

[54] **EXTENDIBLE AND RETRACTABLE
ANTENNA**

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1973, abandoned.

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[51] Int. Cl. **H01q 1/32**

[58] Field of Search **343/713, 714, 717, 882**

[56] **References Cited**

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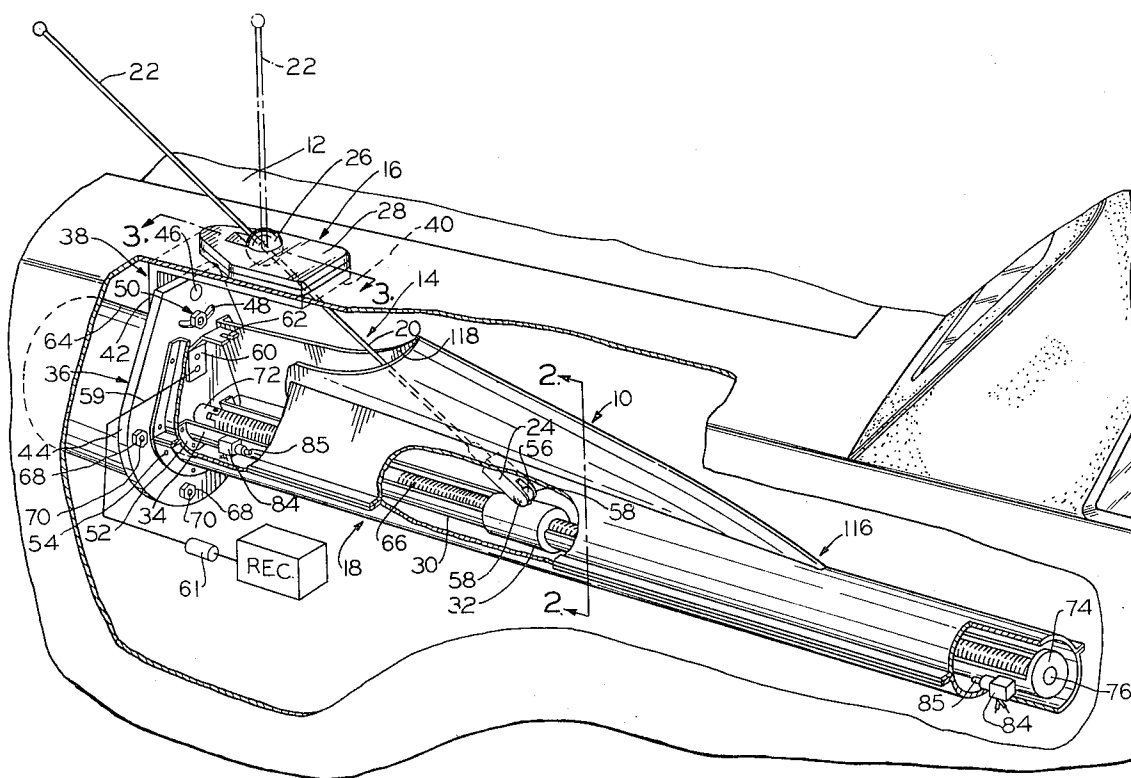
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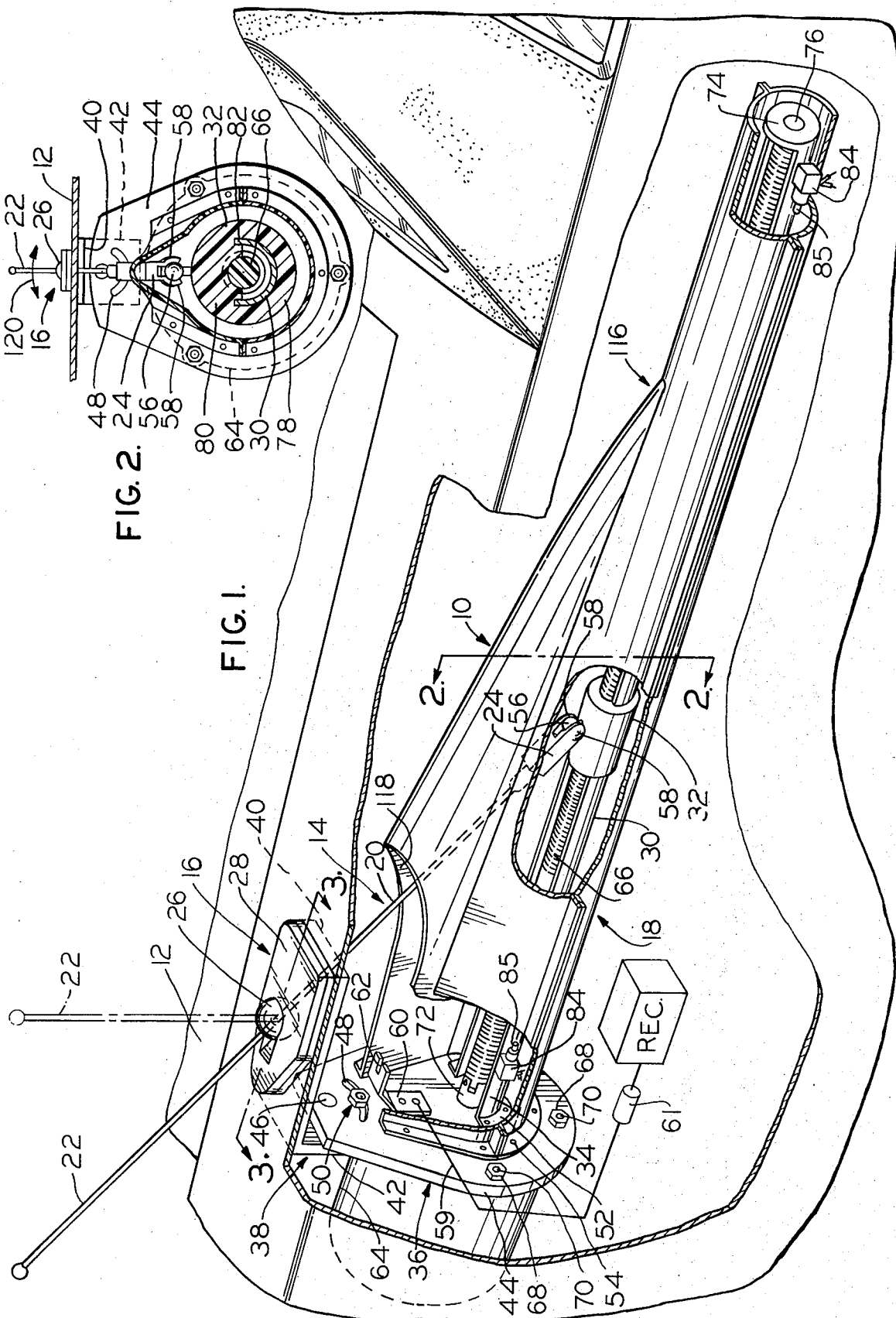
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[57] **ABSTRACT**

A motor operated retractable antenna where the antenna as it is retracted from an extended position generally perpendicular to a supporting panel slides through a guide while simultaneously pivoting to a position generally parallel with the panel. The guide is a spherical ball with an axial passage therethrough, and the motor actuates a slide associated with the lower end of the antenna and which slide moves on a path generally parallel to the panel and spaced from the pivot axis.

13 Claims, 8 Drawing Figures





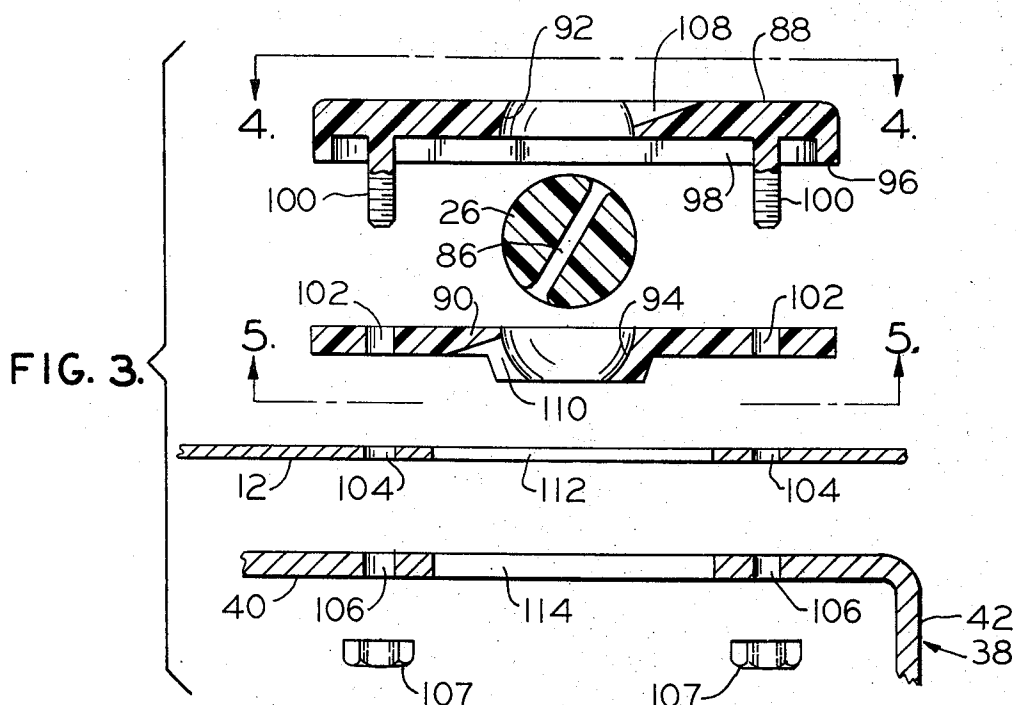
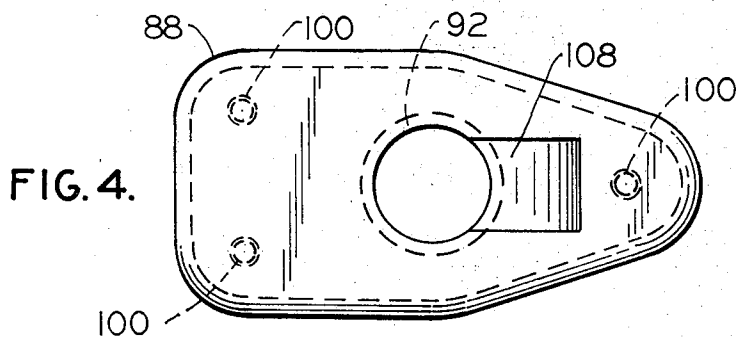
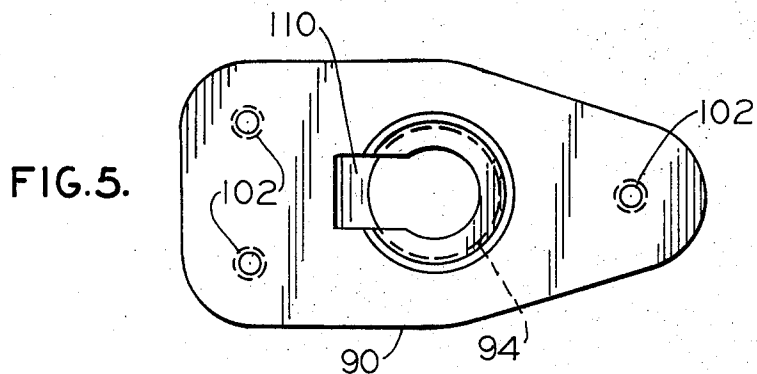


FIG. 8

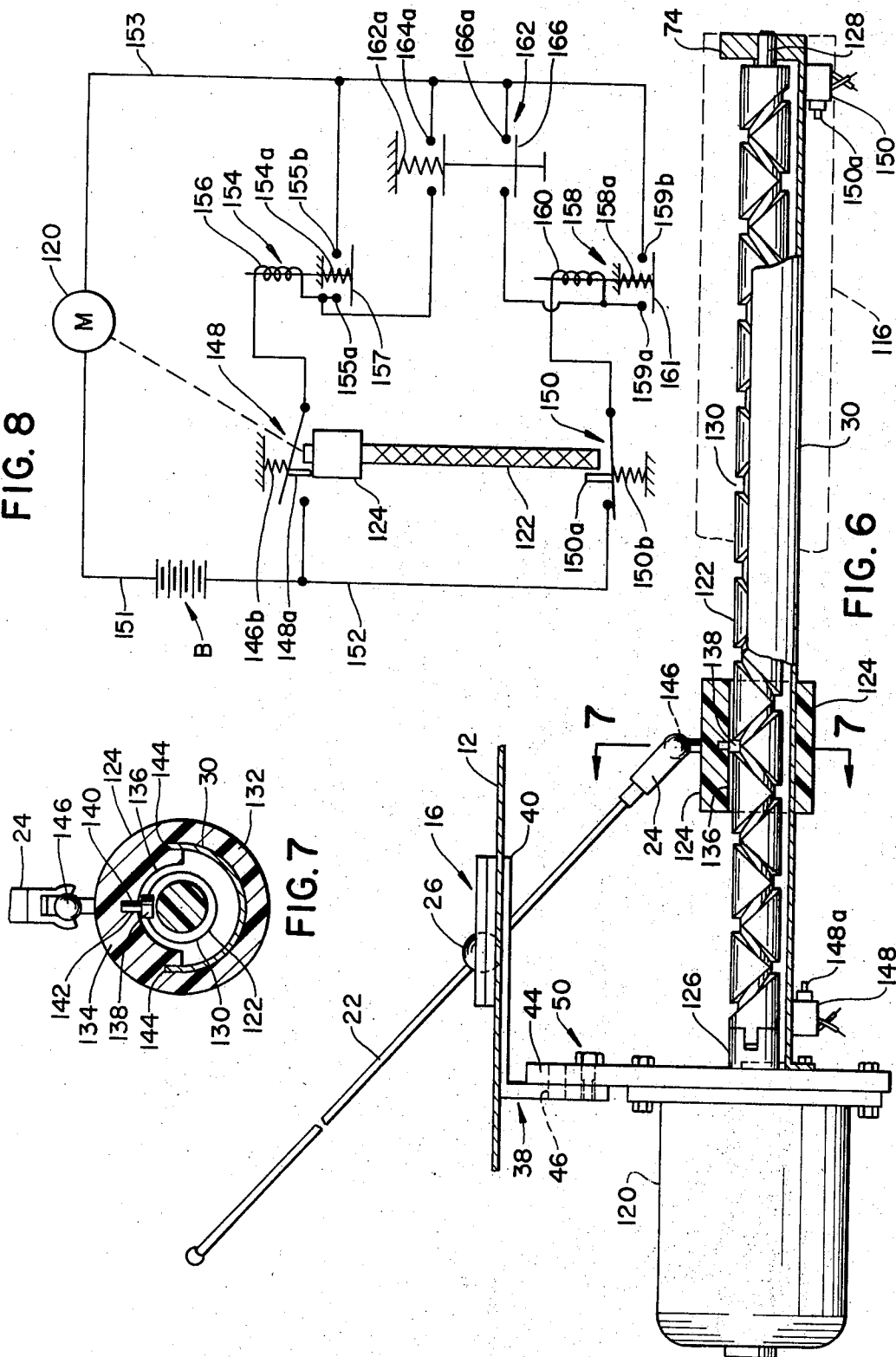


FIG. 7

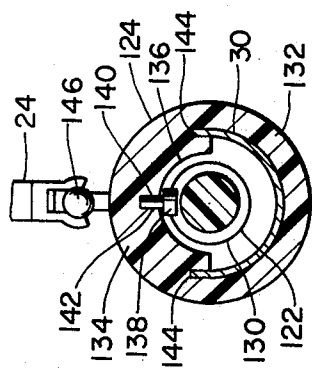
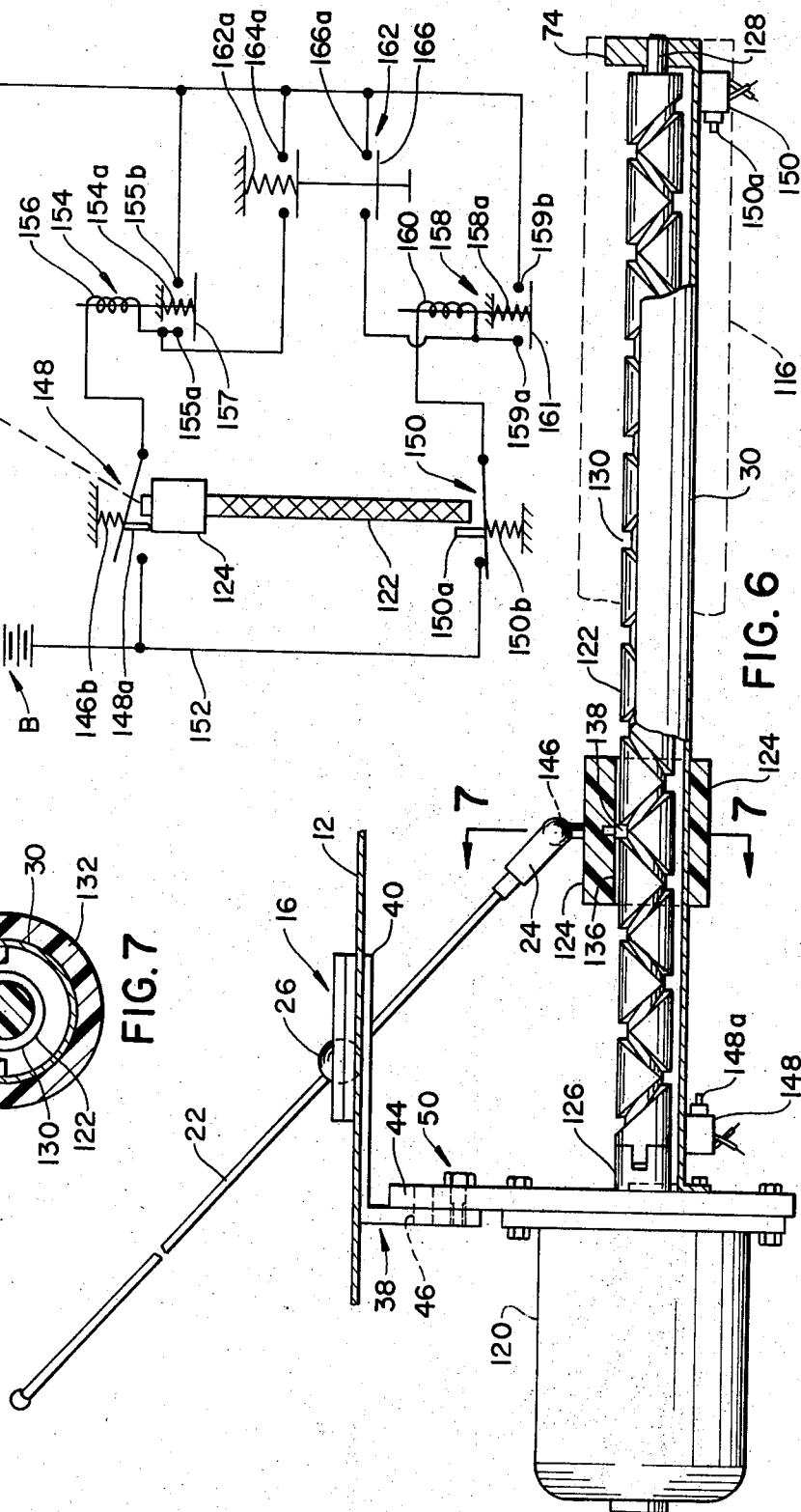


FIG. 6



EXTENDIBLE AND RETRACTABLE ANTENNA

This application is a continuation-in-part of copending application Serial No. 368,280 filed June 8, 1973, now abandoned.

The present invention relates to the art of wave-signal receivers and, more particularly, to an extendible and retractable antenna.

The present invention finds particular utility in conjunction with extendible and retractable radio antennas for automobiles and, accordingly, will be discussed in detail in conjunction therewith. It will be appreciated, however, that the antenna of the present invention can be employed with other signal-receiving apparatus and in structural environments other than automobiles.

Both manually operable and motor driven extendible and retractable antennas have been provided heretofore for use in conjunction with automotive vehicles. Such antenna systems generally include either a continuous, flexible steel rod or, more commonly, a series of telescopically associated sleeves adapted to define an antenna rod. Flexible steel rod antennas generally are displaced between extended and retracted dispositions relative to a vehicle panel by a drive motor which is remotely controlled from within the driving compartment of the vehicle. Telescoping rod antennas, if motor driven, generally include a flexible steel drive rod having one end associated with a reel driven by the motor and the other end operably interconnected with the innermost of the telescoped sleeves to impart reciprocating movement to the sleeves in response to motor operation.

Such antenna devices heretofore known include a housing or sleeve in which the antenna rod components are disposed when in the retracted disposition. Such sleeves or housings are mounted beneath the vehicle panel, such as in a wheel well, and depend vertically from the vehicle panel as much as 18 to 20 inches. The drive motor for the antenna is generally supported at the lower end of the housing or sleeve and generally on the side thereof, thus defining a protruberance extending laterally of the housing. In certain instances, such extendible and retractable antennas are mounted on a rear panel of a vehicle so that the housing and motor components are disposed within the trunk area and thus protected from exposure to deleterious effects of water, dirt and the like which are encountered when the antenna extends into a wheel well or other exposed underside areas of the vehicle.

The foregoing structural and mounting characteristics of antennas heretofore known are undesirable for several reasons. For example, a vehicle owner is often denied the privilege of having the antenna installed in a desired location with respect to the exterior of the vehicle. In this respect, the vertical distance available between the panel of the vehicle such as a fender and underlying structural components of the vehicle may not be sufficient to receive the antenna housing and motor. Further, the vertical disposition of the antenna housing places the lower end thereof at which the motor is disposed closer to the ground and, accordingly, the antenna components and especially the motor are closer to the path of dirt, salt, water and the like which are impelled into wheel wells and other underside areas of the vehicle during use thereof. While the mounting of such antennas in the trunk space of a vehicle avoids exposure thereof to such elements, the antenna housing and motor reduce the available trunk space and are ex-

posed to damage by articles such as suitcases placed in the trunk.

Yet another disadvantage of antennas heretofore known is the fact that they must be mounted on a substantially flat surface of the vehicle, or provided with special mounting bracket arrangements in order to achieve a vertical disposition of the antenna when it is extended. In this respect, the antenna rod is displaced relative to the housing along a linear path. Therefore, if the antenna housing is not accurately positioned with respect to vertical, the antenna rod will extend in an inclined disposition relative to the vehicle which, unless intentional, detracts from the appearance of the vehicle when the antenna is extended.

In accordance with the present invention, the foregoing disadvantages, and others, of antennas heretofore known are advantageously overcome. In this respect, an antenna assembly is provided which requires a minimum amount of vertical space beneath a vertical panel to achieve installation thereof. This enables a much greater latitude in selection of the location on a vehicle for antenna installation. Moreover, the antenna can be installed in a trunk area of a vehicle to gain the advantage of protection against exposure to exterior road and weather conditions and, when installed, the components of the antenna advantageously are disposed adjacent the upper portion of the trunk area whereby available trunk space is increased and the antenna components are less likely to be exposed to contact by articles placed in the trunk.

Still further, an antenna provided in accordance with the present invention can be mounted on vehicle panel surfaces which are inclined from horizontal, without requiring special bracket assemblies, and the antenna when extended will be vertically disposed. This feature further increases the available locations on a vehicle for installation of the antenna.

The foregoing advantages are achieved in accordance with the present invention by a structural interrelationship of antenna rod and support components which enables the antenna rod component of the assembly to be simultaneously reciprocated and pivoted relative to the panel in a manner whereby the rod moves along an arcuate path from a position generally parallel to the panel when retracted to a vertical position when extended.

The arcuate antenna rod movement is achieved by providing for the antenna rod component to be supported intermediate its opposite ends by a guide mounted on the vehicle panel. The guide supports the rod for simultaneous reciprocating movement relative thereto and pivotal movements about a pivot axis through the guide. The end of the rod beneath the vehicle panel is supported for movement along a path generally parallel to the panel and spaced from and transverse to the pivot axis, whereby movement of the latter end of the rod along the path causes the rod to extend or retract relative to the guide member while pivoting about the pivot axis. When the antenna rod is fully extended it is disposed generally perpendicular with respect to the path of movement of the inner end thereof, and when the rod is fully retracted it is disposed at a slight angle relative to the path as determined by the distance between the pivot axis through the guide and the path along which the inner end of the rod moves. Movement of the inner end of the antenna rod along

the path can be achieved manually or otherwise and, preferably, is achieved by an electric drive motor.

While the antenna of the present invention is advantageously mounted in a generally horizontal disposition relative to a vehicle panel, it will be appreciated that the structural interrelationship which enables such disposition further provides for the antenna to be mounted in any location where there is a restriction with respect to available space in the direction perpendicular to the panel on which the antenna is to be mounted and on the side of the panel opposite that from which the antenna rod projects when extended. Thus, the antenna can be mounted in a disposition generally parallel to the panel from which the antenna is to project and this disposition may be other than horizontal.

As mentioned above, movement of the antenna rod between the extended and retracted positions is preferably achieved by an electric drive motor. In accordance with one aspect of the present invention, the motor is reversible and is energized to rotate in opposite directions for respectively extending and retracting the antenna rod. In accordance with another aspect of the present invention, a unidirectional drive motor is employed together with a drive mechanism which provides for the antenna rod to be both extended and retracted in response to rotation of the motor in one direction. This advantageously enables a considerable savings in the cost of the antenna unit in that a unidirectional electric motor is only about 60% the cost of a reversible electric motor. Further, motor actuated extendible and retractable antenna systems employing a reversible electric motor generally include a double pole-double throw switch which is manually actuated in opposite directions, one of which provides for antenna extension and the other for antenna retraction. The use of a unidirectional motor advantageously facilitates the use of a single pole control switch, whereby the vehicle operator does not have to remember in which direction to throw the switch in order to achieve extension and retraction of the antenna. This becomes a safety feature when the vehicle is in motion in that the attention of the operator of the vehicle is not detracted by having to think about or glance at the control switch to determine in which direction to throw the switch.

It is an outstanding object of the present invention to provide an extendible and retractable antenna which requires a minimum amount of mounting space in a direction perpendicular to a panel from which the antenna rod projects when extended.

Another object is the provision of an extendible and retractable antenna for a vehicle which enables a wider selection of locations on the vehicle for mounting the antenna.

Yet another object is the provision of an antenna of the foregoing character in which the components of the antenna when mounted on an exposed under portion of a motor vehicle are more remotely located relative to ground than heretofore possible thus to provide increased protection for the components from direct contact by water, salt, dirt and the like.

A further object is the provision of an antenna of the foregoing character having components mountable in a compartment of the vehicle in a manner whereby available usable space in the compartment is increased and exposure of the antenna components to contact by articles placed in the compartment is minimized.

Still a further object is the provision of an antenna of the foregoing character which is adapted for reversible or unidirectional motor operation.

Another object is the provision of a motor operated extendible and retractable vehicle antenna in which a unidirectional drive mechanism and a unidirectional drive motor therefor operate to both extend and retract the antenna rod.

Still another object is the provision of a unidirectional motor driven extendible and retractable vehicle antenna in which extending and retracting movements of the antenna are terminated automatically and are initiated by momentary actuation of a control switch within the vehicle.

Yet a further object is the provision of a motor operated extendible and retractable vehicle antenna which is of simple construction, comprised of a minimum number of parts and economical to manufacture and install.

The foregoing objects, and others, will in part be obvious and in part pointed out more fully hereinafter in conjunction with the description of the accompanying drawing illustrating a preferred embodiment of the invention and in which:

FIG. 1 is a perspective view of an extendible and retractable antenna made in accordance with the present invention;

FIG. 2 is an elevational view in section of the antenna illustrated in FIG. 1, the section being along line 2—2 in FIG. 1;

FIG. 3 is an exploded view of the antenna rod support components, the panel on which the antenna is mounted and the bracket by which the drive motor and antenna rod actuating mechanism are supported;

FIG. 4 is a plan view of the upper member of the rod support components illustrated in FIG. 3, the view being along line 4—4 in FIG. 3;

FIG. 5 is a plan view of the lower rod supporting component illustrated in FIG. 3, the view being along line 5—5 in FIG. 3;

FIG. 6 is a side elevation view, partially in section, of a modified motor and drive arrangement for the antenna of the present invention;

FIG. 7 is a cross-sectional elevation view of the drive arrangement illustrated in FIG. 6, the section being along line 7—7 in FIG. 6; and,

FIG. 8 is a schematic illustration of an electrical control circuit for the drive arrangement illustrated in FIG. 6.

Referring now in greater detail to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting same, an extendible and retractable antenna 10 is illustrated in FIGS. 1—5 as being mounted on a vehicle panel 12 such as might be defined, for example, by the rear fender panel of the vehicle. The antenna includes an antenna rod 14, a rod guide and guide support assembly 16, and a rod supporting and displacing assembly 18.

In the embodiment illustrated in FIGS. 1—5, antenna rod 14 includes a circular, flexible stainless steel wire member 20 having an outer end 22 adapted to be extended and retracted relative to panel 12, and having its inner end suitably interconnected with a mounting piece 24 of insulating material such as nylon which defines the inner end of the antenna rod 14. The antenna rod is supported for reciprocating and pivotal move-

ment relative to panel 12 during extending and retracting movements by the rod guide and guide support assembly 16 which is described more fully hereinafter. Assembly 16 includes a guide member 26 preferably in the form of a spherical nylon ball, having an aperture therethrough which receives and slidably supports wire member 20 of the antenna rod. Guide member support 28 of assembly 16 provides a socket by which guide member 26 is supported for pivotal movement relative to panel 12.

Antenna rod support and displacing assembly 18 supports the inner end of antenna rod 14 for movement along a path spaced below and generally parallel to panel 12. The path of movement extends transversely of the axis about which guide member 26 pivots during reciprocating movement of the antenna rod therethrough. As will become more apparent hereinafter, many structural arrangements can be employed to achieve the desired support and displacement functions and, in the embodiment illustrated, assembly 18 includes a track member 30 and a rider member 32 supported by the track for sliding movement therealong. Track member 30 is supported relative to mounting panel 12 by a bracket assembly 36 and extends in the direction of the path of movement for the inner end of the antenna rod.

Bracket assembly 36 includes a bracket member 38 having a leg 40 interconnected with panel 12, as described more fully hereinafter, and a leg 42 depending from leg 40. The bracket assembly further includes a mounting plate 44 pivotally interconnected with bracket leg 42 by a suitable pivot pin 46. Mounting plate 44 is provided with an arcuate slot 48, and a threaded fastener assembly 50 extends through bracket leg 42 and slot 48. It will be appreciated, that pivot pin 46 provides for mounting plate 44 to pivot relative to leg 42, and that fastener assembly 50 is operable to clampingly interengage leg 42 and mounting plate 44 to retain the mounting plate in a desired position relative to leg 42 and thus panel 12.

In the embodiment illustrated, track member 30 is in the form of an arcuate metal channel, and end 34 thereof is suitably interconnected with mounting plate 44 so that the channel is supported by the mounting plate. Interconnection of the track member with the mounting plate can be achieved in any desired manner such as by providing end 34 with a flange 52 which overlies and is secured to support plate 44 such as by fastener components 54.

It will be appreciated that the length of track member 30 from mounting plate 44 to the opposite end thereof will depend on the length of the path of travel for the inner end of the antenna rod which in turn is dependent on the length of the antenna rod. In any event, the length of track 30 preferably is sufficient to provide for the outermost tip of the antenna rod to be disposed closely adjacent guide member 26 when the antenna rod is in the retracted position.

As mentioned hereinabove, rider member 32 is movable along track member 30 between the opposite ends thereof to achieve displacement of the antenna rod relative to the guide member and guide support assembly 16. Rider member 32 is pivotally interconnected with the corresponding end of rod end member 24 such as, for example, by providing rider 32 with a ball element 56 to which the corresponding end of member 24 is pivotally secured by a socket arrangement 58. Accord-

ingly, it will be appreciated that as rider member 32 moves along track 30 the antenna rod reciprocates relative to spherical guide member 26 and the spherical guide member rotates about an axis transverse to the path of movement of rider member 32, whereby the antenna rod is both reciprocated and pivoted relative to panel 12 during extending and retracting operations.

When the antenna rod is displaced to its fully extended disposition, as illustrated by broken lines in FIG. 1, the inner end of wire element 20 engages a recess in a spring contact finger 60 which is insulated from and fastened to mounting plate 44. Finger 60 is of conductive material and is interconnected with the radio receiver, as schematically depicted in FIG. 1, by line 59 and an inductor 61, whereby the antenna when extended is operable to transmit a received wave signal to the apparatus. It will be appreciated that the antenna rod is relatively short. Accordingly, to enhance reception, inductor 61 has an inductance and distribution capacity providing for the inductor and antenna to resonate at the center of the received band, for example, 98.0 mHz for standard F.M. reception. preferably, resilient finger 60 is provided with a recess 62 configured to frictionally engage steel wire 20 to assure good electrical contact therebetween.

It will be appreciated that the antenna rod can be displaced between the extended and retracted dispositions thereof manually. In this respect, when the antenna rod is in its fully retracted disposition outer end 22 of wire member 20 can be grasped and pulled axially of the aperture in guide member 26 to move rider member 32 along track 30. As the rod is pulled axially of the guide member aperture it will also be pulled upwardly relative to panel 12 to achieve the simultaneous reciprocating and pivotal movement necessary to achieve extension of the antenna rod. Retraction of the rod manually can be achieved by displacing the rod arcuately toward panel 12 and at the same time applying force axially of the aperture in guide member 26 to achieve movement of rider member 32 in the direction from mounting plate 44 toward the outer end of track member 30.

While manual operation is possible, it is preferred that the extension and retraction operations be achieved by drive means such as a motor. This advantageously enables remote control of the antenna from within the vehicle. In the embodiment described above, motor driven actuation of the antenna rod is achieved by a drive motor 64 and a lead screw 66 extending along track member 30. Drive motor 64 is preferably a reversible electric motor suitably attached to mounting plate 44 so as to be supported thereby. In this respect, for example, the motor housing can be provided with threaded studs 68 adapted to extend through corresponding apertures in mounting plate 44 and receive threaded nuts 70, whereby the motor is releasably interconnected with the mounting plate. Output shaft 72 of the motor extends through a suitable opening in mounting plate 44 and, preferably, lead screw 66 is a separate component suitably interconnected with drive shaft 72 so as to be rotated thereby in response to motor operation. Any suitable interconnection between output shaft 72 and lead screw 66 can be employed and, for example, a cooperable axial tongue and recess joint can be provided therebetween together with suitable pin means to maintain the output shaft and lead screw against axial separation. Lead screw 66 is coextensive with track 30 and, preferably, is pro-

duced of a light weight non-metallic material such as nylon to minimize the weight thereof and any load which might be placed on track 30 thereby. The outer end of the channel shaped track member 30 can be provided with an end wall 74 suitably apertured to receive and rotatably support a stub shaft 76 provided on the outer end of lead screw 66.

The structure of and the interrelationship between track member 30, rider member 32 and lead screw 66 will be more clearly understood with reference to FIG. 2 of the drawing. In this respect, rider member 32 is in the form of a sleeve having a lower portion 78 extending under track member 30 between the opposite sides thereof and an upper portion 80 which is internally threaded for meshing engagement with the threads on lead screw 66. The sides of rider member 32 between lower and upper portions 78 and 80 are recessed to provide longitudinal slots 82 adapted to receive the corresponding longitudinal edge of track member 30. Slots 82 and the edges of track member 30 interengage to restrain rotation of rider member 32 during movement of the rider member along the track. Preferably, rider member 32 is of material such as nylon to minimize the weight thereof, to enhance the sliding movement thereof relative to the metal track, and to provide low friction driving engagement of lead screw 66 therethrough.

From the foregoing description, it will be appreciated that rotation of the output shaft 72 in opposite directions imparts reciprocating movement to rider member 32 in opposite directions along track member 30 to displace the inner end of antenna rod 14 relative to the track, whereby the antenna is moved between the extended and retracted positions thereof. Actuation of motor 64 preferably is remotely controlled in a well known manner by a suitable switch device (not illustrated) mounted, for example, on the dashboard of the vehicle. It will be appreciated that such a switch device may be operable in one mode to energize the motor for operation in one direction and operable in another mode to cause energization of the motor for rotation in the opposite direction thus to achieve the extending and retracting operations. The switch device and control circuitry for the motor can be such that the switch must be held in the one mode until the antenna rod is fully extended and held in the other mode until the antenna rod is fully retracted. The track and rider arrangement, however, advantageously facilitates providing for the deenergization of the motor at the end of the extending and retracting operations to be automatic, whereby the operator need only displace the switch to one or the other of the modes thereof and then release the switch. In this respect, limit switches 84, such as microswitches, can be mounted on track member 30 in positions adjacent the opposite ends thereof corresponding to the fully extended and fully retracted positions of the antenna rod. Such limit switches have actuating plungers 85 positioned to be engaged by rider member 32 when the rider member reaches the switch position, thus to actuate the switch. The circuitry by which the limit switches maintain the motor energized following actuation of the control switch by the operator does not form a part of the present invention and many operable circuit arrangements will be readily apparent to those skilled in the art.

As mentioned hereinabove, steel wire member 20 of the antenna rod is supported for reciprocating and piv-

otal movement relative to panel 12 of the vehicle by guide members and guide member support assembly 16. A preferred structure and interrelationship between the components of assembly 16 is illustrated in detail in FIGS. 3-5 of the drawing. In this respect, guide member 26 is a spherical ball having an aperture 86 extending diametrically therethrough. Wire member 20 of the antenna rod is adapted to extend through aperture 86 for sliding engagement therewith. Guide member 26 is adapted to be captured between upper and lower guide member support components 88 and 90 so that the guide member is universally pivotal relative thereto. For this purpose, upper member 88 is provided with an opening therethrough having a spherical surface 92 and lower member 90 is provided with an opening therethrough having a spherical surface 94. Members 88 and 90 are adapted to be interconnected to clampingly engage guide member 26 therebetween, and members 26, 88 and 90 preferably are produced from self-sealing insulating material such as nylon to enhance the sealing engagement therebetween and at the same time provide for relatively free pivotal movement of guide member 26 relative to members 88 and 90. Moreover, nylon material provides a good bearing surface for wire member 20 of the antenna rod so that the cross-sectional dimension of aperture 86 can closely conform to that of the wire element to achieve sealing without binding during reciprocation of the wire element relative to the guide member.

Members 88 and 90 can be of any suitable exterior configuration and mating relationship. Preferably, however, upper member 88 is provided with a depending peripheral flange 96 defining a recess 98, and member 90 has a peripheral contour corresponding to that defined by flange 96. Accordingly, when members 88 and 90 are in assembled relationship flange 96 surrounds the periphery of member 90 to close off and seal the juncture between the members. The sealed relationship between members 88 and 90 and underlying portions of the antenna assembly is further enhanced by avoiding the use of fasteners which are exposed relative to the outer surface of member 88. In this respect, member 88 is provided with integral threaded studs 100 which depend from the underside of the member. Member 90 is provided with corresponding apertures 102 through which the threaded studs extend upon assembly of the components and, likewise, vehicle panel 12 is provided with corresponding apertures 104, and leg 40 of bracket 38 is provided with apertures 106 through which the threaded studs extend to receive threaded nuts 107. This arrangement further provides for the guide member and guide member support components and bracket 38 to be interengaged with vehicle panel 12 clamped therebetween so that these components together with the antenna rod support and displacing assembly 18 are supported by panel 12. It will be appreciated that many arrangements can be devised for supporting the guide member and guide support assembly relative to panel 12, either together with or independent of the support of the antenna rod support and displacing assembly relative to panel 12.

When the antenna rod is in its fully retracted disposition, the rod is disposed at an acute angle with respect to vehicle panel 12. The degree of the angle will depend, of course, on the length of the antenna rod and the vertical distance between support member 26 and track 30. To facilitate the acute angular disposition of

the antenna rod without interference thereof with members 88 and 90 of the guide member support assembly, it may be necessary to provide inclined recesses extending laterally from the spherical surfaces of the members. For example, as illustrated in FIGS. 3-5, the upper side of upper member 88 is provided with an inclined recess 108 and the lower side of lower member 90 is provided with an inclined recess 110. Recesses 108 and 110 are on diametrically opposite sides of the openings in the members and are of a width to provide for the antenna rod to swing laterally of members 88 and 90 for the purpose set forth hereinafter.

It will be appreciated that vehicle panel 12 and bracket 38 will be provided with openings 112 and 114, respectively, to provide for the antenna rod to extend therethrough. It will be further appreciated that openings 112 and 114 will be dimensioned to permit movement of the antenna rod between the extended and retracted dispositions thereof without engagement with the bracket and vehicle panel.

If desired, the antenna rod support and displacing assembly 18 can be provided with a suitable protective sheath such as indicated generally by the numeral 116 in FIG. 1 of the drawing. Such a sheath can be of plastic material and of one or two piece construction, and is suitably secured at one end to mounting plate 44 to surround and protect the components of the assembly. The housing illustrated in FIG. 1 is provided with an opening 118 to facilitate movement of the antenna rod between the extended and retracted dispositions without engagement with the housing. It will be appreciated, however, that the housing could be configured for the walls thereof adjacent the end mounted on plate 44 to expand upwardly toward vehicle panel 12 to further protect the components enclosed thereby.

Referring again to FIGS. 1 and 2 of the drawing, the pivotal interconnection between mounting plate 44 and bracket arm 42, together with the universally pivotal support of spherical guide member 26, advantageously provide for mounting plate 44 to be adjusted for track 30 and rider 32 to be positioned vertically below guide member 26 when the vehicle panel is inclined with respect to the horizontal disposition thereof illustrated in FIG. 2. This adjustment enables the path of movement of the inner end of the antenna rod to be vertically below guide member 26 so that the antenna, when extended, is disposed vertically as opposed to being perpendicular to the vehicle panel as would be the case if panel 12 in FIG. 2 and the antenna assembly in its entirety were tilted from the illustrated disposition. It will be seen from FIG. 1 that spherical guide 26 and accordingly the pivot axis thereof is spaced above the pivot axis for mounting plate 44 as defined by pin 46. It will be appreciated, therefore, that pivotal movement of mounting plate 44 relative to leg portion 42 of bracket 38 to bring the inner end of antenna rod 14 into vertical alignment with spherical guide member 26 will cause the antenna rod to be disposed at an angle with respect to a plane through the axis of pivot pin 46 and the center of ball 26. The ball and socket interconnection between end members 24 of the antenna rod and rider member 32 provides for relative adjustment between the end member 24 and rider 32 necessary to achieve the operable interconnection therebetween without binding during movement of the rider along track 30 and reciprocating and pivotal movement of the antenna rod during such movement of the rider. Accordingly,

the antenna unit can be mounted on a panel which is inclined considerably with respect to horizontal and the antenna, for aesthetic or other purposes, will assume a vertical disposition when in the extended position.

FIGS. 6-8 illustrate a modification of the drive arrangement for displacing the inner end of the antenna rod in the assembly illustrated in FIGS. 1-5 and described hereinabove. The modification includes a unidirectional motor 120 which replaces motor 64, a reverse or cross-threaded shaft 122 which replaces lead screw 66, and a rider 124 which replaces rider 32. The antenna assembly illustrated in FIG. 6 otherwise corresponds structurally with the arrangement illustrated in FIGS. 1-5 and, in this respect, like numerals appear in FIGS. 1-5 and FIG. 6 to designate like components. To facilitate the illustration and description of the modified drive arrangement in FIG. 6, certain of the remaining components of the antenna assembly are illustrated in phantom.

As will be seen in FIG. 6, unidirectional motor 120 is bolted to mounting plate 44 and output shaft 126 of the motor extends through a suitable opening therefor in the mounting plate. Shaft 122 is coaxial with output shaft 126 and is interconnected for rotation with the output shaft, such as by a cooperable axial tongue and recess joint therebetween. Shaft 122 is coextensive with track 30 and, preferably, is produced of a light weight non-metallic material, such as nylon. The apertured outer end wall 74 of track 30 receives and rotatably supports a stub shaft 128 mounted on the outer end of shaft 122.

Shaft 122 is provided along the length thereof with reverse or cross-threads 130 which, in a well known manner, are adapted to cooperate with a suitable follower on a movable element to impart rectilinear reciprocating movement to the element in response to unidirectional rotation of the shaft. In the embodiment illustrated in FIGS. 6 and 7, the element to be displaced is rider 124.

Rider 124 is structurally similar in certain respects to rider 32 in the embodiment of FIGS. 1-5. More particularly, rider 124 is in the form of a hollow sleeve having a lower portion 132 extending under track member 30 between the opposite sides thereof and an upper portion 134 including an axial recess 136 spaced radially outwardly of shaft 122. Rider 124 is provided intermediate its opposite ends with a follower component 138 which extends radially inwardly from recess 136 to engage threads 130 of the shaft. Follower 138 includes a cylindrical pin portion 140 disposed in a cylindrical recess 142 in upper portion 134 of the rider, whereby the follower is freely pivotal about an axis perpendicular to and intersecting the axis of shaft 122. Reverse or cross-threaded shaft and cooperable follower arrangements are well known, and the thread and follower arrangement illustrated herein is merely intended to be illustrative of one such arrangement for achieving reciprocation of rider 124 relative to track 30 in response to unidirectional rotation of shaft 122.

In the manner described hereinabove with regard to the embodiment of FIGS. 1-5, the sides of rider 124 between lower and upper portions 132 and 134 are recessed to provide longitudinal slots 144 which receive the corresponding longitudinal edge of track member 30 to restrain rotation of rider 124 during movement of the rider member along the track. Preferably, as in the previous embodiment, rider member 124 is of a non-

metallic material, such as nylon, to minimize the weight thereof and to enhance the sliding movement thereof relative to the track which is metal. Further, upper portion 134 of the rider is provided with a ball element 146 to facilitate pivotal interconnection between the rider and antenna 22 in the manner described hereinabove in connection with the embodiment of FIGS. 1-5.

It will be appreciated from the foregoing description of FIGS. 6 and 7 that operation of unidirectional motor 120 rotates shaft 122 unidirectionally and that follower 138 cooperatively interengages with threads 130 of shaft 122 to reciprocate rider 124 in opposite directions along track 30, thus to retract and extend antenna rod 22. Preferably, motor 120 is an electrical motor, the energization of which is controlled from within the vehicle such as by a control switch mounted on the dashboard of the vehicle. Moreover, in accordance with the preferred embodiment, suitable control circuitry is provided to enable motor 120 to be energized by momentary actuation of the control switch to move rider 124 along track 30 in a first direction and to be automatically de-energized when the rider reaches the end of shaft threads 130 in the direction of movement resulting from such motor energization. To achieve de-energization of the motor in response to movement of rider 124 to the opposite end positions thereof along track 30, limit switches 148 and 150 are suitably mounted on or supported at opposite ends of track 30 and in the path of movement of rider 124 so as to be engaged by the rider when follower 138 reaches the corresponding end of threads 130. Switches 148 and 150 are provided with corresponding actuators such as plungers 148a and 150a which are engaged and depressed by the adjacent end of rider 124 to actuate the switch in a manner to cause de-energization of motor 120.

Any suitable control circuit arrangement can be provided for achieving the foregoing desired control of motor 120 through a control switch in the vehicle and limit switches actuated by the rider. One such control circuit arrangement is illustrated in FIG. 8 as an example. In this respect, the control circuit includes a pair of leads 151 and 153 across which motor 120 is connected. Motor 120 is in series with a suitable power source B, such as the battery of the vehicle, through lead 151 connected to one terminal of the power source. A lead 152 is connected to the opposite terminal of the power source. Limit switch 148 is connected across leads 152 and 153 in series with motor 120 and power source B through a relay switch 154. Switch 154 includes a coil 156 in series with switch 148 across leads 152 and 153 through contacts 155a and 155b and switch contact plate 157. Limit switch 150 is connected across leads 152 and 153 in parallel with switch 148 and is connected in series with the motor and power source through a relay switch 158. Switch 158 includes a coil 160 in series with switch 150 across leads 152 and 153 through contacts 159a and 159b and switch contact plate 161. Limit switches 148 and 150 are normally closed switches opened by engagement of rider 124 with the corresponding switch plunger against the bias of corresponding closing springs 148b and 150b. Relay switches 154 and 158 are normally open and are closed by energization of the corresponding one of the coils 156 and 160 and against the opening bias of corresponding springs 154a and 158a.

Coils 156 and 160 are adapted to be momentarily connected across leads 152 and 153 in series with motor 120 and power source B by a control switch 162 mounted, for example, on the dashboard of the vehicle.

Switch 162 is normally open and can, for example, be a pushbutton switch which is manually closed against the bias of a return spring 162a. Further, switch 162 includes a pair of contact plates 164 and 166 which, upon closure of the switch, simultaneously engage corresponding pairs of contacts 164a and 166a. Contacts 164a engaged by switch plate 164 are connected one to lead 153 and the other to the end of coil 156 connected to switch contact 155a. Similarly, contacts 166a engaged by switch plate 166 are connected one to lead 153 and the other to the end of coil 160 connected to switch contact 159a.

Presuming rider 124 to be at the end of shaft 122 at which limit switch 148 is located, the rider engages switch plunger 148a to open switch 148 against the bias of closing spring 148b. In this position of the components the antenna rod 22 is in its extended position and limit switch 150 is closed by return spring 150b. When the vehicle operator desires to retract the antenna, he momentarily depresses control switch 162 to close switch plates 164 and 166 against the corresponding switch contacts. When so closed, coil 160 of relay switch 158 is energized through closed limit switch 150 and closed control switch 162. At the same time, relay switch coil 156 remains deenergized by the open condition of limit switch 148.

Energization of relay coil 160 closes switch plate 161 against contacts 159a and 159b to establish a holding circuit for the relay coil. Accordingly, when the operator releases control switch 162 relay switch 158 remains closed and motor 120 is energized by power source B through the closed limit switch 150 and relay switch 158. Rotation of shaft 122 in response to motor actuation causes rider 124 to move away from limit switch 148 toward limit switch 150, whereby closing spring 148b closes limit switch 148. Since relay switch 154 and control switch 162 are now open, coil 156 is not energized at this time by closure of limit switch 148. Motor 120 continues to rotate shaft 122 to advance rider 124 toward limit switch 150 until the rider engages plunger 150a of the latter switch and moves the switch to its open position. At this time, the antenna rod is in its retracted position, and the opening of limit switch 150 opens the circuit to motor 120 and coil 160 to de-energize the motor and open relay switch 158.

Upon the next momentary closure of control switch 162 relay coil 156 is energized through the now closed limit switch 148, whereby motor 120 is energized and switch plate 157 closes against contacts 155a and 155b to establish a holding circuit for relay switch 154. At the same time, limit switch 150 is open whereby relay coil 160 is not energized by the closure of control switch 162. Motor 120 again rotates shaft 122 in the same direction and rider 124 is advanced along the shaft in the direction from limit switch 150 back toward limit switch 148 until the rider engages switch plunger 148a to open the limit switch and thus de-energize the motor and relay coil 156.

While considerable emphasis has been placed herein on the fact that the antenna rod guide member is a spherical ball, it will be appreciated that other guide member structures can be employed which will provide both reciprocating and pivotal support for the antenna

rod. Further, antenna rods having cross sections other than circular can be employed without departing from the principles of the present invention. Many guide members and cooperable antenna arrangements will be readily apparent to those skilled in the art upon reading the foregoing description. Further, it will be appreciated that the antenna rod support and displacing assembly can be provided by structures other than the specific arcuate track, rider and lead screw arrangements described herein. For example, with regard to the reversible motor drive, the track member could be provided with a slidable carriage adapted to be displaced therealong by a pulley and endless cord or chain assembly. The cord or chain would be attached to the carriage, and the pulley would be driven by the motor such as through a worm gear to drive the cord or chain and thus displace the carriage along the track.

As a further example, with regard to either the reversible or unidirectional drive motor arrangements, the lead screw or cross-threaded shaft could be driven by the motor through a suitable gear arrangement therebetween as opposed to the direct drive illustrated. Moreover, with regard to the unidirectional drive, the cross-threaded shaft and the track support for the rider could be disposed side-by-side with the follower on the rider extending from an external surface portion thereof into engagement with the cross-threads. Many structural arrangements for achieving rectilinear reciprocating movement of the rider by unidirectional rotation of the reverse or cross-threaded shaft, and many modifications of the structural arrangement illustrated and described herein, will be obvious to those skilled in the art and can be provided without departing from the principles of the present invention. Still further, it will be appreciated that the mounting plate supporting the motor, track and rider components could be mounted on the vehicle panel by a bracket member independent of the bracket by which the antenna guide member and guide member support components are mounted on the panel, and that the latter components can be mounted on the vehicle panel independent of a bracket member without affecting the operating function thereof.

As many possible embodiments of the present invention may be made and as many possible changes may be made in the embodiments herein illustrated and described, it is to be distinctly understood that the foregoing descriptive matter is to be interrupted merely as illustrative of the invention and not as a limitation.

What is claimed is:

1. An extendible and retractable vehicle antenna mounted on and beneath a generally horizontal vehicle panel having inner and outer sides comprising, an antenna rod having inner and outer ends with respect to said panel, a track having opposite ends, said track being closely spaced beneath said panel and extending generally parallel thereto, a rider supported by said track for reciprocation therealong, means pivotally interconnecting said inner end of said antenna rod with said rider, antenna rod guide means supported by said panel for pivotal movement about an axis, said guide means supporting said antenna rod intermediate the ends thereof for reciprocation transverse to said axis, means interconnecting said track and guide means with said axis spaced from and overlying one end of said track, said other end of said track being horizontally spaced from said one end, and means to displace said rider in opposite directions along said track to displace

said inner end of said antenna rod along said track and move said antenna rod between retracted and extended positions relative to said panel, said antenna rod in the extended position being generally vertical, said track having a length between said ends substantially greater than the spacing thereof from said guide means axis, and said track length and spacing providing for said antenna in the retracted position to be disposed at an angle more acute with respect to horizontal than vertical.

2. The antenna according to claim 1, wherein said displacing means includes motor means and means drivingly interconnecting said motor means with said rider.

3. The antenna according to claim 1, wherein said rider includes a threaded portion, and said displacing means includes shaft means extending along said track and having thread means in meshing engagement with said threaded portion of said rider for rotation of said shaft means to displace said rider, and motor means for rotating said shaft means.

4. The antenna according to claim 1, wherein said antenna rod guide means includes a guide member and guide member support means, said guide member having an aperture therethrough, said antenna rod extending through said aperture, said guide member having an outer surface at least a portion of which is spherical, and said guide member support means including means providing a cooperative supporting surface for said spherical portion.

5. The antenna according to claim 4, said rider including a threaded portion, and said displacing means including shaft means extending along said track and having thread means in meshing engagement with said threaded portion of said rider for rotation of said shaft means to displace said rider, and motor means for rotating said shaft means.

6. The antenna according to claim 4, wherein said guide member support means is mountable on said vehicle panel, said means interconnecting said track and guide means includes a support plate interconnected with said guide member support means for pivotal movement about an axis generally parallel to said track, said track being mounted on said support plate.

7. The antenna according to claim 6, wherein said rider includes a threaded portion, and said displacing means includes shaft means extending along said track and having thread means in meshing engagement with said threaded portion of said rider for rotation of said shaft means to displace said rider, said displacing means further including a reversible electric motor for rotating said shaft means, said motor being mounted on said support plate.

8. The antenna according to claim 5, wherein said guide member support means is mountable on said vehicle panel, said means interconnecting said track and guide means includes a support plate interconnected with said guide member support means for pivotal movement about an axis generally parallel to said track, said track being mounted on said support plate.

9. The antenna according to claim 8, wherein said motor means is a reversible electric motor mounted on said support plate.

10. The antenna according to claim 2, wherein said motor means is a unidirectional motor and said means drivingly interconnecting said motor means and rider includes reverse threaded shaft means parallel to said

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track and rotatable by said motor, and follower means on said rider cooperatively engaging said reverse threads for unidirectional rotation of said shaft means to reciprocate said rider in opposite directions along said track.

11. The antenna according to claim 10, wherein said unidirectional motor is an electric motor, and control circuit means for connecting said motor across a power supply, said control circuit means including switch means operable to disconnect said motor from said power supply when said follower means reaches the opposite ends of said reverse threads.

12. The antenna according to claim 4, wherein said means for displacing said rider includes reverse threaded shaft means extending along said track and follower means on said rider in engagement with said reverse threads of said shaft means for unidirectional rotation of said shaft means to reciprocate said rider in opposite directions along said track, a unidirectional electric motor for rotating said shaft means, and con-

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5 trol circuit means for connecting said motor across a power supply, said control circuit means including switch means operable to disconnect said motor from said power supply when said follower means reaches the opposite ends of said reverse threads.

13. The antenna according to claim 6, wherein said means for displacing said rider includes a unidirectional electric motor mounted on said support plate, reversely threaded shaft means parallel to said track means and driven by said motor, follower means on said rider engaging said reversely threaded shaft means for unidirectional rotation of said shaft means to reciprocate said rider in opposite directions along said track means, and control circuit means for connecting said motor across a power supply, said control circuit means including switch means operable to disconnect said motor from said power supply when said follower means reaches the opposite ends of said reverse threads.

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