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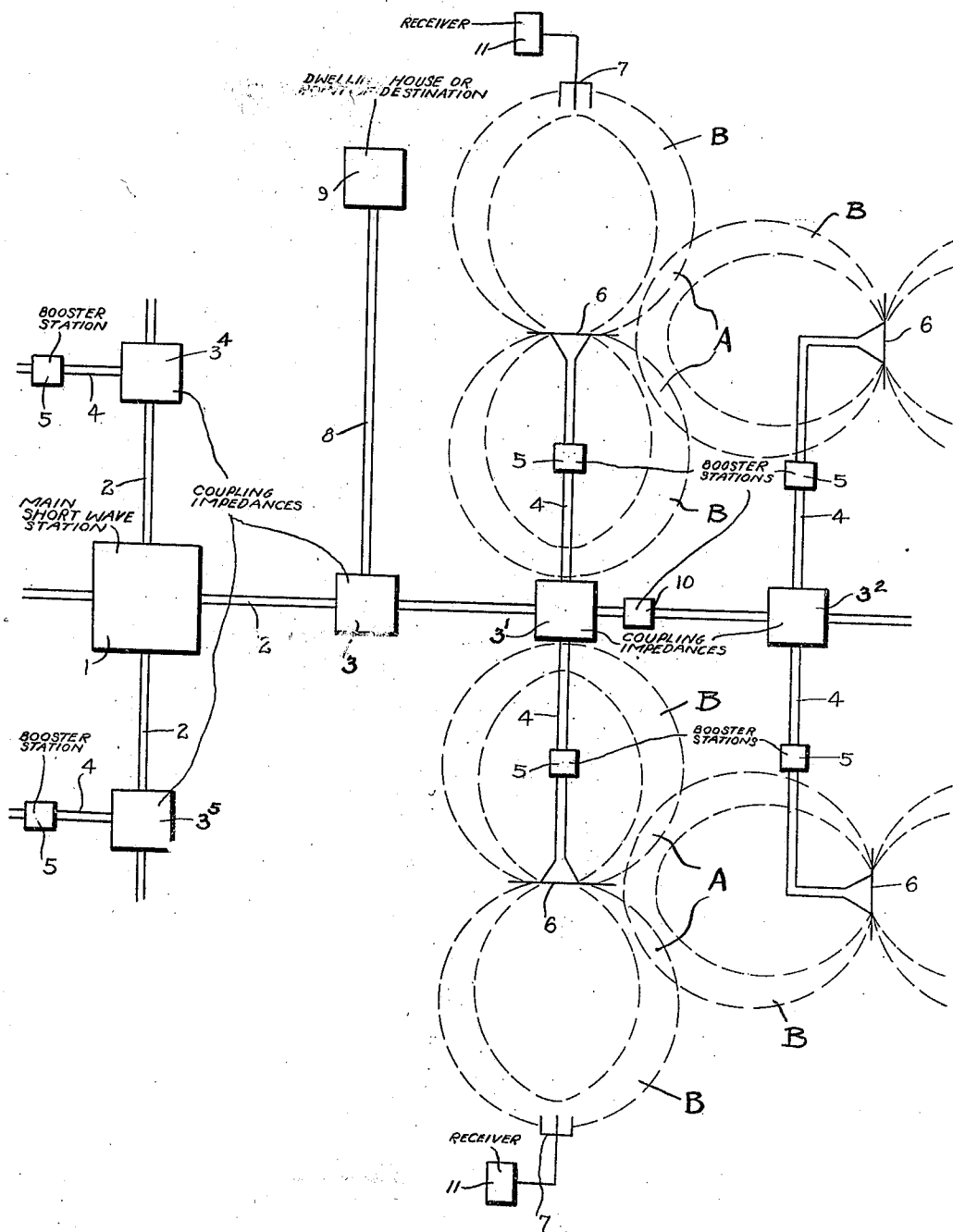
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ELECTROMAGNETIC WAVE SIGNALING SYSTEM

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ELECTROMAGNETIC WAVE SIGNALING
SYSTEM

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6 Claims. (Cl. 250—6)

This invention relates to an improved elec-
tromagnetic wave signaling system and has par-
ticular reference to a more efficient system for
distributing electromagnetic wave signaling en-
ergy.

One of the principal objects of the invention
is to provide a method of distributing ultra short
wave signals over a large area.

Another important object of the invention is
to provide an improved method of broadcasting
television signals or signals having very wide
side-bands and of distributing said signals over
a large area.

Another important object is to provide an im-
proved short wave arrangement whereby trans-
mitting stations can be so located as to broad-
cast ultra short wave bands over selected areas
to effect distribution over a large area, and to
arrange such stations so that there will be only
a limited interference pattern, if any, between
the stations wherein the broadcastings of one
station overlap the broadcastings of the other.

Another object is to provide transmission lines
connecting a central station to a plurality of sepa-
rated stations which are in predetermined rela-
tion with each other and to provide means where-
by ultra short waves may be transmitted from
said separated stations over a continuous trans-
mission line or through space to their points of
destination.

Another object is to provide an improved ar-
rangement whereby ultra short wave signals may
be transmitted over direct lines to a plurality of
separated stations in predetermined relation with
each other, and to provide means at such stations
for keeping up a reasonable level of energy in
the direct lines and also to provide booster and
radiating stations of high power or medium power
along these lines for taking off to separate trans-
mitters.

Another object is to provide a novel means
and method for electromagnetic signaling in
which a source of modulated radio frequency en-
ergy is distributed to spaced points over a non-
radiating wire system and said signals are then
radiated, or broadcast, from radiators, or an-
tennas, connected to said wire system and which
are spaced so that the signals from the different
radiators, or antennas, do not substantially over-
lap.

Another object is to provide a novel signaling
system of the type above described in which a
master carrier wave of high frequency is modu-
lated by one or more modulated carriers of dif-
ferent frequency, which are in turn modulated

with television, audio or other desired signals,
then fed to radiating systems over a non-radiat-
ing system where the different signals are then
radiated from spaced radiators as desired.

Another object is to provide a signaling system
of the types above described in which the ra-
diators, or antennas, have directional charac-
teristics and are arranged so that their fields
of radiation do not substantially overlap.

Another object is to provide automatically op-
erating means in intermediate booster and trans-
mitting stations in lines of this character where-
by the said intermediate stations may be con-
trolled from the main station or station of ori-
gin.

Another object is to provide a multiple tele-
phone channel over a short wave transmission
line by which a very large number of messages
may be transmitted simultaneously.

Another object of the invention is to provide
an improved method by which television may be
economically distributed to the public through
the use of well known apparatus.

Other objects and advantages of the invention
will become apparent from the following descrip-
tion taken in connection with the accompanying
drawing, and it will be apparent that many
changes may be made in the details of construc-
tion, arrangement of parts and methods shown
and described without departing from the spirit
of the invention as expressed in the accompany-
ing claims. I, therefore, do not wish to be lim-
ited to the exact details and methods shown and
described as the preferred forms only have been
shown by way of illustration.

Referring to the drawing:

The figure illustrates diagrammatically the
method by which I distribute short wave signals
to produce a large field of radiation.

It is well known that the broadcasting of tele-
vision over the ordinary radio wave lengths is not
at present feasible because of the width of the
side bands required to produce good television
pictures. For example, to produce ordinary fair
television pictures, the width of the side bands
should be at least 100 kc. which is greater in
width than from 580 to 760 kc. in which interval
there are now in actual use substantially 18
bands for present broadcasting. If these 18 nor-
mal broadcasting bands were simultaneously
available, even then the television station would
be too limited in band width for excellent defi-
nition. As is well known the really feasible po-
sition for television is in the very short wave
length, say 5 meters which has a frequency of

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60,000 kc., so that 100 kc. each side of this 60,000 would not be of much consequence, and would be well within the range of reception of the 60,000 kc. receiver. In fact, it would not be at all im-
 5 possible to run 1,000 kc. each side of the 60,000 (i. e. 61,000 to 59,000 kc.) and the width of the side bands would be no larger, relatively than on the present broadcast system for music, etc.

Although ultra short waves are practical and
 10 necessary from the above standpoint, there is, however, a serious objection to such waves, this objection being that the waves act more like light than radio and travel in straight lines, or nearly straight lines. They are, as far as is
 15 known, not returned to earth by the Heavyside layer except in exceptional circumstances. The transmitter must therefore be within the range of visibility of the receiver, or nearly so, to enable the reception of such waves. There may, in some
 20 instances, be some apparent bending, refraction, or reflection of the waves, but in most instances the waves travel in nearly straight lines.

It is apparent that due to this straight line of travel it would be practically impossible to trans-
 25 mit these ultra short waves in the same manner as the present broadcast waves for large area coverage, as the transmitter would have to be miles high to cover the required area with direct radiation.

30 It, therefore, is one of the primary objects of this invention to overcome the above difficulties by providing an improved method whereby ultra short waves may be economically distributed over a large area through the use of well known ap-
 35 paratus.

It is to be understood that when I refer to 5 meter transmission I simply mean waves which approximately follow optical paths rather than ordinary radio wave paths. It is to be under-
 40 stood that this is not to be limited to the 5 meter wave length but to any wave lengths which will satisfactorily carry out the objects of this invention.

Broadly, this invention contemplates a system
 45 of electromagnetic signaling in which a source of modulated radio frequency energy, preferably at the point of origination of the signals, is connected by means of a non-radiating network or wire circuit to a plurality of spaced radiators, or
 50 antennas, for broadcasting, or the non-radiating wire circuit may feed any signal receiver directly. The radiators, or antennas, are preferably spaced relative to each other and the wave lengths and power used is such that the signals from
 55 the antennas do not substantially overlap. The number of such radiators are such that any predetermined area may be reached by at least one of the stations. Where it is desired to cover a very large area or where it is desired to distrib-
 60 ute the signals at considerable distances from the source of the modulated carrier wave, it may be necessary to employ booster stations, which are simply amplifiers.

Referring now more particularly to the drawing wherein like characters of reference design-
 65 ate like parts throughout the several views, the method I propose to use is that of providing a main short wave station 1 which is a source of high frequency modulated by the desired sig-
 70 nals connected by direct non-radiating feeder lines 2 to a plurality of coupling impedances 3, 3¹, 3², 3⁴ and 3⁵.

The impedances serve to couple the non-radiat-
 75 ing feed lines 2 to the non-radiating branch feed lines 4, which feed the antennas 6 from which

the electromagnetic signals are broadcast over predetermined areas and directions to be received by the receiving antennas 7 and receivers 11. If desired suitable booster stations 5 may be placed in the feeder lines 4 to amplify and in-
 5 crease the power radiated from the antennas 6. It is to be understood that these stations 5 are merely amplifiers and not original sources of radio frequency energy. This arrangement greatly reduces the amount of apparatus and power
 10 necessary to distribute electromagnetic signals over a predetermined area and also reduces the distortion of the signals. Since the intensity of the radiated electromagnetic energy is substantially inversely proportional to the square of the
 15 distance from the source, it will be readily apparent that if the electromagnetic energy is distributed to localized areas over wire transmission systems to radiating antennas from which the
 20 energy is radiated or broadcast a much more efficient distribution system is produced than where the electromagnetic wave energy must be greatly amplified and increased in power in order to cover the same area by radiation from one
 25 point.

If desired the program may be carried over a direct line 8 to a theater, dwelling house or other point of destination 9 from a coupling device in the feed line 2, the direct line 8 being adapted
 30 particularly to provide direct connection without the difficulty attending atmospherics. Attention is directed to the fact that suitable booster stations 10 may be interposed at intervals in the feeder line 2 in order to overcome the attenuation
 35 losses of the feeder lines and to maintain the desired energy level along the feeder line.

In general, the main purpose of this arrangement is to provide a nearly continuous field of radiation of electromagnetic energy which can be received by those within proper distance of the
 40 transmission or feeder line. The radiating antennas 2 and 4 consist primarily of two wires running at a predetermined distance apart, which distance must be held quite constant, that is, not to be sagging so that at one point it is twice as
 45 far apart as it is at another, or it may consist of a single wire inside of a conductor such as a pipe, or of one wire between two others, the two outer wires being connected together, or of four wires
 50 at the corners of a square which are connected together diagonally, or any other transmission line known to the art. The energy put upon these wires is relatively at a low level, and is carried to the booster stations 5 and 10 at predeter-
 55 mined intervals to keep up a reasonable level of energy in these wires. The booster or antenna stations taking off to the separate antennas 6 may be of a high power or medium power, depending upon the immediate requirements. These intermediate booster stations may be en-
 60 tirely automatic in their actions as it is possible to send very low frequency control current to start and stop the stations over the same wires that carry the high radio frequency current, or even send direct current impulses for control
 65 purposes. These low frequency or direct currents for automatically controlling the starting and stopping of the intermediate stations may be made in the same manner as sleet melting low frequency currents such as are applied to high
 70 frequency antenna or by other means known in the art.

The coupling impedances in the non-radiating transmission lines with which the radiators or
 75 antennas 6, or any other desirable translation de-

vices are connected to these lines are for the purpose of preventing reflection of waves back and forth on the lines resulting in great loss in energy. The coupling devices make it possible to distribute the electromagnetic wave energy to the various devices without affecting the electrical length of the transmission lines and therefore preventing radiation from the transmission lines.

The distributing or broadcasting means, as a whole, provides a very efficient system of distributing electromagnetic signals, and especially signals covering a very wide side band range, over predetermined desired areas. With the system of this invention, distribution of signals can be more readily confined to a predetermined area, if desired, and with a much smaller expenditure of energy and more even distribution than with systems heretofore, where in order to cover a certain area the intensity of the electromagnetic wave energy had to be very great. Consequently, near the antennas the signals were very strong and near the outer boundary of the area covered the signals were very weak making the distribution of signal strength very uneven and requiring a very large amount of power due to the fact the dissipation of the radiated waves is substantially proportional to the square of the distance from the radiator or antenna.

By choosing very short waves, which are more efficient for very short distances, and by spacing the radiators or antennas from which the waves are broadcast, a more even and efficient system of signal distribution is provided. The short waves which are of very high frequency make it inherently possible to handle efficiently signals having very wide side bands.

On these ultra short waves with what might be called directed optical paths, energy levels are very much lower than on present broadcasts. The boosters 5 and 10 and transmitter stations along the feeder lines will be relatively small, involving only a few watts of energy and can be made entirely automatic and can be controlled from the main distributing center 1 by simply throwing a switch or other suitable means. There are no details of the specific apparatus involved in any one of these points as each one is well known and can be found in the engineering handbooks and other technical publications on radio, such as the Proceedings of the Institute of Radio Engineers.

The antenna of an ultra short wave transmission say at five meters, which is used herein only as an example, is very small, in fact, a five meter oscillating doublet, which is almost an ideal form of antenna, is $7\frac{1}{2}$ feet long, so that these can be erected at frequent intervals and located easily where desired without difficult construction.

Transmission lines for radio frequencies are not new. For instance, the telephone system itself uses several carrier frequencies which are each modulated with the speech frequency, then later demodulated after such separations by tuning at the receiving end in order to get several messages over the same wire. These are carried from one station to another at radio frequencies, then sent out to the subscriber at audio frequencies. A few radio stations carry on experimental broadcasting on the same wave length, such as WEA and WTIC. The waves are sent by various systems from one station to another and the results are in general unsatisfactory, because of the overlapping interference pattern due to the shifting of the phase of the waves.

The system I propose for signal distribution uses ultra high frequencies furnished from a common source of signal modulated carrier energy and broadcast from spaced antennas so positioned that there will be a very small interference area between the stations. Fading of the signals in the overlapping area is substantially eliminated since the frequencies utilized have substantially only direct wave components as distinguished from the reflected sky-component of other frequencies. The direct wave component will not vary greatly in intensity nor phase displacement since the radiators or antennas are fairly close together. Consequently, the signal in the interfering area will be substantially constant even though it may be stronger or weaker in the interfering area than at points where the signal is received from only one antenna. It will be readily apparent that no particular difficulty will be experienced in receiving in such area because once a receiver is regulated as to volume it will remain substantially constant.

As has been stated above the antennas 6 are preferably doublets which, of course, are highly directional. As will be seen from an inspection of the drawing, at least some of these antennas may be so oriented that the axes of maximum radiation are at right angles to each other, and so that the axis of maximum radiation of one antenna is aligned with the axis of the other antenna to produce a desired radiation pattern to get a desired signal distribution.

When referring to interference pattern it might be well to state that with the five meter transmission from multiple stations such as that shown and described by applicant, one station can be so located and oriented relative to the other that the radiations from said stations will not greatly overlap each other. There may be a short interval at some one point between the two stations where overlapping interference can occur, but, in general, either one station or the other station will be the predominating factor and will be practically the only station received. This depends upon the contour of the land and the shadows produced by the intervening hills.

The antennas 6 are located in separated zones so that the broadcasts for said stations will overlap a relatively small area at the edges of the zones as shown at the points A of the drawing.

To each separate booster station there is connected the antenna 6 from which the electromagnetic waves B are broadcasted.

A plurality of receiving apparatus may be provided within the area B as indicated at 7.

The details of construction of the source of the modulated carrier frequency 1, the coupling devices 3, 3¹, 3², 3⁴, and 3⁵, etc., the booster stations 5, antenna 6, receiving apparatus 7 including a receiver 11, the transmission lines 2 and direct lines 8, etc. are devices well known in the prior art. My invention does not relate to the details of construction of these parts but resides in the novel arrangement and combination of these parts to perform new operations and to obtain new results.

It is not considered practical to distribute television signals which require frequencies from 0 to 100 kc. over a line, then at the distant point modulate a high frequency transmitter with the television signals. First of all, it is difficult to transmit a band from 0 to 100 kc. without having the higher frequency end attenuated at a very different rate than the lower frequency, and thus produce very great distortion, but if, as proposed

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the frequency of 60,000 kc. is used as a carrier, little difference in attenuation occurs between 59,900 and 60,100 kc. It is evident that a line designed for 60,000 kc. will transmit easily 60,100 kc. and 59,900 kc.

A transmission line of this nature could be so designed in addition to carrying 60,000 kc. to carry another frequency quite different, say 40,000 or 90,000 kc. or both. This could be modulated by multiple carrier frequencies for transmitting other television programs, or for transmitting telegraphic or other signaling transmissions, or for transmitting many telephone conversations or various combinations of these. For example, hundreds of telephone conversations could be put over the same transmission line that was in use at the same time for television radio transmission or several television programs could be simultaneously sent over the transmission line. As a support for this statement, it is entirely possible to pick off, say, the 60,000 kc. for radio television and say 90,000 kc. for a high frequency carrier of lower frequency carrier waves of audio components. The 90,000 kc. is a radio frequency, modulated by a lower radio frequency which is modulated by an audio frequency. This picking off can be accomplished by any of the standard tuning methods. Now let us assume that we are wanting to use say 90,000 kc. as a carrier of the voice carrier wave system. Also we can take 5 kc. as a more than sufficient band width of a voice carrier frequency. Thus let us say that we have one voice carrier wave of 100 kc., another one of 110, another of 120, another of 140 kc. and so on up to 1,100 kc. Now each one of these bands at 10 kc. intervals from 100 kc. to 1,100 kc. could be used as a carrier of this 5 kc. voice frequency. This would make only a modulation of the 90,000 kc. by 1,100 kc., that is a band from 88,900 to 91,100 and the attenuation over this whole group would be practically identical, so this whole group of 100 voice carrier frequency currents would be transmitted with the same attenuation and without distortion. Although 100 voice carriers have been described it is apparent that many more or less can be used. It is thus seen that at the same time television is put over this transmission line very many telephone conversations can be simultaneously put over said line. Likewise, if it is desired to send speech accompanying television, this could be put on, say, at 40,000 kc. and transmitted over the same line at the same time the television is transmitted. This obviously is very simple. Moreover, another group say 80,000 kc. can be used to carry the modulated voice carrier waves the same as the 90,000 kc. band mentioned above.

It is apparent from the above that a plurality of different signals or communications may be simultaneously transmitted by impressing each of the separate signals or communications on separate carrier waves of given frequencies, then modulating a high frequency wave by means of all of these separate carrier frequencies, transmitting this multiply modulated high frequency wave over a transmission line, and then demodulating this high frequency wave to pick out a desired carrier wave of a given frequency to obtain the desired signal or communication.

It is apparent that one or more groups of different signals or communications may be transmitted by the above method and that the energy level and impedance of the feeder lines may be regulated or matched during said transmissions as desired as previously described.

Attention is directed to the fact that the various stations connected through the feeder lines 2' to the main station 1 from which the program originates are all placed in proper relation with each other so that the waves transmitted from said stations will cover specific areas. From a reasonable height these ultra short waves can, for example, be received at fifty or more miles from the transmitter. This is merely an illustrative figure to give an idea of the magnitude of distance at which the various stations may be placed relative to each other.

In the use of the term ultra short waves throughout the specification I mean waves less than about 15 meters and which at present are considered not to be generally reflected back to earth.

From the foregoing description, it will be seen that I have provided simple, efficient and novel methods of distributing short wave transmissions of all kinds over a large area similar to that accomplished by ordinary radio wave lengths.

Having described my invention I claim:

1. A radio signaling system for wide area distribution of ultra high frequency electromagnetic energy by simultaneous operation of a plurality of radiators at the same frequency comprising a source of ultra high frequency energy modulated with desired signals, a series of booster stations for stepping up energy level to a desired amount, a practically non-radiating transmission line connecting said source of modulated ultra high frequency energy to each of said booster stations for conveying the modulated high frequency energy to said booster stations substantially free from outside disturbances and a plurality of high frequency directional radiators operating on said ultra high frequency whose waves have quasi optical properties and are of the same frequency for all of said radiators, said radiators being connected with some of said booster stations and being distributed so as to radiate said high frequency energy over contiguous component areas of the area to be covered with substantially little overlapping of said areas and with at least a part of said transmission line lying within said area.

2. A radio signaling system for wide area distribution of ultra high frequency electromagnetic energy by simultaneous operation of a plurality of radiators at the same frequency comprising a source of ultra high frequency energy modulated with desired signals, a practically non-radiating transmission line, a booster station connected by said transmission line to said source of modulated high frequency energy for amplifying the energy to a desired energy level, a high frequency directional radiator which radiates in a plurality of directions connected with a part of this amplified energy and operating on said ultra high frequency whose waves have quasi optical properties, a separate transmission line practically free from radiation and reception of undesired electromagnetic disturbances connected with another part of the amplified energy, another booster station connected to said last-named separate transmission line for amplifying the energy at said station to a desired energy level and another high frequency directional radiator which radiates in a plurality of directions connected with a part of the amplified energy of said last-named booster station and operating on said ultra high frequency whose waves have quasi optical properties and which has the same frequency as the first-named radiator, said radiators being dis-

tributed so as to radiate said high frequency energy over contiguous component areas of the area to be covered with substantially little overlapping of said areas.

- 5 3. A method of wide area distribution of signals involving ultra high frequency waves having quasi optical properties by simultaneous operation of a plurality of radiators connected by transmission lines, comprising modulating a source of ultra high frequency energy with the desired signals, transmitting said modulated ultra high frequency energy to given destinations by said transmission lines practically free from radiation and from reception of undesired electromagnetic disturbances, amplifying the energy along said lines to desired energy levels and radiating said high frequency energy having quasi optical properties directionally from a plurality of radiators over contiguous component areas of the total area to be covered with substantially little overlapping of said contiguous areas, and with at least a part of said transmission lines lying within said area.

4. A method of wide area distribution of signals involving ultra high frequency having quasi optical properties by simultaneous operation of a plurality of radiators connected by a transmission line, comprising modulating a source of ultra high frequency energy with the desired signals, transmitting said modulated ultra high frequency energy to a given destination over a transmission line practically free from radiation and from reception of undesired electromagnetic disturbances, amplifying the energy along said line to a desired energy level, radiating a portion of said high frequency energy directionally over a first given area at said destination, transmitting another part of said amplified energy over another transmission line to another given destination, amplifying said other part of said energy along said other transmission line and radiating said amplified energy directionally over another given area contiguous with said first area and with substantially little, if any, overlapping of said first area and with at least a part of one

of said transmission lines lying within a portion of the total of said combined areas.

5. A radio signaling system for wide area distribution of ultra high frequency electromagnetic energy waves by simultaneous operation of a plurality of radiators at the same frequency comprising a source of ultra high frequency energy modulated with desired signals, a series of booster stations for stepping up energy level to a desired amount, a practically non-radiating transmission line connecting said source of modulated ultra high frequency energy to each of said booster stations for conveying the modulated high frequency energy to said booster stations substantially free from outside disturbances and a plurality of high frequency directional radiators each of which radiates in a plurality of directions operating on said ultra high frequency, said waves having quasi optical properties and being of the same frequency for all of said radiators, said radiators being connected with some of said booster stations and being distributed so as to radiate said high frequency energy over contiguous component areas of the area to be covered with substantially little overlapping of said areas.

6. A method of wide area distribution of signals involving ultra high frequency waves having quasi optical properties by simultaneous operation of a plurality of radiators connected by a transmission line, comprising modulating a source of ultra high frequency energy with the desired signals, transmitting said modulated ultra high frequency energy to given destinations by a transmission line practically free from radiation and from reception of undesired electromagnetic disturbances, amplifying the energy along said line to desired energy levels and radiating said high frequency energy having quasi optical properties directionally from a plurality of radiators each of which radiates in a plurality of directions and over the component areas of the area to be covered with substantially little, if any, overlapping of said areas.

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