Sept. 30, 1958 Z. R. TAYLOR ET AL 2,854,667

SERVO MOBILE ANTENNAS

Filed Feb. 24, 1956 2 Sheets-Sheet 1

FIG. 1.

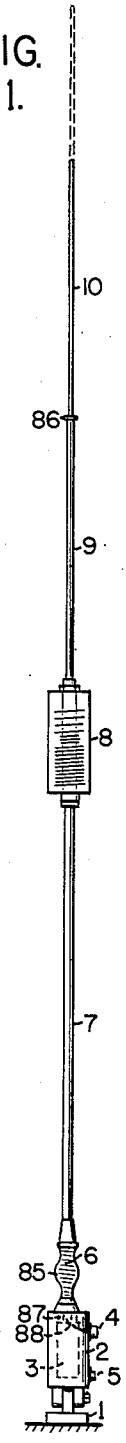


FIG. 6.

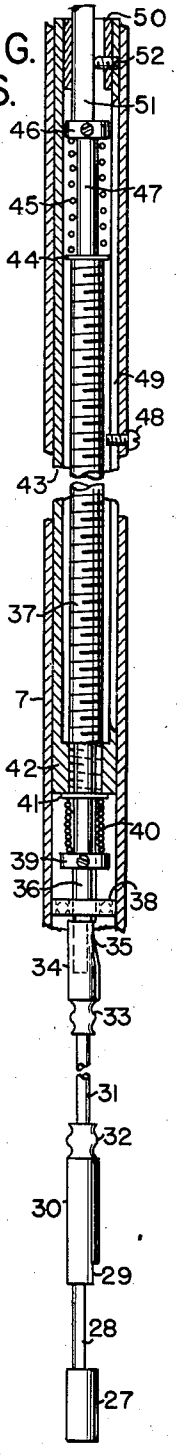


FIG. 2.

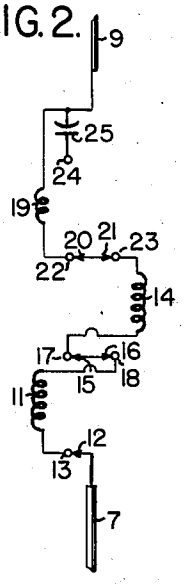


FIG. 3.

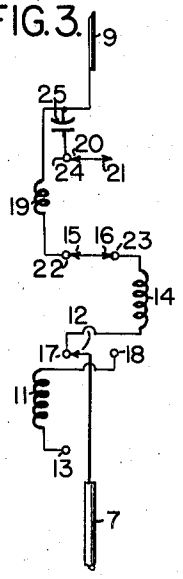


FIG. 4.

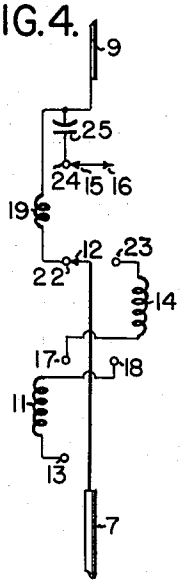
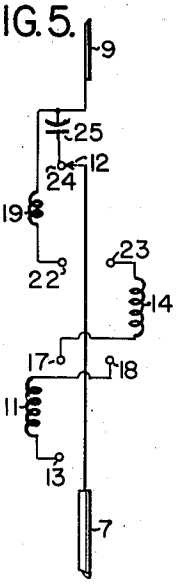


FIG. 5.



INVENTORS
ZACHARY R. TAYLOR &
LESTER W. WILLIAMS

BY Harry R. Lubcke
AGENT

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FIG. 7.

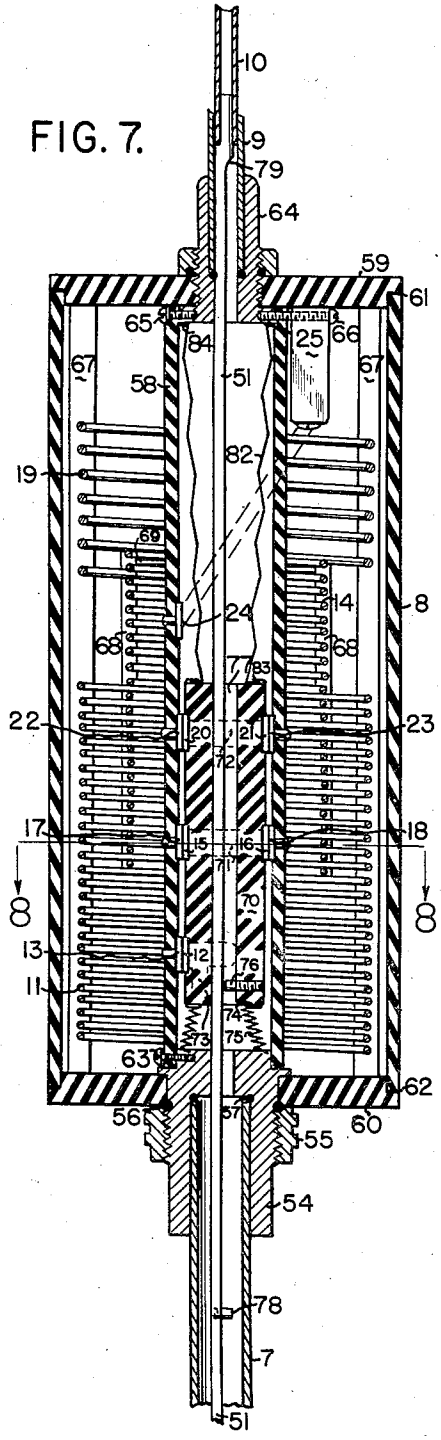
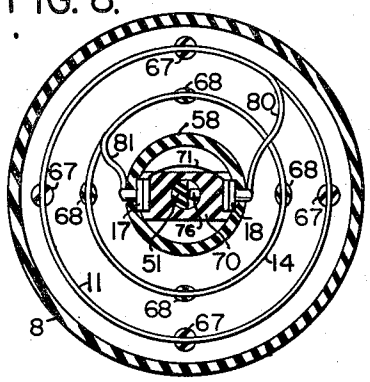


FIG. 8.



INVENTORS
ZACHARY R. TAYLOR &
LESTER W. WILLIAMS

BY Harry K. Lubeke
AGENT

United States Patent Office 2,854,667
Patented Sept. 30, 1958

2,854,667

SERVO MOBILE ANTENNAS

Zachary R. Taylor and Lester W. Williams,
Los Angeles, Calif.

Application February 24, 1956, Serial No. 567,644

15 Claims. (Cl. 343—750)

Our invention relates to resonantly operated antennas and particularly to those so operated which cannot be mechanically or electrically adjusted by hand for different resonant frequencies.

The substantial increase in power radiated by an antenna operated at resonance over one not operated at resonance for a given power availability at a transmitter is well known. The increase in receptivity of a resonant antenna in receiving radio energy is also well known.

Regardless of these facts the mobile art has been constrained to operate antennas off resonant frequency because of the impracticability of adjusting the same in use, particularly where more than one frequency of operation has been involved. Palliatives have been used, such as connecting a coil of adjustable inductance at the base of an antenna, at which position it can sometimes be adjusted. However, this arrangement reduces the energy radiated by the antenna because of unfavorable current distribution.

The advantage of being able to exactly resonate an antenna to any frequency over a number of octaves by remote control is seen to be very great. Such an antenna system is not only valuable for mobile operation on automobiles, trains, aircraft, ships and submarines where hand adjustment is impossible but also for mounting upon roofs of buildings, tops of towers and elsewhere where manual adjustment is inconvenient.

An object of our invention is to provide an antenna capable of being exactly resonated to frequencies over several octaves by remote control.

Another object is to provide such an antenna having a high radiating efficiency.

Another object is to provide an antenna having a servo mechanism which prevents damage to the mechanical adjustment of the antenna regardless of careless manipulation by the operator.

Another object is to resonate a given mechanical antenna structure not only to radio frequencies lower than the electrical resonant frequency thereof but also to higher radio frequencies.

Another object is to provide a servo resonant antenna of relatively simple and rugged construction and which may be constructed to be waterproof.

Other objects will become apparent upon reading the following detailed specification and upon examining the related drawings, in which:

Fig. 1 shows an assembled view of our antenna in elevation,

Figs. 2, 3, 4 and 5 show the schematic circuit of the antenna system in different states of adjustment,

Fig. 6 shows the slotted tube detail in sectional elevation,

Fig. 7 shows the inductor and switch detail in sectional elevation, and

Fig. 8 shows the same in end section.

In Fig. 1 element **1** is a base fitting adapted to support the antenna to any vehicle or other structure. Cylindrical housing **2** is also a supporting element. It is hollow

and houses actuating motor **3**. A coaxial cable connector **4** is preferably also mounted thereon for convenient connection of the antenna to a coaxial cable extending to the transmitter or receiver with which the antenna is to be used. Another connector **5** provides convenient connection of at least three wires to accomplish reversible energization of motor **3**. A coiled spring flexible support **6** joins the antenna proper to the cylindrical housing in a flexible manner, allowing the antenna to be considerably displaced from the vertical in case obstacles are encountered in mobile operation.

The lower radiator **7** is of tubular construction to house certain adjusting elements and is about half as long as the whole antenna. Cylindrical case **8** contains inductive and capacitative elements and a switch for altering the connections of these elements. The stationary or fixed section of the upper radiator **9** is fixedly supported to case **8** and is tubular to accommodate the extensible section **10** of the upper radiator. The latter is shown in full lines in the retracted position and in dotted lines as extended.

We are able to accomplish both band change and fine adjustment of resonant frequency with only one motor in a manner which forms an important part of our invention.

In Figs. 2 through 5 the electrical aspects of band changing are shown. In Fig. 2 the schematic circuit for the lowest frequency band is given. Coil **11** is of large diameter and has the greatest number of turns of the three coils shown. It is shown also in the lower portion of Fig. 7. For the circuit of Fig. 2 the movable contacts piece (**70**) of the switch are in the lower positions, resulting in movable contact **12** making connection with stationary contact **13**. In this position, coil **14**, having a large number of turns but a smaller diameter than coil **11** is connected to lower radiator **7** through coil **11** in a series aiding relation to the latter coil through movable contacts **15** and **16** and stationary contacts **17** and **18**. Similarly, coil **19**, having a few turns of large diameter, is connected in series aiding relation to the prior coils through movable contacts **20** and **21** and stationary contacts **22** and **23**. The upper end of coil **19** connects directly and permanently to the fixed section **9** of the upper radiator. All the coils are connected in series-aiding mutual inductance relationship. With the switch in the position shown in Fig. 2 the antenna is inductively loaded the maximum amount and the resonant frequency is the lowest. Still lower frequencies are reached by extending the extensible section **10** of Fig. 1 of the upper radiator by mechanical means to be described later. Electrically, it will be understood that such extending provides vernier frequency adjustment over a band grossly determined by the center loading. It is also recognized that center loading is a highly efficient means for decreasing the frequency of resonance of the necessarily small antenna needed for mobile operation.

In Fig. 3 the movable contact piece of the switch has been moved upward by the spacing of one set of contacts. Thus, movable contact **12** makes connection with stationary contact **17**, connecting lower radiator **7** directly to coil **14** and resulting in coil **11** floating electrically free; a most desirable manner of handling unwanted inductance. Movable contacts **15** and **16** take the place of prior contacts **20** and **21**, which now engage stationary contact **24** connected to capacitor **25**. This latter contacting is without electrical consequence, as is apparent. In this swtiching position a higher frequency band is reached and extension of upper radiator section **10** of Fig. 1 reduces the frequency toward those covered with the prior switching position.

In Fig. 4 the movable contact piece has been moved upward by two contact positions. Movable contact **12** makes contact with stationary contact **22**, connecting

radiator 7 directly to coil 19 and resulting in coils 11 and 14 floating free. Movable contacts 15 and 16 engage stationary contact 24, but without electrical consequence. Movable contacts 20 and 21 have now passed beyond all fixed contacts and are not shown in Fig. 4 for sake of clarity. Extension of section 10 again gives fine tuning at frequencies at and below the resonant frequency of the antenna as above loaded.

In Fig. 5 the movable contact piece has been moved upward by three contact positions. Movable contact 12 makes contact with stationary contact 24, connecting radiator 7 to capacitor 25 and resulting in all coils being removed from the circuit of the antenna. All movable contacts save 12 have passed beyond any fixed contacts and are not shown.

A series capacitor between two radiating sections of an antenna results in a resonant frequency higher than the electrical equivalent of the length of the radiators. Thus we are able to both electrically lengthen the antenna with the inductors having inductive reactance and to electrically shorten it with the capacitor having capacitative reactance with our switching arrangement, providing a relatively wide range of frequency of operation with a given physical structure.

As before, extension of upper section 10 lowers the frequency of resonance from the value set by the band switch. In this way we accomplish certain of the objects of our invention.

The mechanical arrangement for adjusting our antenna will now be described. In Fig. 6 element 27 is preferably an insulating member which is suitably rigidly attached to the shaft of the driving motor for the antenna. The latter may be any of the well-known small fractional horsepower power motors, of which a reversible D. C. motor of $\frac{1}{20}$ horsepower and 1700 revolutions per minute speed for operation on a 6, 12 or 28 volt vehicle storage battery is an example. The upper portion of element 27 is formed with a flat 28 which is held by depressed portion 29 of sleeve 30 so that the latter and the further structure above is rotatable by element 27. Sleeve 30 is free to slide up and down on flat 28 to accommodate extension of the structure when flexible support 6 of Fig. 1 is deformed by the antenna striking an obstacle. For this reason also, a flexible shaft 31 is provided. This may be a section of wire-wound speedometer cable and it occupies the same vertical position as flexible support 6. The cable is tightly held by rolled crimps 32 and 33 to sleeves 30 and 34. A depressed portion 35 of the latter fits with a flat portion of the smooth cylindrical end 36 of threaded rod 37, to transmit rotational drive thereto. Threaded rod 37 is housed in lower radiator 7, being fastened therein by ball bearing 38. Damage to the mechanism, previously referred to, is prevented by coaction of fixed collar 39, compression coiled spring 40, slidable collar 41 and the internally threaded section 42 of slotted tube 43.

In the position shown in Fig. 6 the slotted tube 43 is at the lowermost location and the smooth cylindrical end 36 is free to revolve in threaded section 42 without further lowering the slotted tube. This is occasioned by continued rotation of the threaded rod 37 in the clockwise direction as viewed from the bottom. Spring 40 is compressed, tending to move slotted tube 43 upward. However, as long as rod 37 rotates clockwise the threads thereon and the threads in section 42 slip by each other once each revolution (for a single pitch thread) and the slotted tube remains stationary. As soon as the direction of revolution is reversed the threads engage because of the compressed spring and tube 43 moves upward. This continues for the full length of threaded rod 37 until threaded section 42 bears against a second slidable collar 44 and compresses second spring 45. This is shown in Fig. 6 in the uncompressed position. Spring 45 is compressed against second fixed collar 46. Threaded section 42 then threads out upon smooth cylindrical end 47 and when fully out thereon slips past the upper end thread of rod 37.

Screw 48 rides in the slot of slotted tube 43 and is attached to lower radiator 7 so that the tube cannot revolve within the radiator. Were this to occur the travel of the tube caused by the rotation of the threaded rod would be negated. Radiator 7 is part of the stationary structure of the antenna to which the frame of motor 3 is mounted, as can be seen in Fig. 1.

At 50 in Fig. 6 a bushing reduces the inner bore of the slotted tube to the outer diameter of insulated rod 51. The latter has a flat relieved portion and headless set screw 52 clamps rod 51 so that it becomes an extension of slotted tube 43. Rod 51 carries the motion imparted to tube 43 by threaded rod 37 to the switch and to extensible section 10 of the upper radiator, the details of which are shown in Fig. 7.

In Fig. 7 the upper portion of lower radiator 7 and the insulated rod 51 previously shown in Fig. 6 are seen at the bottom of the figure. Fitting 54 makes case 8 structurally one with radiator 7, with the aid of nut 55. Rubber or equivalent washers 56 and 57 perform part of the function of making the antenna water-tight. The body of the band change switch, an insulated tube 58, takes structural stress in tension while outer case 8, through top 59 and bottom 60, is in compression. At least the top or the bottom of the case are removable for the purpose of inserting the inductors, etc. Where there are joints, these are made water-tight by gaskets, such as 61 and 62. Fitting 54 is attached to insulated tube 58 by three or more screws, one of which, 63, is shown. Likewise, upper fitting 64 is attached by screws 65. Screw 66 also serves to attach but the prime purpose thereof is to support capacitor 25 and to electrically connect one terminal thereof to the upper radiator 9 through metal fitting 64.

Inductors (also known as coils) 11 and 19 are supported within case 8 by four rods 67 of polystyrene or equivalent satisfactory radio frequency insulation, the turns of the coils being embedded in the rods. The lengths of the rods are such that tightening the ends 59 and 60 of the case holds the rods in place. In a similar manner inductor 14 is supported by insulating rods 68, which in turn, are attached by projections 69 to switch tube 58. It is desirable that case 8 also be formed of a low loss radio frequency dielectric because of its proximity to the inductors. Further details of this construction are revealed in Fig. 8.

We now turn to the detailed construction of movable contact piece 70. This is formed of a suitable radio frequency insulating material and of a size to slide snugly and smoothly within the insulated switch tube 58. We have found that the stationary contacts 17, 18, etc. keep piece 70 circumferentially aligned. Movable contacts 15 and 16 are joined by a low radio frequency resistance strap of spring bronze 71. This is mechanically biased before assembly of the switch to press the movable contacts outwardly against the stationary ones. A similar strap 72 is provided between movable contacts 20 and 21. Single movable contact 12 is connected by a strap 73 to ring 74. This ring also fastens a flexible bellows 75, of metal or of plastic with an electroplated conductor, to the contact piece 70. The other (lower) end of this bellows is similarly attached to metal fitting 54. In this way movable contact 12 is electrically connected to lower radiator 7.

Movable contact piece 70 is provided with a stud 76 which extends into the central hole 77 and engages stud 78 on rod 51 when the piece is to be moved upward and with the end of the milled-flat portion 79 when the piece is to be moved downward. These distances are fixed in manufacture so that a few inches before the end of the downward travel of the extensible section 10 portion 79 thereof engages stud 76 and moves the switch to its lower position, as shown in Figs. 2 and 7. In the position shown in Fig. 7 spring 40 of Fig. 6 has been fully compressed as

shown in Fig. 6 and then motor 3 has been reversed to move rod 51 upward for resonance of the antenna system to a low frequency relatively near the low frequency limit of the system by the section 10 being extended about two-thirds of the full amount possible. Any desired resonant frequency in the lowest band may be obtained by suitably energizing motor 3 either forward or backward.

Assume that the operator desires to operate the antenna at a frequency in the next higher band. He would energize the motor to move the section 10 to full extension and just prior to obtaining this position stud 78 would engage stud 76 and carry piece 70 upward. As soon as the second set of contacts were in position the operator would deenergize the motor. This condition he can determine remotely by checking the antenna or feeder current or equivalent indicating meters on his transmitter, noting a sudden rise from a small value, or by observing the radiated fieldstrength with the very simplest type of fieldstrength meter. In reception, the absence of signals between contacts and the presence thereof at contacts is a very good indicator of band changing. It is to be noted that the several stationary and movable contacts are relatively large and that considerable tolerance exists in the mechanical placement of the movable switch piece for contacting a desired band electrically. Should the operator desire to go to still higher bands he merely allows the motor to continue to operate until the desired band is reached. The mechanical arrangement associated with spring 45 of Fig. 6 prevents upward motion of contact 12 beyond contact 24 of Fig. 2 and the same associated with spring 40 prevents downward motion of contact 12 beyond contact 13.

Band changes and extension of section 10 are accomplished in a very few seconds with the structure described.

Completing the structure within case 8 with the aid of Fig. 8, coil 11 is connected to stationary contact 18 by a curved end of coil 80, coil 14 to contact 17 by end 81 and so on. These connections are soldered to the studs or rivets holding the contacts or may be held under nuts. Bellows 82 of Fig. 7 is formed of some non-metallic material such as one of the flexible plastics. It is mounted under ring 83 at the movable contact piece and under ring 84 at upper fitting 64. It is employed to maintain the inside of case 8 water-tight. Non-metallic material is specified for the upper bellows to avoid losses in high frequency inductor 19 when the bellows is extended as shown. When the lower bellows 75 is extended the lower inductor 11 is not in circuit, as will be noted by Figs. 4 and 5.

In order to complete the water-proofing flexible support 6 of Fig. 1 is covered with a flexible and perhaps transparent plastic or rubber boot 85. Stationary section 9 of the upper radiator is also provided with a gland or stuffing box 86 so that water or any fluid will not seep through the joint between it and the extensible section 10.

It is to be noted in Fig. 7 that inductors 11, 14 and 19 are nested one within the other. Since these are connected in a series-aiding configuration the effect of mutual inductance considerably raises the overall inductance. That is, the inductance for the circuit of Fig. 2 is considerably greater than were the same inductors similarly connected but out of mutual inductive relation with each other. This condition also obtains to a lesser degree when inductors 14 and 19 are in use, as in Fig. 3. It is absent, of course, for Figs. 4 and 5. In addition to the electrical advantage, most pronounced on the low frequency band, an important saving of space is accomplished.

It is desirable that the path of the coil leads, such as 80 and 81, be arranged with adequate space between the same and the coils. This is to prevent voltage flashover with high power, or with reactive off-tune conditions occasioned if the antenna is adjusted under certain conditions under full power from the transmitter. When necessary, the space between case 8 and insulated tube 58 may be filled with an inert gas under pressure or may be evacuated for greater voltage rating.

In construction, flexible support 6 is mounted by an insulated bushing 87 to cylindrical housing 2 of Fig. 1, so that the antenna is insulated from the support to which it is attached and the motor 3 and its circuit is not at radio frequency potential. The outer conductor of coaxial cable connector 4 is connected to housing 2 and so to ground, but the inner conductor is connected through finger connector 88 to flexible support 6 and lower radiator 7.

Our antenna may be constructed in a number of alternate embodiments without departing from the teaching of this invention.

More or fewer inductors and capacitors may be employed by providing additional or fewer stationary and movable contacts, as taught by Figs. 2 through 5. A pair of contacts may be provided for which neither inductors nor capacitors are connected in the center of the antenna. The inductors may have more or fewer turns and a different joint spacing, with the same connected in parallel, or series-parallel, and with mutual inductance opposing as well as aiding. Capacitors may be similarly connected in parallel as well as in series, and may be connected as composite impedances with the inductors.

The coils may be wound upon solid insulation of good radio frequency quality, such as Teflons or rexolites 1422. For economy in manufacture for civilian use the water-proofing elements may be eliminated.

A characteristic embodiment of this antenna resonates in selected bands from a frequency of less than 4 megacycles to one of 30 megacycles, the overall height being ten feet. The antenna may be constructed in almost any size, however, by proportion from the electrical and mechanical structures given, from the broadcast band to microwaves. By reducing the difference in the inductance of the inductors a contiguous band of frequencies may be covered, with a reduction of the spread between the extreme frequencies given. By utilizing more inductors and both aiding and opposing mutual inductance a frequency band even larger than that mentioned may be covered.

The advantage in switching the inductors rather than utilizing a slider or coil turn clip selector in a coil is seen in the fact that the unused coils float electrically free rather than remaining as either shorted or electrically connected turns.

It is to be noted that our threaded-rod-slotted-tube structure allows relatively great extensibility of the extensible section 10 of the upper radiator. Devices of the prior art have been of such construction that extensibility is limited.

Certain embodiments of our antenna have included a visual band-in-use indicator. This is comprised of a small rod attached to the movable piece 70 and extending downward through a hole in fitting 54 to give an external showing of the position of the movable contacts. An alternate arrangement is to construct all of the elements (save the inductors) surrounding piece 70 of transparent material.

Having thus fully described our invention and the manner in which it is to be practiced, we claim:

1. An adjustable antenna comprising a lower radiator, an upper radiator having only one extensible section, plural separate unlike reactive electrical elements, means to selectively connect said elements between said radiators, and a mechanism disposed in relation to said lower radiator and insulatingly connected to said extensible section to extend said section and also connected to said means to connect; the recited parts related to move said extensible section a large fraction of the length of said upper radiator near an extreme in one direction, then to also actuate said means to connect and finally to limit travel in that direction notwithstanding continued operation of said mechanism; said means to connect acting to selectively change the resonant frequency of said antenna by large increments above and below that corresponding

to the length thereof and the extension of said upper radiator to change the resonant frequency of said antenna by small increments.

2. An adjustable antenna comprising a lower radiator, an upper radiator having an extensible section, plural separate reactive electrical elements adapted to alter the electrical length of said antenna both longer and shorter than the physical length thereof, means to selectively connect said elements between said radiators, and an electromechanical mechanism within and below said lower radiator insulatingly connected to said extensible section of said upper radiator to extend said section, said mechanism also insulatingly connected to said means to connect; the recited parts related to move said extensible section near an extreme in one direction, then to move said extensible section and actuate said means to connect and finally to limit the travel in that direction notwithstanding continued operation of said mechanism; actuation of said means to connect acting to selectively connect said reactive elements to said radiator to change the frequency band of resonance of said antenna and the extension of said upper radiator to resonate said antenna to a frequency within a band.

3. An adjustable antenna comprising a lower radiator, one upper radiator having an extensible section, plural separate reactive electrical loading elements, means to electrically connect said elements between said radiators, threaded members having compliant means to limit relative travel disposed within said lower radiator, means to rotate one threaded member, and insulated means connecting another threaded member to said extensible section through said upper radiator, said means to connect related to said insulated means for actuation thereby; the recited parts proportioned to move said extensible section a substantial fraction of the length of said upper radiator to near an extreme of travel in one direction, then to move said extensible section and actuate said means to connect, and finally to limit travel in that direction notwithstanding continued operation of said means to rotate in that direction; actuation of said means to connect acting to selectively connect said reactive elements to said radiators to change the frequency band of resonance of said antenna and the extension of said upper radiator to resonate said antenna to a frequency within a band.

4. An adjustable antenna comprising a lower radiator, an upper radiator having an extensible section, plural separate inductively and capacitatively reactive electrical elements, switching means to selectively connect said elements between said radiators, only two threaded members within said lower radiator, means to rotate one said threaded member connected thereto, compliant means at each end of said one threaded member, the recited mechanical structure adapted to limit excursions of travel of the second threaded member with respect to said lower radiator notwithstanding continued operation of said means to rotate in one direction and to initiate the return excursion upon operation of said means to rotate in the opposite direction, and insulated means connecting said second threaded member to said extensible section through said upper radiator, said means to connect related to said insulated means to be actuated thereby, the parts proportioned to move said extensible section to near an extreme of travel in one direction, then to move said extensible section and to actuate said switching means, and finally to limit travel in that direction regardless of continued operation of said means to rotate in that direction, actuation of said switching means acting to selectively connect different said reactive components to said radiators to change the frequency band of resonance of said antenna and the extension of said upper radiator to resonate said antenna to a frequency within a band.

5. An adjustable antenna comprising a lower radiator, plural separate unlike electrical reactive components surmounting said lower radiator, an upper radiator having an extensible section, linearly operable switching means to selectively electrically connect said components between said radiators; a member having an internally threaded portion disposed within said lower radiator, a long threaded member within said member, compliant means at each end of said threaded member bearable against said member at the extremes of travel of said threaded member, means to rotate said threaded member connected thereto, the recited mechanical structure adapted to limit excursions of travel notwithstanding continued operation of said means to rotate in one direction and to initiate the return excursion upon operation of said means to rotate in the opposite direction; and insulated means within said upper radiator fastened to said member and to said extensible section to extend the latter a large fraction of the length of said upper radiator according to movement of said member, said switching means actuated by said insulated means, the parts related to move said extensible section to near an extreme of travel in one direction, then to move said extensible section and actuate said switching means, and finally to limit the travel in that direction regardless of continued operation of said means to rotate in that direction; the selective connection of said reactive components adapted to change the frequency band of resonance of said antenna and the extension of said upper radiator to resonate said antenna to a particular frequency within a band.

6. A remotely adjustable antenna comprising a lower radiator, plural electrical reactive components surmounting said lower radiator, a plural-position switch associated with said components, said components connected to contacts upon said switch, a slotted tube having an internally threaded portion disposed within said lower radiator, a threaded member within said slotted tube, compliant means at each end of said threaded member bearable against said slotted tube at the extremes of travel of said member with respect to said tube, means to rotate said member connected thereto, the recited mechanical structure adapted to limit excursions of travel notwithstanding continued operation of said means to rotate in one direction and to initiate the return excursion upon operation of said means to rotate in the opposite direction; an upper radiator having an extensible section surmounting said components, insulating means fastened to said slotted tube and to said extensible section to extend and retract the same according to movement of said slotted tube, and a movable contact piece for said switch actuated by said insulating means, the parts related to move said extensible section to near an extreme of travel in one direction, then to move said extensible section and said contact piece in the same direction and finally to limit the travel in that direction regardless of continued operation of said means to rotate in that direction; the contacts of said switch and of said movable contact piece disposed to connect components to the radiators to give a different reactance at each contact position of said piece, such connection adapted to change the resonant frequency of the antenna system from one frequency band to another and the extension of said upper radiator to bring the resonant frequency of said system to a selected frequency in a band.

7. A remotely adjustable antenna comprising a lower radiator, plural electrical reactive components surmounting said lower radiator, a plural-position linear-throw switch associated with said components, said components connected to contacts upon said switch, a slotted tube having an internally threaded portion disposed within said lower radiator, a threaded rod within said slotted tube, a spring at each end of said threaded rod bearable against said slotted tube at the extremes of travel of said rod with respect to said tube, reversible means to rotate said threaded rod connected thereto, the recited mechanical structure adapted to limit the excursions of travel notwithstanding continued operation of said means to

rotate in one direction and to initiate the return excursion upon operation of said means to rotate in the opposite direction; an upper radiatior surmounting said components, said upper radiator having an extensible section, an insulated rod fastened to said slotted tube and to said extensible section to extend and retract the same according to axial movement of said slotted tube, and a movable contact piece for said switch actuated by said insulated rod, the parts related to move said extensible section to near an extreme position in one direction, then to move both said extensible section and said contact piece in the same direction and finally to limit the motion in that direction regardless of continued operation of said means to rotate in that direction and also related to accomplish the same sequence of events in the opposite direction; the contacts of said switch and of said movable contact piece disposed to connect components to the radiators to give a different reactance at each contact position of said piece, such switch action adapted to change the resonant frequency of the antenna system from one frequency band to another and the extension of said upper radiator to bring the resonant frequency of said system to a selected frequency in a band.

8. A remotely adjustable antenna comprising a reversible electric motor having a flexible extensible external shaft, a lower radiator surmounting said shaft, plural electrical reactive components surmounting said lower radiator, a plural-position linear-throw switch associated with said components and structurally attached to said lower radiator, said components electrically connected to stationary contacts upon said switch, a slotted tube having an internally threaded portion disposed within said lower radiator, a threaded rod within said slotted tube, a spring at each end of said threaded rod attached thereto and bearable against said slotted tube at the extremes of travel of said threaded rod with respect to said tube, said threaded rod connected to said shaft for rotation by said motor, the recited mechanical structure adapted to limit the excursions of travel notwithstanding continued operation of said motor in one direction and to initiate the return excursion upon operation of said motor in the opposite direction; an upper radiator surmounting said components, said upper radiator having fixed and extensible sections, an insulated rod fastened to said slotted tube and to the extensible section to extend and retract the same with respect to the fixed section according to the axial movement of said slotted tube, and a movable contact piece for said switch adjacent said insulated rod, stops upon said insulated rod to engage said contact piece near the ends of travel of said insulated rod, the parts proportioned to move the extensible section to near an extreme position in one direction, then to move both said extensible section and said contact piece in the same direction and finally to limit the motion in one direction regardless of continued operation of the motor in that direction, and also proportioned to accomplish the same sequence of events in the opposite direction; said reactive components, said switch contacts and said movable contact piece disposed to connect plural components of one reactive characteristic to the upper and lower radiators in one extreme position of the contact piece, to disconnect a component in succeeding positions, thereafter to connect plural components of an opposite reactive characteristic, and to disconnect a latter said component in succeeding positions, said connection changes adapted to change the resonant frequency of the antenna system from one band to another and the extensions of the upper radiator to bring the resonant frequency thereof to a selected frequency within a band.

9. The antenna of claim 8 in which the plural reactive components of one reactive characteristic are inductive and said components of opposite reactive characteristic are capacitative.

10. A remotely adjustable antenna comprising a reversible electric motor, a flexible support surmounting the same, a flexible extensible shaft attached to said motor to accommodate flexure of said support, a lower tubular radiator surmounting said support, plural coaxially related inductors and plural capacitors surmounting said lower radiator, a plural-position linear-throw switch positioned within said inductors and structurally attached to said lower radiator, said inductors and capacitors connected to stationary contacts upon said switch, a slotted tube having an internally threaded portion positioned within said lower radiator, a threaded rod within said slotted tube, a compression spring at each end of said threaded rod fastened thereto and bearable against said slotted tube at the extremes of travel of said threaded rod with respect to said tube, said threaded rod connected to said shaft for rotation by said motor; the recited mechanical structure adapted to limit the excursions of travel notwithstanding continued operation of said motor in one direction and to initiate the return excursion upon operation of said motor in the opposite direction; an upper radiator surmounting said inductors, said upper radiator having fixed and extensible sections, an insulated rod fastened to said slotted tube and to the extensible section to extend and retract the same with respect to the fixed section according to the axial movement of said slotted tube, a movable contact piece for said switch adjacent to said insulated rod, and stops upon said insulated rod to engage said contact piece near the ends of travel of said insulated rod, the parts proportioned to move the extensible section to near an extreme position in one direction, then to move both said extensible section and said contact piece in the same direction and finally to limit the motion in one direction regardless of continued operation of the motor in that direction, and also proportioned to accomplish the same sequence of events in the opposite direction; said inductors and capacitors, said stationary switch contacts and said movable contact piece disposed to connect all inductors to the lower and upper radiators in one extreme position of the contact piece, to disconnect one inductor from this circuit in each next position of the contact piece to the plurality of inductors, thereafter to connect all said capacitors to the lower and upper radiators and to disconnect one capacitor from this circuit in each next position of the contact piece to the plurality of capacitors, said connection changes adapted to change the resonant frequency of the antenna system from one band to another and the extension of the upper radiator to bring the resonant frequency thereof to a selected frequency within a band.

11. The antenna of claim 10 in which bellows are attached to said movable contact piece and to said switch adjacent said lower and upper radiators to maintain parts of said switch out of contact with fluids.

12. The antenna of claim 10 in which bellows are attached to said movable contact piece and to said switch adjacent said lower and said upper radiators and means attached to the fixed section of said upper radiator surrounding said extensible section to maintain internal parts of said antenna out of contact with ambient fluids.

13. The antenna of claim 10 in which metallic bellows are attached to said movable contact piece and to said switch adjacent to said lower radiator and insulating bellows attached to said piece and to said switch adjacent said upper radiator, and a gland attached to said upper radiator at said fixed section surrounding said extensible section to protect internal parts of said antenna from ambient liquid.

14. A remotely adjustable antenna comprising a lower housing, a reversible electric motor within said housing, a flexible antenna support surmounting said housing, a flexible extensible shaft attached to said motor to accommodate flexure of said antenna support, a lower tubular radiator surmounting said support, plural coaxially nested inductors and a capacitor surmounting said

lower radiator, a plural-position linear-throw switch coaxially positioned within said inductors and structurally attached to said lower radiator, said inductors and capacitor connected to stationary contacts upon said switch, a slotted tube having an internally threaded portion positioned within said lower radiator, a threaded rod having smooth cylindrical ends within said slotted tube, a compression spring at each end of said threaded rod fastened thereto and bearable against said slotted tube at the extremes of travel of said threaded rod with respect to said tube, said threaded rod connected to said shaft for rotation by said motor; the recited mechanical structure adapted to limit excursions of travel of said slotted tube notwithstanding continued operation of said motor in one direction and to initiate the return excursion upon operation of said motor in the opposite direction; an upper radiator surmounting said inductors and structurally attached to said switch, said upper radiator having fixed and extensible sections, an insulated rod fastened to said slotted tube and to the extensible section to extend and retract the same with respect to the fixed section according to the axial movement of said slotted tube, a movable contact piece for said switch adjacent said insulated rod, and stops upon said insulated rod to engage said contact piece near the ends of travel of said insulated rod, the parts related to move the extensible section to near an extreme position in one direction, then to move both said extensible section and said contact piece in the same direction and finally to limit the motion in one direction regardless of continued operation of the motor in that direction, and also related to accomplish the same sequence of events in the opposite direction; said inductors and capacitor, said stationary switch contacts and said movable contact piece disposed to connect all inductors in series and to the lower and upper radiators in one extreme position of the contact piece, to disconnect one inductor from this circuit in each next position of the contact piece, and to connect said capacitor in series with the lower and upper radiators in the other extreme position, said connection changes adapted to change the resonant frequency of the antenna system from one band to another and the extension of the upper radiator to bring the resonant frequency thereof to a selected frequency within a band.

15. A remotely adjustable mobile antenna comprising a lower cylindrical housing, a reversible electric motor within said housing, a flexible antenna support surmounting said housing, a flexible extensible shaft attached to said motor to accommodate flexure of said antenna support, a lower tubular radiator surmounting said support, three coaxially nested inductors and one capacitor surmounting said lower radiator, a four-position linear-throw switch coaxially positioned within said inductors and structurally attached to said lower radiator, said inductors and capacitor connected to stationary contacts upon said switch, a slotted tube having an internally threaded portion positioned within said lower radiator, a threaded rod having smooth cylindrical ends within said slotted tube, a compression spring at each end of said threaded rod fastened thereto and bearable against said slotted tube at the extremes of travel of said threaded rod with respect to said tube, said threaded rod connected to said flexible extensible shaft for rotation by said motor; the recited mechanical structure adapted to limit the excursions of travel notwithstanding continued operation of said motor in one direction and to initiate the return excursion upon operation of said motor in the opposite direction; an upper radiator surmounting said inductors and structurally attached to said switch, said upper radiator having fixed and extensible sections, an insulated rod fastened to said slotted tube and the extensible section to extend and retract the same with respect to the fixed section according to the axial movement of said slotted tube, a movable contact piece for said switch surrounding said insulated rod, and stops upon said insulated rod to engage said contact piece near the ends of travel of said insulated rod, the parts proportioned and related to move the extensible section to near an extreme position in one direction, then to move both said extensible section and said contact piece in the same direction and finally to limit the motion in one direction regardless of continued operation of the motor in that direction, and also related to accomplish the same sequence of events in the opposite direction; said inductors and capacitor, said stationary switch contacts and said movable contact piece disposed to connect said three inductors in series and to the lower and upper radiators in one extreme position of the contact piece, to disconnect one inductor from this circuit in the next position of the contact piece with respect to the stationary contacts, to disconnect two inductors from the circuit in the next further position, and to disconnect three inductors from the circuit and to connect said capacitor only in series with the lower and upper radiators in the other extreme position; said connection changes adapted to change the resonant frequency of the antenna system from one frequency band to another and the variation of the extension of the upper radiator to bring the resonant frequency thereof exactly to a selected frequency within a band.

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