July 9, 1946. N. E. LINDENBLAD 2,403,726

PULSE TRANSMISSION SYSTEM

Filed Aug. 13, 1942

Fig. 1.

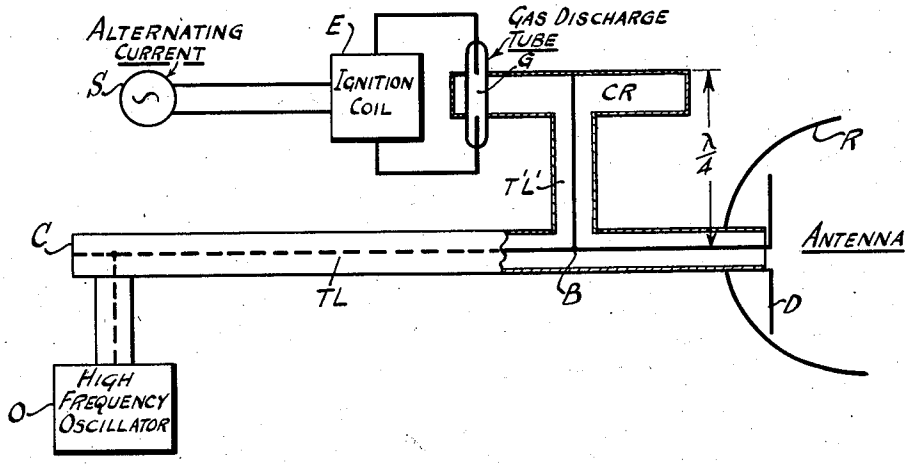
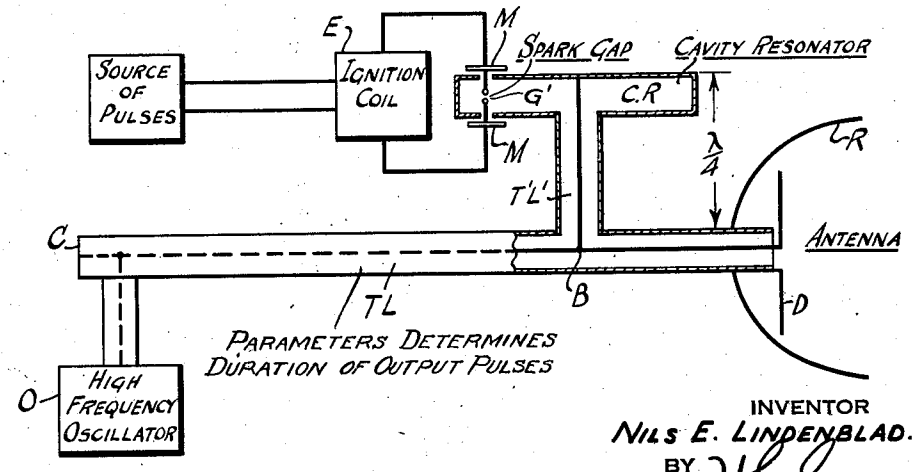


Fig. 2.



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Patented July 9, 1946 2,403,726

UNITED STATES PATENT OFFICE

2,403,726

PULSE TRANSMISSION SYSTEM

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Application August 13, 1942, Serial No. 454,660

10 Claims. (Cl. 250—17)

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The present invention relates to a method of and apparatus for producing carrier wave pulses of short duration.

One of the objects of the invention is to enable the production of substantially constant magnitude pulses from stored radio frequency energy.

A more detailed description of the invention follows in conjunction with a drawing, wherein Figs. 1 and 2 illustrate two different embodiments of the invention.

The same parts are represented by the same reference numerals throughout the two figures of the drawing.

Referring to Fig. 1 in more detail, there is shown a pulse type transmitter in accordance with one embodiment of the invention, comprising an ultra high frequency oscillator O which feeds into a low impedance line TL of high Q. Line TL is matched to a load, here shown as an antenna comprising a radiating dipole D in the focus of a parabolic reflector R. Across the line TL at point B there is a section of coaxial line T'L' which terminates in a cavity resonator CR, in turn resonant to the frequency of oscillator O. The length of the circuit including line section T'L', as measured from the point B to the remote wall of the cavity resonator, is an odd multiple including unity of a quarter wave at the frequency of oscillator O.

In view of the length of this quarter wave circuit T'L', CR, it will be seen that when the cavity resonator is excited by virtue of the small amount of energy in line T'L' obtained from line TL, the cavity resonator will be a high impedance at the end of line T'L' and thus produce a short-circuit or extremely low impedance across the main transmission line at the location B. This is the normal condition of the system in the absence of any detuning effects on the resonator.

The line TL acts as a storing device to store up energy fed into it by the oscillator O and has a length equivalent to half the length of space travel of the pulse to be transmitted. Such a line, generally speaking, has a large continuous phase distribution or phase angle, and may be made up of lumped inductances and capacitances, an ordinary coaxial line, or a wave guide. Thus, if it is desired that the pulse to be radiated by the antenna be one-tenth of a microsecond duration, the line TL should be about fifty feet long electrically; or putting it in other words, the line TL has such an electrical length that the time required for a wave to travel the length of the line is substantially one-half the duration of the

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pulse to be generated and radiated. For the sake of compactness, the line TL can be coiled or of the type described in Fig. 1a of my copending application Serial No. 441,311, filed May 1, 1942. The energy stored up in the line TL is in the form of a standing wave, the nature of which is that it consists of two wave components traveling in opposite directions. It will thus be seen that the line system must have such length that resonance exists during the building up or storage interval.

By means of suitable apparatus such as a gas discharge tube G (having helium or argon gas) and an ignition coil switch circuit E fed by an alternating current source S, I am able to detune the cavity resonator whenever the spark gap in the tube G breaks down. This detuning of the cavity resonator CR produced by a discharge in tube G will change the short circuit at B to a high impedance, thus permitting the energy stored in line TL to flow into the antenna as a burst of power. The line TL and resonator CR can thus be looked at as a valve or a quarter wave modulation switch which controls the passage of energy from the main transmission line TL to the load.

By making the losses in line TL reasonably low, there is obtained a constant amplitude pulse which has a time duration corresponding to twice the length of line TL from points B to C, for utilization by the antenna. Putting it in other words, there is a substantially uniform flow of energy from line TL to the antenna until all the stored energy in line TL is used up, while the resonator is detuned. The length of line TL between points C and B should be a multiple of a half wave.

The interval between pulses, or between times of breakdown of the spark gap in tube G, should be as large compared to the pulse duration as the output power to the antenna is compared to the oscillator output.

The apparatus at E contains a switch for exciting an ignition coil and can have any desired rate of closure. If desired, the switch can be eliminated, and sharp pulses employed to break down the spark gap in the discharge tube G.

Fig. 2 is similar to Fig. 1 except that the gas discharge tube of Fig. 1 is replaced by a spark gap G'. Both of the connections from apparatus E to the spark gap G' are capacitively coupled to the resonator by means of metallic plates M, from a radio frequency standpoint. Such an arrangement constitutes in effect a blocking condenser for the radio frequency energy in the resonator.

One application of the present invention is in connection with radio locating apparatus where it is desirable to radiate short wave carrier pulses of extremely short duration. In such a system, oscillator O can be designed to generate oscillations in the wavelength range of 10 to 20 cm. The radiated pulses may be of the order of one-half microsecond or less and repeated at the rate of preferably not more than 1000 per second.

If desired, the output of oscillator O can be modulated or keyed, in which case the pulse rate from the system should be higher than the modulation frequency.

What is claimed is:

1. A pulse transmitter system including a power storing circuit in the form of a radio frequency wave carrying line circuit of large continuous phase distribution, a high frequency oscillator feeding energy into one end of said circuit, a load at the other end of said circuit, and means coupled across said circuit at a point intermediate the ends of said circuit for enabling the energy stored in said circuit to be periodically utilized by said load, said line circuit having such parameters that the time it takes a wave to travel the length of the line circuit as measured from the end coupled to the oscillator to said point is equal to one-half the duration of the pulse delivered to said load.

2. A pulse transmitter including a power storing circuit in the form of a transmission line, a high frequency oscillator feeding energy into one end of said line, a load at the other end of said line, a section of line coupled across said transmission line at a point intermediate the ends thereof, a cavity resonator terminating said section at the end removed from said transmission line, said section and resonator having a length equivalent to one-quarter wavelength at the operating frequency of said oscillator, a circuit for periodically detuning said resonator for alternately producing low and high impedances across said transmission line, whereby said section and resonator constitute a quarter wave modulation switch, said line having such parameters that the time it takes a wave to travel the length of the transmission line as measured from the end coupled to said oscillator to said point is equal to one-half the duration of the pulse delivered to said load.

3. A pulse type radio transmitter including a power storing circuit in the form of a low loss transmission line having such parameters that the time it takes a wave to travel the effective length of the line is equal to one-half the duration of the pulse to be generated, a source of carrier wave energy coupled to said line near one end thereof, an antenna coupled to the other end of said line and matched to said line from an impedance standpoint, and a modulation switch whose length is electrically an odd multiple including unity of a quarter wave at the frequency of said source coupled across said line at a point near said antenna.

4. A pulse type radio transmitter including a power storing circuit in the form of a low loss transmission line having such parameters that the time it takes a wave to travel the effective length of the line is equal to one-half the duration of the pulse to be generated, an ultra high frequency generator of oscillations whose wavelength is of the order of at least several centimeters coupled to said line near one end, a directive antenna coupled to the other end of said line and matched to said line from an impedance standpoint, and a quarter wave valve circuit for enabling the periodic utilization of the energy stored in said line by said antenna, said quarter wave circuit including a resonator coupled by means of a suitable feeder system across said line at a point intermediate the ends thereof, there being means for periodically detuning said resonator.

5. A radio system having a transmitter arranged to store up alternating current energy and to transmit periodically pulses of stored alternating current energy for time periods short compared to the time intervals between transmitted pulses, said system including an energy storing circuit in the form of a section of coaxial transmission line having such parameters that the time it takes a wave to travel the effective length of said line is equal to one-half the duration of the pulses generated.

6. A radio system having a transmitter arranged to store up energy and to transmit periodically pulses of stored energy for time periods short compared to the time intervals between transmitted pulses, said system including an energy storing circuit in the form of a section of coaxial transmission line having such parameters that the time it takes a wave to travel the effective length of said line is equal to one-half the duration of the pulses generated, a source of high frequency energy coupled to said line near one end thereof, an antenna coupled to said line at the other end thereof and matched thereto, and means coupled across said line between said antenna and said source for periodically shunting said line with a high and a low impedance for enabling periodic utilization of the energy stored in said line.

7. A pulse transmitter in accordance with claim 1, characterized in this that said radio frequency wave carrying circuit of large continuous phase distribution is a two-conductor line.

8. A pulse transmitter in accordance with claim 1, characterized in this that said radio frequency wave carrying circuit of large continuous phase distribution is a wave guide.

9. A radio system having a transmitter arranged to store up energy and to transmit periodically pulses of stored energy for time periods short compared to the time intervals between transmitted pulses, said system including an energy storing circuit in the form of a line whose effective length is such that the time required for a wave to travel the length of the line is substantially equal to one-half the duration of the pulses generated.

10. A radio system having a transmitter arranged to store up energy and to transmit periodically pulses of stored energy for time periods short compared to the time intervals between transmitted pulses, said system including an energy storing circuit in the form of a line whose effective length is such that the time required for a wave to travel the length of the line is substantially equal to one-half the duration of the pulses generated, and a load coupled to one end of said line and matched to said line from an impedance standpoint.

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