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RECEIVER PROTECTIVE CIRCUIT FOR
PULSE TRANSMISSION SYSTEMS
Filed June 30, 1945

FIG. 1

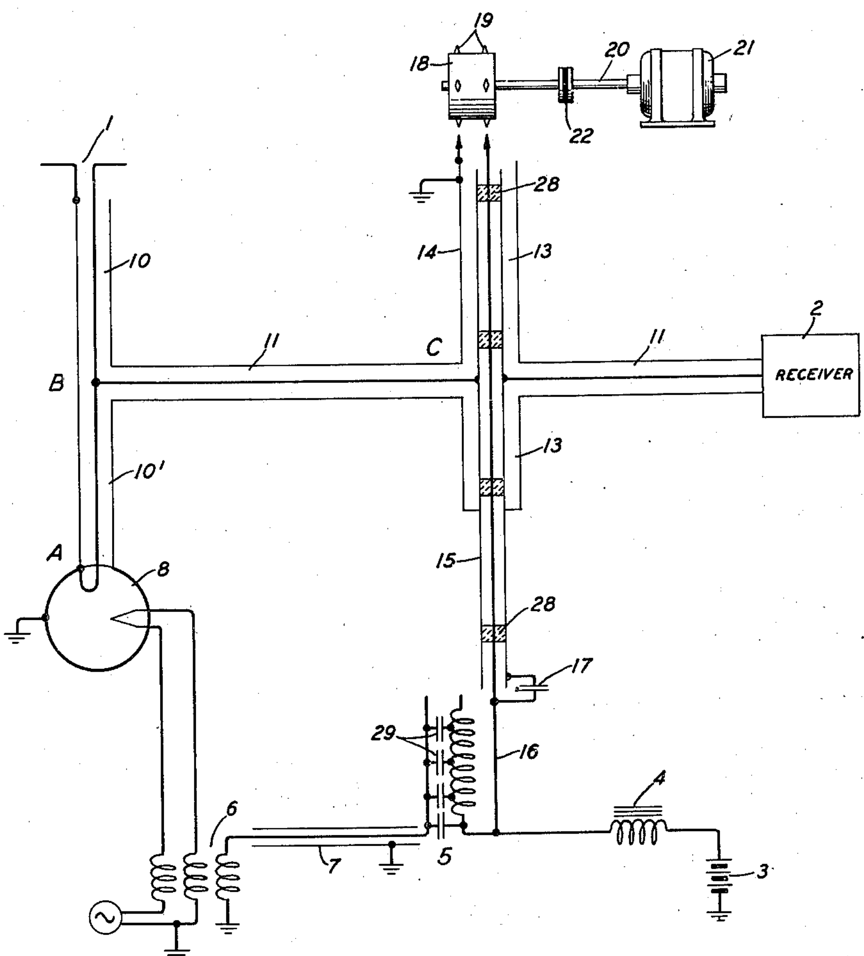
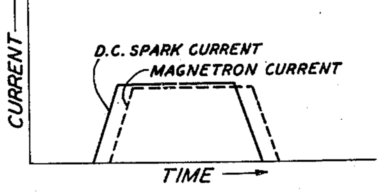


FIG. 2



INVENTOR
B. H. KLYCE, JR.
BY
B. H. Stoddard
ATTORNEY

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RECEIVER PROTECTIVE CIRCUIT FOR PULSE TRANSMISSION SYSTEMS

Battle H. Klyce, Jr., Morristown, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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2 Claims. (Cl. 250—13)

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This invention relates to two-way radio signaling and, more particularly, to control means for automatically decoupling the receiver of a combined radio transmitting and receiving station using a common antenna during transmission periods.

In operating a combined pulse transmitting and receiving station, such as an object locating system, having an antenna common to both the receiver and the transmitter, it has been found that it is advisable to employ some means for preventing the pulses generated by the transmitter from passing directly into the receiver. Unless such means are employed, the powerful pulses from the transmitter will produce an extreme overload on the receiver such as may damage the apparatus elements thereof or develop paralyzing bias voltages on the vacuum tubes that would disable the receiver for unduly long intervals.

Accordingly an object of the invention is to provide a combined radio transmitting and receiving station, having an antenna common to both the radio receiver and the radio transmitter, with improved means for automatically decoupling the receiver from the antenna when transmission is initiated by the transmitter.

Another object is to provide a combined pulse transmitting and receiving station, having an antenna common to both the pulse receiver and the pulse transmitter, with improved means for automatically decoupling the receiver from the antenna in response to the generation of a pulse by the transmitter.

Another object is to provide a combined pulse transmitting and receiving station, having an antenna common to both the pulse receiver and the pulse transmitter, with improved means for automatically decoupling the receiver from the antenna just before a pulse is transmitted and to maintain the receiver decoupled until the end of the pulse.

These objects of the invention are accomplished in a pulse transmission system in which the transmitted pulses are produced by the discharge of a condenser through a discharging switch or spark gap, by utilizing the same discharging switch or gap, as described in detail later, to effectively short-circuit the input circuits of the receiver during the passage of the high frequency pulse. An advantage of the invention is that, where the condenser discharge is used to energize a high frequency oscillation generator, the disabling of the receiver takes place before the high frequency waves make their appearance and continues at least as long as the

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high frequency pulse exists. This results in improved protection of the receiver.

These and other features of the invention are explained more fully in connection with the following detailed description of the drawing in which:

Fig. 1 shows the invention applied to a combined pulse transmitting and receiving station having an antenna common to both the pulse receiver and the pulse transmitter; and

Fig. 2 is a diagram representing a comparison between the time of occurrence and duration of the direct current component of the spark current with the time of occurrence and duration of the magnetron current.

The combined pulse transmitting and receiving station shown in Fig. 1 includes an antenna 1 coupled to a pulse receiver 2 by coaxial transmission lines 10 and 11. The antenna 1 is also coupled by coaxial line 10, 10' to a pulse transmitter comprising a magnetron 8 having high-voltage pulses impressed upon its anode-cathode circuit by means of the bifilar secondary windings of a pulse transformer 6. These pulses are supplied to the primary winding of the pulse transformer 6 by a coaxial cable 7 connected to a pulse generator comprising a capacitive pulse-forming network 5. The network 5 includes a plurality of condensers 29 which are periodically charged from a suitable source 3 of high voltage power connected to the network 5 through a charging inductor 4. The network 5 is periodically discharged through a rotary spark gap constituted in part by the rotating electrodes 19 mounted on a metallic wheel 18.

Since the antenna 1 and the coaxial line 10 carry both outgoing and incoming pulses, it is advisable, for the reasons already stated, to prevent the radio-frequency pulses generated by the magnetron 8 from passing directly into the pulse receiver 2. This is accomplished in the system shown in Fig. 1 by employing control means for automatically decoupling the pulse receiver 2 from the antenna circuit with the same spark discharge that is used to initiate the transmission of a pulse. For this purpose the discharging circuit for condensers 29 is carried by conductor 16 through a triple concentric line 13, branching from receiver line 11, to a rotary spark gap comprising metallic wheel 18 having spark points 19 mounted thereon in pairs. These are disposed to produce a double spark path between the end of conductor 16 and the grounded outer sheath 14 of line 13. Conductor 16 is carried through the center of intermediate conductor 15, being insulated therefrom, for example, by spaced insulators 28. Conductor 15 is connected directly to the central conductor of receiver line 11 as shown.

The upper portion of line 13, that is the portion between the receiver line and the spark gap, has a length equal to an integral number of half wavelengths at the operating radio frequency of the system and is normally open at its outer end. The lower portion of line 13, which is provided mainly for convenience in supporting the inner conductor, is short-circuited at its outer end and extends an odd number of quarter wavelengths so that it introduces little or no energy loss at the operating frequency. The intermediate conductor 15 extends sufficiently below the lower end of line 13 to make its total length equal to one or more wavelengths and is connected at its end to conductor 16 through by-pass condenser 17. This has the effect of making the impedance of the central pair at the end adjacent the spark gap very low at the operating radio frequency in consequence of which radio frequency currents entering line 11 from magnetron 8 pass freely to conductor 16 and from thence to the spark path. Alternatively, condenser 17 may be located at the end of line 15 adjacent the spark gap in which case the lower extension of line 15 would be omitted. The arrangement shown, however, has the advantage that the condenser is removed from the vicinity of the spark and is not subject to the corroding influence of the products generated in the air by the spark.

The spark gap wheel 18 is mounted on the shaft 20 of motor 21 and is insulated from ground by insulating coupling 22. The motor speed may be controlled by conventional means, not shown, to give a desired spark recurrence rate.

In operation, the condensers 29 in network 5 are discharged periodically through the pulse transformer 6, the wire conductor 16 and the two spark gaps in series. The resulting pulse delivered by the pulse transformer 6 to the magnetron 8 renders the cathode of the magnetron 8 highly negative with respect to its anode which is grounded. This causes a large plate current to flow which, in turn, causes the magnetron 8 to oscillate at a very high radio frequency until the condensers 29 in the network 5 are almost completely discharged.

The high frequency currents delivered by the magnetron will pass principally along line 10, 10′ to the antenna, but some part will be diverted into line 11 and will travel towards the receiver. These currents will travel along line 13 and will arrive at its outer end while the spark is still present. Because the line section constituted by conductors 15 and 16 is an integral number of wavelengths and is short-circuited at its remote end, its impedance at its open end is negligibly small. Consequently, the high frequency currents can pass readily to conductor 16 and then to ground through the short-circuit created by the spark. Since the upper portion of line 13 is a half wave section, the short-circuit at its outer end is effectively transferred to the branch point C; that is, the branch line 13 acts as a short-circuit across line 11 and so effectively protects the receiver.

The other significant line sections are proportioned in accordance with customary practice. The section from point A at the magnetron 8 to branch point B is a half wavelength or an integral multiple thereof. This ensures that the line section presents a substantially infinite impedance to waves received on antenna 1 in the

intervals between pulses when the magnetron space path is open. The section between branch points B and C is an odd number of quarter waves in length. This ensures that a short-circuit effective at C results in the section having a very high impedance at the branch point B and so prevents a large diversion of energy from the transmitted pulse. By virtue of the use of these dimensions, the total length between the magnetron and the actual spark gap is an odd number of quarter waves and because of this the high frequency current traversing the spark path behaves as though it came from a very high impedance source. Slight changes in the spark resistance make little difference to the high frequency current flow which, therefore, maintains the spark until the transmitted pulse has completely passed.

Protection of the receiver thus starts from an instant shortly before the appearance of the high frequency pulse and continues at least until the pulse has passed.

What is claimed is:

1. A pulse transmitting and receiving station comprising in combination an antenna, pulse transmitting means coupled to the antenna, a spark gap, a source of direct current for producing a spark discharge across the spark gap for initiating the generation of pulse energy by the pulse transmitting means, pulse receiving means, a coaxial transmission line for coupling the pulse receiving means to the antenna, and protective means for protecting the pulse receiving means from pulse energy generated by the pulse transmitting means, said protective means including an open-ended stub coaxial line extending from said coaxial transmission line for a length that is an even multiple of a quater wavelength of the pulse energy transmitted by the transmitting means, means for short-circuiting the open end of the stub line with said spark discharge whereby said short-circuit is virtually transferred to the coaxial transmission line, said means comprising said source of direct current and a wire conductor connected to said source and extending through the stub coaxial line to the open end thereof for forming one electrode of said spark gap, said wire conductor being capacitatively coupled to one of the concentric conductors of said stub coaxial line.

2. A pulse transmitting and receiving station comprising in combination an antenna, pulse transmitting means coupled to the antenna, a spark gap, a source of direct current for producing a spark discharge across the spark gap for initiating the generation of pulse energy by the pulse transmitting means, pulse receiving means, a coaxial transmission line for coupling the pulse receiving means to the antenna, and protective means for protecting the pulse receiving means from pulse energy generated by the pulse transmitting means, said protective means including an open-ended stub coaxial line extending from said coaxial transmission line for a length that is an even multiple of a quarter wavelength of the pulse energy transmitted by the transmitting means, means for short-circuiting the open end of the stub line with said spark discharge whereby said short-circuit is virtually transferred to the coaxial transmission line, said means comprising said source of direct current and a wire conductor connected to said source and extending through the stub coaxial line to the open end thereof for forming one electrode of said spark gap, said wire conductor being capacitatively

coupled to one of the concentric conductors of said stub coaxial line, means having an inherent transmission delay for delaying the transmission of pulse energy from the pulse transmitting means until after the coaxial transmission line has been short-circuited, and means for maintaining said spark discharge for a short time after the flow of direct current along the wire conductor has ceased.

BATTLE H. KLYCE, Jr.

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