March 12, 1940. P. KOTOWSKI ET AL 2,192,975

METHOD OF SENDING AND RECEIVING RADIO FREQUENCY IMPULSES

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FIG. 1.

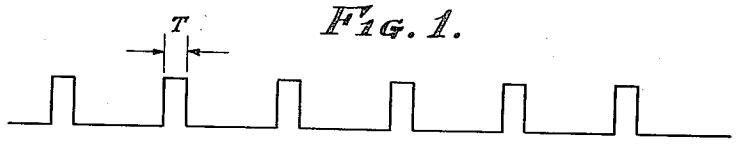


FIG. 2.

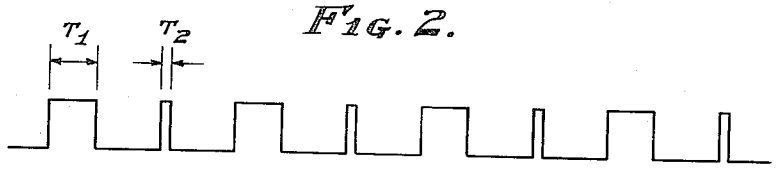


FIG. 3.

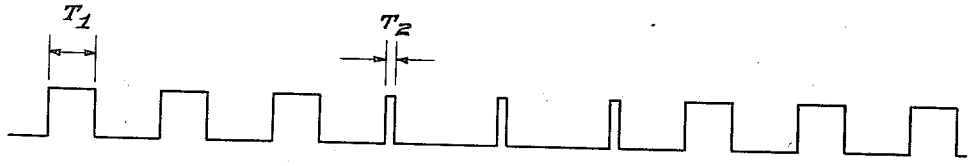


FIG. 4.

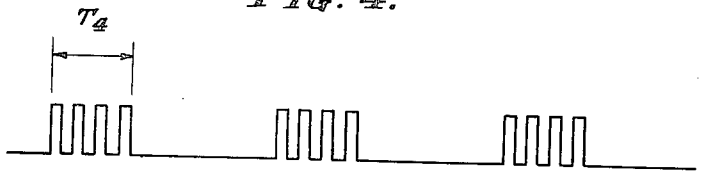
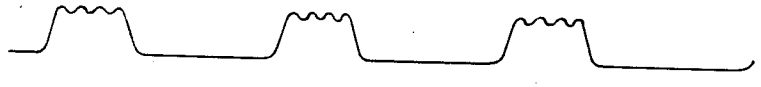


FIG. 5.



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Fig. 6.

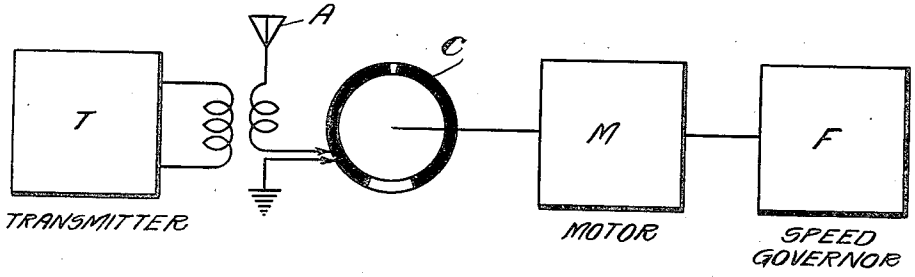
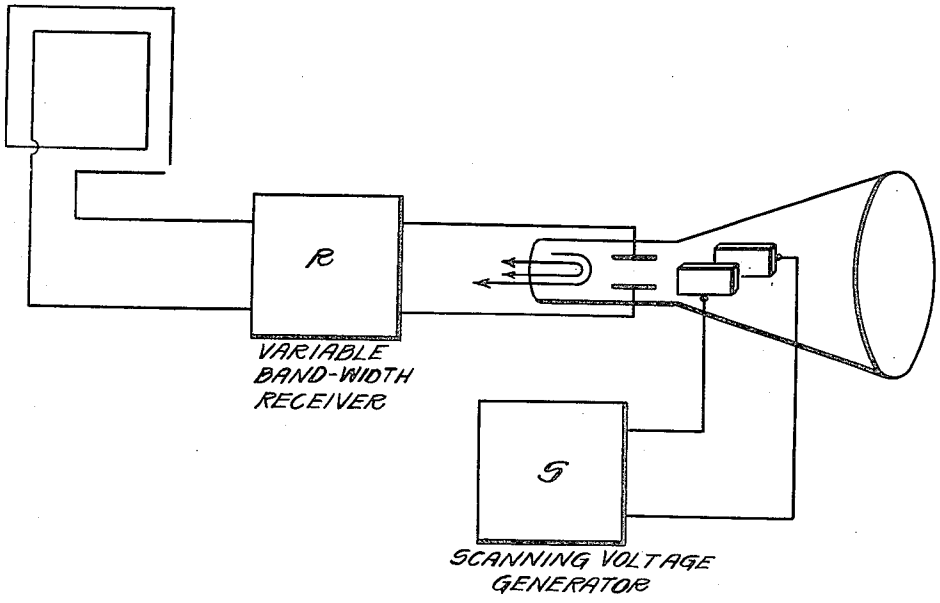


Fig. 7.



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METHOD OF SENDING AND RECEIVING RADIO FREQUENCY IMPULSES

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Application January 27, 1938, Serial No. 187,288
In Germany February 4, 1937

6 Claims. (Cl. 250—11)

This invention relates to the transmission and reception of impulses for use in direction finding devices, and the like. More particularly, this invention relates to a system for increasing the signal-noise ratio in a direction finder of the impulse type by receiving impulses of very short duration on a receiver having a wide band-width characteristic to obtain maximum accuracy during periods which are free from static disturbances and increasing the signal-noise ratio in the presence of static by decreasing the band-width characteristic of the receiver, thus eliminating the short impulses, and providing impulses of longer duration for use with the reduced band-width to provide an indication.

This invention will be better understood from the following description when considered in connection with the accompanying drawings, in which:

Figure 1 shows the nature of the signal sent out by the transmitter of an impulse direction finding system;

Figure 2 shows the nature of the impulses according to this invention;

Figure 3 shows an alternate form of impulse arrangement;

Figure 4 shows another arrangement of the impulses;

Figure 5 shows the nature of the impulse of Fig. 4 after it has been received;

Figure 6 is a simple transmitter adapted to carry out this invention; and

Figure 7 is a receiver for use in connection with this invention.

In order to obtain direction-finding under conditions free from night effects, recourse has been had to impulse direction-finding. A transmitter or beacon station sends out periodically impulses of a duration T (Fig. 1). The time T is substantially less than the time required for the impulse to reach the receiver, and the interval between impulses is greater than the transit time, as is well known. At the receiving end, not only the ground wave but also the space or sky wave with its various echoes resulting from such impulses are picked up. However, inasmuch as the time of transit of the sky or space wave is greater than that of the ground wave, the result is that the signals which travel to the receiver over different paths will reach the receiver one after the other (in time sequence). It is known that by the aid of suitable indicator means, such as a Braun or cathode-ray tube, ground and space waves may be separated from each other, with the result that only the ground or direct wave is utilized for direction finding. It is only this ground wave that results in true bearings.

However, in procticing any of these methods serious difficulties frequently arise on account of the fact that at greater distances it is often impossible to identify the impulse from among the various stray signals and static that are picked up by the receiver. In fact, for clear discrimination or separation, the signal impulse amplitude must surpass the amplitude of the stray signals at least by a factor of two.

It is known that a rectangular impulse can be considered as being composed of a large number of different frequencies. Consequently, in order to reproduce a rectangular impulse without distortion a wide band receiver is necessary. It can be shown that the band width which is required to reproduce a rectangular impulse is inversely proportional to the length or duration of the impulse. It is also known that the amount of static and noise which is picked up by a receiver is dependent upon the receiver band-width characteristic. The narrower the band-width, the less the noise which will be received.

In cases of this kind where static is bad a longer impulse would be more suited since it would make it feasible at the receiving end to utilize a receiver having a narrow frequency band; and, as a result, the ratio of the stray noise amplitude to the impulse amplitude could be diminished. The extent to which the band-width can be decreased is limited by the relation

$$f=\frac{1}{T_1}$$

where f is the band-width of the receiver and T_1 is the length of the impulses in seconds. Further frequency-band compression will then affect the signal and the stray amplitude or height in like proportion and is therefore without any practical purpose. On the other hand, a narrow impulse (T_2) affords greater accuracy in reading; and when applied to impulse direction-finding it allows more accurate position finding.

According to this invention, therefore, alternately a wide and a narrow impulse (Fig. 2) or groups of broad and of narrow impulses are sent out (Fig. 3). When interference is bad the receiver band-width is reduced, that is, its selectivity is increased to eliminate or reduce the interference. At the same time this prevents the undistorted reception of very short impulses, T_2, but allows the reception of the longer impulses T_1. While the accuracy of the direction indicator is somewhat reduced, reception is accomplished

where it would otherwise have been impossible. When conditions are good, the receiver band-width is increased and the short impulses utilized to provide an accurate determination of direction. Another scheme as shown in Fig. 4 would be to transmit groups of narrow and closely adjacent impulses which, upon compression of the incoming frequency band would be caused to coalesce into what is effectively a single impulse (Fig. 5) having an impulse period T_4. The impulse duration of the wide and the narrow impulses as shown in Fig. 3 amount to T_1 and T_2, respectively. Of course, the impulse width could also be steadily varied with time.

Compression or contraction of the frequency band at the receiving end is accomplished by a variation of the transmission characteristic of the receiver. As known in the art, this may be done for radio frequency either by altering the damping of the circuits or by variation of the coupling. Finally, also the audio frequency transmission characteristic could be regulated by a variable low-pass filter.

Fig. 6 illustrates a transmitter which will transmit alternate short and long pulses of the type illustrated in Fig. 2. A transmitter T is coupled to an antenna A, the ground connection to which is made through a commutator C. The commutator has alternate short and long contacting members which are insulated by a suitable insulating material. Upon rotation the commutator intermittently completes the antenna circuit to ground, producing short impulses whose relative duration and spacing are determined by the construction of the commutator.

A motor M is used to drive the commutator at a suitable rate of speed so that the duration of each impulse is of the order of .00015 second. The motor is driven at a constant speed by a speed governor F. The illustrated transmitter is a modification of a transmitter shown in U. S. Patent No. 2,031,677, filed February 3, 1933, and issued February 18, 1936 to S. B. Smith, et al. The modification comprises the arrangement of the commutator to produce the desired short and long impulses. It will be understood how the commutator may be arranged to produce impulses of the types illustrated in Figs. 2 to 5.

Fig. 7 is a directional receiver arrangement of the general type disclosed by Chireix in U. S. Patent No. 2,059,315, filed July 17, 1935, and issued November 3, 1936. The receiver R however, is a variable band-width receiver, for example of the type disclosed in a patent of Carlson, No. 2,133,808, filed September 27, 1933, and issued October 18, 1938. The scanning voltage generator S is synchronized with the speed governor F in any well known manner.

We claim as our invention:

1. In a direction finding system which comprises an impulse transmitter and a directive variable band-width receiver, the method of operation which consists of transmitting impulses of different effective duration, the duration of said impulses being less than the transit time from said transmitter to said receiver, receiving said impulses, and adjusting the band-width of said receiver to receive effectively short impulses in the absence of static and other interference and adjusting the band-width of said receiver to receive effectively long impulses in the presence of static and other interference.

2. In a direction finding system which utilizes an impulse transmitter and a directive variable band-width receiver, the method of maintaining an indication in the presence of interfering noises and static which includes the steps of generating and transmitting impulses of non-uniform time duration, receiving said impulses, the time duration of said impulses being less than the transit time of an impulse, and utilizing the shorter of said non-uniform impulses to indicate direction when interference and static are not excessive, and utilizing the longer of said impulses to indicate direction when receiving conditions do not permit the use of said shorter impulses.

3. In a direction finding system which comprises an impulse transmitter, and a directive variable band-width receiver, the method of maintaining an indication in the presence of interference and static which includes the steps of generating and transmitting impulses of non-uniform time duration, said time duration being appreciably less than the transit time between said transmitter and said receiver, adjusting the band-width of said receiver to receive the shortest of said impulses in the absence of interfering noises and static, and adjusting the band-width of said receiver to pass only said impulses of long duration in the presence of interfering noises and static, thus also reducing said noises and static.

4. In a direction finder which comprises an impulse transmitter and a directive variable band-width receiver, the method of operation which includes the steps of transmitting alternate short and long impulses, said long impulses being of less duration than the transit time required for an impulse to pass from said transmitter to said receiver, and the interval between impulses being longer than said transit time, receiving said pulses, increasing the band-width response of said receiver to pass said long and said short impulses, and utilizing said short impulses to accurately determine a direction, and, when necessary, decreasing the band-width response of said receiver to reduce interference and static, thus reducing or eliminating said short impulses, and utilizing said long impulses to give a less accurate but static-free indication of direction.

5. A method as set forth in claim 1 in which said impulses of different effective duration constitute groups of short closely adjacent impulses.

6. A method as set forth in claim 1 in which said impulses of different effective duration constitute alternate groups of long and short impulses.

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