Feb. 10, 1931. D. J. STEWART 1,792,193

TRANSMITTING ANTENNA

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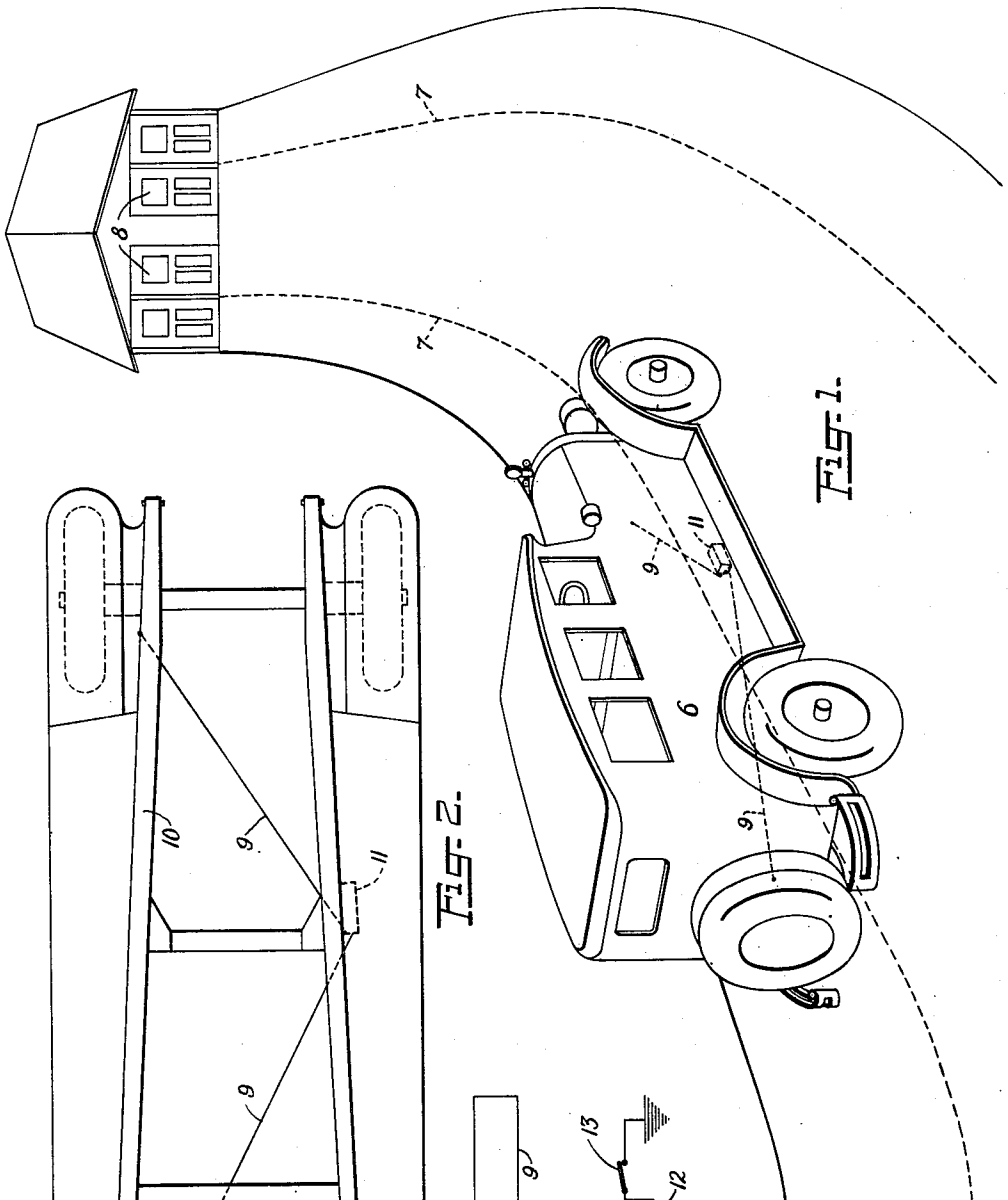


Fig. 1.

Fig. 2.

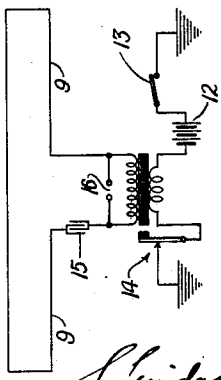


Fig. 3.

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Fig. 4.

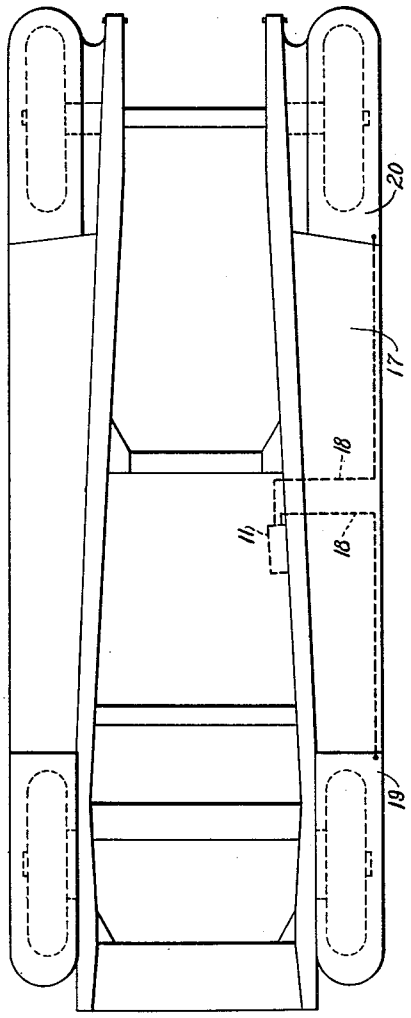
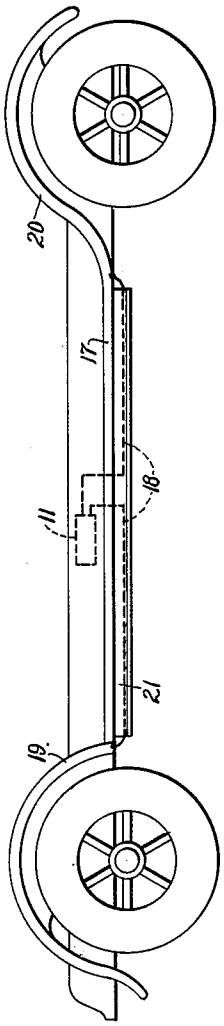


Fig. 5.



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UNITED STATES PATENT OFFICE

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TRANSMITTING ANTENNA

Application filed June 6, 1927. Serial No. 196,710.

This invention relates to antennæ for transmitting radiant energy and more particularly to an antenna on a moving object, such as a motor vehicle.

In a copending application by Howard D. Colman Serial No. 175,377, filed March 14, 1927, there is disclosed a radiant energy signalling system for selectively controlling a power-driven garage door operator by signal combinations transmitted from a motor vehicle. The transmitting antenna of this system is carried by the motor vehicle while the receiving antenna preferably extends along the driveway leading to the garage building and is connected with a simple vacuum-tube receiving circuit for controlling a selective mechanism which is adapted to start the driving unit of a door operator upon the reception of a predetermined combination of signal impulses and space units.

In such a system, the two antennæ can be brought into relatively close association during signalling, and therefore the electromagnetic field as distinguished from the so-called electrostatic and radiation fields, all of which fields exist about or emanate from a transmitting antenna, may be utilized to control the selector, it being a known fact that the electromagnetic field is very strong in the vicinity of an antenna but that the strength of the field decreases rapidly as the distance from the antenna increases. On account of this close association of the antenna, a low power transmitter may be used which will not materially affect the radio receiving sets in the neighborhood, and yet the detector circuit used may be simple and rugged in construction.

In the system above mentioned, the antenna should be mounted on the vehicle so that it will not disfigure the vehicle or interfere with its operation; so that it may be easily installed; and so that it will not be disturbed in the ordinary use of the vehicle, that is, it should be protected mechanically by the parts of the vehicle. To meet these requirements, it is desirable to place the antenna beneath the body structure of the vehicle. But it has been found that when an insulated antenna is mounted beneath the vehicle in close association with the metallic parts thereof such as the chassis frame structure and electromagnetic fields created about the antenna when a current is caused to flow therein are relatively weak and cannot be detected readily.

The primary object of the present invention is to provide a transmitting antenna on a motor vehicle which meets the above requirements as to location and installation and which at the same time is capable of producing signals of such strength as to insure the operation of a receiving mechanism having a simple detector circuit.

Another object is to provide a transmitting antenna on a motor vehicle which is shielded above and laterally by the metallic frame and body structure of the vehicle thereby minimizing the effect of the electromagnetic fields produced thereby on the radio receiving sets in the surrounding neighborhood.

Still another object is to provide a transmitting antenna which is particularly adapted for use on vehicles having metal running boards.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a view of a motor vehicle and a garage showing transmitting and receiving antennæ associated therewith.

Fig. 2 is a plan view of the chassis of the motor vehicle showing the manner in which the transmitting antenna is mounted thereon.

Fig. 3 is a wiring diagram showing a suitable transmitting circuit.

Fig. 4 is a plan view of a motor vehicle frame structure showing a modified form of the invention.

Fig. 5 is a side view of the chassis frame shown in Fig. 4.

While I have illustrated the preferred embodiment of my invention, it is to be understood that various modifications may be made without departing from the spirit and scope of the invention as expressed in the appended claims.

In the drawings the invention is illustrated as applied to a motor vehicle 6 for transmitting electromagnetic fields of radiant energy for detection by a receiving antenna 7 to initiate the operation of the power operator for the doors 8 of a garage building so that the vehicle may enter or leave the garage. Two receiving antennæ are provided in the present instance comprising single wires embedded in the surface of the driveway leading to different parts of the garage. Both of these antennæ may be connected to a simple vacuum tube detector circuit (not shown).

The invention in general comprises a pair of electrical conductors mounted beneath the body of the vehicle so as to form therewith a closed loop which is disposed substantially in a vertical plane. In its most satisfactory form as exemplified by Figs. 1 and 2, the loop is formed by two wires 9 electrically connected at one of their ends to a frame bar 10 of the vehicle chassis and extending transversely of the chassis for connection with a transmitting unit 11. Preferably, the wires are extended diagonally of the chassis, one forwardly and the other rearwardly. However, the positions and lengths of the wires may be varied so as to avoid engagement thereof with the crank case or other parts of the vehicle normally positioned between the side channels of the chassis. Thus, one wire may be relatively short and connected to the frame of the vehicle close to the transmitting unit. It will be seen that by connecting the wires 9 to the frame bar 10 the metallic structure of the vehicle constitutes a part of the antenna loop. When thus mounted, the wires above mentioned are disposed relatively close to the ground but above the level of the running boards of the vehicle so that they are well protected mechanically against displacement under ordinary service conditions.

The transmitter comprises an induction coil the primary of which includes a battery 12, a control switch 13, and the usual interrupter 14. The antenna circuit includes the loop 9 and the usual condenser 15 and spark gap 16. One plate of the condenser is connected to the loop while the other plate is connected to the spark gap, the latter being connected to the other end of the loop. The secondary of the induction coil is connected in parallel with the spark gap. When the switch 13 is closed, the spark coil operates in a well-known manner to cause a damped alternating current to flow in the loop circuit, the frequency being determined by the circuit itself. The changing current in the loop creates a varying electromagnetic field. If a portion of the receiving antenna circuit is linked with flux due to the magnetic field about the antenna, an electromotive force will be created therein by mutual induction, and the voltages thus induced may be detected by the circuit connected to the receiving antenna.

The theoretical magnitude of the voltage induced in the receiving antenna is proportional to the time rate of change of the flux created by the currents in the transmitting loop which flux links with the receiving antenna. This rate of change of flux is in turn dependent upon the frequency of oscillation of the current in the transmitting loop, which frequency is determined by the transmitting circuit and is substantially constant. The rate of change of flux is also dependent upon the total flux linking with the receiving circuit for any given position of the vehicle with respect to the receiving antenna. The total flux is equal to the surface integral of the flux density taken over the surface enclosed by the receiving circuit. Therefore for any position of the vehicle relative to the receiving antenna, the strength of the impulses produced in the antenna and affecting the detector tube in the receiving circuit is determined by the frequency of the current alternating in the antenna circuit and also by the surface integral of the flux density over the surface bounded by the receiving antenna circuit. The flux density is substantially proportional to the current in the transmitting antenna.

While it is theoretically possible from the above considerations to compute the voltage induced in a receiving antenna due to the flux produced by a given current in a transmitting antenna, such computation is rendered practically impossible when the transmitting antenna is mounted on a motor vehicle as in the present instance. The problem of producing a strong electromagnetic field for detection by the receiving circuit is thus complicated where, by practical necessity, the transmitting loop is located in close proximity to the metallic structure of a motor vehicle and preferably underneath the body structure thereof. The frame and body structure of the vehicle may be considered as forming innumerable inductive circuits which link with the flux produced about the transmitting loop. Thus, when a current changes in the loop antenna, which constitutes a primary circuit, currents are induced in any adjacent secondary circuit with which the flux of the primary circuit links. The magnitude of this current depends upon the total flux linking with the secondary circuit and also upon the impedance of the secondary circuit. The currents in the secondary circuits in general flow in paths adjacent to and in directions opposite to the current in the primary circuit. The flux, due to the secondary currents, which links with the receiving antenna is therefore opposed to the flux due to the primary circuit. Since the reactance of the primary circuit is practically zero, the secondary currents cannot de-

crease the impedance in the primary and therefore the current in the primary cannot be increased to compensate for the secondary currents. The resultant effect of the existence of the metal parts of the vehicle adjacent the transmitting loop is to weaken the electromagnetic fields which constitute the signals in the present system.

The inductive effect of the metal parts of the vehicle can be considerably reduced by mounting the antenna loop in a substantially vertical plane with the lower leg of the loop positioned between the metallic parts of the vehicle and the ground but above the level of the running boards. However, in the present instance the inductive effect of the secondary circuits is minimized and the installation of the antenna is simplified by using the frame of the vehicle as the upper leg of the loop described above. With such an antenna, there will be some reduction in the flux about the loop due to the formation of eddy currents and to the counter-inductive effect of the innumerable circuits formed within the adjacent metal parts of the vehicle. Since the loop is electrically connected to these parts, the magnetizing current will flow therein in such a path that the impedance of the antenna circuit will be decreased to a minimum. This path is determined, of course, by the arrangement of the parts of the vehicle and is different for every kind of vehicle. However, I have found that, in every instance, the path of the primary current is such that the transmitter field is very strong beneath the vehicle. Therefore, during signalling with such an antenna the vehicle should be driven directly over the receiving antenna.

An important advantage of such an antenna located beneath the body structure of the vehicle is that the signals have practically no influence upon radio receiving sets in the neighborhood. This may be viewed as being due to the shielding of the antenna loop from above and laterally by the metallic body, running boards, and the like commonly provided on automotive vehicles. These parts form return paths for the flux which would otherwise pass laterally from the vehicle for detection by radio sets. This effect of the metallic body accounts for the necessity of driving the vehicle directly over the receiving antenna during signalling. The radiation and electrostatic fields emanating from such an antenna are very weak.

In Figs. 4 and 5 there is shown a modification of the invention comprising a loop antenna mounted beneath the metal running board 17. This loop is formed by two wires 18 connected at one of their ends to a transmitter unit 11. One wire extends rearwardly and is connected electrically to the running board near the rear fender 19 while the other is connected to the front fender 20. An insulating member 21 may be secured to the under side of the running board to maintain the shape of the loop. Thus, the metal running board together with the wires 18 constitute a closed loop which is disposed in a vertical plane at right angles to the running board. With this antenna, the currents induced in the running board are minimized and the inductive effect of the metallic parts of the vehicle is also reduced to a minimum by reason of the fact that the running board itself constitutes a part of the loop and further by the location of the loop remote from most of the metallic parts of the vehicle. An antenna thus mounted is not so well protected from injury as is the form shown in Figs. 1 and 2, but is capable of transmitting strong signals. The electromagnetic field about this antenna is not confined to a downward direction so that it is not necessary to position the vehicle directly over the receiving antenna during signalling.

I claim as my invention:

1. The combination with the chassis frame of a motor vehicle, of a pair of conductors extending transversely and diagonally of said frame, said conductors being connected electrically at one of their ends to said frame so as to form therewith a loop antenna.

2. The combination with a motor vehicle of a transmitting antenna loop mounted beneath the body structure of the vehicle and having its opposite side portions disposed one above the other so that the loop extends upwardly in a substantially vertical direction.

3. The combination with a motor vehicle, of a closed transmitting antenna circuit positioned beneath the body of said vehicle, a portion of the metallic structure of the vehicle constituting a part of said circuit.

4. The combination with a motor vehicle of a transmitting antenna beneath the metallic body structure of the vehicle and partially enclosed thereby, said body structure thereby constituting a shield substantially preventing the emanation of radiant energy fields from the antenna in upward and lateral directions.

5. The combination with a motor vehicle having a metallic chassis frame structure, of a wire connected to and extending transversely of said frame structure to form therewith a transmitting antenna loop.

6. The combination with the chassis frame of a motor vehicle, of a pair of conductors extending transversely of said frame, said conductors being connected electrically at one of their ends to the metallic structure of the vehicle so as to form therewith an antenna loop.

7. In a system of the character described for signalling from a moving motor vehicle, the combination of a receiving antenna comprising a conductor extending along the roadway over which said vehicle is to pass, a ra-

diant energy transmitter on said vehicle, and an antenna loop mounted beneath the body structure of said vehicle and adapted to be energized in the operation of said transmitter, said loop having opposite side portions disposed one above the other so that the loop extends upwardly whereby the fields of radiant energy emanating therefrom link effectually with said receiving antenna.

8. In a system of the character described for signalling from a moving motor vehicle, the combination of a receiving antenna comprising a conductor extending along a driveway over which said vehicle is to pass, a radiant energy transmitter on said vehicle, and an antenna loop adapted to be energized in the operation of said transmitter and mounted beneath the metallic body structure of the vehicle so as to be shielded by said structure whereby the latter effectually prevents the emanation of radiant energy fields from said transmitting loop except in a downward direction, said transmitting loop being disposed so that the radiant energy fields emanating therefrom link with said receiving antenna.

9. In a system of the character described for signalling from a moving motor vehicle, the combination of a radiant energy transmitter having two terminals, one connected to the metallic structure of said vehicle, a wire conductor connected to said other terminal and extending in a direction generally longitudinally of said vehicle, said wire being connected at its other end to the metallic structure of the vehicle so that said conductor, said metallic structure and said transmitter form a closed antenna loop disposed in an upwardly extending plane.

In testimony whereof, I have hereunto affixed my signature.

DUNCAN J. STEWART.