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(54) **A three-band antenna for vehicles.**

(57) A three-band automobile antenna assembly including an antenna mast (10) made up of two slidably and coaxially connected antenna tubes (11, 12), one of which negates a reversed-phase current for the telephone, and an antenna accommodation tube (13) which houses the antenna mast (10) therein in such a manner that the antenna mast (10) is freely retracted into and withdrawn from the tube. The antenna assembly further includes a separator (81, 82) which is connected to a feeding section of the antenna accommodation tube (13) to separate three bands consisting of telephone, FM and AM waves, and a mount (14) made primarily of plastic to mount the antenna accommodation tube (13) to the vehicle body (15). The electrical length between outer conductor of the feeding cable (21) and vehicle body (15) is set to be 0 to X/2 so that the impedance of ground circuit is substantially zero.

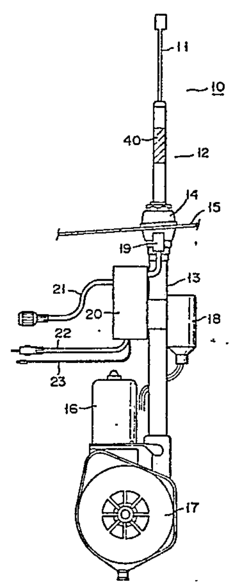

FIG. 1

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Description

A three-band antenna for vehicles

The present invention relates to an antenna for use with automobiles, and more particularly to a three-band automobile antenna used for three different types of bands, i.e. telephone, FM and AM bands.

Fig. 7 illustrates a conventional three-band antenna used for telephone, FM and AM bands. A dipole antenna 1 housed in an insulating tube 2 is used for the telephone band, and it has a length of $\lambda/2$. This telephone dipole antenna 1 is supported by a supporting column 4 so that it is positioned at a predetermined height above a fender 3 of an automobile. The supporting column 4 is a tubular body made of conductive material and is used as an AM/FM antenna. The length of this supporting column 4 is determined by the supporting height of the telephone dipole antenna 1 and is ordinarily about 25 cm. However, the supporting column 4 tends to be insufficient sensitivity for AM/FM bands. In order to solve this problem, a booster 5 is used in combination with the supporting column 4.

In the above described conventional antenna, the telephone dipole antenna 1 is fed accomplished via a coaxial cable 6 which passes through the inside of the supporting column 4. The coaxial (feeding) cable 6 is taken up on and fed out from the drum 9 via a motor 8 so that the cable 6 is moved along with a rope 7 which is for extension and retraction of the antenna 1.

In the conventional telephone/FM/AM antennas described above, however, the coaxial cable 6 must be able to withstand various environmental requirements. In other words, the cable 6 must have appropriate cold resistance, heat resistance, chemical resistance, etc. Furthermore, in terms of electrical characteristics, the cable 6 must have low dielectric constant, and in terms of mechanical characteristics, it must have good bucking resistance so that it does not show any signs of "snaking." In order to satisfy these requirements, a "Teflon" material is usually used as an insulator which covers the coaxial cable 6. However, such materials are extremely expensive.

Furthermore, conventional antennas require a device to take up the coaxial cable 6. Such a device is usually extremely complex and large, resulting in that such antennas cannot be mass produced.

In addition, since the coaxial cable 6 must be taken up, the length of the coaxial cable 6 must be longer than the actually required feeding length. As a result, high-frequency loss occurring when the telephone dipole antenna is used in the ultrashort wave region becomes too great to ignore.

Furthermore, since the telephone dipole antenna 1 must maintain broad-band characteristics, the diameter of the antenna 1 cannot be very small, and there also are various restrictions on attachment of the antenna. As a result, the number of telescoping stages used in the telephone dipole antenna is limited to about two. Due to these restrictions, the length of the so-called "neck-down," which is the antenna length housed in the vehicle body, tends to increase. Thus, mounting of the antenna in certain types of vehicles is very difficult, and it is more difficult to meet the demands of users.

Lastly, since the conventional antenna has a special structure, it cannot be serviced by ordinary repair techniques.

Accordingly, it is a primary object of the present invention to provide a three-band antenna for use in vehicles which does not have a feeding cable for the telephone antenna inside the antenna assembly.

It is another object of the present invention to provide an antenna which has only a small amount of high-frequency loss, is compact and simple in structure and is light weight.

It is still another object of the present invention to provide an antenna which has a short "neck-down" dimension and is therefore superior in terms of usability in various vehicles, meets the requirements necessary for mass production and can be manufactured at low cost.

The above objects of the present invention are accomplished by a unique structure for an automobile antenna assembly which includes an antenna mast formed by connecting a first antenna element, which has a phase coil section for negating reversed-phase current used for the telephone, to a second antenna element so that these two antenna elements are free to slide to each other. The antenna mast is housed in an antenna accommodation tube such that the antenna mast can be freely inserted into and withdrawn from the tube, and a separator is connected to a feeding point of the antenna accommodation tube so that it separates the three bands, that is, telephone, FM and AM bands. In addition, an antenna mounting assembly made primarily of plastic is used to mount the antenna accommodation tube to the vehicle body, and a means for causing the impedance of the ground path between the grounding part of the feeding point and the vehicle body to be close to zero is incorporated into the antenna assembly.

With the above structure, since there is no need to install a feeding cable for the telephone antenna inside the antenna body, an expensive coaxial cable is no longer necessary. Therefore, the antenna can be manufactured at low cost. Also, the structure of the mechanical section of the antenna can be simple, compact and light, so that the antenna meets mass production requirement, and reliability of the antenna in terms of product quality is improved. In addition, since there is no need for the feeding cable to be long, high-frequency loss is very small. Furthermore, the "neck-down" dimension is very small, and the antenna can be installed in any type of vehicle. Therefore, the antenna of the present invention is superior in terms of general applicability and can be serviced using ordinary repair techniques.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a side view of the three-band antenna assembly according to the present invention;

Fig. 2 is a cross sectional view of the antenna mast;

Figs. 3(a) and 3(b) are perspective views of a phase coil used in the antenna assembly of the present invention;

Fig. 4 is a cross sectional view of a mount for the antenna assembly;

Fig. 5(a), 5(b) and 5(c) show the disassembled mount;

Fig. 6 is a diagram which illustrates the electrical circuit for the antenna assembly; and

Fig. 7 is an illustration of a conventional three-band antenna.

In Fig. 1, reference numeral 10 is a two-stage telescoping type antenna mast consisting of two antenna elements 11 and 12. The antenna mast 10 is housed in an antenna accommodation tube 13 which is located in the vehicle body.

The first antenna element 11 is inserted into the second antenna element 12 so that the first element 11 can freely slide in the second antenna element 12. The second antenna element 12 is inserted into the antenna accommodation tube 13 so as to freely slide therein.

The upper-end portion of the antenna accommodation tube 13, that is, mount 14, is fastened in an attachment hole formed in the vehicle body wall 15. An antenna drive section 17 which includes a rotary drum, rope feed gears, etc. (not shown) and is driven by a motor 16 is provided at the lower end of the accommodation tube 13. The mechanism in the antenna drive section 17 extends and retracts the antenna mast 10. In other words, the drive section 17 retracts the antenna mast 10 into the accommodation tube 13 and withdraws the antenna mast 10 from the accommodation tube 13 via an antenna drive rope (not shown in Fig. 1).

A relay box 18 is attached to the middle portion of the antenna accommodation tube 13 and contains therein a relay which is used for a forward and reverse rotation control of the motor 16. An antenna feeding section 19 which is connected to a control box 20 is provided near the upper end of the antenna accommodation tube 13, and a telephone coaxial cable 21, an AM/FM coaxial cable 22 and a +12 V power supply line 23, etc. are connected to the control box 20.

A phase coil section 40 which negates the reversed-phase current used for the telephone is provided at middle portion of the second antenna element 12.

Fig. 2 illustrates an enlarged cross section of the antenna mast 10.

The first antenna element 11 is formed as a conductive rod-shaped body, and a cap 11a is attached at its top end. A recess 11b of the cap 11 fits over the top area of the second antenna element 12 when the first antenna element 11 is inserted inside the second antenna element 12.

One end of an antenna drive rope 25 is connected to the base end of the first antenna element 11 via a joint 24. The antenna drive rope 25 has a rack 25a along the length on its circumferential surface. Thus, the antenna drive rope or rack-equipped rope 25 travels in the second antenna element 12 by means of a feed gear (not shown) provided in the antenna drive section 17.

The second antenna element 12 consists of three different sections: a conductive section 30 which ensures electrical continuity with the first antenna element 11, a phase coil section 40 which is used to negate reversed-phase current used for telephone, and a telephone antenna section 50.

The conductive section 30 is a coaxial tube which includes conductive tubular parts 31, 32, 33 and 34 made of metal, etc. A conductive spring 35 is mounted on the base end of the first antenna element 11, and when the spring 35 is pressed against the inner circumferential surface of the inner tube part 33, it causes electrical continuity between the first and second antenna elements 11 and 12. Reference numeral 36 is a collar which serves as both a seal and a stopper.

The phase coil section 40 of the second antenna element 12 is constructed by coaxially installing two insulating tubular members 41 (outside) and 42 (inside). Both are made of an insulating material such as plastic, etc. A phase coil 43 made of metal is interposed between the insulating tubular members 41 and 42.

Figs. 3(a) and 3(b) illustrate the phase coil 43. The phase coil 43 is a so-called "bifilar" coil which is formed by wrapping a V-shaped conductive wire strip 43a around the external circumferential surface of the inner insulating tubular member 42 as indicated by 43b (in other words, the numeral 43b indicates the wrapped state of the strip 43a). The object of the present invention cap also be achieved using a helical coil, but a bifilar coil is preferable from the standpoint of mass production. Connecting parts 43c and 43d, which are C-shaped, are attached at both ends of the phase coil 43. The connecting part 43c fits into the tubular conductive part 32 of the conductive section 30, and the other connecting part 43d fits into a tubular conductive part 44 so that necessary electrical connection is obtained.

Referring back to Fig. 2, the telephone antenna section 50 in the second antenna element 12 is constructed from a tubular pipe 51 and tubular parts 52 and 53, all made of conductive materials. A part of the insulating tubular member 42 in the phase coil section 40 extends coaxially into the central portion of the telephone antenna section 50. One end of the tubular conductive part 52 is internally threaded so that it engages with threads formed on one end of the tubular conductive part 44 of the phase coil section 40 so that the two parts 44 and 52 are connected electrically and mechanically.

The length of the first antenna element 11 is set so that the electrical length thereof is $\lambda/2$ to $5\lambda/8$. The length of the pipe 51 of the telephone antenna section 50 in the second antenna element 12 is set so that the electrical length of the pipe 51 is $\lambda/4$ to $3\lambda/8$. Accordingly, the total extended length of the antenna elements 11 and 12 is an electrical length of 1 to 1.5λ including the physical length of the phase coil 43.

The frequency of the telephone band is usually around 800 MHz, the frequency of the FM band is about 1/10 thereof, and the frequency of the AM band is about 1/1000 thereof. Accordingly, the effect of the phase coil 43 on the FM and AM bands can be ignored.

With the above described structure, the antenna mast 10 as a whole can receive telephone, AM and FM waves. In this regard, the structure of the antenna assembly of the present invention is greatly simplified compared to conventional antennas wherein the telephone and AM/FM waves are received separately. In addition, the antenna assembly of the present invention has a considerably short "neck-down" dimension and thus a simple structure can be obtained.

Fig. 4 illustrates a cross section of the mount 14 used to mount the antenna assembly on the vehicle body wall 15. Figs. 5(a), 5(b) and 5(c) show the mount 14 disassembled.

An insulation tube 60 provided at the top of the accommodation tube 13 is formed from reinforced plastic, etc. A ground side conductive pipe 61 is provided over the outer circumference of the lower portion of this insulating tube 60. A conductive cap 62 is situated on the upper end of the conductive pipe 61, and a cap-like lower fastening member 63 which also acts as a grounding conductor is fit over the insulating tube 60 above the conductive cap 62.

As shown in Fig. 5(b), the lower fastening member 63 has projections 63a on the upper surface of the rim which bite into the undersurface of the vehicle body wall 15. An insertion opening 63b for a feeding cable 64 and a drain hole 63c for allowing the drainage of rain water, etc. are formed in the rim of the lower fastening member 63.

As seen from Fig. 5(a), the feeding cable 64 is a coaxial cable, and the central core conductor 64a of this cable 64 is connected by soldering, etc. to a conductive pipe 65 which is inserted into the insulating tube 60 so as to be positioned around the internal circumference of the tube 60. The outer conductor 64b of the cable 64, which is a braided wire, is connected by soldering, etc. to the rim near the insertion opening 63b of the lower fastening member 63. The connected sections of the feeding cable 64 are molded in an insulating material 66, i.e. reinforced plastic, etc. so that the molding is integrated with the insulating tube 60.

An upper fastening member 67 formed from an insulating material such as reinforced plastic, etc. is inserted from above the vehicle body wall 15 into the attachment hole formed in the vehicle body wall 15. A ring-from pad 68 made of soft rubber, etc. is interposed between the upper fastening member 67 and the vehicle body wall 15. The insulating tube 60, which projects upward through the central hole of the upper fastening member 67, has external threads on the circumferential surface thereof. The upper surface of the upper fastening member 67 is pressed downward by a first nut 69 which engages with the external threads of the insulating tube 60. Thus, when the first nut 69 is tightened, the upper fastening member 67 is pressed against the vehicle body wall 15, and the lower fastening member 63 is correspondingly pressed against the under surface of the vehicle body wall 15 so that the projections 63a bite into the under surface. As a result, the antenna accommodation tube 13 as a whole is stationary to the vehicle body wall 15.

The antenna mast 10 is inserted into the antenna accommodation tube 13, which is fixed in place with respect to the vehicle body wall 15, through the opening at the upper end of the insulating tube 60. A conductive sleeve 70 (as illustrated in Figs. 5(a) and 5(c)) is fitted beforehand around the external circumference of the base portion of the antenna mast 10. This conductive sleeve 70 is formed from a conductive spring material such as phosphor bronze. Contacts parts 70a and 70b are cut out and caused to project from the middle section of the conductive sleeve 70, and a flange 70c is formed around the upper end of the conductive sleeve 70. Thus, when the antenna mast 10 with the sleeve 70 attached thereto is inserted and reaches a certain depth in the insulating tube 60, the flange 70c of the conductive sleeve 70 is caught by the upper edge of the insulating tube 60, and the conductive sleeve 70 is positioned in the conductive pipe 65. The flange 70c of the conductive sleeve 70 is pressed against the upper edge of the insulating tube 60 by a presser 71 which is made of soft rubber, etc. and acts as a waterproof packing.

A second nut 72 locks the presser 71 when the inner threads of the second nut 72 engage with the external threads of the first nut 69. Thus, the antenna mast 10 is housed in the antenna accommodation tube 13 so that it can be freely inserted into or withdrawn from the antenna accommodation tube 13. At the same time, the antenna mast 10 remains in a state of pressure contact by the contact part 70b of the conductive sleeve 70 fixed in the insulating tube 60.

Electrical connection of the antenna assembly is formed via a conductive path comprising the antenna mast 10, conductive sleeve 70, conductive pipe 65 and core conductor 64a of the feeding cable 64.

A flange 10a formed at the lower end of the antenna mast 10 abuts against the lower-end rim of the conductive sleeve 70 which is fixed in place as described above. Accordingly, the antenna mast 10 is prevented from slipping out of the antenna accommodation tube 13.

In the structure of conventional vehicle antenna attachment assemblies, there is a large stray capacity. As a result, leakage loss during transmission and reception in the telephone band tends to increase, which leads to mismatched impedance and the possibility of a drop in sensitivity. Furthermore, such prior art antennas become high-impedance antennas with respect to AM/FM waves, thus leading to the possibility of sensitivity drop in these bands also. To the contrary, almost all of the components of the mount 14 except for the grounding parts, etc. of the antenna assembly of the present invention are made of a resin insulating material such as reinforced plastic, etc. Accordingly, the stray capacity is reduced, and impedance mismatch and high impedance are avoided, with no sensitivity drop.

Furthermore, in the present invention the distance, i.e. the physical length L, between the outer conductor 64b of the power supply cable 64 and the vehicle body wall 15 is designed so as to become as close to 0 or λ/2 as possible when calculated in terms of electrical length. As a result, the impedance in the ground path is near zero, and the ground loss in the telephone band is extremely small.

Fig. 6 illustrates the electrical circuit of the antenna assembly of the present invention in which wave separators 81 and 82, known in prior art, consist of L elements (coils) and C elements (condensers), respectively, and are housed in the control box 20 along with a booster 83. A cable 21 is connected to the C element of the wave separator 81, and a cable 22 and a power supply line 23 are connected to the booster 83. A relay 90, which includes a coil 91 and switching contacts 92 and 93, is set in the relay box 18. The relay 90 is designed so that when the automobile ignition switch IGN-SW is switched ON, the relay 90 is acttated in an ON mode and causes forward rotation of the motor 16 so that the antenna mast 10 is extended. When the ignition switch IGN-SW is switched OFF, the relay 90 is actuated in an OFF mode and causes reverse rotation of the motor 16 so that the antenna mast 10 is retracted. At the respective time at which the extension and/or retraction of the antenna mast 10 is completed, limit switches LSI and LS2 are actuated so that the power to the motor 16 is cut off.

As described above, with the above described structure,

(1) The manufacturing cost of the antenna assembly is approximately half to one third that of conventional antennas.

(2) The weight of the antenna assembly is less than half that of the conventional antennas.

(3) The "neck-down" dimension is approximately 400 mm in the conventional antenna but is only about 300 mm in the antenna of the present invention, i.e., three quarters the size found in conventional antenna.

(4) The sensitivity of the antenna of the present invention is equivalent to or better than that of conventional antennas in the telephone/AM/FM bands.

(5) Follow-up maintenance can be performed using existing techniques, and there is no need to use any special techniques.

The present invention is not limited to the embodiments described above. It goes without saying that various modifications are possible within the spirit and scope of the present invention.

As described in detail above, the present invention provides a three-band automobile antenna in which there is no need to install a telephone antenna feeding cable through the interior of the antenna mast, and in which high-frequency loss is small. The antenna assembly has a simple and compact structure, is light in weight, has a short "neck-down" dimension and is therefore superior in general application terms. In addition, the antenna assembly is superior in terms of mass production characteristics and can be manufactured at low cost.

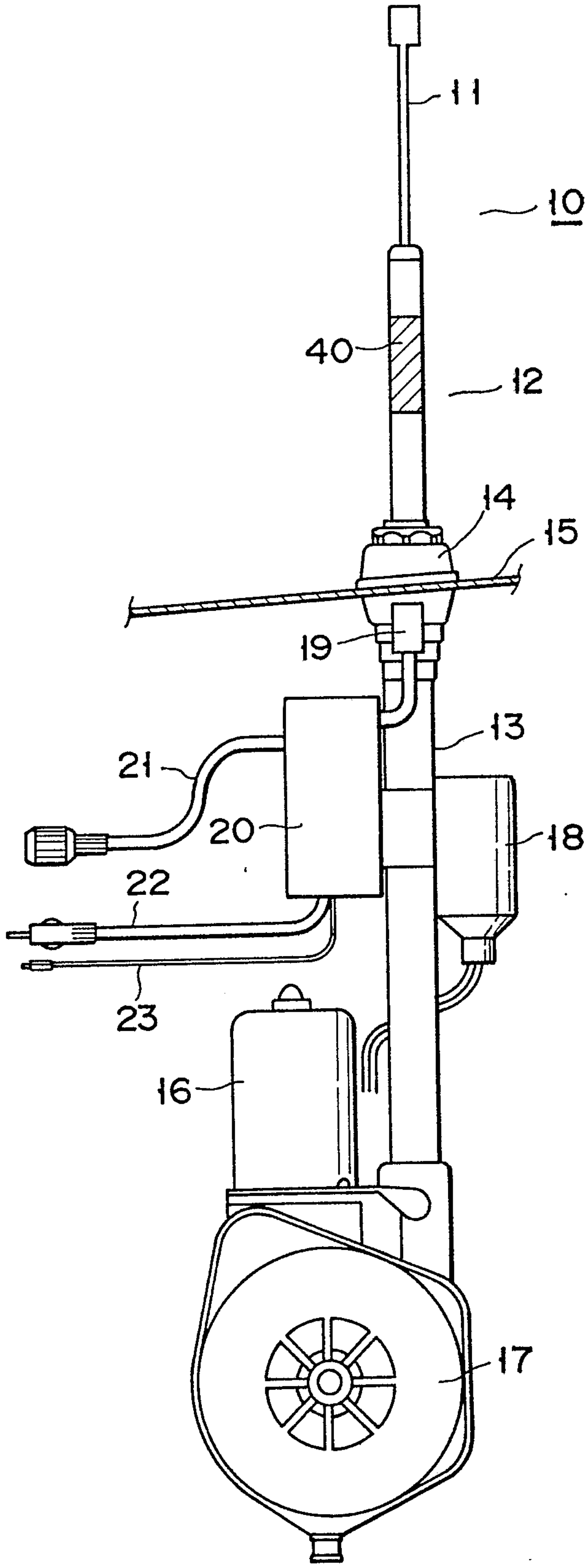
Claims

1. A three-band antenna assembly for use in vehicles characterized in that said antenna assembly comprises:
an antenna mast (10) formed by coaxially connecting two antenna elements (11, 12) so as to slide relative to each other, one of said antenna elements having a phase coil section (40) for negating reversed-phase current used for a telephone;
an antenna accommodation tube (13) which accommodates said antenna mast (10) so that said antenna mast can be freely inserted into and withdrawn from said antenna accommodation tube;
a separating means (81, 82) which separates three bands consisting of telephone, FM and AM bands, said separating means being connected to a feeding section (19) of said antenna accommodation tube (13);
a mount (14) for mounting said antenna accommodation tube (13) to the vehicle body wall (15), said mount being made primarily of resins; and
a means (60, 69) for rendering the impedance of a ground path which connects a ground part of said feeding section (19) and said vehicle body (15) to zero.

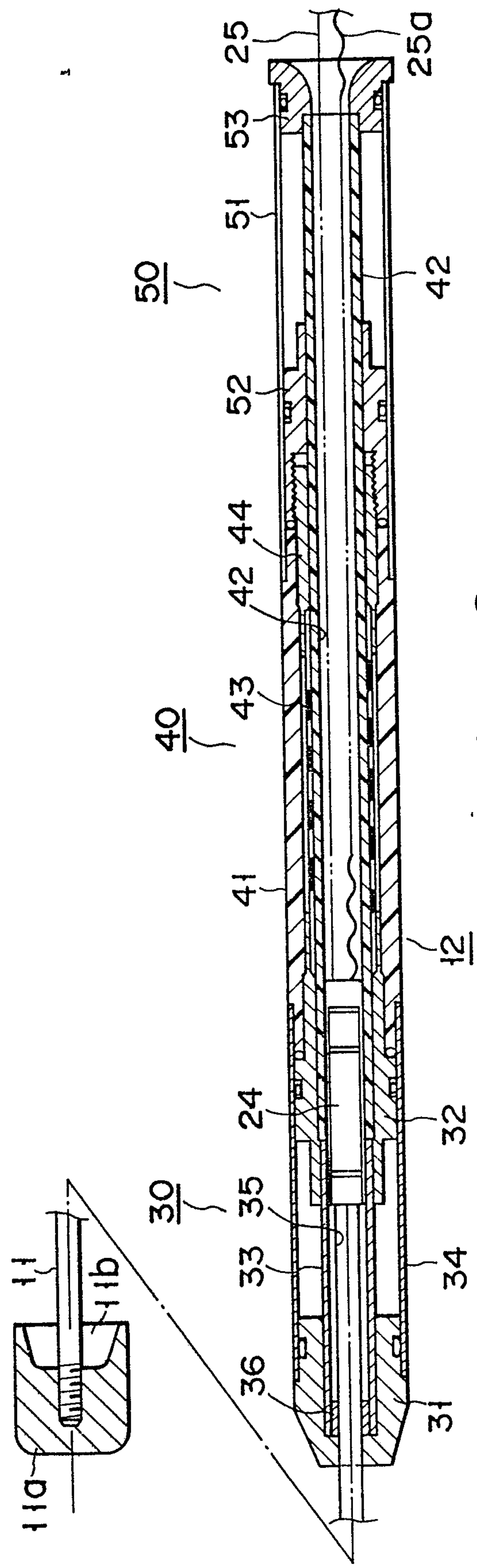
2. A three-band antenna assembly for use in vehicles characterized in that said antenna assembly comprises:
an antenna mast (10) comprising coaxially connected first and second antenna elements (11, 12), said first antenna element (11) being slidable inside said second antenna element (12) which has a phase coil section (40) for negating reversed-phase current used for a telephone;
an antenna accommodation tube (13) which accommodates said antenna mast (10) so that said antenna mast can be freely inserted into and withdrawn from said antenna accommodation tube;
a separating means (81, 82) which separates three bands consisting of telephone, FM and AM bands, said separating means being connected to a feeding section (19) of said antenna accommodation tube (13); and
a mount (14) for mounting said antenna accommodation tube to the vehicle body wall (15); characterized by
impedance of a ground path between a ground part of said feeding section (19) and said vehicle body wall (15) is approximately zero.

3. A three-band antenna assembly according to claim 2, characterized in that said mount (14) is made of resins.

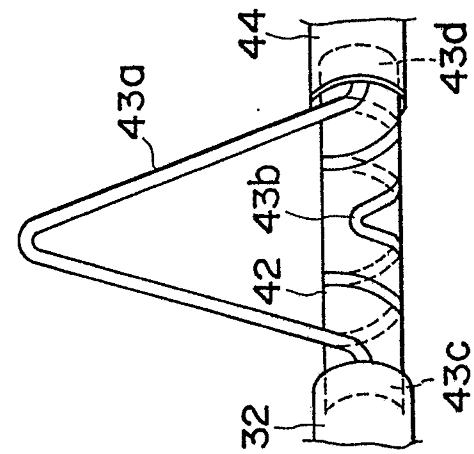
4. A three-band antenna assembly according to claim 2, characterized in that said separating means (81, 82) comprises L elements consisting of coils and C elements consisting of condensers.



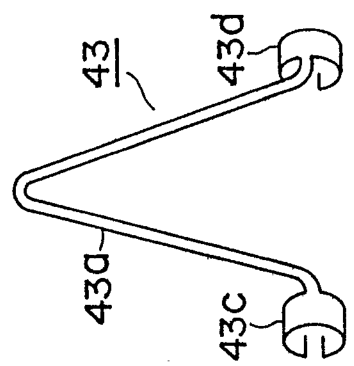
F I G. 1



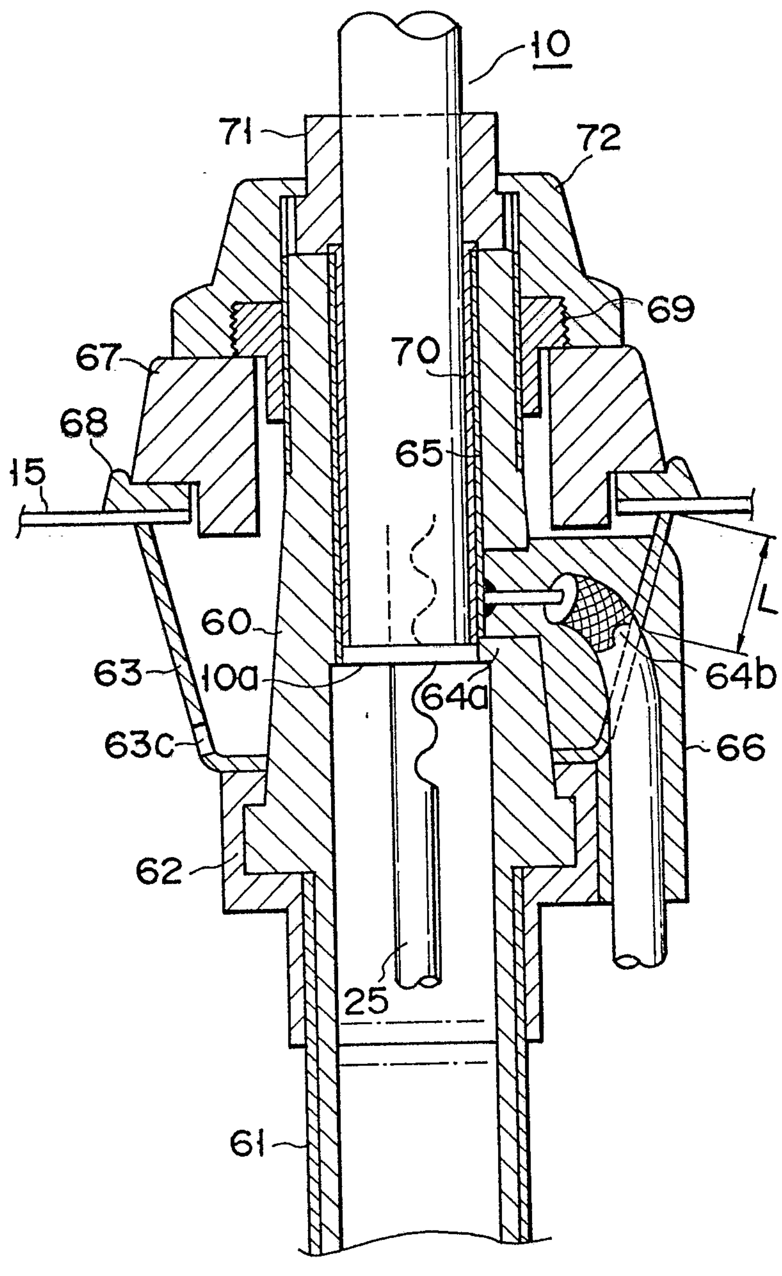
F I G. 2



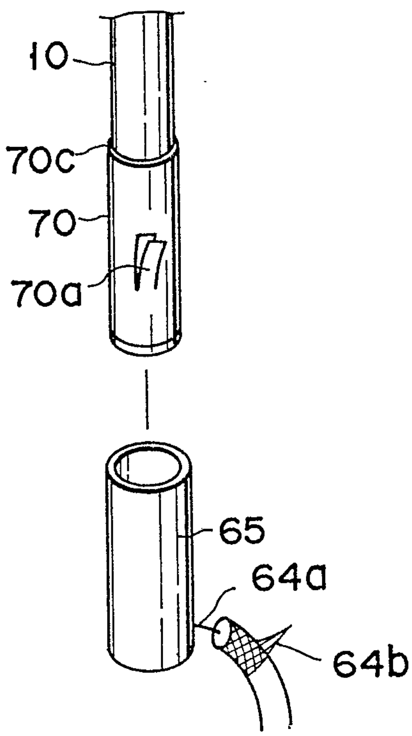
F I G. 3(a)



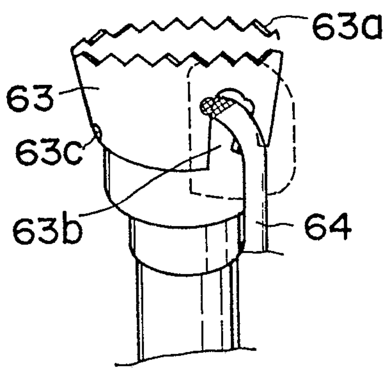
F I G. 3(b)



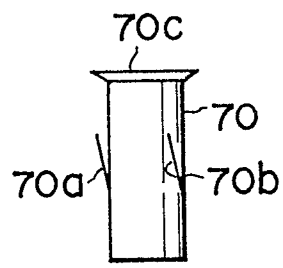
F I G. 4



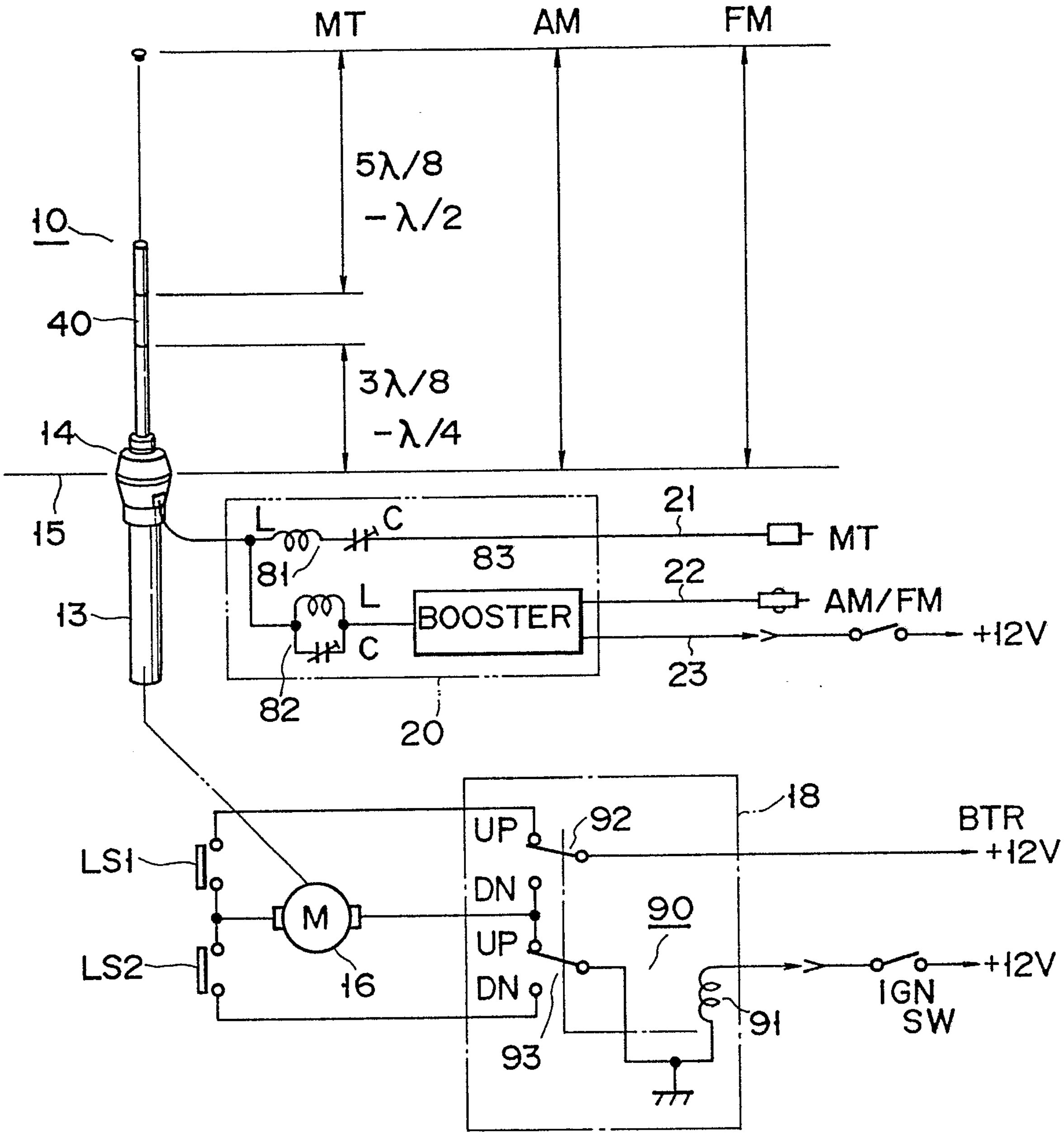
F I G. 5(a)



F I G. 5(b)



F I G. 5(c)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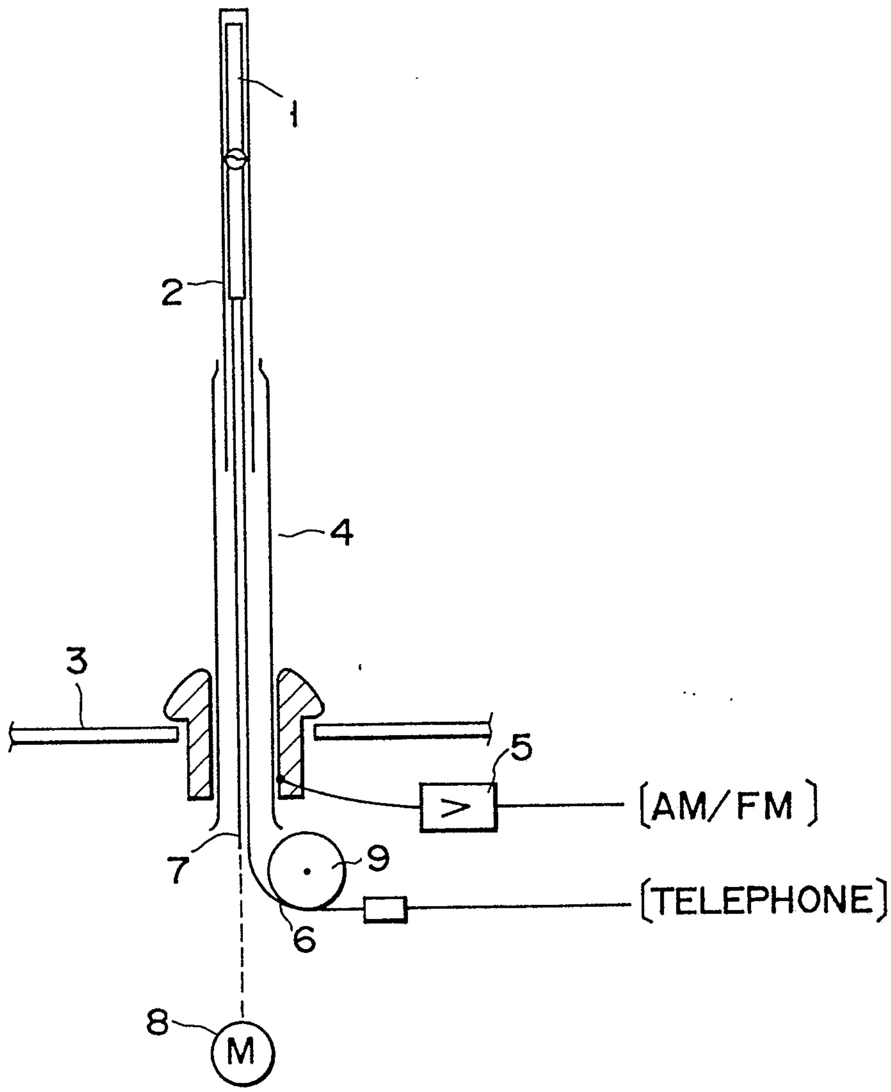
F I G. 6



F I G. 7