July 16, 1940. J. J. HUGON 2,208,422

PULSE PHASING APPARATUS

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FIG. 1.

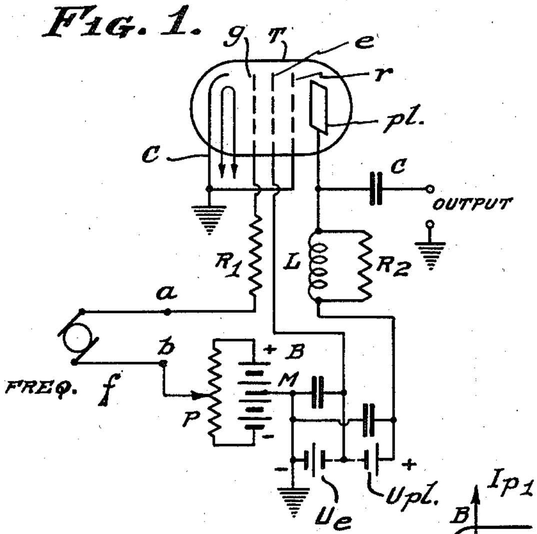

FIG. 4.

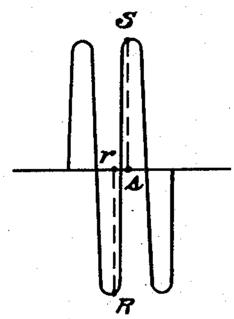

FIG. 2.

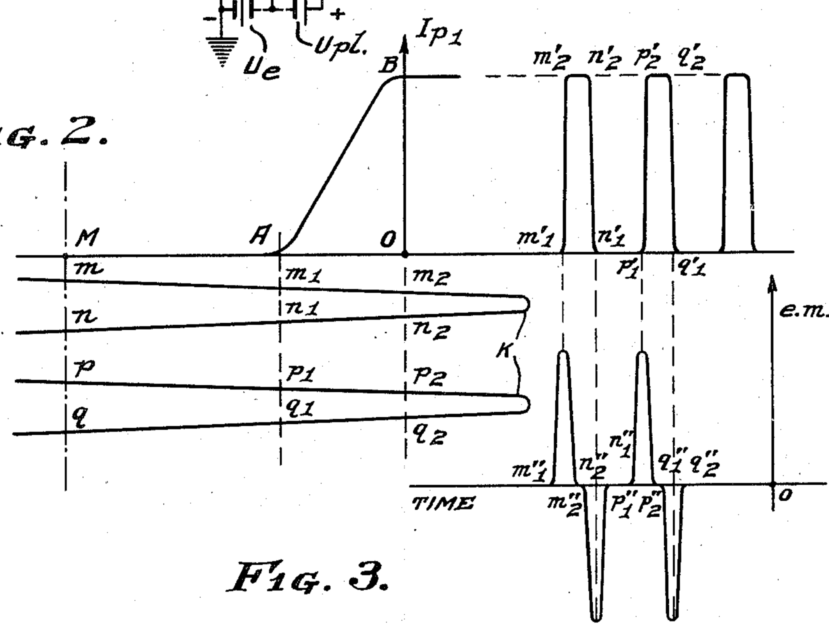

FIG. 3.

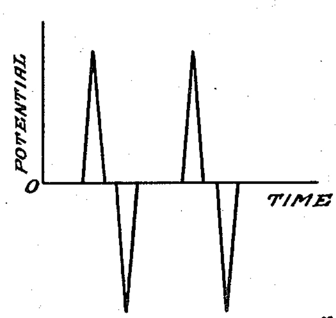

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FIG. 5.

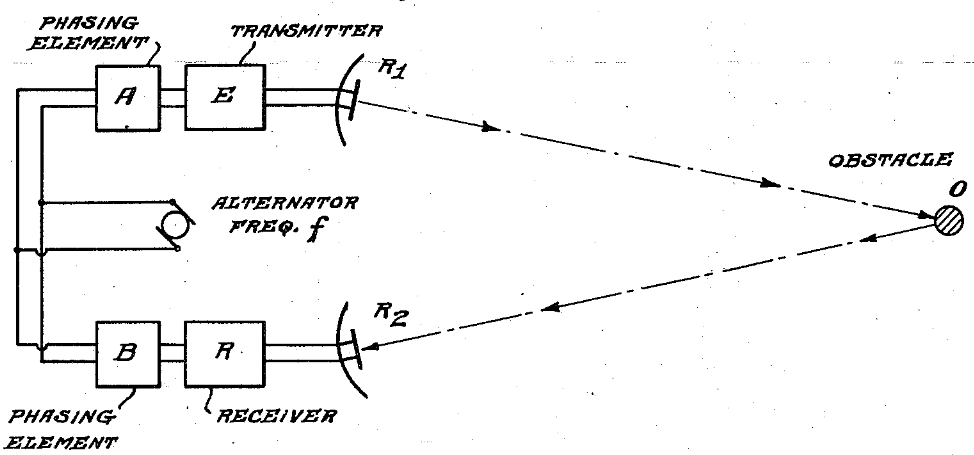
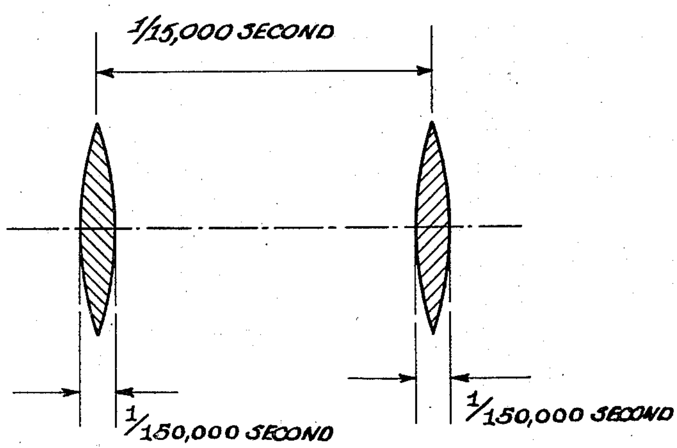


FIG. 6.



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Patented July 16, 1940

2,208,422

UNITED STATES PATENT OFFICE

2,208,422

PULSE PHASING APPARATUS

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Application December 9, 1938, Serial No. 244,814
In France February 16, 1938

6 Claims. (Cl. 250—36)

In certain radio-electric applications such as for radio-goniometry on short waves and the detection of obstacles, it is necessary to produce radiations of very short duration which are repeated a certain number of times per second such as for instance p times. A receiver is in general associated with this transmitter and provisions are made to block the receiver during the periods of radiation. The transmitter system includes a source of radio frequency energy which is controlled by a generator of impulses of very short duration repeated with the frequency f. The receiver includes on the other hand, aside from the normal receiving devices, a generator of impulses which are synchronized with those of the generator of the transmitter. In order to synchronize these two impulse generators, it is suitable to control them by means of the same alternating potential having the frequency f. The impulse generator system thereby employed is known as such, but difficulties are encountered in determining the phase of the impulse applied to the receiver with respect to the phase applied to the transmitter. The present invention has for its object to overcome these difficulties. It will be better understood by reference to the accompanying figures.

The invention will be described by reference to the accompanying drawings in which—

Figure 1 is a schematic circuit diagram of one embodiment of the invention;

Figures 2, 3 and 4 are characteristic curves used to illustrate the operation of the invention;

Figure 5 is a schematic diagram of the invention applied to an obstacle detector; and

Figure 6 is an illustration of the nature of the transmitted impulses.

Figure 1 shows an impulse generator in accordance with the present invention. A vacuum tube T, preferably of the pentode type, includes in series in its control grid g, a resistor R_1 of high value, a potentiometer P connected to the terminals of a battery B whose center point M is grounded, and two terminals a, b between which an E. M. F. having the frequency f is applied which determines the synchronized impulses. The screen grid e of this tube is connected to a suitable potential source which is perfectly filtered and designated by U_e. The plate circuit beginning with the plate pl includes a self inductance L which is so chosen that its natural oscillation period is substantially lower than twice the duration of an impulse. This self inductance is shunted by a suitable resistor R_2 which suppresses the natural oscillations of the circuit constituted by the self inductance L, by its natural residual capacity, by the inner capacity of the vacuum tube T and by the residual capacities of the connections. The cathode C of the tube T, common negative pole, screen and plate sources as well as the suppressor grid r are directly connected to ground.

The mechanism of the production of the impulses becomes clear from the characteristic graphs shown in Fig. 2. In this figure, the curve AB represents the static characteristic of the vacuum tube T for a definite screen potential. The flattening of the characteristic for the positive potentials applied to the grid is due to the presence of the resistor R_1 of high value, and due to the flow of grid current. There is shown on the other hand in m, m_1, m_2, n_2, n_1, n a portion of a sinusoidal oscillation of the frequency f which is applied between the terminals a and b. Finally, there is indicated in M the point of grid bias determined by the position of the movable part of the potentiometer P. The curves m'_1, m'_2, n'_2, n'_1, etc. . . ., represent the current impulses obtained under these conditions. These current impulses are trapezoidal and the sides m'_1, m'_2, n'_2, n'_1, etc. . . . are substantially rectilinear if the segments m_1, m_2, etc. . . . are sufficiently away from the peaks K of the sinusoidal cycle of frequency f.

Finally there is indicated below the preceding curve, the theoretical pattern of the E. M. F. of the self induction taking place in the self inductance L by the action of the current impulses. It is seen that each current impulse creates two potential impulses of very short duration spaced by the duration of one current impulse. These potential impulses should present theoretically the form of an elongated trapeze whose small base will be equal to the time of the displacement of the current from m'_1 to m'_2. Since the current varies as a function of time, the E. M. F. of the self induction should in fact maintain itself constant from m'_1 to m'_2 by virtue of the well known law of

$$-L\frac{dI}{dt}$$

Actually the natural frequency of the coil and the transitory performance of creating the current modify substantially the form of the potential impulses. The impulse currents, for an appropriate resistor R, assume the pattern indicated in Fig. 3. The trapezoidal impulses become triangular and are highly tapered.

Assuming that the bias applied to the control grid of the tube T is modified by means of the potentiometer P, the segment m_1, m_2 can be moved along the sinusoidal curve between the two points R and S (Fig. 4) and rather close respectively to the maximum and minimum of this sine wave. It will, therefore, be noted that if the segment m_1, m_2 is small in comparison with the amplitude of the sine wave, the phase of the potential impulse can be varied within very wide limits without changing its amplitude, the phase variation thus obtainable for each impulse generator being of the order of 150 degrees. Two impulses can be obtained (the one from the transmitter impulse generator and the other from the receiver impulse generator) which are displaced relative each other from +150 to −150°, i. e., a relative variation of the phase equal to 300°.

The importance of the present invention lies essentially in the fact that the phase variation is obtained by simply varying a direct biasing potential without the amplitude of the potential impulse being modified at all by this phase variation. The control device (potentiometer P) may thus be placed anywhere, or as far as desired from the impulse generator since the length of the connecting leads will have no deleterious effect. It should be remarked in this connection that the solution, which would consist of working on the phase of the E. M. F. having the frequency f would present on the contrary many drawbacks, since it is always very difficult to vary the phase of an alternating E. M. F. very much while maintaining its potential constant. Such condition is, however, primordial for maintaining a constant amplitude of the potential impulse.

Fig. 5 represents, by way of example, the application of the invention to a device for detecting obstacles. This figure shows schematically in E and in R a transmitter and a directional ultra-short wave receiver with the respective reflectors R_1 and R_2. There is shown in 0 the obstacle to be impinged by the waves, and from which they are reflected towards the receiver. The signals sent out by the transmitter E may have for instance the form represented in the Fig. 6 which shows impulses of 1/150,000 second with an interval of 1/15,000 second therebetween. These impulses of the transmitter E and the corresponding blocking of the receiver R are assured by the alternating source f, across phase displacement elements A and B formed as was indicated above.

It can be readily found and it can be shown in an oscillograph that by suitably adjusting the potentiometers of these two impulse generators, the two actions thereof can be exactly synchronized in such a manner that the receiver, which is made insensitive to the signals laterally received from the transmitter situated close by, maintains the oscillograph responsive to the signals reflected by the obstacle.

I claim:

1. The method of varying the relative phase displacement of impulses of short duration which includes generating an alternating current, selecting a portion of each positive half of said alternating current, deriving from said portion two discrete impulses and adjusting the phase of said impulses by the selection of said portion.

2. The method of varying the relative phase displacement of two series of impulses of short duration which includes generating an alternating current, selecting substantially symmetrical portions of each positive half cycle of said alternating current, deriving from said portions two series of discrete impulses and adjusting the phase of said impulses as a function of the said selection.

3. An impulse generator including a thermionic tube, means for applying an alternating current to the input of said tube, means for biasing said input with a d—c potential, a resistor connected in the input of said tube for limiting its output current, means for differentiating in the output circuit of said tube currents corresponding to portions of said applied alternating currents, and a potentiometer for varying said d—c bias potential to vary the phase of said differentiated output currents.

4. An impulse generator including a thermionic tube, means for applying an alternating current to the input of said tube, means for biasing said input with a d—c potential, a resistor connected in the input of said tube for limiting its output current, means for differentiating in the output circuit of said tube currents corresponding to portions of said applied alternating currents, and means for varying said d—c biasing potential so that the relative phases of said differentiated currents may be adjusted.

5. The method of generating and controlling the phase of impulses by means of a d—c bias applied to a thermionic tube which includes applying alternating currents to the input circuit of said tube, selecting portions of said alternating currents to obtain currents of flat top wave form, differentiating currents in the output of said tube corresponding to said selected portions of said applied alternating currents, and adjusting the phase of said differentiated currents by adjusting said d—c bias to thereby select currents of flat top portions of different widths to obtain the desired phase relation of the differentiated currents.

6. A pair of impulse generators each including a thermionic tube, means for applying an alternating current to the input of said tube, means for biasing said input with a d—c potential to select from said applied alternating current a current of flat top wave form, means for differentiating in the output circuit of said tube currents corresponding to selected portions of said applied alternating currents, and means for varying said relative d—c biasing potentials to vary the width of the flat top portion of the selected current so that the relative phases of said differentiated currents may be adjusted.

JEAN JACQUES HUGON.