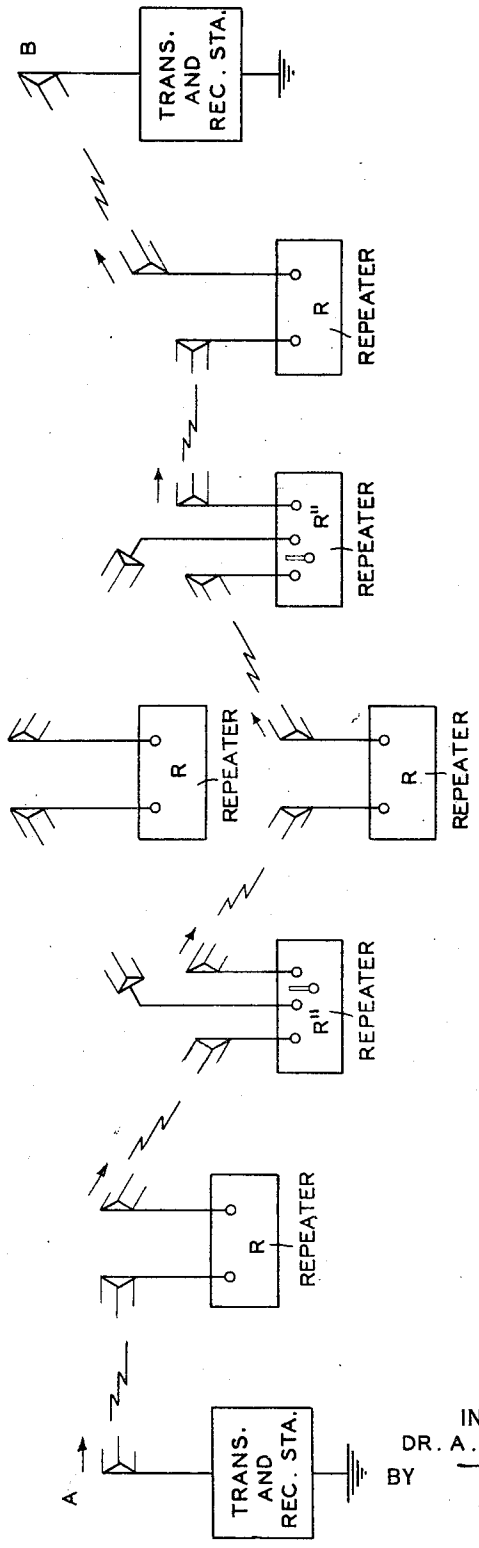
Sept. 26, 1933. A. N. GOLDSMITH 1,927,827

SIGNAL RELAYING SYSTEM

Filed Feb. 20, 1932 2 Sheets-Sheet 1

Fig. 1



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Filed Feb. 20, 1932 2 Sheets-Sheet 2

Fig. 2

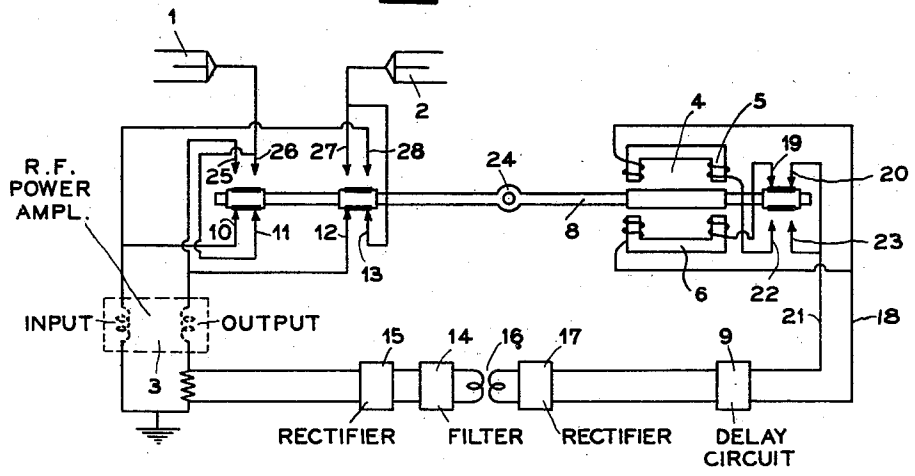
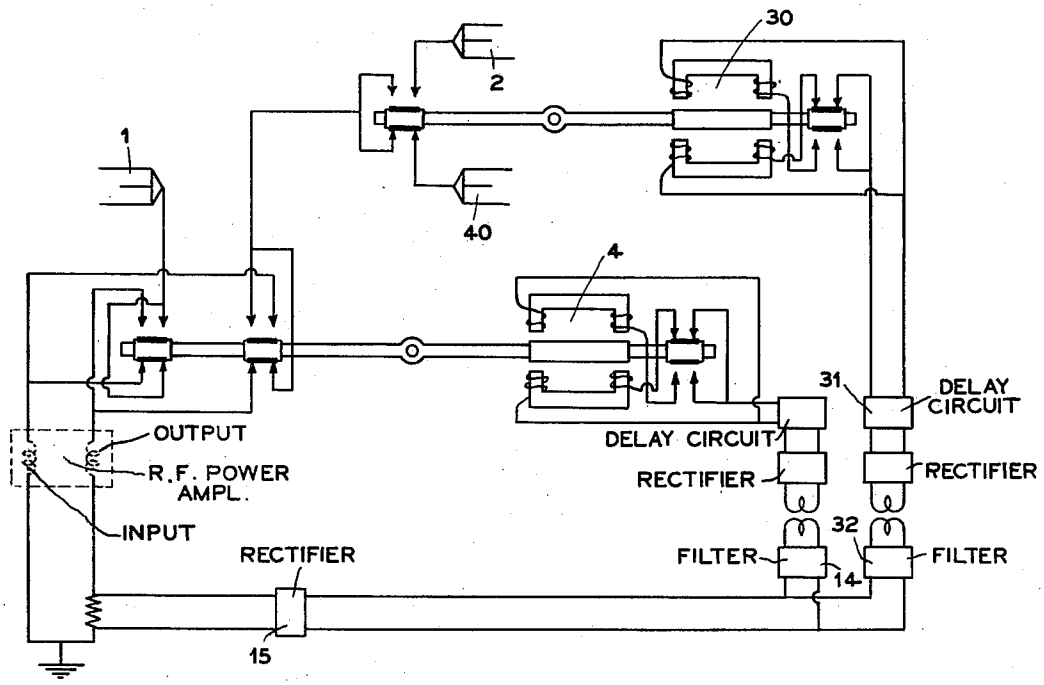


Fig. 3



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SIGNAL RELAYING SYSTEM

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6 Claims. (Cl. 250—15)

This invention relates to the transmission of radio signals and more particularly to arrangements for relaying such signals between remote points.

When ultra-short waves are used in the transmission of signals it has been found that such signals frequently are not received beyond points separated from the transmitting station by distances as short as thirty or forty miles. Primarily, this effect is due to the characteristics of electromagnetic waves at the lower wave lengths, which characteristics are similar in many respects to those of light waves. The inter-position of any object in the path of transmission, it has been found, affects, to an extent at least, the ability of a station to receive the transmitting signals. It may thus be seen that the condition of the local topography is an element of consideration in the design of an ultra-short wave communication system.

An object of the present invention is to enable the reception of electromagnetic waves with high efficiency at points remote from the transmitting station irrespective of atmospheric conditions or the nature of the intervening topography.

Another object is to provide a relay or so-called repeater station which is capable of automatically reversing its direction of transmission.

A feature of the present invention is the special electromagnetic switching relay employed in the repeating station for reversedly connecting either of two antennæ to the station equipment. This feature permits the automatic conditioning of the system for transmission or reception, in either of two directions, without the aid of operators at the intermediate repeating stations.

Other objects and features will appear later in the detailed description.

Briefly, this invention comprises a radio communication system having a plurality of repeater stations located between the terminal transmitting and receiving stations. Each of these repeaters is comprised of a plurality of directional antennæ which are individually positioned or arranged to be effective in different directions toward the next adjacent repeater stations. Connected between the directional antennæ at each repeater there is provided suitable equipment for amplifying the signals received prior to their passage to the transmitting antenna. An electromagnetic switching relay is also provided at each repeater for reversedly connecting the amplifying equipment to either of two directional antennæ for conditioning the repeater station to relay signals in different directions. This switching apparatus is adapted to respond to a special signal of a predetermined nature which is sent out from the transmitting station. A time-delay element in the circuit permits a slight interval of time to elapse before the reversing equipment functions in order to insure proper conditioning of all stations for transmission in the desired direction. Thus, there is avoided a condition whereby different repeaters of the radio communication system are "pointed" in opposite directions.

In the accompanying drawings, Figure 1 illustrates, diagrammatically, a radio communication system embodying the principles of the present invention, and Figures 2 and 3 illustrate different types of repeater stations for use in the present invention.

Referring to Figure 1, there are shown two transmitting and receiving stations A and B between which it is desired to transmit signals. As indicated in the drawings by the direction of the arrows, station A is arranged to transmit signals and station B to receive signals. Intermediate A and B are a plurality of repeater stations R and R''. These repeaters are provided with a plurality of directional antennæ, one of which is adapted to receive signals and is operative in the direction of the next adjacent transmitting station, and the other of which is adapted to transmit signals in the direction of the next adjacent receiving station.

At each repeater is an electromagnetic switching relay which is responsive to a special signal from the transmitting station, in this case station A, for conditioning the repeater to receive and transmit in the reverse direction. This feature will be described subsequently in connection with the circuits of Figures 2 and 3.

If desired, a plurality of transmission paths may be provided between certain repeating stations. Such an arrangement is advantageous when the transmission of signals over a particular path is at times difficult, such as may be the case when the territory between the two repeaters is mountainous or crossed by rivers. Maintenance considerations are also a factor which may make it advisable to provide a plurality of paths.

If such an arrangement is used, special repeaters, such as R'', are provided at the splitting points of the radio transmission line. These special repeaters are designed to receive over one directional antenna and to transmit over either of two other directional antennæ. A second switching relay, which is responsive to a special

signal from the transmitting terminal station, is adapted to switch the equipment at the special repeater R'' from one transmitting antenna to the other. This is described later in connection with Figure 3.

Figure 2 illustrates a repeater of the type indicated by reference character R in Figure 1, and comprises two directional antennæ 1 and 2. A radio frequency power amplifier 3, having input and output circuits for amplifying the received signals, is shown associated with the antennæ 1 and 2 and with an electromagnetic switching relay 4. This relay comprises an upper winding 5 and a lower winding 6, and is adapted to respond to a special signal received over the transmission circuit, actuating shaft 8 in either one of two directions. When this shaft is actuated by the upper winding 5, then the repeater station is conditioned for receiving signals over antenna 1 and for transmitting the amplified signals over antenna 2. When shaft 8 is attracted by the lower winding 6 of relay 4, the directions of reception and transmission are reversed. This shaft is arranged to remain in its last actuated position until a reversing signal is received.

The special signal sent from the transmitting station for conditioning the repeater to relay signals in a desired direction may be a code signal comprising a series of dots and dashes, a high frequency tone signal of a predetermined frequency and having a definite duration, or any other suitable signal. The apparatus responsive to this special signal for actuating electromagnetic switch 4 may be any type well known in the art, such as a signal selector. For purposes of describing the present invention, a sustained toned signal of relatively considerable length will be employed to reverse the direction of the repeater.

A delay circuit 9 is utilized to retard the action of the special signal. This circuit has a two-fold purpose, first, to permit the reception of the special signal at all repeaters before the direction of transmission is reversed so as to avoid a condition whereby different sections of the system are pointed in opposite directions, and second, to insure the operation of switch relay 4 only upon the reception of the correct tone signal of a definite duration. This delay element prevents the operation of the switch when the repeater is energized by stray excitation on the signalling frequency, such as may be due to a lightning flash or other electrical disturbance.

The time-delay element may comprise any type well known in the art and may be either of the mechanical (dashpot) or of the electrical type, analogous to a very slightly damped resonant circuit, or of any other convenient form.

The directional antennæ 1 and 2 are pointed directly at the next adjacent station to which it is desired to transmit or from which it is desired to receive signals. It may be advisable to stagger the repeater stations slightly to avoid one station from affecting another station which is directly in the line of transmission, but which is more remote than its adjacent station. These antennæ may be highly directional or less so, in order to feed broad swathes of territory. From this point of view the ideal directional characteristic would be more or less of the cardioid type, as nearly circular as possible, and with a sharp "dimple" toward the associated repeater antenna.

The operation of the circuit will now be described.

Assuming that directional antenna 1 is pointed toward the transmitting station and that the relay 4 is in the position shown in the drawings, then signals received at the repeater over 1 will pass through the two lower left contacts 10 and 11 of relay 8, into the input circuit of amplifier 3, out over the output circuit of 3 and lower inner contacts 12 and 13 to antenna 2, which is pointed in the direction of the next adjacent repeater wherein the same operation will be repeated.

Filter circuit 14 is arranged to pass a narrow band of frequencies corresponding to the desired frequencies of the special signal, which frequencies are outside the range of the message signals. In this manner, the message waves are prevented from actuating relay 4.

The reception of the special tone signal from the transmitting station will cause the actuation of switch relay 4. This special signal is rectified or demodulated by the apparatus 15 and allowed to pass through filter 14 to the primary winding of transformer 16. The special tone signal is again rectified by rectifier 17 prior to entering delay circuit 9 from which the signal current flows over lead 18 through the lower winding 6 of switch 4, through the upper right contacts 19 and 20, over lead 21 and back to rectifier 17 to actuate switch relay 4. All contacts of switch relay 4 are, of course, insulated from the shaft. The armature shaft 8 is thus attracted downwardly, causing the opening of contacts 19 and 20 and the closure of contacts 22 and 23. Since shaft 8 is pivoted at 24 its downward movement will cause the opening of contacts 10, 11 and 12, 13, and the closure of contacts 25, 26 and 27, 28.

The operation of relay 4, it will be noted, connects the input circuit of amplifier 3 to the antenna 2 over the upper inner contacts 28, 27 and the output circuit of amplifier 3 to antenna 1 over the upper outer contacts 25, 26. The repeater is now in condition to receive signals over antenna 2 and to transmit the amplifier signals over antenna 1.

Similarly, a special reverse signal received over antenna 2 will actuate the upper winding of switch relay 4 in an obvious manner, to connect the input and output circuits of amplifier apparatus 3 to antennæ 1 and 2 respectively.

Figure 3 illustrates a repeater station quite similar to that shown in Figure 2 except for the addition of another directional antenna and another switching relay with associated apparatus for operatively associating either one of two directional antennæ 2 and 40 with antenna 1. The operation, in most respects, is identical with that hereinabove described in connection with Figure 2.

A second switching relay 30 is shown connected to a second time-delay element 31. Switch 30 is adapted to respond to a second special tone signal for changing the direction of transmission or reception from antenna 2 to antenna 40, or vice versa. This second signal, of course, is of a frequency quite different from the special signal adapted to operate switch 4. Filters 14 and 32 are respectively arranged to discriminate between the two special signals. It is to be understood that the signal which is adapted to operate switch 30 will not affect any of the switches 4 in any of the repeater stations.

In practice, stations A and B at both ends of the communication system will be both transmitting and receiving stations provided with the necessary equipment for the transmission of the two special signals. Only the terminal station which happens to be transmitting will be able to

reverse the direction of transmission in the intermediate repeater stations. If desired, station A or B, or both A and B, may be broadcasting stations and may be provided with auxiliary telephone communication apparatus.

Although this invention finds particular application in the ultra-short wave field, it is to be distinctly understood that it is not limited thereto, but may be utilized advantageously in the transmission of all types of electromagnetic waves. A system of the type herein described may be used for the broadcasting of television service.

It is also to be understood that various modifications may be made in the present invention without departing from the spirit and scope thereof.

I claim:

1. A short wave radio communication system comprising a transmitting station, a remote receiving station, and a plurality of intermediate repeating stations, each of said repeating stations comprising a directional antenna positioned to receive signal waves from its next adjacent repeating station located in the approximate direction of the transmitter, and a second directional antenna positioned to transmit signal waves toward its next adjacent repeating station located in the approximate direction of the receiver, and signal amplifying apparatus at each repeating station connected between said two directional antennæ for amplifying the received signal waves, an input circuit and an output circuit for said amplifying apparatus, and switching means for reversedly connecting said circuits to either of said two directional antennæ.

2. A short wave radio communication system as defined in claim 1, characterized in this, that said switching means comprises electromagnetic relay apparatus adapted to respond to a predetermined signal.

3. A relaying station for radio signal waves comprising two directional antennæ, each of said antennæ being positioned in different directions, signal amplifying apparatus having input and output circuits, and switching means for reversedly connecting said circuits to either of said two directional antennæ.

4. A relaying station for radio signal waves comprising a first, second and third directional antenna, each of said antennæ being positioned in different directions, signal amplifying means having input and output circuits, said input circuit being coupled to said first antenna, switching means for connecting said output circuit with either said second or third antennæ, but not with both simultaneously, said switching means being adapted to respond to signals received over said first antenna.

5. A relaying station for radio signal waves comprising two directional antennæ, each of said antennæ being positioned in different directions, signal amplifying apparatus having input and output circuits, and switching means for automatically reversedly connecting said circuits to either of said two directional antennæ, said switching means being adapted to respond to a predetermined signal wave received by said station.

6. A relaying system for radio signal waves comprising a receiving directional antenna, and two transmitting directional antennæ, signal amplifying apparatus having an input circuit coupled to said receiving antenna and an output circuit coupled to one of said two transmitting antennæ, and switching means responsive to a predetermined signal received over said receiving antenna for connecting said output circuit from said one transmitting antenna to the other transmitting antenna.

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