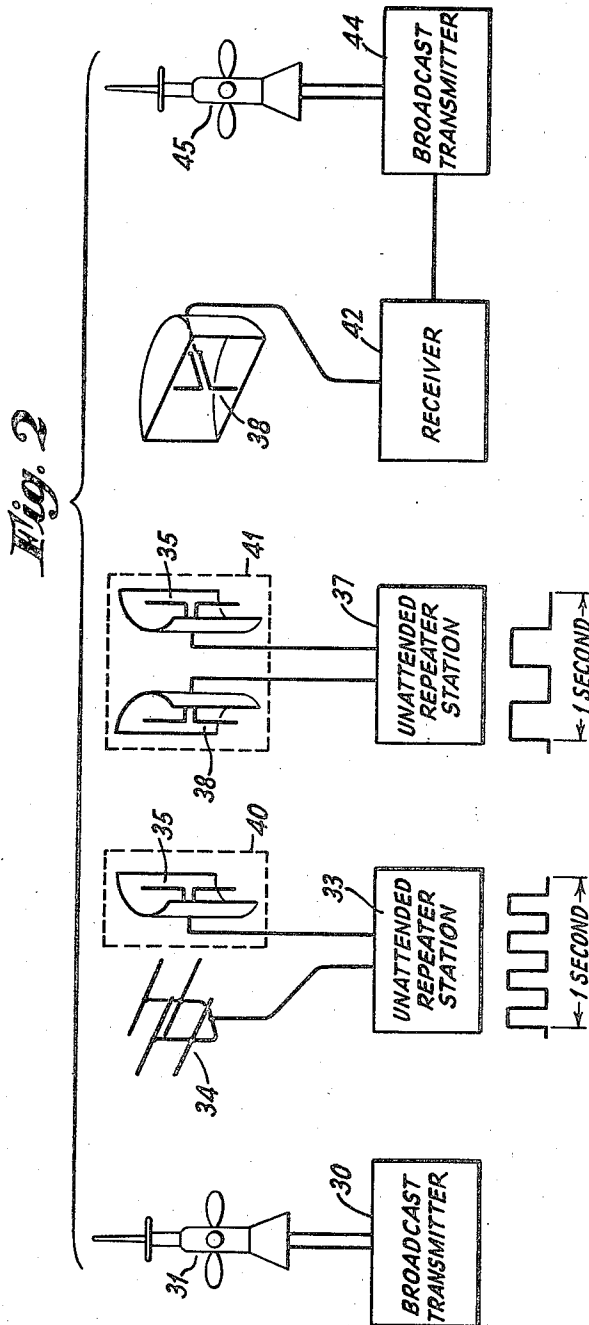
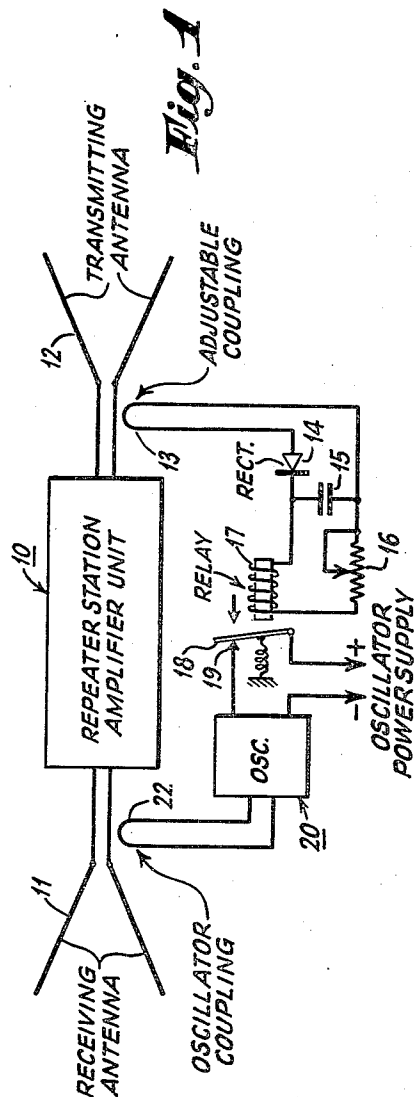


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RELAY SYSTEM MONITOR
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RELAY SYSTEM MONITOR

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The present invention relates to radio relaying systems and, more particularly, to monitoring arrangements for the aforesaid systems.

An object of the present invention is to improve the operation of radio relay systems having unattended repeater stations.

A further object of the present invention is the provision in a relay system, as aforesaid, of means for automatically determining the location of a failure in operation immediately when such failure occurs. In the operation of radio relaying systems in which operating personnel is in attendance only at the system terminals a problem arises when, for any reason, there is a failure at an unattended repeater station. It is desirable to know at once, at a terminal station, where the failure has occurred so that no time will be lost in getting maintenance personnel to the proper repeater station. To do this, in accordance with the present invention, I propose to supply an oscillator at each repeater station, which is preferably modulated, the oscillating frequency of which is substantially the same as that of the carrier wave which is to be repeated at that station. When a normal carrier wave current is being repeated so that there is output power from the repeater, a small portion of the output power is utilized to keep the oscillator from functioning. However, if for any reason, the carrier wave is interrupted so that there is no signal in the output of the repeater, the oscillator is allowed to function.

The operation of the oscillator at each relay station is arranged to be intermittent so that it will be caused to oscillate in pulses, these pulses, for example, occupying half the functioning time. The frequency of operation of each oscillator is different and therefore characteristic of the particular repeater station. The impulse frequency may be utilized at a receiving terminal as a means for identification of the station.

Starting from the receiving terminal of a relay chain and going through the system to the transmitting terminal, the first unattended repeater may have an arrangement such that when the repeater is receiving no signal its oscillator will be operating at a pulse rate of one per second so that the oscillator functions for half second intervals separated by half second off periods.

The second repeater station is similarly arranged except that the oscillator pulse rate may be, for example, two per second when no signal wave to be repeated is being received.

The third repeater is also similar, except that

the pulse rate is four per second and so on through the system.

The circuits at each repeater are so arranged that a small interval of time after failure of the received signal wave is required before the oscillator can begin to function. For instance, at the first mentioned repeater the time interval may be a half second; at the second repeater a quarter of a second; at the third repeater an eighth of a second, etc.

In consequence, no oscillator at any repeater will function as long as the oscillator, at least the immediately precedent station, is functioning and delivering carrier wave pulses to the repeater. Therefore, at the receiving terminal a pulse wave will be received which is interrupted at a rate corresponding to the nearest functioning repeater station. By this means, when failure occurs the receiving terminal operating personnel may know at once where a failure has occurred and can direct maintenance personnel to that particular station immediately. Ordinarily, this will be done by means of existing public service telephone or telegraph connections, or by means of private wire or radio telephone or telegraph connections whichever is the most convenient.

Further objects, features and advantages of the present invention will be clearly understood by reference to the following detailed description which is accompanied by a drawing in which Figure 1 illustrates, diagrammatically, a radio relay station, while Figure 2 illustrates a general layout of a complete radio relay system involving my invention.

In Figure 1, reference character 10 indicates by means of a conventional box a repeater station amplifier unit. The arriving signals are picked up by receiving antenna 11, applied to the input of the amplifier 10, and from the output of the amplifier applied to a transmitting antenna 12. From transmitting antenna 12 the signals are sent on to the next repeater station. In adjustable coupling relationship with the transmission line from the output of amplifier 10 to the transmitting antenna 12 is a coupling loop 13 which abstracts a small portion of the energy appearing in the transmission line. This energy is rectified by rectifier 14 and applied to the operating winding 17 of a relay. The circuit between rectifier 14 and winding 17 includes a condenser 15 and a variable resistance 16 by means of which the response time of the relay may be adjusted. The relay winding 17 is arranged to attract contact arm 18 when energizing thus

breaking its connection with a back contact 19. As long as signals are picked up by the coupling loop 13 the relay winding 17 is maintained energized and contacts 18 and 19 are separated. The oscillator 20 is therefore prevented from operating. If, for any reason, signals cease to appear in the output of amplifier 10, the winding 17 of the relay is de-energized, contacts 18 and 19 are closed and oscillator 20 is energized from a convenient power supply, not shown but conventionally indicated. The output of the oscillator 20 is applied by means of a coupling loop 22 in adjustable relationship with the input of the amplifier 10.

The capacity of condenser 15 and the resistance of variable resistor 16 are so adjusted that at the relay station nearest the receiving terminal it requires, for example, a half second for the relay to close its back contacts when no signal is being received. The oscillator 20 being energized transmits a signal through the amplifier 10 if it is in an operative condition. The resultant amplified signal appearing in the output of the amplifier is picked up by coupling loop 13 and the relay is caused to open the contacts 18 and 19. Thus, a pulse of approximately a half second in duration is transmitted. The time period between pulses will also be about a half second in duration.

The rate of opening and closing and the ratio of time closed to time open of the relay contacts 18, 19, may be made any desired value over a large range through a choice of circuit constants and coupling adjustment and by suitable design and adjustment of the relay.

A relay system in which my invention may be employed is shown in Figure 2, with the typical oscillator pulse rates shown below two of the intermediate and unattended repeater stations 33 and 37. In this system, a television transmitter 30 applies signals to broadcast antenna 31 broadcasting the signals over a desired control service area. Near an edge of the area consistently supplied by good quality signals from transmitter 30, is located in an unattended repeater station 33 having receiving antenna 34 and a sharply directional transmitting antenna 35. Antenna 34 is preferably directional and is shown as a type of array which is conveniently useable at the frequencies assigned for television broadcast use. Antenna 35 is shown as of the type employing a parabolic reflector for its direction effect. Ordinarily, the frequencies transmitted are much higher than those from transmitter 30 and are, therefore, conveniently focussed by this type of antenna. In order to protect the antenna 35 from adverse weather conditions, it may be enclosed within a shield 40 made of wood or other non-conducting material. The repeater station 33 may include amplifier units such as amplifier 10 of Figure 1. In the embodiment shown it may also include a frequency changer. The signal transmitted from antenna 35 is picked up at a second repeater station 37 by receiving antenna 38 and retransmitted over directional receiving transmitter 35. At this particular station, the entire transmitting and receiving equipment including the antennas, may be enclosed within a cylindrical drum-like structure 41 at the top of a tall tower. All of the equipment being compactly grouped, losses in transmission lines may be reduced. The enclosure 41 is similar to enclosure 40 at the first repeater station and performs the same functions.

The signal radiated from transmitting antenna

35 may be re-relayed through as many additional repeater stations as may be required until the signal finally reaches the terminal receiver 42. Here the signal is converted to the broadcast band in a second broadcast transmitter 44 and reradiated over the desired service area by means of broadcast transmitting antenna 45. Since transmitters 30 and 44 are out of each others range, the same or closely adjacent frequencies may be used. Also located at the terminal receiver 42 is the monitor equipment for indicating the reception of pulses from the monitoring equipment at each of the intermediate and unattended stations. As shown beneath the repeater stations, 33 and 37, the timing of the monitor pulses is made to vary as the distance from the receiver 42 increases. For instance, at an assumed repeater station between station 37 and receiver 42, but not shown, the pulse rate may be one per second with each pulse lasting one-half second, as described with reference to Figure 1. The previous station 37 has a pulse rate of 2 per second and the length of each pulse is made a quarter of a second. Similarly, the preceding repeater station 33 has a monitor pulse rate of four per second. The length of each pulse here is an eighth of a second. The pulse rate at each station is thus fast enough that at all succeeding stations the monitor oscillator is kept out of operation. This is apparent since it requires a period of no signals of at least a quarter of a second at station 37 for its monitor to start operating. In this length of time there must be at least one impulse from station 33 and more than that from any previous stations, not shown in the diagram.

Since each of the different repeater stations, as shown in Figure 2, is characterized by its own pulse rate, it will be at once evident to the personnel at the receiving terminal 42 which repeater it is which is supplying the pulses and it will immediately be apparent that the next previous repeater in the system has failed.

As an aid to identification and to distinguish the oscillator pulses from noise, the oscillators are preferably frequency modulated. They may, for example, be modulated by currents derived from the power supply frequency, which in the United States may be 60 cycles per second. Also, the frequency of the modulation of each succeeding oscillator may be different so that frequency selectivity of the terminal, as well as the pulse rate, may be utilized as an aid to identifying the most remote repeater which is still functioning.

The signaling impulses received at the terminal receiver 42 may, if desired, be utilized for selective operation of automatic indicators and alarms to bring a failure to the immediate attention and to locate the origin of the signal impulses. It should, of course, be apparent that the transmission of a program from transmitter 30 over the relay chain will keep all of the monitor oscillators inoperative up to the repeater which has failed, if such there be.

While I have shown and particularly described several embodiments of my invention, it is to be distinctly understood that my invention is not limited thereto but that modifications within the scope of my invention may be used.

I claim:

1. In a radio relay system having a pair of terminal stations, and one or more intermediate repeater stations, each having an input and an output, means in each repeater station responsive

to a cessation of signals for a predetermined time in the output thereof for introducing a characteristic signal in its input, the characteristic of the signal from each station differing from that of every other station by a factor determined by said predetermined time.

2. In a radio relay system having a pair of terminal stations, and one or more intermediate repeater stations, each having an input and an output, means in each repeater station responsive to a cessation of signals in the output thereof for a different predetermined time for each repeater station for introducing a signal in its input, the predetermined time for each repeater station being longer than for the immediately preceding station.

3. In a radio relay system having a pair of terminal stations, and one or more intermediate repeater stations, each having an input and an output, means in each repeater station responsive to a cessation of signals in the output thereof for a predetermined time for introducing a signal in its input, said means being disabled by an appearance of signals in said output whereby in the absence of signal input to each of said repeater stations said signal introducing means is intermittently operated.

4. In a radio relay system, a repeater station having input and output connections, a generator of high frequency energy coupled to said input, means responsive to energy in said output connections for disabling said generator, said last means being so responsive to an absence of high frequency energy in said output for a predetermined time for energizing said generator and so constructed and arranged that in the absence of high frequency energy input to said repeater station said generator is intermittently energized.

5. In a radio relay system, a repeater station having amplifying equipment therein, said amplifying equipment having input and output connections, a generator of high frequency energy coupled to said input, means responsive to energy in said output connections for disabling said generator, said last means being so responsive to the absence of high frequency energy in said output

for a predetermined time for energizing said generator and so constructed and arranged that in the absence of high frequency energy input to said repeater station said generator is intermittently energized.

6. In a radio relay system, including a plurality of cascaded repeater stations each having input and output connections, each station including a generator of high frequency energy coupled to said input, a circuit coupled to said output connections, said circuit containing means for rectifying high frequency energy and a relay winding, said relay winding being adapted to disengage a pair of contacts in response to energization, said pair of contacts being adapted to control said generator, said circuit also containing means for maintaining said relay winding energized for a predetermined time after high frequency energy disappears in said output connections said predetermined time for each station being longer than for the immediately preceding station.

7. In a radio relay system, a repeater station having input and output connections, a generator of high frequency energy coupled to said input, a circuit coupled to said output connections, said circuit containing means for rectifying high frequency energy and a relay winding, said relay winding being adapted to disengage a pair of contacts in response to energization, said pair of contacts being adapted to control said generator.

8. In a radio relay system, a repeater station having amplifying equipment therein, said amplifying equipment having input and output connections, a generator of high frequency energy coupled to said input, a circuit coupled to said output connections, said circuit containing means for rectifying high frequency energy and a relay winding, said relay winding being adapted to disengage a pair of contacts in response to energization, said pair of contacts being adapted to control said generator, said circuit also containing means for maintaining said relay winding energized for a predetermined time after high frequency energy disappears in said output connections.

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