

July 29, 1941.

A. N. GOLDSMITH
RELAY SYSTEM MONITORING

2,250,950

Filed Dec. 9, 1939

3 Sheets-Sheet 1

Fig. 1

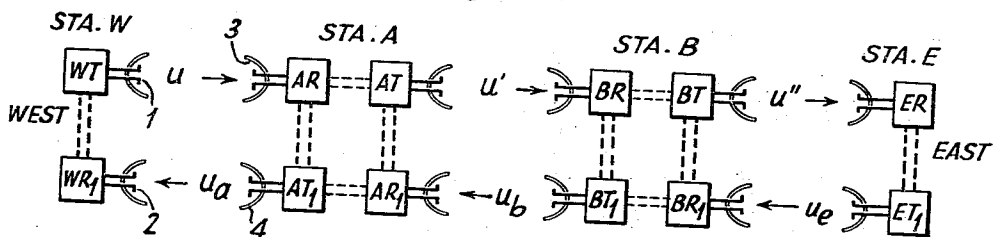


Fig. 2

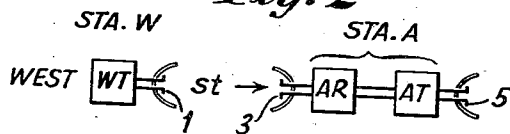


Fig. 3

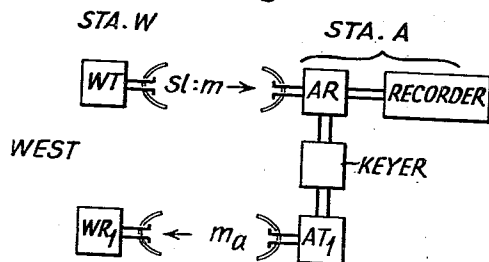


Fig. 4

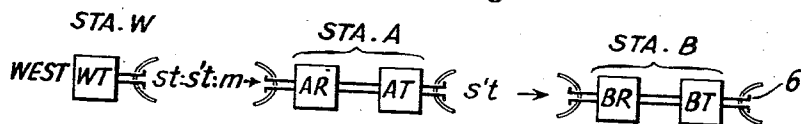
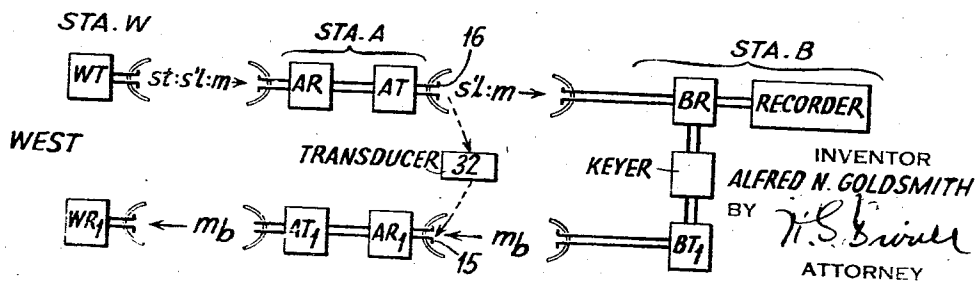


Fig. 5



INVENTOR
ALFRED N. GOLDSMITH
BY *H. S. Swire*
ATTORNEY

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Fig. 6

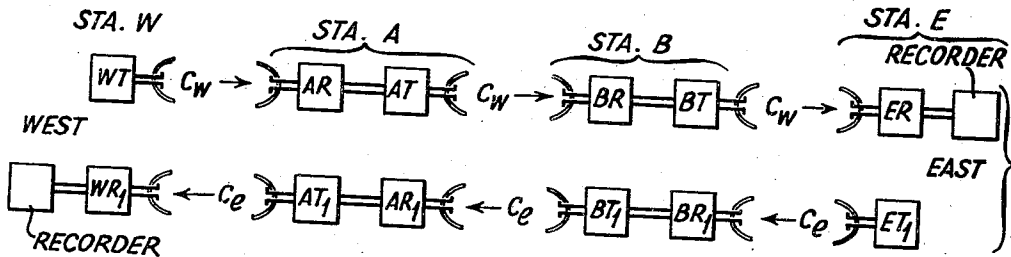


Fig. 7

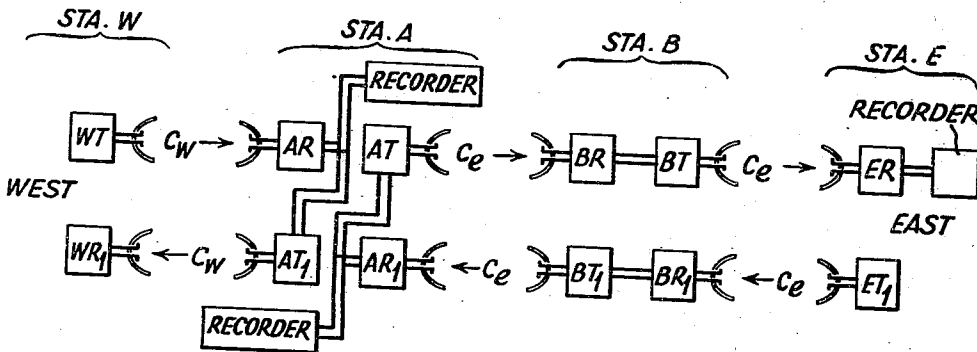
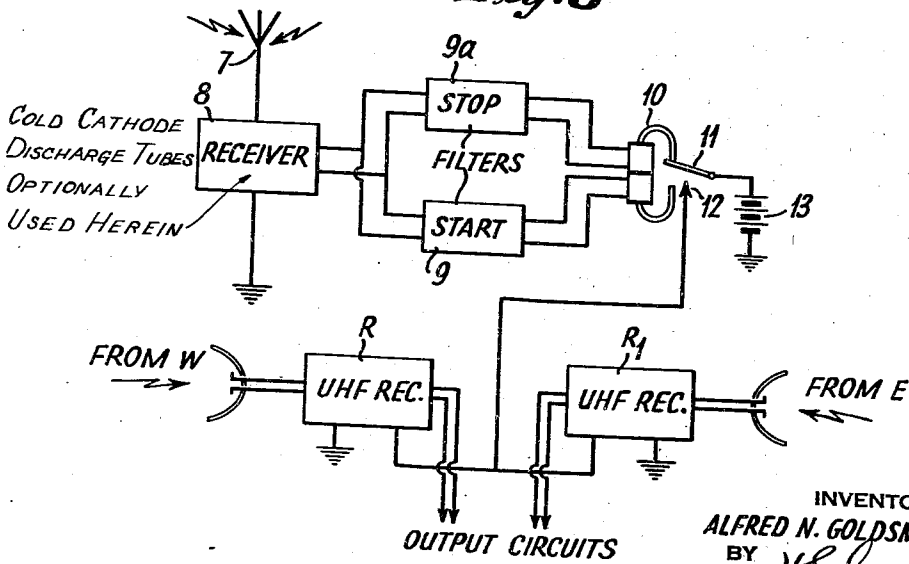


Fig. 8



INVENTOR
ALFRED N. GOLDSMITH
BY *H.S. Sworer*
ATTORNEY

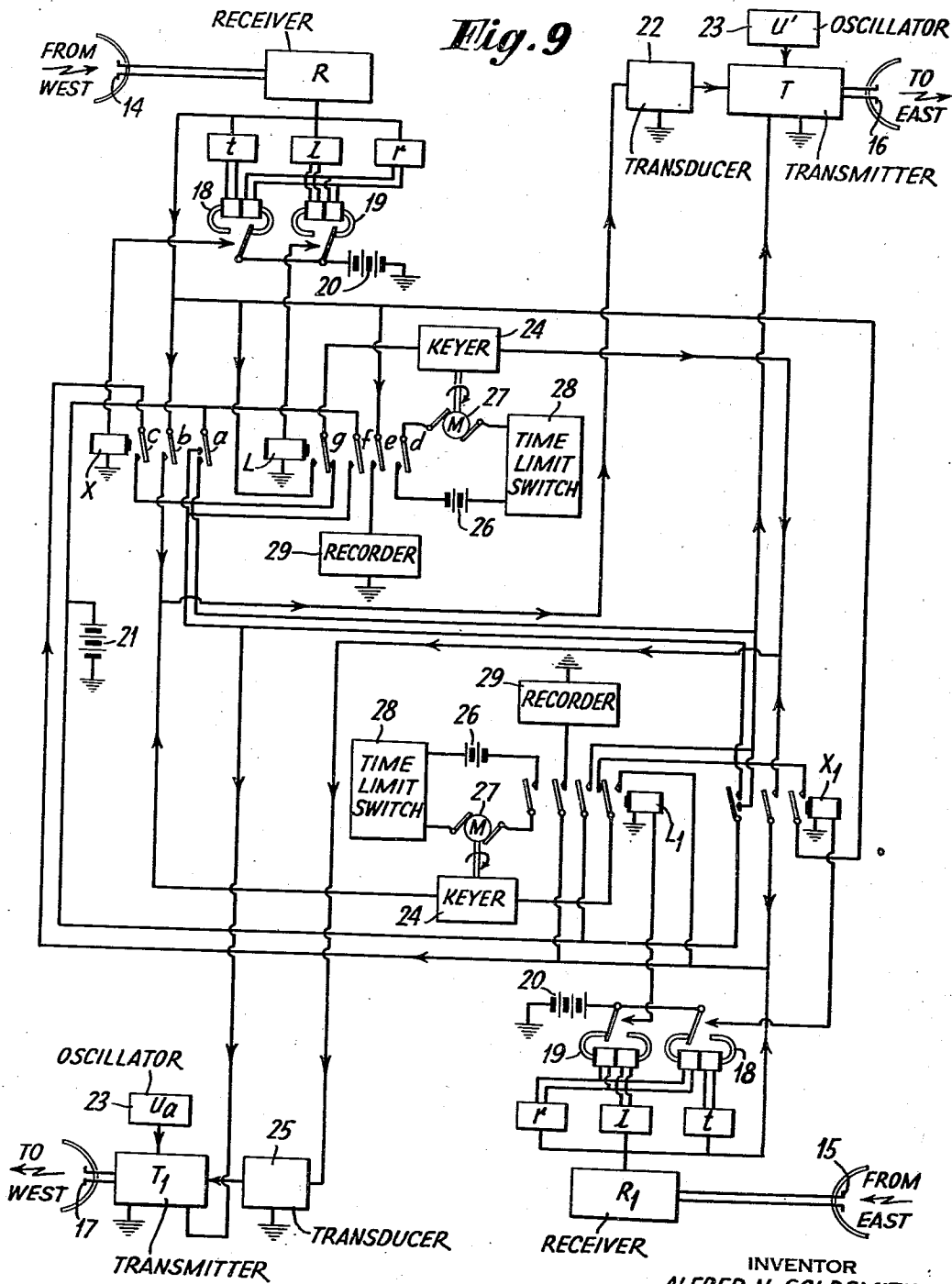
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A. N. GOLDSMITH
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Fig. 9



INVENTOR
ALFRED N. GOLDSMITH
BY *H. S. Siver*
ATTORNEY

UNITED STATES PATENT OFFICE

2,250,950

RELAY SYSTEM MONITORING

Alfred N. Goldsmith, New York, N. Y.

Application December 9, 1939, Serial No. 308,388

8 Claims. (Cl. 250—15)

This invention relates to remote control systems for radio relay stations, and has more particularly to do with a device of this character which is suitable for controlling a radio relay station from a distant terminal station, and also to control a chain of such relay stations by remote control signals from either one of two terminal stations at the ends of the chain.

While my invention has utility in a great variety of different remote control systems, it may be best illustrated by its use in connection with typical ultra-short wave radio relay systems for the transmission of communications, such as messages, sound broadcast programs, or television broadcast programs.

According to present practice it is necessary in transmitting communications over ultra-high frequency channels to locate a number of relay stations along a route, so that the maximum distance of transmission of the radiant energy from one station to another shall be preferably no greater than the line of sight. Obviously, if the transmitters and receivers can be located at elevated points within sight of each other, highly directional antennas may be used to secure the requisite and desirable power gain in the chosen relay direction. The relay stations themselves may in general be located at distances between 10 and 50 miles apart, depending upon terrain conditions.

In long relay systems of this sort there will obviously be a large number of relay stations. Economic considerations dictate that these stations shall, in the main, be unattended, but subject to periodic inspection and overhauling. It is also desirable that there shall be a minimum continuous power drain in each of these relay stations, and accordingly it is preferred that only receiving equipment (and preferably only one receiver) shall be active at all times in each relay station.

A relay system such as the above is vulnerable to an occasional breakdown or sub-normal operation in one or more of its individual relay stations. If, however, a single relay station breaks down along the network or system, serious and objectionable conditions arise. In the first place, the signal is lost at the distant end of the system. In the second place, there is no speedy means, in the system itself, for determining where the break or deficient operation has occurred. Thus it becomes difficult to know where to send a repair crew. In the third place, if the operation of a relay station becomes deficient in some respect (e. g. frequency characteristic or

introduction of noise) there is no means of determining readily by means of the system itself where imperfect operation is originating. Thus there may be long and costly delays and explorations on such a relay system under such conditions.

Another limitation of existing networks is the fact that the unmanned network must, in general, be used as a unit from end to end, and that it cannot be shortened if desired by terminating it at some specific station. Still another limitation of present relay systems is that there is no way of monitoring the operation of all or a part of the relay system from one or both terminal stations thereof. Further, presently used relay systems in general are one way and cannot readily be made one way or two way at will from one or both terminals.

It is the object of the present invention to overcome the limitations mentioned above. The objects of the invention thus include the following:

(a) Means whereby a break or discontinuity of service in the network at any point thereon can speedily be located (and in some cases partly or entirely diagnosed as to its cause).

(b) Means whereby the particular relay station in which a deficiency of quality in relaying occurs may be readily determined from the terminal station.

(c) Means whereby the network can be started up, relay station by relay station, from a terminal thereof, the operation of the system for each portion of increasing length thereof being also determinable at the said terminal station.

(d) Means whereby an extensible test loop, extending as far along the system as desired, can be set up from the terminal station and its operation studied.

(e) Means whereby networks of the above characteristics may be operated in either or both directions.

(f) Means whereby maximum economy of power in the relay stations during periods between times of active operation may be secured.

(g) Means whereby certain failures or deficiencies in individual relay stations may be identified and studied at a terminal station.

The invention itself and the preferred methods to be employed in carrying it out may best be understood by the following description when read in view of the accompanying drawings, in which

Figure 1 shows diagrammatically the inter-relationship between a plurality of ultra-short

wave stations each having its appropriate transmitter or transmitters for radiating energy of an appropriate ultra-high frequency;

Fig. 2 illustrates also diagrammatically an operating condition in which a station in the west controls a relay station in a direction easterly therefrom for the transmission of its traffic signals further east;

Fig. 3 illustrates an operating condition in which a station in the west sets up at an easterly station the proper conditions for recording the communication thereat while causing the easterly station to re-radiate an identifying monitoring signal on its own carrier wave back to the original sending station;

Fig. 4 illustrates how a terminal station in the west may transmit a succession of suitable signals such as will set up through connections for relaying a communication over successive easterly bound links of a radio network;

Fig. 5 illustrates the operating conditions at three stations in a chain, such as will enable the westerly terminal to transmit a communication through an adjacent easterly relay station, and thence to a station further east, where it is recorded and caused to transmit back a monitoring signal, which is ultimately received at the westerly point of origin of the communication;

Fig. 6 illustrates the operating conditions to be obtained in a two-way radio network which comprises at least two relay stations intermediate between the terminal stations;

Fig. 7 illustrates another operating condition in which communications may be originated simultaneously at each of two terminals and transmitted over different links of the network;

Fig. 8 shows diagrammatically how a low-power receiver operating under continuous service conditions, may be employed in response to start-and-stop signals for controlling the feeding of energy to a plurality of ultra-high frequency receivers, the object being to conserve power during stand-by periods; and

Fig. 9 illustrates in considerable detail a preferred circuit arrangement of relaying and switching apparatus to be used at a single remotely controlled relay station.

Referring first to Fig. 1, I have indicated by block diagrams different transmitters and receivers at each of four stations. The west terminal station W comprises a transmitter WT capable of feeding a carrier wave u to a transmitting antenna 1. The west terminal station also comprises a receiver WR₁ which derives its signals from a receiving antenna 2. In this case it is indicated that the carrier wave to be received is one which may be designated u_a , because it originates at station A and is sent out by a transmitter AT₁ located at station A.

In like manner different receivers and transmitters are shown in the blocks appropriately grouped as being comprised in either station A, station B, or the east terminal station E. Thus the transmitter AT at station A is adapted to radiate signals superposed on a carrier wave u' , while the transmitter BT at station B radiates the carrier u'' . Likewise, for transmitting communications from east to west transmitter ET₁ radiates a carrier wave u_e which is received at station B by the antenna connected to receiver BR₁. Re-transmission from station B on carrier u_b is obtained by the operation of transmitter BT₁, this wave being received at station A by receiver AR₁.

In Fig. 1 the four units at station A are

shown inter-connected by dotted lines to indicate that under different conditions they may be inter-connected in different ways. Thus, when it is desired that a communication shall be sent through station A from a point of origin at the west terminal and proceeding in a direction further east, then the receiver AR will be arranged to control the transmitter AT. However, if it is desired for test purposes, a signal from the west terminal may be reverted by station A back to the point of origin, receiver AR being then caused to control transmitter AT₁.

A further possibility exists in testing the operativeness of a series of unattended relay stations as shown in Fig. 1. Assume, for example, that it were desired to transmit a message from the west terminal transmitter WT through stations A and B to the east terminal receiver ER, but that for some reason or another the messages do not go through. It is then necessary to locate the particular relay station or terminal which has failed. To do this a monitoring signal may be sent out from the west terminal transmitter WT under conditions which, if there were no break in the chain, would be successively relayed to the east terminal where it would be reverted after being keyed with the signature of the east terminal and would proceed over the links of the channel which include the transmission carriers u_e , u_b and u_a , the latter arriving at the west terminal receiver WR₁. If this monitoring signal fails to come through, then a remote control signal may be transmitted which operates switches at station B for controlling the transmitter BT₁ directly from the receiver BR. The reverted monitoring signal is then to be keyed by a signature code appropriate to station B. If this signal fails to come through to the west terminal, still another switching operation may be performed at station A whereat the transmitter AT₁ is placed under direct control of receiver AR. Here an unkeyed monitoring signal is transmitted easterly over only one link, is then keyed and re-transmitted westerly over only one link. Thus, wherever it is found that a signal can be reverted it is known that a failure of operating equipment has occurred beyond that point. At times it may be desirable to check the operative conditions at relay stations from both directions, that is, by sending out an unkeyed monitoring signal from each terminal (but in general not at the same time, since they would interfere with one another), thereby to test the inter-connections between receivers and transmitters at each of the relay stations. This, of course, can be readily accomplished as will be indicated more in detail in the description to follow.

Referring to Fig. 2, I illustrate a portion of a radio network which comprises a west terminal having a transmitter WT whose antenna 1 is aimed toward a receiving antenna 3 located at relay station A. The diagram is intended to illustrate the use of a remote control signal for establishing connections between the receiver AR and the transmitter AT at station A, whereby the communication may be relayed in an easterly direction from antenna 5. As will be shown hereinafter, the carrier wave u which is appropriate to the west terminal transmitter, may have superposed thereon a tone frequency or a code signal of any desired character, indicated in the diagram as st , for operating a suitable relay at station A, thereby to establish the necessary connections. After this signal st has been transmitted it is then possible to continue operation of the trans-

mitter WT for sending out a message, a broadcast program, or the like, in an easterly direction, so as to be re-radiated by the transmitting antenna 5 at station A.

Referring to Fig. 3, I show how a test of operating conditions at station A may be made by remote control from the west terminal. In this case it is preferable to send out a relay setting signal st for establishing the control of the transmitter AT₁ from receiver AR, both at station A. Receiver AR has connected thereto a recorder and also a keyer, the latter being interposed between the receiver AR and the transmitter AT₁. After the switching signal st has been sent, a monitoring signal m may then be superposed on the carrier from the transmitter WT, and this monitoring signal, after reception at AR, is keyed with the signature which identifies station A, and then caused to control transmitter AT₁ for reverting the monitoring signal to the west receiver WR₁. It should be understood that since station A transmits on a different carrier wave than the west terminal, the monitoring signal m will preferably be demodulated and then keyed as monitoring signal m_a for modulating the carrier wave u_a .

Fig. 4 illustrates a system in which it is required that each of two stations A and B shall be successively remotely controlled by signals st and st' originating at station W, the west terminal. The signal st establishes connections between the receiver AR and the transmitter AT at station A. The signal st' then follows through station A and is sent out therefrom to control the establishment of connections between receiver BR and transmitter BT of station B. After these connections have been made, it is possible to transmit the communication from station W through station A and out of station B on antenna 6.

Fig. 5 illustrates a system in which it is possible to transmit a succession of switching signals and a monitoring signal for testing the operating conditions at each of two unattended relay stations A and B. The transmission of switching signal st from the transmitter WT at station W establishes connection between receiver AR and transmitter AT at station A. Then follows the transmission of a further switching signal st' which follows through station A and is received at station B for establishing inter-connection thereat from the receiver BR through a keyer to the transmitter BT₁. After these connections have been made, an unkeyed monitoring signal m transmitted from station W is relayed by station A to station B, where it is keyed with the signature of station B and caused to control the transmitter BT₁ for reverting a keyed monitoring signal through station A and thence to receiver WR₁ at station W. Obviously, the same principles apply for an extension of this test signal system as far as there may be connecting links between a terminal station and a remote relay station. When keying is referred to herein, it should be understood to cover broadly the impressing of any desired identifiable characteristic on the carrier wave by a modulation process.

Fig. 6 illustrates how the various receiving and transmitting units which are preferably provided at each terminal and at each of a series of relay stations may be employed simultaneously for two-way communications. In this case a communication designated c_w originates at station W, and is transmitted successively over the dif-

ferent inter-connecting links between that station and station A, thence to station B, and finally to station E whose receiver ER controls a recorder or other utilization device. Simultaneously a communication designated c_e may originate at station E where it is sent out from the transmitter ET, and is passed through stations B and A successively, thence to be transmitted to and recorded at station W. It is to be understood in this connection that the east-bound and west-bound channels may be entirely separated from one another, as shown in the diagram, merely by setting up the proper inter-connections and controls at each relay station. The carrier waves to be employed for east-bound traffic are, in general, distinct from the carrier waves to be employed for west-bound traffic, so that no interference between the east-bound and west-bound communications occurs.

Fig. 7 will now be referred to for showing how different links of a radio network may be simultaneously employed when it is not required that a communication shall be sent clear through from one terminal to the other. Reference to the drawings will indicate that it may be desired to send a communication originating at station W only so far as station A, where it may be recorded. It will be understood that the recorder or recorders here used are of a type suitable for the corresponding type of communication, e. g., an ink-siphon recorder for telegraph signals, for printer telegraph signals, a phonographic disc recorder for telephone signals, a motion-picture camera recorder for television signals, or equivalent devices. In order to monitor the communication designated c_w it is preferable to interconnect the receiver AR and the transmitter AT₁ so that the signal itself may be reverted back to receiver WR₁ at station W.

While the communication c_w is being transmitted, it is possible to employ other links of the radio network, say, for example, by sending out a communication c_e from the transmitter ET₁ at station E, this transmission being relayed through station B to the receiver AR₁ at station A, provided this station is equipped with a second recorder. The communication c_e may also be reverted and sent back to station E over east-bound links of the network. Hence the various links may be checked for operativeness during times when stations A and B are unattended.

Fig. 8 is now referred to for showing a simple system in which it is possible to conserve power at any one of a plurality of radio stations which for the most part remain unattended. It is to be understood that any receiving equipment, which is to be utilized under heavy traffic conditions, will require the expenditure of considerable power for filament heating of the discharge tubes and for plate current therein. It is desirable, therefore, that these receivers be turned off when no traffic requirements are imposed thereon. It is possible, however, to equip each radio relay station with a stand-by receiver which shall at all times be receptive of appropriate incoming signals. The receiver itself may be fed with energy from an omni-directional antenna 7, if desired. Furthermore, it may be preferable to employ signalling waves in the lower range of high frequencies in order to reach greater distances from the terminal to any number of relay stations in a given network. For the sake of simplicity it may be assumed further that one receiver 8, located at each relay station, may be sufficient for applying filament and

plate potentials to each and all of the ultra-high frequency receiving units located at a given relay station. Under these conditions it is sufficient for the receiver 8 to respond to a predetermined signal having a selective modulating frequency superimposed thereon such as will be passed by a filter 9 for controlling a relay 10, to throw its armature 11 against the contact 12 so that power from the source 13 shall be applied to each of the receivers R and R₁. The relay 10 is preferably polarized so that its armature 11 will, after movement to one side or the other, remain in the position in which it is set until moved in the opposite direction by reversal of the magnetism in the relay core.

Assuming that the receivers R and R₁ have been placed in operation by a start signal having a given frequency characteristic for being passed through the filter 9, and that the lower winding of the relay 10 has been energized to pull the armature 11 against the contact 12, this condition may continue indefinitely as long as it is desired to operate the receivers. The transmission of a stop signal having a modulation frequency characteristic different from that of the start signal will be passed through filter 9a and cause the upper winding of the relay 10 to be energized, thus restoring the armature 11 to the position shown in the drawings, whereat the power circuit through the contact 12 is opened and the receivers R and R₁ are shut off. It is to be understood that various equivalent means for selecting the "stop" and "start" signals which pass through units 9a and 9 may be adopted. Thus, units 9a and 9 may be code selectors responsive in each instance only to a particular keying succession of dots, dashes, or both. Otherwise stated, any practical forms of distinctive modulation of the carrier for actuating 9a and 9 may be substituted for the tone modulations hereinabove described.

It will be obvious to those skilled in the art that various changes may be made in the particular circuit arrangement shown in Fig. 8 for the purpose of switching the power on and off at an unattended relay station. Among the alternative arrangements are those which would not necessarily require the use of an omnidirectional antenna. In certain instances a stand-by receiver having ultra-high frequency apparatus for detecting a highly directional beam signal may be used, if desired. In any event, however, it is preferable to conserve power at a station which is unattended by providing a lower power receiver or one which does not consume an appreciable amount of power in the absence of signals, this receiver being available at all times for starting up other receiving and possibly transmitting equipment for the interchange of traffic signals. As an example of apparatus of this type, reference is made to United States Patent #1,731,983, granted October 15, 1929 to Charles E. Prince, and entitled "Electric call apparatus." In the patent means are shown which are responsive to signalling energy and which do not require a wasteful consumption of tube filament power during stand-by periods. The apparatus therein disclosed operates in such manner that when a signal is received, it is rectified without amplification, thereby operating a sensitive relay which closes filament and plate circuits for auxiliary apparatus in the receiver so that dependable reception may thereafter be obtained. Improvements over the system of Prince are also known in the art. Receivers such as that disclosed in Holl-

mann 1,123,242 dated July 12, 1938 may be employed. They utilize recently developed discharge tubes which operate with cold cathodes and consume no power until triggered off by a signal potential. Such tubes are described in an article by Seely, Deal and Kimball, in the Proceedings of the Institute of Radio Engineers, 1938, pages 818 to 825.

Referring now to Fig. 9, I show therein a circuit diagram which will explain more in detail my preferred mode of operation of an unattended radio relay station. In this diagram, for the sake of simplicity, the circuit arrangements of Fig. 8 are omitted, since it may be assumed that apparatus equivalent to that of Fig. 8 will be employed wherever it is required to start and stop the operation of the receivers R and R₁ (Fig. 9). Receiver R has connected thereto an antenna 14 which is aimed to receive signals from a station to the west. Receiver R₁ likewise is connected to an antenna 15 for receiving signals from a station to the east. In the upper right-hand corner of the diagram a transmitter T is shown having an antenna 16 facing to the east, and in the lower left-hand corner is a transmitter T₁ having an antenna 17 facing to the west.

The circuit arrangements are substantially duplicated in order that control of the relay station may be had from a remote station either to the west or to the east. It will be sufficient, therefore, for purposes of understanding the diagram, to describe the operation of the system as controlled by signals from the station to the west of the relay station.

Connected with the output side of the receiver R, I preferably employ three devices *t*, *l*, and *r* which may, if desired, be in the form of tone frequency filters, or alternatively they may be in the form of code selectors. It is to be understood, therefore, that these devices may be varied to suit the circumstances under which the relay station is to be operated. For the sake of simplicity however, devices *t*, *l* and *r* will be hereinafter mentioned as selectors or filters.

Associated with these selectors are two polarized relays 18 and 19, each relay possessing two windings, one for actuating the armature in one direction, and the other for actuating said armature in a reverse direction. The normal position of the armatures is shown in the drawings as an open circuit position for the circuit to be controlled. Selector *t* responds only to a given type of signal and actuates relay 18 for closing a circuit from battery 20 to relay X. This relay is used to establish suitable connections for passing signals through the relay station and out on a communications link further east thereof. The traffic signals which will follow the operation of the selector relay X will, of course, be of a type which will be blocked by the selector *t* as well as by the other selectors *l* and *r*. Hence the relay 18 will remain in its operating position during the transmission of traffic signals of any desired character. Also the relay X will remain energized during such a period.

The through-circuit connections preferably include the following: Armature *a* of relay X is connected to a power supply 21 for energizing both of the transmitters T and T'. The object attained by energizing both transmitters is to enable the operation of the relay station to be monitored from the west terminal station. In other words, the traffic signals may be preceded by a monitoring signal having preferably a predetermined tone frequency modulation. This

monitoring signal passes through the relay station the same as any traffic signals and is reverted back after being keyed at the station of destination of the signals. The reverted monitoring signal must, of course, be transmitted over channels having distinguishing carrier frequencies, as has been shown in the description of Fig. 5. The monitoring signals may be transmitted back through one or more relay stations to the point of origin. Such a channel for reverted signals may also be used, if desired, for continuous monitoring of traffic signals but without the necessity for keying to identify the station at destination.

Relay X also closes a circuit through its armature *b* for controlling a so-called transducer 22 by signals passed through the receiver R, so that the incoming signals as demodulated may be applied as modulations for signals retransmitted by the transmitting unit T. Hence the output side of the transducer 22 is connected to the input side of the modulating circuit of the transmitter T. An oscillator 23 delivers a suitable carrier frequency wave *u'* to the transmitter and it is, therefore, seen that this wave may be suitably modulated by output from the transducer 22 and radiated from the antenna 16.

Details of the transducers 22 and 25 are not herein given since they are well known in the art. In some cases it may be desirable to employ a passive type of transducer 32 as shown in Fig. 5. This unit may consist of a reflector disposed so as to receive part of the energy radiated from the antenna 16 and to be reflected toward the antenna 15. Testing of all the apparatus located at relay station A is then readily accomplished, even though it might be impossible to utilize the channels between station A and station B.

It will be apparent that if the transducer 32 is to be used only for test purposes, it should be rendered inactive during normal traffic conditions, especially when two-way communications are under way. Accordingly it will generally be arranged for such a reflector 32 to be moved into and out of its functioning position in response to a remote control signal of any suitable characteristic. Facilities for accomplishing this result are well known in the art and need not be further detailed herein.

Still other types of transducers and coupling circuits may be employed at each relay station, if desired. They will preferably include amplifier systems where it is necessary to strengthen the received signals before using the same to modulate an out-going wave.

The relay X also closes a circuit through its armature *c* for deriving reverted signals from the receiver R₁, these signals being then passed through a back contact and armature *g* of relay L, to an inactive keyer 24, and thence to the input side of a transducer 25 connected to transmitter T₁ whose antenna 17 is aimed in a westerly direction. It may be stated here that the keyer 24 plays no part in this circuit at this time, it being normally positioned so as to provide a closed circuit therethrough.

When the transmission of a communication has been completed the relay station apparatus may be brought to idle condition by the transmission of a selector signal to which the selector *r* will respond, this signal as shown being received on an ultra-high frequency wave collected by the antenna 14. The response to such signal is one which will restore to normal either of the

relays 18 and 19, thus opening the operating circuits to the selector relays X or L.

When it is desired that the relay station shall operate for locally recording a communication or for utilizing traffic signals in any other desired manner, a preliminary selector signal may be sent, to which the selector *l* is responsive. This causes the relay 19 to operate for closing a circuit from the battery 20 through the winding of relay L. In this case the following circuits are established for placing the relay station in operative condition. Only the transmitter T₁ is to be energized in this case for reverting monitoring and other signals back to the west station. The power supply source 21 is, therefore, connected through armature *f* of relay L and thence to the power supply terminal of the transmitter T₁.

It is to be presumed that the signals to be sent to the relay station will serve either as monitoring signals for informing the operator at the west station that the relay station is in operative condition, or else for recording at the relay station a given communication. Accordingly, I have shown auxiliary circuits to be also established, as desired, by the operation of the relay L. One of these circuits is closed through armature *d* for causing an energy source 26 to drive a motor 27 whereby the keyer 24 is operated to superpose a signature code upon the received monitoring signals. The operation of the motor 27 may be limited to a predetermined time by including in the motor circuit a time limit switch 28. Such switches are well known in the art and may be employed in this connection for automatically breaking the motor circuit after sufficient time has been allowed for observing the monitoring signals. The operation of the keyer 24 is preferably one which will introduce dots, dashes, or other code identification signals and apply the same to the incoming tone frequency signals as collected by the antenna 14. The path for such signals may now be traced through armature *g* of relay L, thence through the keyer 24 and then to the transducer 25 which causes the transmitter T₁ to be modulated for reverting the monitoring signals from antenna 17 to the west station. The incoming signals which are passed through the receiver R may also be recorded by passing the same through the armature *e* and thence to a recorder 29.

Assuming that conditions have been found operative at the relay station as noted by the reverted transmission of the keyed monitoring signals, a message of any length may then be recorded at the unit 29 and thereafter the relay station itself may be closed down by the reception of a stop signal to which the selector *r* is responsive. This signal, as has previously been stated, operates to restore relay 19, thus releasing the relay L.

When it is desired that the relay station shall be rendered operative for two-way communications, it is only necessary for a through selector signal to be transmitted from either terminal station alone. This fact may readily be understood by tracing the circuits as follows: Assuming that relay X has been operated, incoming signals collected by antenna 14 will be passed through the receiver R, and thence through armature *b* of relay X to the transducer 22 which controls the modulation of transmitter T. Simultaneously signals originating at the east terminal may be collected on antenna 15, received and detected by receiver R₁, passed through arma-

ture c of relay X, and thence through the back contact and armature g of relay L to the inactive keyer 24 through which signals are passed to the transducer 25 for controlling the modulation of transmitter T₁ whereby the signals are sent out from antenna 17 to the west terminal.

Various auxiliary selective apparatus and relays may also be used, if desired, for substituting, either automatically or upon reception of an actuating signal, certain stand-by equipment in a relay station for equipment which has failed to operate. The principles involved in the application of these selectors and circuit switching means are substantially illustrated by the selectors and relays shown in Fig. 9. For the sake of simplicity, therefore, they have not been added to the circuit diagram.

As will be clearly understood by those skilled in the art, various modifications of the invention itself are to be considered as falling within the scope of the subject matter claimed. The invention is, therefore, limited only in accordance with the claims.

I claim:

1. In a radio relay system, a plurality of stations, radio links for establishing communication from station to station, means including low power apparatus responsive to a start signal from a manned station for setting up a predetermined operating condition at an un-manned station, selective means for causing signals received at said un-manned station to be relayed forward to another station, means at the last mentioned station for causing at least some of the signals received thereat to be reverted, and means operable in response to reverted signals received at said un-manned station from said other station for relaying said reverted signals back to said manned station.

2. In a radio relay system, the combination according to claim 1, and means for keying said reverted signals by a signature code which identifies the station where reversion of the signals takes place.

3. In a radio relay system, a plurality of stations, radio links for establishing communication from station to station, means including low power apparatus responsive to a start signal from a manned station for setting up a predetermined operating condition at an un-manned station, selective means for causing signals received at said un-manned station to be recorded, a transmitter and directive antenna operative to propagate a radiant energy beam in the direction of said manned station and means controlled by signaling energy received at said un-manned station for modulating the output from said transmitter.

4. In a radio relay system having a plurality of stations and intercommunicating links therebetween, the method of testing each intermediate station as to operativeness or failure which comprises transmitting remote control signals, and monitoring signals from one end of the system to each succeeding station by relaying the same over successive communication links, causing said monitoring signals to be reverted at the station beyond which a failure occurs, keying said monitoring signals by a signature code appropriate to the station where reversion takes place, and transmitting the keyed signals back to the point from which the unkeyed signals originated.

5. In a radio relay system having a plurality of stations and intercommunicating links therebetween, the method of operating said system as a two-way network which comprises transmitting remote switching control signals destined to be responded to at each successive station, causing the response at each station to prepare two linkages, one for retransmission of switching control signals, test signals and traffic signals through said station in one direction, the other for retransmission of test signals and traffic signals through said station in another direction, drawing upon two carrier wave sources at each intermediate station for desired retransmission of signals in appropriate directions, causing the signals received at each intermediate station over one link to be retransmitted over another link by modulating an appropriate wave from one of said carrier sources, and causing said test signals to be reverted over any desired number of links to the point of origin.

6. In a radio relay system a plurality of stations, including terminal stations and at least one relay station, each of said stations being provided with receiving and transmitting apparatus units and said relay station being provided with remote control apparatus operable by signals from a terminal station for starting and stopping various ones of said units, means at said relay station operable under control of test signals sent out from the transmitting apparatus of a terminal station for modulating the output of a transmitting unit at said relay station, thereby to revert said test signals to the originating terminal station, means for so characterizing said modulated output as to indicate the then existing condition of said apparatus units, and means including said receiving apparatus at a terminal station for rendering the modulated test signals intelligible.

7. A system according to claim 6 and having means including directional antennae connected with each apparatus unit at the several stations, whereby said signals are efficiently directed to their proper destination.

8. In a radio relay system, a plurality of stations each having receiving and transmitting apparatus units, a directive antenna connected to each unit and suitably aimed toward an antenna appropriate to a different station, remote control apparatus at a given one of said stations comprising a radiant-energy-responsive-cold-cathode-discharge-tube-relay for rendering at least one of said apparatus units operative, other remote control apparatus at said given station responsive to appropriate signals from a remote station for effecting a desired set of circuit connections between different receiving and transmitting apparatus units, means including a suitably disposed radiant energy reflector for receiving from one said antenna and re-radiating toward another said antenna at said given station signals originating at a remote station, means for reverting said signals by transmission thereof in the direction of said remote station, and means at said remote station responsive to said reverted signals for giving an indication as to the character of the operating conditions established at said given station.

ALFRED N. GOLDSMITH.