

April 7, 1942.

W. PETERS

2,278,560

ANTENNA

Filed Sept. 30, 1939

Fig. 1

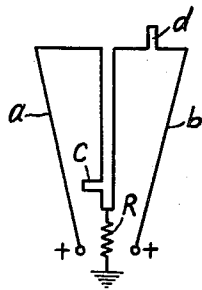


Fig. 2

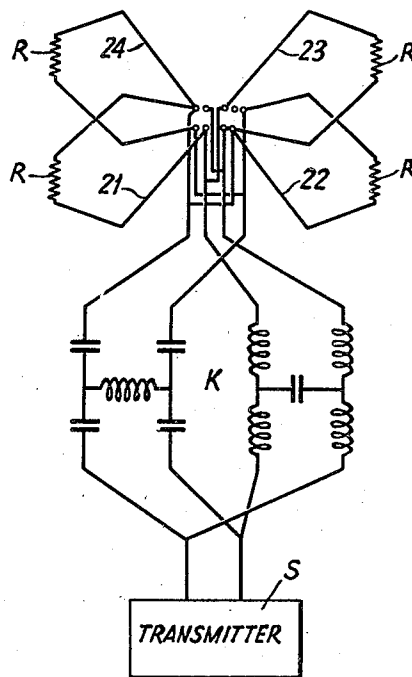


Fig. 3

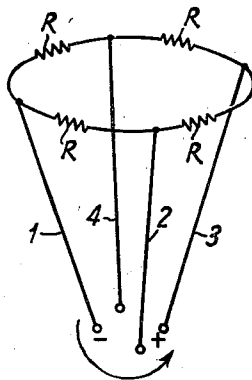


Fig. 5

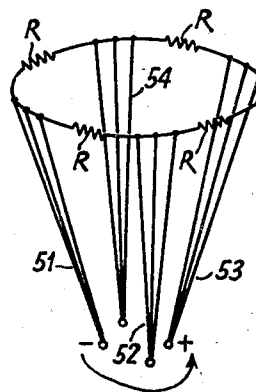
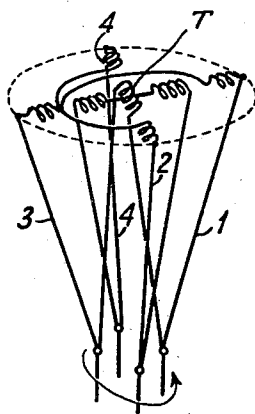


Fig. 4



INVENTOR
WILHELM PETERS
BY *H. S. Snover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,278,560

ANTENNA

Wilhelm Peters, Berlin, Germany, assignor to
Telefunken Gesellschaft für Drahtlose Tele-
graphie m. b. H., Berlin, Germany, a corpora-
tion of Germany

Application September 30, 1939, Serial No. 297,296
In Germany July 21, 1938

9 Claims. (Cl. 250—33)

The invention relates to an antenna arrange-
ment, more especially for short waves and ultra-
short waves such as is used primarily for sending
out television programs. Therefore, the antenna
must be matched with the transmitter for a very
wide frequency band. The maximum radiation
should be directed towards the horizon to cover
as wide a territory as possible. The radiation
upwards should be but slight. Furthermore, the
radiation about the antenna should be as uniform
as possible, but there also should be the possi-
bility of providing a preferred radiation in the
one or the other direction. Since a wide fre-
quency band is to be transmitted, which means
that the amplitudes of the various frequencies
within the band are to be radiated in a uniform
fashion, the wattless resistance within the fre-
quency range must be constant, at any rate it
should vary at least to a very slight degree only.
Furthermore, the antenna should have a high
radiation resistance and high degree of efficiency
of the radiation in order to realize as high an
intensity of the receiving field as possible.

Attempts have been made to fulfill these con-
ditions by means of a cone shaped antenna or
double cone antenna which is made to oscillate
in standing waves and which is tuned to the
carrier wave. For the choice of this antenna the
important point was that the cone shape has a
lower wave resistance than a corresponding rod-
shaped antenna and that, therefore, for variation
of the frequency in the vicinity of the tuning fre-
quency a lower gradient of the wattless resistance
exists. Unfortunately, the radiation conditions
of the cone antenna are in the case of standing
waves poorer than in the rod-shaped antenna
since, due to the difference in travel length of the
waves, the useful field intensity radiated de-
creases in the horizontal while the radiation up-
wards increases in an oblique direction in an un-
desirable way.

The invention described in the following aims
at providing an antenna shape whose wattless re-
sistance practically disappears and which still
assures a more favorable radiation than does the
ordinary cone antenna. In order to obtain a
matching of the transmitter with the antenna
throughout a wide frequency band, the arrange-
ment according to the invention uses individual
radiators which are made to oscillate in travelling
waves. However, such radiators have, as is
known, a highly unilaterally directional diagram.
Hence, with a single antenna excited in progres-
sing waves, a horizontal non-directional diagram
can never be obtained. This is accomplished in

accordance with the invention in that a suitable
number of such radiators excited by travelling
waves are disposed symmetrically about a center,
more especially such that a cone-like, or other
rotationally symmetrical combination of radia-
tors is employed. The lengths of said radiators
lie along the surface of a rotationally symmetrical
conic solid of revolution and are preferably con-
nected to the excitation source at their ends
which are most closely adjacent. The further
advantage of utilizing travelling waves resides
also in the fact that a unilateral directive ray
action is therewith obtained. Therefore, a
favorable shielding of the frontal radiators with
respect to those at the rear can be achieved and
vice versa, so that disturbances caused by travel
differences are prevented. In this way the radia-
tion in the main direction of the ray, for instance
in the horizontal, will be amplified. In order to
attain highest ray intensities there is an optimum
angle of divergence of the cone.

Antennas with progressing waves are known as
such in the form of directional radiators, for in-
stance as single wire-Beverage antenna, as twin
wire V-antenna, or as four wire-rhombic an-
tenna. These antennas are built ordinarily to
provide a horizontal polarization of the elec-
trical field strength so that the wires extend
parallel to the ground. Since, in the above stated
modes of construction, the antennas are built
for wide frequency ranges extending from about
15 m. to 60 m., the radiator length must be several
wavelengths, in order to prevent the radiation
from being influenced by the variation of the
wavelength. For non-directional radiators which
operate with a single carrier, for instance an-
tennas for television, relatively shorter radiation
wires of about one-half wavelength and less can
be employed advantageously. In accordance
with the invention in order to realize a horizontal
non-directional radiation a number of elementary
radiators of V-shape, for instance, are so ar-
ranged in a circle that the sides thereof form a
cone, as shown in Figure 1, while Figure 2 shows
an example of construction for a rotary field
antenna formed of four vertically disposed
rhombi 21—24 extending in four directions and
fed in a phase sequence; Figure 3 shows the ar-
rangement of the radiators on the surface of a
conic solid of revolution with a ring-like con-
nection and Figure 4 shows an example of con-
struction of a rotary field antenna with return
feed to the radiator ends nearest the transmitter,
and Figure 5 shows a modification of Figure 3.
The return line, according to Figure 1, is so ar-

ranged in the axis of the cone that the return of two diametrically situated radiators a and b are relatively displaced by such travel difference that the radiators of the partial waves of the central wires eliminate one another. This can be accomplished, for instance, by means of phase shifting loops c and d which for variation of the wavelength must be altered. This difficulty can be overcome by rectifying the current of the travelling waves before its return.

The assembling of individual radiators having travelling waves of equal phase furnishes a more or less star-shaped diagram depending on the number and diagram sharpness of the individual radiators. In order to round off still more this diagram, the individual radiators are, in accordance with the present invention, fed in a phase sequence moving about the center of the arrangement, such that a rotating field will be obtained as radiation field which rotates with the frequency of the carrier wave, or fraction, or multiple thereof. In accordance with a further idea of the invention a non-directional radiation antenna arrangement is formed by several directional individual radiators such that several directional antennas are excited by travelling waves having such relative phases that a rotating radiation field is produced. The individual radiators are arranged preferably on surfaces of revolution such as cones, or double cones.

Aside from the already mentioned advantage, namely, that the wattless resistance and the gradient of the wattless resistance are equal to zero in a very wide frequency range and that the ray action is unilateral, such an antenna arrangement has the following further advantages: The difficulty of the return through a non-radiating wire is overcome since the sum of the currents must always be zero at the point of joining. By means of the rotational field it is accomplished that two diametral radiators or generally two radiators relatively displaced by a pole division are connected together through a terminal resistance R . However, the energy can be made available again for the transmitter by means of coupling the rotary field and by return, as shown in Figure 4. The coupling of the rotary field affords in particular a very simple regulation for variation of the wavelength. Also, in this case there is obtained a most favorable opening angle and resultant diameter in which the conically arranged radiators are situated. More especially may it be favorable to arrange the antenna in a frustum of a cone. The connecting together of the individual radiators in the base surfaces of the cone can be done by means of radial wires or also by means of annular rings.

The coupling in each of the examples may be done by inductive means or capacitive means. In all these examples of construction the antennas are formed by four elements. The radiators spacially displaced at 90° are fed with voltages displaced by 90° . The voltage is produced, for instance, in a known manner by means of phasing loops, chain conductors or by two generators having their phases displaced by 90° . The antenna in accordance with the invention may, as is obvious, also consist of any other even number of individual radiators such as six radiators for instance. In this case the voltages in the case of rotary field feed, must be displaced by 60° .

Figure 2 represents an example of construction for the production of voltage oscillating in a displaced fashion whereby a chain conductor arrangement K is used. If the wave resistance of

the two diametrically disposed radiator lead-ins is additionally matched with the respective radiation resistance, it can be accomplished that the ohmic terminal resistance R remains relatively low while the efficiency of the antenna is favorable even without the use of a special return feed. The decrease of the wave resistance towards the end is obtained in this case in that the individual wires are substituted each by three wires for instance, as shown by radiator 51—54 of Figure 5, which diverge towards the end. In Figure 4, the non-radiated energy is applied again to the transmitter through a rotary field coupling with the aid of a rotation field transformer T such as is proposed already for rhombus antennas according to a copending Moser application, Serial #205,198, filed April 30, 1938. By twisting the primary part of the transformer relative to the secondary part thereof the energy feed can be accurately set for progressing waves on the radiator wires.

The arrangements just described relate to non-directional radiators for vertically polarized field intensities such as required in particular for television purposes. However, cases are conceivable in which non-directional radiators may be employed for horizontally polarized field intensities such as, for instance, for electric markers or for direction finding utilizing several radiators radiating rotating fields of opposite direction, of rotation. The idea of the invention of the rotary field antenna with progressing waves can also be applied and used for non-directional radiators for a horizontally polarized field.

I claim:

1. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of the surface of a conic solid of revolution, means for so energizing said conductors at their most closely adjacent ends and means for so terminating said conductors at their other ends that a traveling wave is set up along said conductors, said conductors being so energized from said means that the instantaneous phase relationship of energy in said conductors progressively advances around said surface whereby a rotating field of radiation is established.

2. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of the surface of a conic solid of revolution, means for energizing said conductors at their most closely adjacent ends, the instantaneous phase relationship of the energy in adjacent conductors progressively advancing around said surface whereby a rotating field of radiation is established and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors whereby a traveling wave is set up along said conductors.

3. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of a conical surface of revolution having the axis of revolution vertical, means for so energizing said conductors at their most closely adjacent ends that the instantaneous phase relationship of the energy in adjacent conductors progressively advances around said surface whereby a rotating field of radiation is established and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors whereby a traveling wave is set up along said conductors.

4. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of a surface of revolution formed by rotating a rhombus about a vertical axis outside of said rhombus, means for so energizing said conductors at their inner ends that the instantaneous phase relationship of the energy and adjacent conductors progressively advances around said surface whereby a rotating field of radiation is established and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors whereby a traveling wave is set up along said conductors.

5. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of a surface of revolution formed by rotating a rhombus about a vertical axis outside of said rhombus, and means for so energizing said conductors at their inner ends and so terminating said conductors at their other ends that a traveling wave is set up along said conductors, the instantaneous phase relationship of the energy in adjacent conductors progressively advancing around said surface whereby a rotating field of radiation is established.

6. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of a conical surface of revolution, means for energizing said conductors at their more closely adjacent ends so that a traveling wave is set up along said conductors, the instantaneous phase relationship of the energy in adjacent conductors being such that a rotating field of radiation is established, and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors, said last mentioned means comprising a series connected ring of resistors joining said outer ends.

7. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of the surface of a conic solid of revolution, means for energizing said conductors at

their most closely adjacent ends, the instantaneous phase relationship of the energy in adjacent conductors progressively advancing around said surface whereby a rotating field of radiation is established and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors whereby a traveling wave is set up along said conductors, said last mentioned means comprising a series connected ring of resistors joining said outer ends.

8. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of the surface of a conic solid of revolution, means for energizing said conductors at their most closely adjacent ends, the instantaneous phase relationship of the energy in adjacent conductors progressively advancing around said surface whereby a rotating field of radiation is established and means connected to the outer ends of said conductors for preventing the reflection of energy from said outer ends back along said conductors whereby a traveling wave is set up along said conductors, said last mentioned means comprising means for conducting all radiation arriving at said outer ends to said inner ends.

9. An antenna comprising a plurality of conductors arranged with their length parallel to the generatrix of the surface of a conic solid of revolution, means for so energizing said conductors at their most closely adjacent ends and means for so terminating said conductors at their other ends that a traveling wave is set up along said conductors, said conductors being so energized from said energizing means that the instantaneous phase relationship of the energy in said conductors progressively advances around said surface whereby a rotating field of radiation is established, each of said conductors comprising a plurality of wires connected together at said first mentioned ends and fanned out towards the other ends.

WILHELM PETERS.