member being movable to engage successive inclusive members of contact arms; the engagement portion means, respectively connected to selected portions of the coil, and spaced along the path, the member being movable to engage successive inclusive members of contact arms; the spacing of the arms relative to the insulation portions being such that conductive engagement of the member with the arms is simultaneously established upon movement of the member in one direction.

4. In an antenna structure: a first antenna section having a tubular end; an insulation rod affixed to and extending beyond the tubular end; said rod having an axially elongate recess at one side thereof; a coil; end supports for the coil, one of which telescopes over the rod to locate the rod, with substantial clearance within the coil; means for securing the end supports in place longitudinally of the rod; a second antenna section fixed to the end of the rod remote from the first section; a series of arcuate contact arms made of resilient material carried by the rod and connected at selected positions along the length of the coil; the arcuate contact arms extending about the axis of the rod and each having an end overlying the slot; a bar slidably in and guided by the recess the rod to engage the contact arms in succession; means connecting the arm to the first antenna section; and means connecting one end of the coil to the other antenna section.

5. In an antenna structure: an antenna section including a tubular member and a hollow casing forming an operative part of the antenna; a coil carried at one end of the tubular member; a series of spaced contact arms within the coil and connected at selected positions along the length of the coil; a switch bar movable longitudinally of the coil for engagement with the contact arms in succession; said switch bar being retractable within the tubular member; there being intermediate non-contacting positions of the switch bar; reversible motor operated means mounted in the casing cooperating with the bar for moving the bar; an indicator structure having a series of spaced contacts in the tubular member; and means carried by the operating means for engaging the spaced contacts in succession in accordance with the contacting positions of the switch bar.

6. In an antenna structure: a coil; a switch bar movable longitudinally of the coil; a series of contact arms connected at selected positions along the length of the coil and engaged by the bar; a pair of antenna sections, one of which is connected to the bar and the other of which is connected to one end of the coil; an endless cable fixed to the bar; reversible motor operated means for moving the cable; a conductive tubular member through which one run of the cable extends, said tube having a series of longitudinally spaced transverse slots; series connected circuit elements; contact means connected between the elements, and extending respectively into the slots; a conductive member carried by the cable and movable in the tubular member to engage the contact means; a meter in circuit relationship with the conductive member and the circuit elements for remote indication of the position of the conductive member and of the bar; and
remote control switch for controlling the reversible motor operated means.

7. In an antenna structure: a loading coil; a series of contact means respectively connected to selected turns of the coil, and spaced along a path; the selected turns of the coil connected to the respective contact means determining different frequency bands; a switch member supported for movement to successive positions along the path and having electrically common conductive portions extending in spaced relationship along the switch member in a direction substantially parallel to said path so that said conductive portions of the switch member together engage successive inclusive numbers of contact means as the switch member is moved to successive contacting positions whereby colli sections between contact means so engaged are short circuited; and means operable by movement of the switch member for temporarily disconnecting all contact means from the switch member as the switch member initially arrives at the contacting positions, comprising a series of insulation means interspaced between the conductive portions of the switch member.

8. In combination with radio apparatus: a coil; a plurality of contact means connected to selected turns of the coil and spaced along a path; and a switch member relatively movable along the path and located electrically between the coil and the radio apparatus, the switch member being engageable with successive contact means upon movement of the member in one direction; said switch member having a plurality of electrically common conductive means spaced in a direction of said path so that said electrical common conductive means together engage successive inclusive numbers of contact means as the switch member moves in one direction along said path whereby all inoperative portions of the coil are short-circuited at each contacting position of the member; the spacing between the conductive means relative to the spacing of the contact means being such that the entire coil is disconnected from the radio apparatus immediately prior to arrival of the switch member to successive contacting positions.

9. In combination with radio apparatus: a coil; a plurality of contact means connected to selected turns of the coil and spaced along a path; a switch member supported for movement to successive positions along the path and having common conductive means connected common to the transmitter that extend along the switch member in a direction substantially parallel to said path so that said conductive portions of the switch member engage successive inclusive numbers of contact means as the switch member is moved to successive contacting positions whereby coil sections between contact means so engaged are short circuited; and means operable by movement of the switch member for temporarily disconnecting all contact means from the switch member just prior to initial arrival of the switch member to the contacting positions.

10. In combination with a radio transmitter: a unitary antenna loading coil; an antenna section having one end connected to one end of the coil; a series of contact means respectively connected to selected turns of the coil, and spaced along a path; a switch member supported for movement to successive positions along the path and having conductive means electrically common to the transmitter that extend along the switch member in a direction substantially parallel to said path so that said conductive portions of the switch member engage successive inclusive numbers of contact means as the switch member is moved to successive contacting positions whereby coil sections between contact means so engaged are short circuited; and means operable by movement of the switch member for temporarily disconnecting all contact means from the switch member just prior to initial arrival of the switch member to the contacting positions.

11. In combination with a radio transmitter: an antenna loading coil; an antenna section having one end connected to one end of the coil; a series of contact means respectively connected to selected turns of the coil, and spaced along a path; a switch member supported for movement to successive positions along the path and having conductive means electrically common to the transmitter that extend along the switch member in a direction substantially parallel to said path so that said conductive portions of the switch member engage successive inclusive numbers of contact means as the switch member is moved to successive contacting positions whereby coil sections between contact means so engaged are short circuited; and means operable by movement of the switch member for temporarily disconnecting all contact means from the switch member just prior to initial arrival of the switch member to the contacting positions.

12. In combination with radio apparatus: a coil; a plurality of contact means connected to selected turns of the coil and spaced along a path; and a switch member relatively movable along the path and located electrically between the coil and the radio apparatus, the switch member being engageable with successive contact means upon movement of the member in one direction; said switch member having a plurality of electrically common conductive means spaced in a direction of said path so that said electrical common conductive means together engage successive inclusive numbers of contact means as the switch member moves in one direction along said path whereby all inoperative portions of the coil are short-circuited at each contacting position of the member; the spacing between the conductive means relative to the spacing of the contact means being such that the entire coil is disconnected from the radio apparatus immediately prior to arrival of the switch member to successive contacting positions.

13. In combination with radio apparatus: a coil; a plurality of contact means connected to selected turns of the coil and spaced along a path; a switch member relatively movable along the path and located electrically between the coil and the radio apparatus, the switch member being engageable with successive contact means upon movement of the member in one direction; said switch member having a plurality of electrically common conductive means spaced in a direction of said path so that the switch member engages successive inclusive numbers of contact means as the switch member moves in one direction along said path whereby all inoperative portions of the coil are short-circuited at each contacting position of the member; the spacing between the conductive means relative to the spacing of the contact means being such that the entire coil is disconnected from the radio apparatus immediately prior to arrival of the switch member to successive contacting positions; remote control means for relatively moving the switch member; and remote indicating means for determining the position of the switch member.

14. In combination with a radio transmitter: an antenna section having one end connected to one end of the coil; a series of contact means respectively connected to selected turns of the coil, and spaced along a path; a switch member supported for movement to successive positions along the path and having common conductive means connected common to the transmitter that extend along the switch member in a direction substantially parallel to said path so that said conductive portions of the switch member engage successive inclusive numbers of contact means as the switch member is moved to successive contacting positions whereby coil sections between contact means so engaged are short circuited; and means operable by movement of the switch member for temporarily disconnecting all contact means from the switch member just prior to initial arrival of the switch member to the contacting positions.

15. In combination with high tension power apparatus: a coil; contact means respectively connected permanent-
ly to spaced points of the coil, the contact members being uniformly spaced along a linear path; a conducting member connected to the power apparatus and movable to successive contacting positions along the path for engagement in electrically common relationship with successive inclusive numbers of contact members as the conducting member is moved in one direction whereby the coil sections between the contact members so engaged are short circuited; and insulation pieces uniformly spaced along the conducting member, the spacing of said pieces corresponding to the spacing of the contact members, whereby movement of the conducting member between current conducting positions ensures disconnection of all turns of the coil from the conducting member.

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