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WIRELESS TRANSMISSION SYSTEM

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Fig. 1

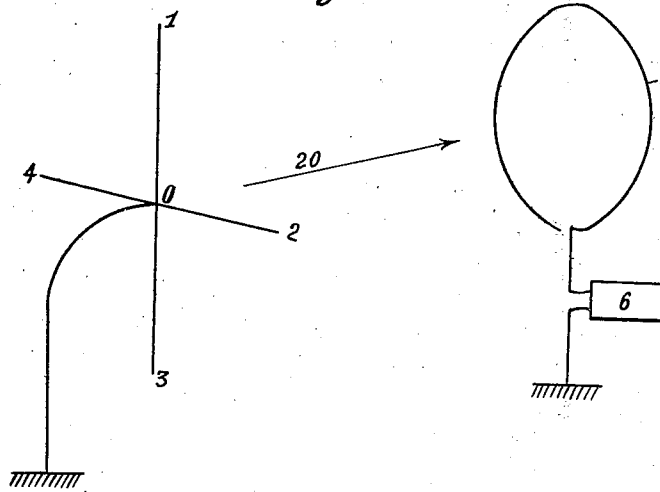
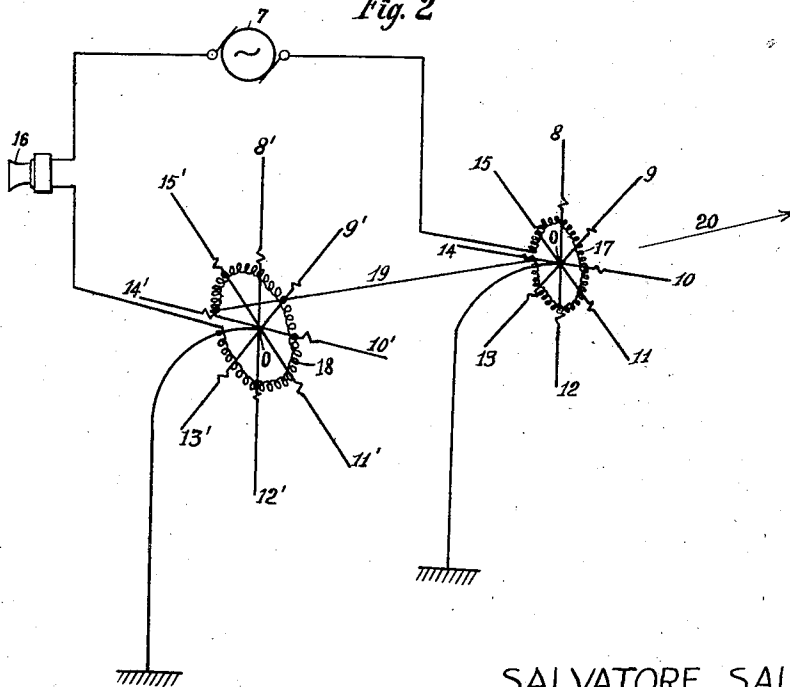


Fig. 2



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WIRELESS TRANSMISSION SYSTEM

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8 Claims. (Cl. 250—11)

This invention relates to a system for radiating energy by means of electromagnetic waves so as to concentrate a maximum of radiation in a given direction so that the receiving station will collect a maximum of energy, and particularly involves a system in which directional emission is obtained by producing a rotating electromagnetic wave disturbance which is capable of being intercepted and detected by the mentioned receiving station.

The main object of my invention is to produce electromagnetic waves polarized in a circular manner, which waves are produced in a reliable manner absolutely regular in form.

Another object is to so propagate radiating energy in a given direction that the transmitted signals shall not be intercepted by receiving stations located in other directions than that of the transmitted wave.

A further object is to provide a system of directional wireless transmission adapted for emission of a modulated or unmodulated rotary electromagnetic field by using aerials or aerial components which are excited by a progressive wave flowing in a circuit coupled with said aerials or aerial components.

Other objects and the various advantages inherent in the nature and embodiment of my invention will appear more fully in detail as the specification proceeds.

In the accompanying drawing forming part hereof,

Figure 1 is a diagram illustrating a basic principle of my invention.

Figure 2 illustrates an embodiment of my invention in one simple but practical form.

As already indicated the system constituting the present invention involves a special arrangement of antennae and their components.

The system advantageously comprises a plurality of aerials disposed radially of a common point and located substantially in a plane perpendicular to the direction of transmission and the progressive wave may be applied by use of a coil preferably of ring formation disposed about such common point. The wave traverses the coil in such fashion that a complete wave with its maxima and minima is included in the coil and such wave, in traversing the coil, sets up an electromagnetic field which turns about an imaginary axis perpendicular to the plane of the coil. Each aerial is coupled either inductively or capacitatively with the coil and is consequently excited with a phase displacement corresponding to its point of coupling with the coil. Thus, if these

couplings are distributed equally along the length of the coil, that is if the aerials are equi-angularly spaced, there will be set up in the aerials, a progressive excitation which will pass successively from a maximum to a minimum and these maxima and minima will be always displaced 180° with respect to each other in diametrically opposite aerials which will thus have the same excitation but of opposite phase. At the same time, each aerial will pass successively through all its values gradually from a maximum to a minimum.

The system provides an electromagnetic field polarized in circular sense comparable to that of a ray of light, if one considers a single one of the innumerable vibrations of which a ray of light is composed. The properties of these electromagnetic vibrations are such that they maintain their direction of propagation, which in the present case is perpendicular to the plane of the aerials, and are able to serve very well for connecting transmitting and receiving stations either for radio-telegraphic or radio-telephonic signalling purposes or for transmitting electromagnetic energy through space.

Referring again to the drawing, it has already been mentioned that Figure 1 illustrates the basic principle of the invention, wherein it may be seen that the transmission system primarily involves a series of simple aerials or aerial components such as 1, 2, 3, 4 which radiate in the form of a star from a central point which is grounded, and disposed vertically so as to face the receiving system.

While the latter is illustrated as a Hertz resonator 5, it might on the other hand be a Marconi aerial properly tuned to the length of the carrier wave of the transmission system or apparatus. The mentioned receiving system will oscillate if it is encountered by this radiation and will transmit potential variations to a detector device 6. If the carrier wave is modulated during transmission, it will be possible to detect the modulation of said wave by means of an ordinary receiving system, whether it be a telephonic or telegraphic receiver, and to use the received energy either as electrical energy or as mechanical energy after conversion by suitable means. The aerials 1, 2, 3, 4 are of a length equal to one quarter of the wave and in practice are excited in such a manner that between any one of them and the next, there is a phase displacement of a quarter the wave length, so that the anti-node of maximum positive potential at the end of the aerials obtains successively on, for instance, aerials, 1, 2, 3, 4, 1, 2, 3, 4, and

so on, whilst at the same time the anti-node of the maximum negative potential passes from aeri-
als 3, 4, 1, 2, 3, 4, 1, 2 and so on. Such an
arrangement will produce a rotary electromag-
netic wave which will travel along an imaginary
axis theoretically at right angles to the plane
of the aeri-als. Deviation from said direction
may be subsequently produced by the conductiv-
ity of the earth and by the magnetic field there-
of, but if the effects of these are previously
known, it is possible to direct the beam in the
desired direction by making an appropriate cor-
rection. For the emission of the rotary electro-
magnetic field, it would theoretically be suffi-
cient to have three aeri-als suitably excited with
a displacement of $\frac{1}{2}$ phase but in practice the
number of aeri-als may be greater as indicated
by Figure 1 and also by Figure 2 which shows
diagrammatically a transmitter with eight
aeri-als 8, 9, 10, 11, 12, 13, 14, 15 arranged in the
form of a star in a vertical plane with angles
of 45° included between the aeri-als.

The aeri-als illustrated in Figure 2 may be
excited by means of a coil 17 of ring formation
which is suitably dimensioned to constitute the
source of a complete progressive wave generated
by an oscillator 7 and modulated by a micro-
phone 16 in order to produce the mentioned
progressive wave in accordance with the prin-
ciples of the invention. For the purpose of in-
suring that the wave in the exciting circuit shall
be progressive, characteristics of the coil should
be such as to correspond with the following for-
mula:

$$\frac{R^2}{4L^2} > \frac{1}{LC} \text{ or in the extreme case } = \frac{1}{LC}$$

where R is the resistance of the circuit 17, 19,
18, 16, 7; L the self-induction of such circuit and
C the capacity. (The parts 18, 19 are herein-
after referred to.) The propagation speed of
the wave along the coil can be deduced from
Lecher's expression, or from the general formula
of the propagation theory, or by experiment.

The maxima and minima of the carrier wave
travel through all of the turns of the annular
coil and create a complete wave travelling along
the turns of the coil. The aeri-als coupled induc-
tively or capacitatively to said coil receive
impulses with phase displacements corre-
sponding to the points of coupling thereto and
as said points are uniformly distributed along
the coil, the aeri-als are excited with equal phase
displacements.

Of course care must be taken that the constants
of the aeri-als are uniformly distributed along
the aerial wire in order to obtain satisfactory
emission and uniform distribution of the po-
tential and current along the aerial. The speed
of propagation of the field or disturbance along
the aerial wire should also be at maximum and
as near as possible to the speed of propagation
of electromagnetic waves in space.

Waves thus created by such a system would be
radiated in space in the two directions which are
at right angles to the plane of the aeri-als. How-
ever in order to avoid radiation in one of these
two directions a reflector is disposed at a distance
equal to or a multiple of $\frac{1}{4}$ of the wave length
from the transmitter, which reflector comprises
a star of aeri-als as shown by way of example in
Figure 2, at 8', 9', 10', 11', 12', 13', 14' and 15',
similar to that of the transmitting aeri-als and
each excited in opposite phase to the correspond-
ing transmitting aerial. In this manner all ra-

diation in the undesirable direction is eliminated
by means of interference, and emission in the
desired direction is reinforced.

The reflector is excited in the same manner as
the transmitting system of aeri-als, the aeri-als
8', 9', 10', 11', 12', 13', 14' and 15' being also pro-
vided with an annular coil 18 through which the
electromagnetic wave travels in the form of a
complete wave. The coil of the transmitter and
the coil of the reflector are connected together by
means of conductor 19 and are designed to have
such constants that the electromagnetic wave is
transmitted with a proper displacement to pro-
duce opposition of phase between the reflector
and aeri-als and the corresponding aeri-als of the
transmitter. In this manner the propagation of
electromagnetic waves towards the reflector may
be completely neutralized by interference be-
tween the waves of the reflector and those of the
transmitter. At the same time the propagation
in the opposite direction will be increased.

The number of aeri-als in the reflector may be
greater or less than in the transmitter and in an
extreme case may be practically infinite and re-
placed by a metal plate or other good electrical
conductor. Direct excitation of the reflector is
also not essential; it may be excited by induction
from the transmitter aeri-als. If a metal plate is
employed, it may act as a Hertzian reflector, in-
tercepting at the same time the electromagnetic
flux in the desired direction.

It is of course commonly known to produce cir-
cular polarized waves with wireless transmission
by means whose operating characteristics are
based on the principle of exciting angularly dis-
posed aeri-als by two or more circuits in which
phase displaced currents through a common gen-
erator are produced by using suitably disposed
inductances and capacities.

However, the present system of transmission of
electromagnetic energy has, among other advan-
tages, over all other heretofore known arrange-
ments of directional wireless transmission, the
great advantage that it attains a greater concen-
tration inasmuch as the rotary electromagnetic
waves radiated into space tend to retain their
direction of propagation apart from any influence
of terrestrial electromagnetic fields.

Whirling electromagnetic motion produced
laterally of the central axis enlarges the field of
electromagnetic wave propagation, the zero field
being at a relatively small distance from the said
axis. Thus it is impossible outside this restricted
field of wave radiation to intercept communica-
tions transmitted. The field of electromagnetic
wave propagation being thus concentrated, it will
be readily understood that the quantity of energy
collected at the receiving station will be much
greater than in systems hitherto known. The
electromagnetic energy received may be utilized
as such or converted into mechanical energy.

Variations may be resorted to and parts used
without others within the scope of my invention.

Having now fully described my invention, I
claim:

1. A directional wireless transmission system
adapted for emission of a modulated or an un-
modulated rotary electromagnetic field in a highly
concentrated beam, comprising a plurality of
aerial members interconnected at a common point
and projecting therefrom in different directions,
a coil coupled with said aerial members and both
concentrically disposed with respect to said com-
mon point and located within the extremities of
said aerial members, and means for causing a

progressive wave to flow in said coil, and thereby excite said aerial members.

2. A directional wireless transmission system adapted for emission of a modulated or an unmodulated rotary electromagnetic field in a highly concentrated beam, comprising a plurality of aeri-als interconnected and radially disposed with respect to a common point and located in a plane substantially perpendicular to the direction of transmission, a substantially annular circuit concentrically disposed with respect to said common point in a plane parallel to said first plane and coupled with said aeri-als and means for causing a progressive wave to flow in said circular circuit to said aeri-als.

3. A directional wireless transmission system adapted for emission of a modulated or an unmodulated rotary electromagnetic field in a highly concentrated beam, comprising a plurality of aeri-als which are connected at, and radially disposed with respect to a common point and located in a plane substantially perpendicular to the direction of transmission, and means for applying a progressive wave to said aeri-als for emission therefrom, including a coil of ring formation coupled with said aeri-als and concentrically disposed about said common point, said aeri-als being equidistantly spaced so as to form substantially equal angles with each other and also projecting radially beyond said coil.

4. A directional wireless transmission system adapted for emission of a modulated or an unmodulated rotary electromagnetic field in a highly concentrated beam, comprising a plurality of interconnected radially projecting and equally spaced aerial members, and means for applying a progressive wave to said aeri-als for emission therefrom, including a coil of ring formation coupled with said aerial members in proximate relation thereto, said aeri-als projecting radially beyond the outline of said coil.

5. A wireless transmission system according to

claim 1 provided with an electromagnetic reflector both similar in construction to the aerial members and the coil coupled therewith and spaced a distance equal to at least one-fourth of the wave length or a multiple thereof from the aerial members, and which reflector is adapted to produce electromagnetic waves which cancel the electromagnetic waves emitted in a predetermined direction by said transmitting aerial members.

6. A wireless transmission system according to claim 2 provided with an electromagnetic reflector both similar in construction to the aeri-als and the annular circuit coupled therewith and spaced a distance equal to at least one-fourth of the wave length or a multiple thereof from the aeri-als, and which reflector is adapted to produce electromagnetic waves which cancel the electromagnetic waves emitted in a predetermined direction by said transmitting aeri-als.

7. A wireless transmission system according to claim 3 provided with an electromagnetic reflector similar in construction to the aeri-als and the coil coupled therewith and spaced a distance equal to at least one-fourth of the wave length or a multiple thereof from the aerial structure, and which reflector is adapted to produce electromagnetic waves which cancel the electromagnetic waves emitted in a predetermined direction by said transmitting aerial structure.

8. A wireless transmission system according to claim 4 provided with an electromagnetic reflector both similar in construction to the aerial members and the coil capacitatively coupled therewith and spaced a distance equal to at least one-fourth of the wave length or a multiple thereof from the aerial structure, and which reflector is adapted to produce electromagnetic waves which cancel the electromagnetic waves emitted in a predetermined direction by said transmitting aerial structure.

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