March 1, 1938. G. W. FYLER 2,110,016

ANTENNA SYSTEM FOR MOTOR VEHICLES

Filed July 18, 1934

Fig. 1.

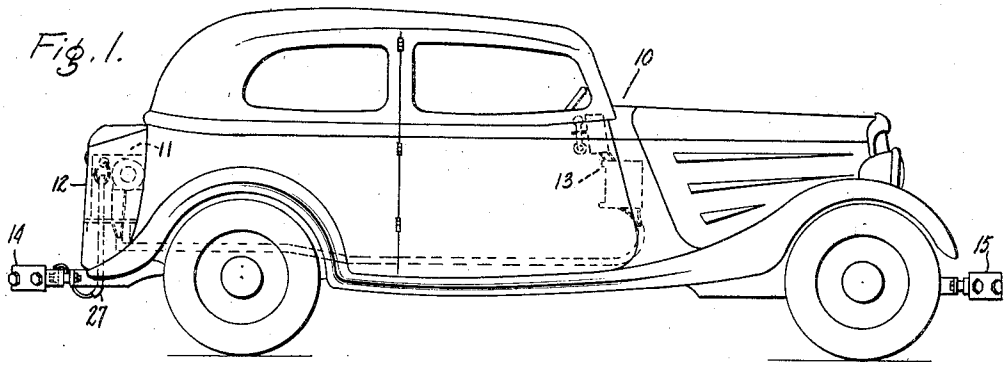


Fig. 2

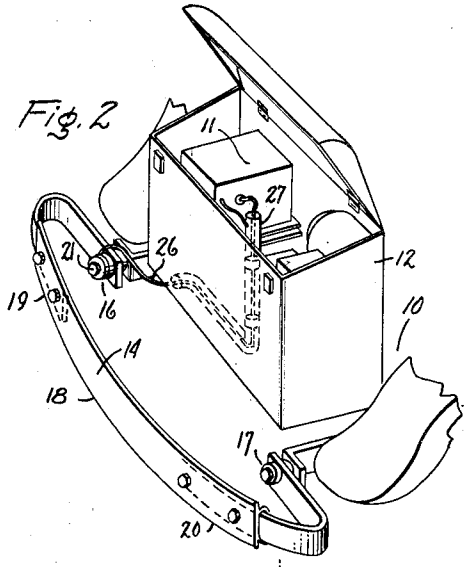


Fig. 6.

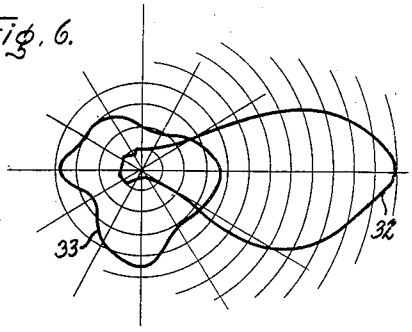


Fig. 4.

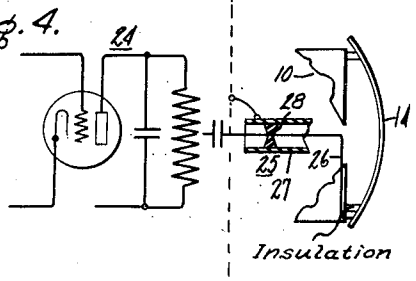


Fig. 5

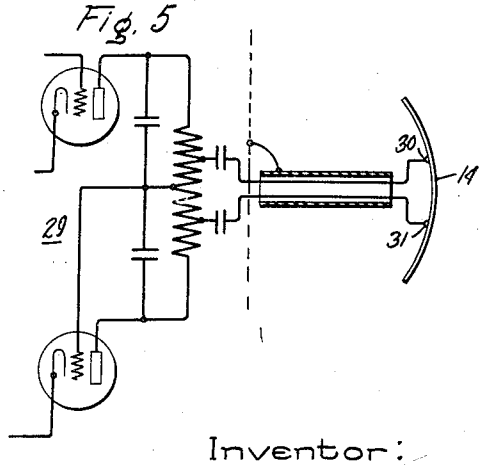
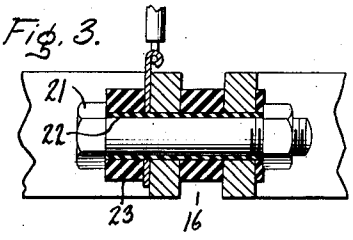


Fig. 3.



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UNITED STATES PATENT OFFICE

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ANTENNA SYSTEM FOR MOTOR VEHICLES

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Application July 18, 1934, Serial No. 735,756

7 Claims. (Cl. 250—33)

My invention relates to antenna systems for radio apparatus, particularly to transmitting antennas for radio equipped motor cars, and its object is to provide an inconspicuous, simple, and efficient antenna arrangement for such vehicles.

The invention is of particular usefulness when applied to radio equipped police motor cars, wherein it is desirable to install both a receiving antenna and a transmitting antenna for the radio system. In such installations the receiving antenna has commonly been mounted in the roof of the car and a vertical transmitting antenna extending well above the roof has been mounted in the rear of the car.

Difficulties have been encountered in the use of a transmitting antenna of the above-described vertical type installed on a motor vehicle. It has been found, for example, that the radiation of energy from this vertical transmitting antenna is far from uniform in all directions, thus seriously limiting in certain directions the distance at which speech or other signals radiated from the vehicle are of sufficient strength to be picked up by radio receiving apparatus.

It is a further disadvantage in the use of the vertical transmitting antenna when installed on a motor car that the antenna adds an undesirably conspicuous element to the car body. This latter disadvantage of the vertical antenna is of particular moment in the case of radio equipped police cars. It has been found very desirable that police motor cars be not unduly conspicuous, and therefore, that the above-described vertical type of transmitting antenna be dispensed with and that the transmitting antenna either be completely concealed or be of such nature as to escape notice.

In accordance with the present invention, the above-mentioned and other difficulties are overcome by utilizing, as a transmitting antenna for a radio equipped motor car or like vehicle, preferably one or more conductive members or portions of the car which, aside from their function as antennas, have other, usually purely mechanical functions in the vehicle assembly. Conductive members for this purpose may be constituted by such well-known motor vehicle elements as metallic tire carriers, or in general any other metal elements performing their usual mechanical functions as constituent parts of the vehicle. Further, a large portion of the vehicle body or assembly, or even substantially the entire vehicle body, may be utilized as antenna means. The above-described conductive members may be arranged to operate not only as transmitting but also as receiving antennas.

The above-mentioned conductive members perform their new electrical function as antennas only when the radio apparatus of the vehicle is operating; they perform their usual mechanical functions under both operating and non-operating conditions of the radio apparatus. The mounting arrangements and form of the conductive members and their means of connection to the radio apparatus all meet the requirement that it shall not be apparent to observers that these conductive members are intended to function as antennas.

I have discovered that the bumper members of a motor car or similar vehicle may be utilized to great advantage as conductive members for the above-described antenna use. To operate as an antenna one or more of the bumpers may be connected to the radio apparatus, the bumper member or members being insulated at one point at least from the vehicle.

The insulating and connection arrangements are such that the appearance of the bumper element and the adjacent portion of the vehicle is practically unchanged, or the changes in appearance are of too slight a nature to attract attention.

The antenna means in accordance with my invention may also be constituted by a conductive member mounted at the rear or front of the vehicle in or near the usual rear or front bumper position, and projecting from the vehicle to form an antenna functioning substantially in the same manner as the antenna constituted, as above-described, by a usual bumper member.

In case one bumper member only is utilized as an antenna, it is preferable to employ the rear bumper. The radio transmitting apparatus which supplies current to this rear bumper antenna is then conveniently mounted in a trunk or compartment at the rear of the car and is connected to the rear bumper by a transmission line which is short, thereby reducing losses in the line.

Preferably when one bumper only is employed as an antenna the bumper is insulated at one point only, as at one extremity, from the frame or other portion of the vehicle to which it is adjacent, and is electrically connected at another point, as at the other extremity, to the vehicle. The transmission line from radio apparatus may conveniently be connected to the bumper at the point thereof at which the bumper is insulatingly connected to the vehicle.

In this latter arrangement in which one bumper

only is employed as an antenna, the bumper constitutes together with the adjacent metal portion of the vehicle a horizontal loop radiator or transmitting antenna.

By the incorporation in the radio apparatus of a suitable push-pull transmitter circuit arrangement the connection to the bumper may be made, through a two-wire transmission line, to two spaced points of the bumper, which is entirely insulated from the vehicle. In this latter circuit arrangement the bumper may be operated, for example, as a dipole antenna having a voltage node at its center.

When a bumper is arranged as hereinbefore described to operate as an antenna, a desirable form of the bumper includes a main body portion and reentrant end portions, the bumper being mechanically connected to the vehicle at the inner extremities of the reentrant portions, there being preferably no metal struts or similar members in electrical contact with and extending across the bumper. In a bumper of this form no portion thereof is short-circuited by conductive struts or similar elements, the full length of the bumper being thereby available as a radiator of signal energy.

It has been suggested heretofore to employ as automobile radio antennas metallic members under and spaced from the running board, or to employ metallic members in the roof of the car. It will be noted that such running board and roof top antennas are primarily capacitive antennas, that is, they consist of a large area of metal connected by a shielded lead-in to the receiver (or transmitter) located at any point in the car. As radiators of radio frequency energy such capacitive antennas are definitely inferior to my bumper antenna, which is an inductive radiator. At very high frequencies, for example 30 megacycles, the roof antenna and the running board antenna require considerable charging current due to their low capacitive reactance, and since the radiation resistance must be low the losses in the coupling and tuning circuits associated with these antennas are inherently high. The bumper antenna being an inductive device has an appreciable radiation resistance particularly at high frequencies, and its inductive reactance is not excessive. It is by analysis a low loss conducting loop reasonably isolated from the car. The inductance of the bumper antenna simply requires additional voltage for feeding the antenna and, in general, the voltage supply in a transmitter is normally nearly correct for easily feeding the bumper antenna without complicated loading circuits. A capacitive antenna, however, requires high current and low voltage with consequent losses in conducting members. Thus the bumper antenna is more efficient as a radiating device than the above-mentioned running board or roof antennas. Also, the field pattern of the bumper antenna is nearly circular and thus normally most desirable. Since the running board antenna is definitely more shielded than the bumper antenna by the car body and chassis structure its field pattern tends to be more peaked in the direction of the side of the car.

Further, the location of the bumper on an automobile is such that an antenna constituted by the bumper is more isolated from the automobile body than either the roof antenna or the running board antenna. In the latter case the metallic member constituting the antenna must be located several inches below the running board to be effective for radio operation between the automobile and distant radio stations or sets, yet must be reasonably well spaced from the ground to prevent its being knocked off when going over bumps. Since, as above explained, it is a capacitive antenna, it does not have good radiating properties due to its being within a few inches of the ground and the capacitive changes due to variations in this spacing tend to cause frequency variations and wide variations in output in a car transmitter. The bumper antenna, however, being an inductive instead of a capacitive device is not appreciably affected by variations of the spacing to ground, particularly since it is normally higher than the usual running board type of antenna, and therefore, considerably farther from the ground. From the mechanical standpoint it is to be noted that the running board antenna is objectionable since it is liable to damage by water sprayed from the front wheels in wet weather, and from stones picked up by the front wheels.

It has also been suggested heretofore to employ as automobile antennas for transmission over a very short distance metallic members mounted under the automobile body and closely adjacent the metal under parts thereof, or else mounted under and very closely adjacent to the metal running board. Such antennas operate as closed loops disposed in a vertical plane and signals from these antennas have practically no influence upon distant radio receiving sets due to the shielding of the antenna loop from above and laterally by the metal body and running board. My bumper antenna, however, being well isolated from the metal elements of the automobile and being located well above the ground beyond an extremity of the automobile, is substantially free from the shielding and excessive reflection effects of the automobile body metal elements. Due to this isolation from the end of the automobile body and to the substantial height above the ground the bumper operates in connection with the adjacent metal portion of the automobile body as a horizontal loop antenna with relatively high efficiency in all directions between the automobile and distant radio sets or stations.

In characterizing the bumper antenna system as inductive it will be understood that the system is inductive when the length of the wave has a definite relation to the length of the antenna, the frequency being below the value at which the reactance of the system becomes capacitive. It will be further understood that in operation of the antenna system which includes the bumper connected as a dipole antenna, the coupling adjustment in the antenna system will under certain conditions determine whether the reactance is inductive or capacitive.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Figs. 1 and 2 are respectively a longitudinal plan view and a perspective view of a radio-equipped motor vehicle in which my invention has been embodied; Fig. 3 illustrates an insulating means for connecting a bumper inconspicuously to a motor vehicle; Fig. 4 is a circuit diagram illustrating connections, through a transmission line, from radio transmitting apparatus to one point of a bumper constituting part of a loop antenna; Fig. 5 is a cir-

cuit diagram similar to that of Fig. 4 but illustrating connections to two points of a bumper operating as a dipole antenna; and Fig. 6 illustrates signal radiation patterns of a bumper type transmitting antenna and of a vertical type vehicle antenna.

In Figs. 1 and 2, the numeral 10 designates a motor vehicle for police or other use, in which is installed a two-way radio communication system comprising radio signal generating apparatus 11 preferably mounted in a trunk or compartment 12 at the rear of the vehicle and connected to suitable microphone, loudspeaker and control means installed toward the front of, or other suitable position in the vehicle and indicated generally by the numeral 13.

The receiving antenna may be of any suitable or usual form, such as a wire or other antenna member (not shown) which may be mounted in the roof of the vehicle or in any other suitable position.

In order to radiate speech or other signals effectively from the vehicle without at the same time adding to the vehicle an antenna element which is conspicuous, or which is even noticeable to an observer of the vehicle, the generating apparatus 11 is arranged to supply its output energy to one or both of the bumpers 14 and 15.

In the present embodiment of the invention the rear bumper 14 alone is preferably utilized for this purpose, and this bumper is preferably so mounted that it is insulated at one point from the vehicle by an insulating fastening means 16 and electrically connected at another point by a suitable fastening means 17.

The bumper 14 may be of any usual form but it is preferable that the form be such that the full length of the bumper may be utilized as a radiator of energy. In the present embodiment of the invention the bumper comprises a main portion 18 and two reentrant portions 19 and 20 the extremities of which are connected respectively to the vehicle by the fastening means 16 and 17.

The insulating fastening means 16, as shown in greater detail in Fig. 3, may comprise a bolt 21 within a mica insulating sleeve 22, and insulating rings 23, preferably of mica sheets tightly pressed and formed into solid blocks by a suitable binder.

As shown in Fig. 4, the radio apparatus 11 may comprise an output circuit 24 which is connected to the bumper 14, preferably at the insulating fastening means 16, through a transmission line 25. The transmission line may comprise a metal conductor 26 inclosed in a tubular shield member 27 from which the wire is insulated by spaced insulating discs 28.

As shown partially in diagram in Fig. 5, the radio apparatus designated in Figs. 1 and 2 by the numeral 11 may comprise, instead of the output circuit 24 illustrated in Fig. 4, a push-pull output circuit 29 connected, through a two-wire transmission line, to two spaced points, as 30, 31, on the bumper, which in this case is completely insulated from the vehicle. With this latter circuit and connection arrangement, the bumper may be operated as a dipole antenna having a voltage node at its center.

Referring to the signal radiation patterns illustrated in Fig. 6, curve 32 is a typical field pattern given by a vehicle transmitter antenna of the hereinbefore mentioned vertical type mounted at the rear of the vehicle and extending above the roof. It will be observed that the radiation efficiency with this antenna is far from uniform in all directions, the ratio of maximum radiation, in a certain direction, to the minimum, in another direction, being as great as twenty to one.

Curve 33 is a typical field pattern given by the antenna constituted by a bumper antenna such as bumper 14. This pattern 33 shows that the radiation of signal energy, from the bumper antenna in accordance with the present invention, is far more nearly uniform in all directions than in the case of the vertical antenna above-described, and that the radiation efficiency of the bumper antenna is fully adequate for efficient radio reception in all directions from the vehicle. The field pattern illustrated in curve 33 was given by a bumper arranged as shown in Figs. 1, 2 and 4 wherein one end of the bumper is electrically connected to the car frame and the other end, insulated from the car frame, is connected to the radio apparatus. In this arrangement the antenna current flows around the horizontal loop enclosed by the bumper and the car frame. The radiation pattern given by the bumper when insulated at both ends and fed at the central portion by a two-wire transmission line as in the arrangement as illustrated in Fig. 5 is, however, essentially the same as the radiation pattern given by the bumper arrangement illustrated in Figs. 1, 2, and 4 due to the circulating current through the two end insulators.

The species of my present invention shown in Fig. 5 is claimed in a copending application Serial No. 159,899, filed August 19, 1937, which is a division of my present application.

I have described my invention in a particular embodiment for purposes of illustration. It will be understood, however, that the invention is susceptible of various changes and modifications without departing from the scope of the invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a motor vehicle, a radio apparatus mounted on said vehicle, a conductive member designed only and appearing solely as a mechanically functioning bumper element of said vehicle, means to connect mechanically said bumper element at two spaced points thereof to said vehicle, means to insulate said bumper element at one of said points from said vehicle, means to ground said bumper element to the adjacent metal portion of said vehicle at a point of said element adjacent the end thereof remote from said one of said spaced points, and means to connect electrically said radio apparatus to said bumper element, said bumper element extending across an end of the vehicle and being spaced a substantial distance from said end and from the ground, whereby said bumper element operates in cooperation with said adjacent metal portion of said vehicle as an antenna.

2. In combination, a motor vehicle, a radio apparatus mounted on said vehicle, a metallic bar member mechanically connected at two spaced points thereof to said vehicle at an end thereof and spaced from said end and from the ground a substantial distance, said metallic member extending transversely of said vehicle a distance substantially equal to the width of said vehicle, means to insulate said bar member at one of said points from said vehicle, means to ground said bar member at the other of said points to said vehicle, and means to connect electrically said radio apparatus to said one of said points of said

metallic member, whereby said metallic member operates in cooperation with the adjacent metal portion of said vehicle as a loop antenna.

3. In combination, a motor vehicle, a radio apparatus mounted on said vehicle, a metallic bar member mechanically connected at points thereof near its extremities to said vehicle at an end thereof and projecting therefrom and being spaced from the ground a substantial distance, said metallic member extending across said end a distance substantially equal to the width of said vehicle in a line at right angles to the longitudinal axis of said vehicle, means to insulate said metallic member from said vehicle at one of said points, means to ground said metallic member to said vehicle at the other of said points, and means to connect electrically said radio apparatus to said one of said points of said metallic member, whereby said metallic member operates in cooperation with the adjacent metal portion of said vehicle as a loop antenna.

4. The combination with a vehicle, of a radio apparatus mounted on said vehicle, a bumper mechanically connected at points adjacent both ends thereof to an end of said vehicle, means to insulate said bumper from said vehicle at one of said points of connection to said vehicle, means to ground to the adjacent metal portion of said vehicle the portion of said bumper adjacent the end thereof remote from said one of said points, and means to connect said radio apparatus to said bumper at a point thereof adjacent to said insulated point of connection, whereby said bumper operates in conjunction with said adjacent portion of said vehicle as a loop antenna.

5. In a motor vehicle, a two-way radio communication system comprising radio signal apparatus mounted on said vehicle adjacent to the rear end thereof, a bumper mechanically connected at two spaced points thereof to said vehicle at said rear end thereof and extending across said end, said bumper being spaced from said end and from the ground a substantial distance, means to insulate said bumper from said vehicle at one of said points, means to ground said bumper to said vehicle at the other of said points and means to connect electrically said signal apparatus to said one of said points of said bumper, whereby said bumper operates in cooperation with the adjacent metal portion of said vehicle as a loop transmitting antenna member in said communication system.

6. In a vehicle, a radio apparatus mounted on said vehicle, a bumper mounted on an end of said vehicle and extending across said end, said bumper being spaced a substantial distance from the ground and from the adjacent metal body portion of said vehicle, said bumper having a main body portion and reentrant portions at the extremities of said main body portion, the inner extremities of said reentrant portions being mechanically connected to said frame, means to insulate one of said last-named extremities from said frame, means to ground the other of said inner extremities to said adjacent metal body portion of said vehicle, said reentrant portions being the sole supporting elements extending from said frame into electrical connection with said main body portion, and means to connect electrically said radio apparatus to said bumper at the extremity thereof insulated from said frame, whereby said bumper operates in cooperation with said adjacent metal body portion of said vehicle as a loop antenna.

7. The combination with a vehicle, of a radio apparatus mounted in a concealed position in said vehicle at a point adjacent to the rear end thereof, a bumper mechanically connected at two spaced points thereof to said rear end of the vehicle and extending across said end, said bumper being spaced from said end and from the ground a substantial distance, means to insulate said bumper from said vehicle at one of said points, means to ground said bumper to the adjacent metal portion of said vehicle at a portion of said bumper adjacent to the other of said spaced points, and electrical connections between said radio apparatus and said bumper so arranged that said bumper is adapted to operate in cooperation with the adjacent metal portions of said vehicle as an antenna without noticeable change in the appearance of said bumper and said portions of said vehicle.

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