

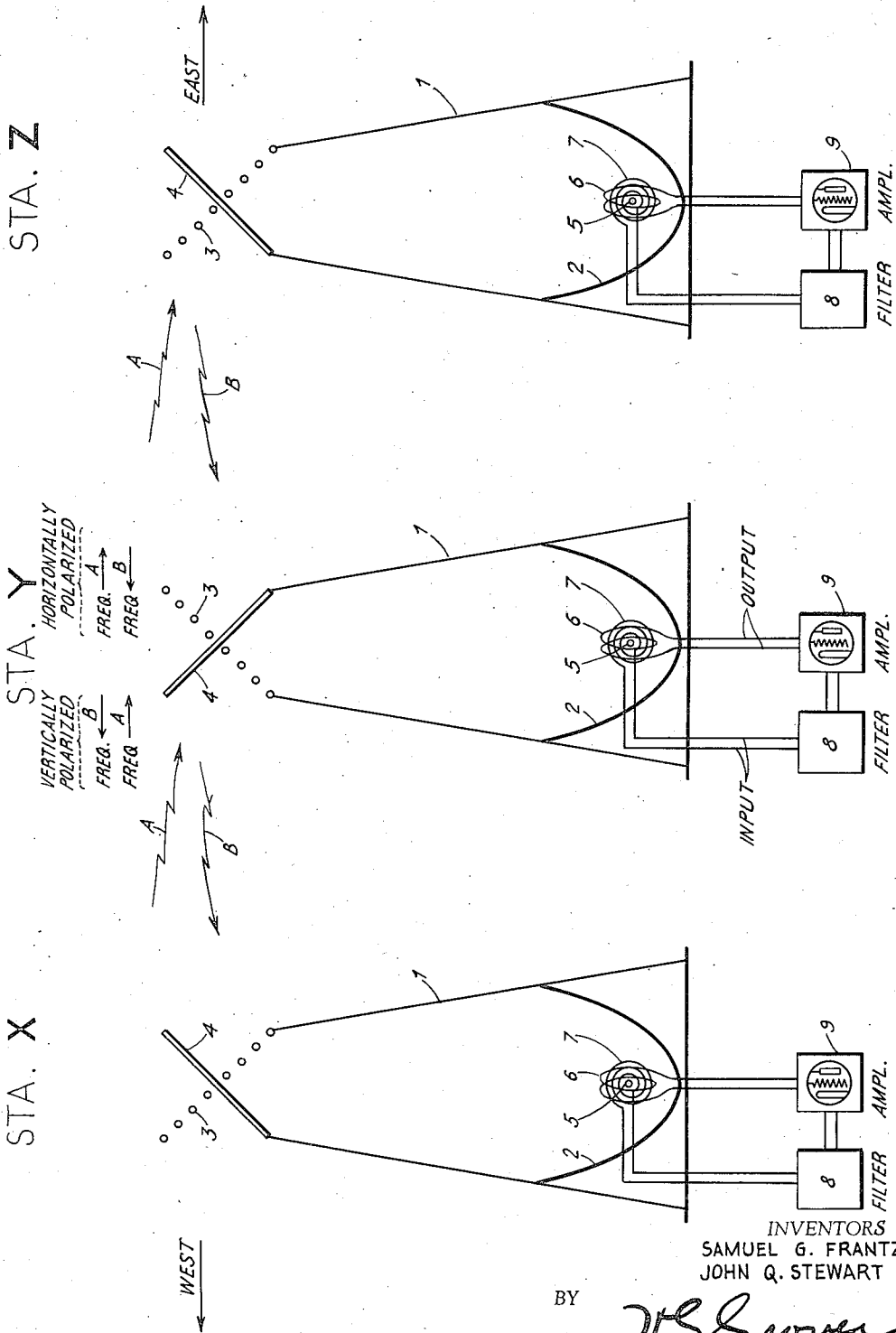
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RADIO RELAYING SYSTEM

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## RADIO RELAYING SYSTEM

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This invention relates to improvements in radio relaying systems, and particularly to ultra short wave relaying systems.

Heretofore, in radio relaying systems, it has been customary to provide at each repeating station one antenna for receiving signals efficiently from only one direction, and another antenna for transmitting signals efficiently in only one other direction, so that for duplex operation four antennae are required at each repeating station. For example, if east to west communication is desired, it has been customary to provide one antenna to receive the signals incoming only from the east and another antenna to transmit the same signals, after amplification, only towards the next adjacent receiving station to the west; similarly, for west to east communication, there have also been required two additional antennae. Arrangements of this type are adequately described in United States Patents Nos. 1,607,683 and 1,918,262, granted November 23, 1926 to De Loss K. Martin and July 18, 1932, to A. N. Goldsmith, respectively, to which reference is made for a more detailed description of prior systems.

One of the objects of the present invention is to provide a highly simplified radio relaying system wherein a single antenna at a repeating station may be utilized simultaneously both to receive a signal from a given direction and to transmit another signal toward that direction.

Another object is to provide an arrangement of antennae and reflectors for a radio relaying system which offers very little resistance to the wind and which at the same time comprises an aesthetic design for the surrounding landscape.

An advantage of the present invention is the great saving in cost of apparatus and supporting structures obtained, as compared with known constructions, since there is now required only a single tower at each repeating station for enabling reception from both directions and transmission in both directions.

A feature of the invention lies in the manner of locating the antennae at each repeating station relative to one another and to the paraboloidal reflector for obtaining best results. A further feature comprises the two angularly disposed coil loops at the focus of the paraboloidal reflector and their associated equipment.

Other objects, features and advantages will appear later from a reading of the detailed description.

In general, the present invention makes use of both horizontally and vertically polarized

waves, one for reception and the other for transmission of the same signal. At each repeating station, there is a tower at the base of which is a parabolic reflector having at its focal point two small coil loops at right angles to each other. Two plane reflectors, hereinbefore referred to as antennae, are set up at the top of the tower, substantially at 45° to the horizontal, one having horizontal conductors for reflecting horizontally polarized waves while the other reflector has conductors making an angle of 90° with the plane of the horizontal conductors for reflecting vertically polarized waves. The waves of one polarization, let us say horizontal polarization, which are received on one plane reflector are reflected down as a beam to the parabolic reflector where they are picked up on one of the small coil loops, amplified, and then reradiated from the other loop at right angles to the first loop and reflected upwards by the parabolic reflector to the other plane reflector which reflects the beam in another direction on vertical polarization. Thus, in the tower between the parabolic reflector and the plane reflectors there is no interference between incoming and outgoing waves of the same frequency, since those waves which are horizontally polarized in their passage between towers are horizontally polarized transverse to the line of direction during their vertical passage between the parabolic and plane reflectors, whereas those waves which are vertically polarized in their passage between towers are horizontally polarized in a direction parallel to the line of direction during their vertical passage between the parabolic reflector and plane reflectors. In other words, the two waves of the same frequency between the plane reflectors and the parabolic reflectors are both horizontally polarized but substantially at right angles to each other. For transmission in the opposite direction, another frequency is used, picked up as vertical polarization, and radiated as horizontal polarization. Hence, the same pair of plane reflectors and pick-up coil loops is used for two way relaying on two different frequencies.

When the present invention is used as a one way relaying system, the difference in polarization of the incoming and outgoing waves is an aid in preventing "singing".

The single figure in the accompanying drawing shows, diagrammatically, a preferred form of a radio relaying system embodying the principles of the present invention, wherein a plurality of repeating stations X, Y, and Z are arranged for duplex operation to relay signals from east to

west, and vice versa, between terminal stations, not shown.

Since the same elements at the three repeating stations X, Y, and Z are labeled with the same reference characters, a description of the operation of the apparatus at station Y, which will now be given, will apply equally well to the apparatus at the other stations.

Referring to station Y, there is shown any suitable supporting structure 1 in which is placed, at its base, a paraboloidal reflector 2 whose axis is vertical. At the top of tower 1 are two plane polarized reflectors 3 and 4, placed approximately at an angle of 45° to the vertical, and azimuthally turned so that a vertical beam projected upward from the paraboloid 2 and polarized with the electric vector north and south will be reflected by 3 in the direction of the adjacent station Z to the east; and a vertical beam from the paraboloid 2, polarized with the electric vector east and west will be reflected by 4 in the direction of the adjacent station X to the west. The reflector 3 is composed of a grid of horizontal conducting bars, and the beam which it projects is horizontally polarized. The reflector 4 is composed of a grid of inclined bars, and the beam which it projects is vertically polarized.

Plane reflectors 3 and 4 may, of course, differ slightly from the 45° angular relation to the vertical to take account of differences in elevation between adjacent stations.

Crossed loops 6 and 7 are placed at the focus 5 of the paraboloid 2, loop 6 being in a vertical plane running substantially north and south so that its axis points in the direction of the adjacent station Z to the east, and loop 7 being also in a vertical plane which passes through the adjacent station X to the west. Thus loop 6, reflector 3, and station Z form one cooperating system while loop 7, reflector 4 and station X form another cooperating system, from which it will be apparent that stations X, Y, and Z need not be on exactly the same straight line. Where the stations are not on the same straight line, it is preferable that loops 6 and 7 be maintained at right angles with respect to each other in order to prevent one loop from picking up energy radiated from the other, the orientations of the two loops each being changed from that mentioned above by an angle equal to one half the angle of deviation of the line of direction of the station in question. The orientations of the plane reflectors, however, are always such as to direct a vertical beam coming from the paraboloid toward their respective cooperating adjacent stations.

In communication, two frequency bands are used which will be designated frequency A and frequency B. These bands are preferably close together but not contiguous. Eastbound traffic is handled on frequency A, and westbound on frequency B. Alternate repetitions of a signal in either direction are horizontally and vertically polarized.

In the operation of the system, incoming signals from station Z in the east, at the tower shown in the drawing, are horizontally polarized, and at frequency B. These are received at station Y, reflected downward by 3, picked up by loop 6, and fed through a band-pass filter 8 passing frequency B to an amplifier 9 whose output is impressed on loop 7. The radiation from 7 is gathered into a parallel beam by 2 and reflected westward by 4 to the west as a vertically polarized beam. At the adjacent station X to

the west, of course, the reflectors corresponding to 3 and 4 are interchanged in position, as shown, the one facing east, namely 4, being vertically polarized.

At the same time that loop 6 is being used to receive from the east a frequency B, it may be transmitting to the east a frequency A; or, if desired, two separate loops may be used.

At each terminal station one of the plane reflectors 3 or 4, and the corresponding loop 6 or 7, would be dispensed with. As an example, if stations X and Z were terminal stations, then plane reflectors 3 and loop 6 at station X and plane reflector 4 and loop 7 at station Z would be omitted. It should be noted in this connection that all communication between stations X and Y take place on vertically polarized waves while all communication between stations Y and Z take place on horizontally polarized waves.

For practical reasons, it is best to locate the paraboloidal reflector as near the ground as possible and at some distance from the plane reflectors in order to overcome wind resistance and to provide an aesthetic design for the landscape.

The present invention, it is to be distinctly understood, is not limited to the precise arrangement of parts shown, since various modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a directional radio relaying system, a repeating station having, in combination, a reflector in a plane at an angle with respect to the horizontal, another reflector in a plane at an angle with respect to the horizontal and inclined with respect to the first named plane, a paraboloidal reflector facing said two reflectors and arranged to receive radiations received on one of said reflectors and to transmit radiations to the other of said reflectors, and high frequency receiving and transmitting apparatus located in the focus of said paraboloidal reflector.

2. In a radio repeating system, in combination, an antenna comprising a plurality of spaced, parallel, horizontal radiators, another antenna comprising a plurality of spaced parallel radiators at an angle with respect to said first radiators, a parabolic reflector below said two antennae and arranged to receive radiations reflected by said antennae and to transmit radiations to said antennae, and receiving and transmitting means at the focus of said parabolic reflector.

3. A radio repeating station comprising a plane reflector having a plurality of horizontal conductors and another plane reflector having inclined conductors disposed substantially at 90° with respect to the horizontal conductors, said two plane reflectors crossing each other substantially at their centers, a paraboloidal reflector facing said two plane reflectors for receiving the radiations reflected from said plane reflectors, two coil loops substantially at the focus of said paraboloidal reflector and disposed at an angle to one another, and an amplifier circuit coupling one of said loops to the other.

4. A radio repeating station comprising a plane reflector having a plurality of horizontal conductors and another plane reflector having inclined conductors disposed substantially at 90° with respect to the horizontal conductors, said two plane reflectors crossing each other substantially at their centers, a paraboloidal reflector facing said two plane reflectors for receiving the

radiations reflected from said plane reflectors, two vertical coil loops located at the focus of said paraboloidal reflector and disposed at an angle to one another, one of said loops being arranged to receive the reflected waves from one of said plane reflectors, a filter coupled to the terminals of said one loop, an amplifier in circuit with said filter and with said other loop for amplifying the waves received by said one loop and for passing the amplified waves to said other loop, said last loop being arranged to radiate the amplified waves to said other plane reflector.

5. A system in accordance with claim 1, characterized in this that one plane reflector comprises a plurality of spaced horizontal conductors, and the other plane reflector also comprises a plurality of spaced conductors but disposed substantially at an angle of 90° with respect to the horizontal conductors, and the paraboloidal reflector is located below said two antennae.

6. In combination, in a radio relaying system, a first repeating station and a second repeating station arranged to receive signals from said first station, a first reflector at each of said stations at an angle with respect to the horizontal, and a second reflector at each station located in a plane inclined with respect to the first-named reflector, a parabolic reflector at each station facing the two reflectors thereat and arranged to receive radiations received on said second reflector and to transmit radiations to the first reflector, high frequency apparatus located in the focus of each parabolic reflector, the second reflector at one of said stations and the first reflector at the other station comprising a plurality of spaced horizontal conductors, and their respective associated reflectors comprising a plurality of spaced conductors disposed at an angle with respect to said horizontal conductors.

7. In an ultra short wave radio relaying system having a repeating station, the method of operation which comprises receiving a horizontally polarized signal on one ultra high frequency at said repeating station, transforming said signal to a vertically polarized signal and transmitting same, simultaneously receiving at said station a vertically polarized signal on another ultra high frequency, transforming said last signal to a horizontally polarized signal and also transmitting said last signal.

8. In combination, two radio stations and a repeating station for repeating signals between said stations, said repeating station comprising two plane reflectors intersecting each other, each reflector being in a plane inclined with respect to the horizontal, a reflector in the form of a surface of rotation facing said two plane reflectors for receiving the radiations reflected from said reflectors, two antennae located at the focus of said reflecting surface of rotation, one of said antennae having its axis substantially point in the direction of one of said radio stations and the other of said antennae being located in a plane which passes substantially through the other radio station.

9. In combination, two radio stations and a repeating station for repeating signals between said stations, said repeating station comprising two plane reflectors intersecting each other, each reflector being in a plane inclined with respect

to the horizontal, a reflector in the form of a surface of rotation facing said two plane reflectors for receiving the radiations reflected from said reflectors, two vertical loop antennae located at the focus of said reflecting surface of rotation and disposed at an angle to each other, one of said loops being in a vertical plane substantially passing through one of said radio stations and the other having its axis pointing substantially in the direction of the other of said radio stations.

10. In combination, two radio stations, and a repeating station located between and in the same straight line with said radio stations for repeating signals between said radio stations, said repeating station comprising two plane reflectors intersecting each other, each reflector being in a plane inclined with respect to the horizontal, a reflector in the form of a surface of rotation facing said two plane reflectors for receiving the radiations reflected from said reflectors, two vertical loop antennae located at the focus of said reflecting surface of rotation and disposed at a right angle to each other, one of said loops being in a vertical plane passing through one of said radio stations and the other having its axis pointing in the direction of the other of said radio stations.

11. In a two way radio communication system having first, second and third stations, said second station repeating the signals between said first and third stations, the method of operation which includes transmitting signals between said first and second stations in both directions only on horizontally polarized waves, and transmitting signals between said second and third stations in both directions only on vertically polarized waves.

12. A radio repeating station comprising a reflector in a plane at an angle with respect to the horizontal and arranged to receive vertically polarized waves, another reflector in a plane at an angle with respect to the horizontal and arranged to transmit horizontally polarized waves, both said plane reflectors being at an angle with respect to each other, a reflector in the form of a surface of rotation facing said two plane reflectors and arranged to receive a beam of horizontally polarized waves from one of said plane reflectors and to transmit a beam of horizontally polarized waves to the other of said plane reflectors, the directions of polarization of said beams forming an angle with respect to each other.

13. In combination, two radio stations and a repeating station for repeating signals between said stations, said repeating station comprising two plane reflectors intersecting each other, each reflector being in a plane inclined with respect to the horizontal, a reflector in the form of a surface of rotation facing said two plane reflectors for receiving the radiations reflected from said reflectors, two antennae located at the focus of said reflecting surface of rotation and substantially at right angles to each other, one of said antennae having its axis substantially point in the direction of one of said radio stations and the other of said antennae being located in a plane which passes substantially through the other radio station.

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