Oct. 26, 1954 C. J. YOUNG 2,692,954

PULSE GENERATOR

Filed Feb. 27, 1951.

2 Sheets-Sheet 1

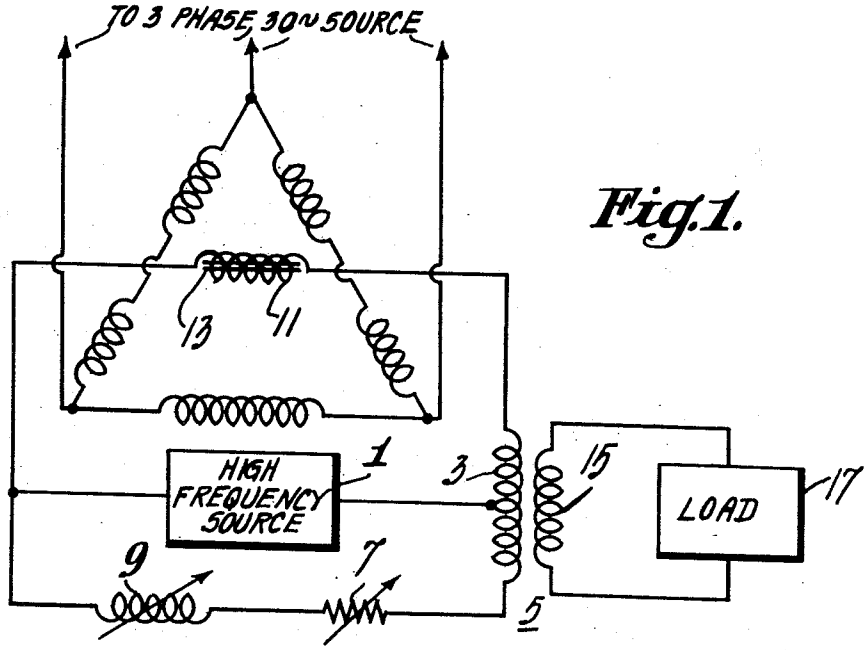


Fig. 1.

Fig. 2.

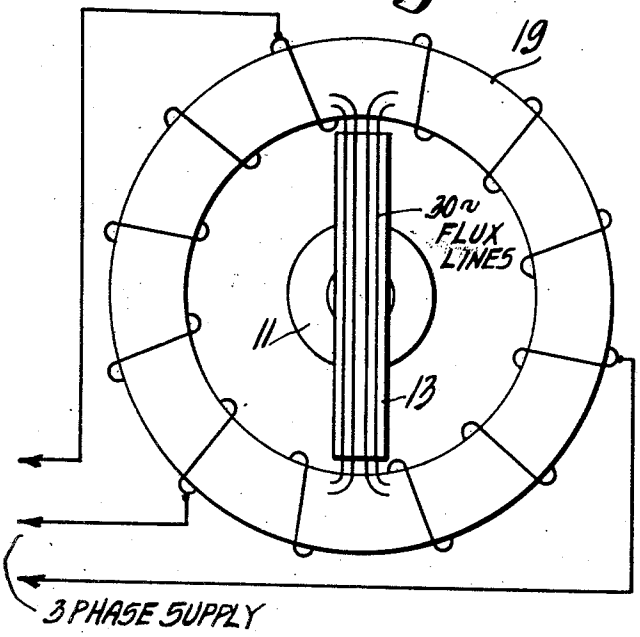
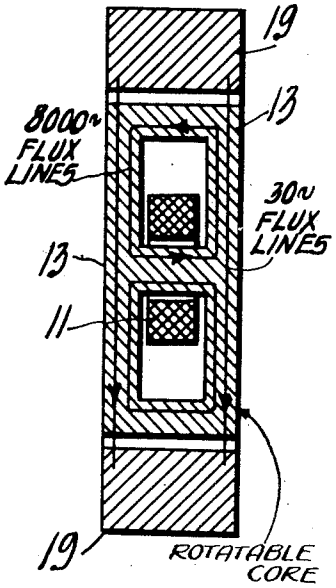


Fig. 3.



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Fig. 4.

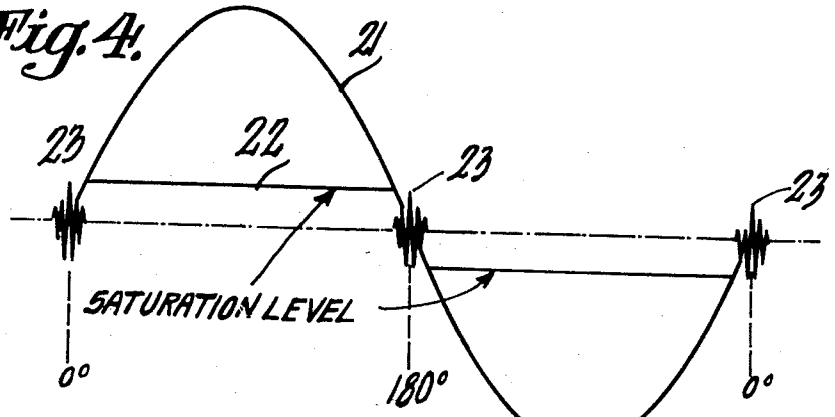


Fig. 5.

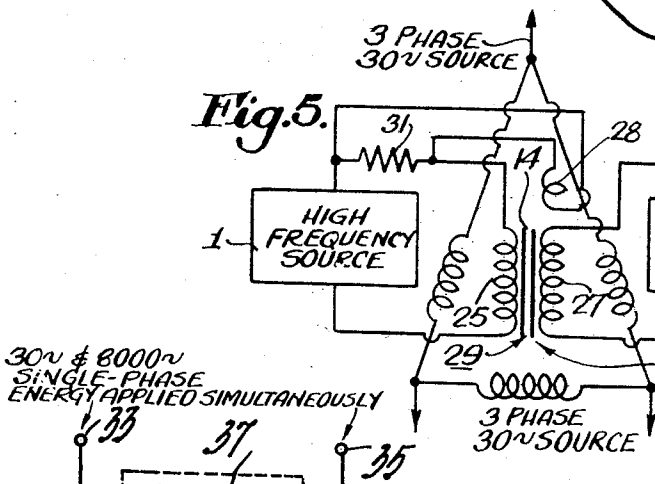
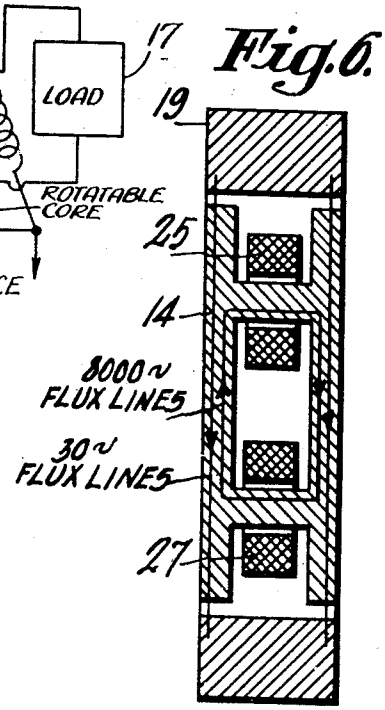


Fig. 6.



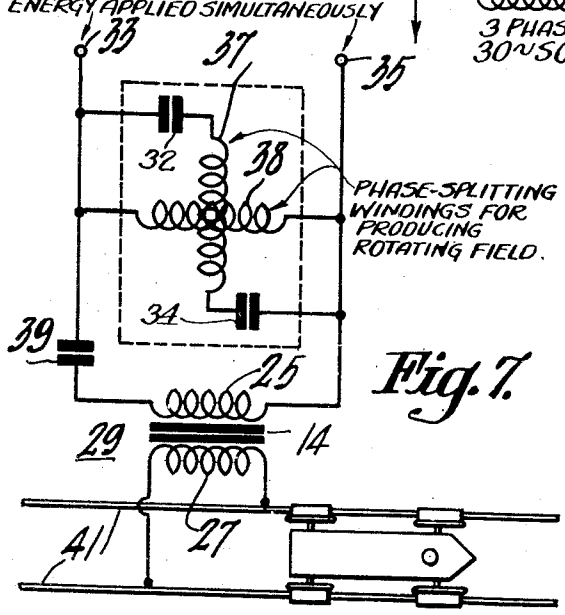


Fig. 7.

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PULSE GENERATOR

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9 Claims. (Cl. 307—106)

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This invention relates generally to signalling systems and more particularly to a pulse generator for generating time-modulated pulse energy at discrete time intervals.

Previous time-modulated pulse generators have been extremely useful, for example, in railway signalling systems wherein it is desirable to determine the distance between two successive conveyances, such as trains, operating on the same track. A plurality of time-modulated generators may be located at selected intervals along the right-of-way of a railway system and phased so that only one generator delivers an output at a particular time.

The transmission line to which the generators are coupled generally comprises the track on which the trains operate. The axles of the two trains effectively terminate the transmission line so that a car-borne receiver located on one of the trains receives only pulses from the wayside generators located between the trains. The pulses are then received and counted or otherwise utilized to provide an indication that a safe distance is being maintained between the two successive trains.

A copending application Serial No. 135,347, filed December 28, 1949, by John Ford and entitled Signalling System includes a wayside generator in which a plurality of vacuum tubes and much associated circuitry are used. Another copending application Serial No. 135,478, filed December 28, 1949, now abandoned, by William Ayres, and entitled Signalling System, also utilizes an electronic wayside generator.

While such generators generally are satisfactory, it is desirable that a more rugged generator be devised that is especially adapted to outdoor use and requires very little maintenance or service. The pulse generator subsequently herein disclosed is particularly useful for a railway signalling system but generally may be used in any circuit or system requiring time-modulated generation of pulse energy.

An object of the invention is to provide an improved time-modulated pulse generator.

Another object of the invention is to provide a simplified time-modulated pulse generator.

Another object of the invention is to provide a time-modulated pulse generator the timing of which modulation is readily adjustable.

A further object of the invention is to provide a time-modulated pulse generator especially adapted to outdoor use.

In a typical embodiment, according to the invention, an iron core is disposed within a rotating polyphase magnetic field having sufficient flux density to saturate the core. A reactor is wound about the iron core and is connected to a relatively high-frequency source, the strength of the magnetic field of which is not in itself quite sufficient to saturate the core. For a given physical position of the core in the rotating polyphase field, the core is unsaturated only when the low frequency flux in the core is substantially zero. Under such condition, which occurs at the 0° and 180° "cross-over" points for the polyphase flux, the reactor has high impedance to the high-frequency signal energy. The change in impedance of the reactor serves to unbalance a normally balanced transformer which subsequently delivers high-frequency output pulses to a suitable load circuit.

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The time at which the core is sufficiently unsaturated for the reactor to develop a high impedance is determined by the physical positioning of the coil in the low-frequency rotating polyphase magnetic field. In this manner a plurality of such generators may be phased to deliver time-modulated pulses of energy to a common load at separate time intervals.

The invention, and embodiments thereof, will be described in greater detail with reference to the accompanying drawing of which Figure 1 is a schematic circuit diagram, according to the invention, of a time-modulated pulse generator including a reactor and a balanced transformer; Figures 2 and 3 are front and side views, respectively, of the reactor of Figure 1 disposed within a polyphase magnetic field; Figure 4 is a wave diagram illustrating saturation and conduction periods of the time-modulated generator, according to the invention; Figure 5 is a schematic circuit diagram, according to the invention, of a time-modulated pulse generator including a saturable transformer; Figure 6 is a section view of the saturable transformer of Figure 5; and Figure 7 is a schematic circuit diagram of a time-modulated pulse generator, according to the invention, for use in a railway signalling system.

Referring to Figure 1 of the drawing, a potential source 1, the output of which varies on the order of 8,000 cycles per second, is connected to the midpoint of the primary winding 3 of a balanced transformer 5. One end of the winding 3 is returned to the potential source 1 through a resistor 7 and an inductor 9. The remaining end of the winding coupled to the source 1 through a reactance coil 11 wound about an iron core 13 disposed within a low-frequency polyphase rotating magnetic field which field ro-

tates at approximately 30 cycles per second. The secondary winding 15 of the transformer 5 is coupled to a suitable load 17.

The physical arrangement of the reactance coil 11 as disposed within the polyphase field structure is illustrated in Figures 2 and 3. The core 13 is enclosed by structure 19 similar to stator structure of a polyphase induction motor. Polyphase power, three-phase for example, is supplied to windings wound about this stator structure 19 thereby setting up a rotating magnetic field.

While the strength of the high-frequency magnetic field is insufficient to saturate the iron core 13, the polyphase field strength is of sufficient magnitude and saturates the core 13, as is indicated in Figure 4, for a major portion of the cycle of the polyphase magnetomotive force 21. Thus the reactance coil 11 has low impedance while the core 13 is saturated. The resistor 7 and the inductor 9, serially connected in opposition to the reactance coil 11 are adjusted to provide zero output from the transformer secondary winding 15 under a condition of saturation of the reactance coil core 13. The core 13 is unsaturated when the polyphase field flux 22 is substantially zero, which situation occurs approximately at 0° and 180° "cross-over" points. Near these points the reactance coil impedance increases and an unbalance occurs in the transformer primary winding 3 producing output pulses 23, as shown in Figure 3. The output pulses 23 are then coupled to a suitable load 17.

The generator may be phased to deliver an output at selected time periods by rotating the core 13 to a new position in the polyphase field. In this way totalization of outputs from a plurality of generators may be obtained.

A second embodiment, according to the invention and with reference to Figures 5 and 6 includes an iron core 14, similar to the core 13 used in the previous embodiment, placed in a polyphase magnetic field in the manner described above. The primary and secondary windings 25, 27 of a transformer 29 are wound about the core 14. The primary winding 25 is connected to an 8,000 cycle per second potential source 1 and the secondary winding 27 is connected to a load 17. When the core is saturated the primary and secondary windings 25, 27 are effectively decoupled from each other. Near the "cross-over" points the core is unsaturated and the energy of the 8,000 cycle pulses 23 is transferred to the secondary winding 27 to be fed to a load 17. In the event that the design of the transformer 29 makes it difficult to satisfactorily decouple the primary and secondary windings 25, 27 it may be desirable to insert a resistor 31 in series with the 8,000 cycle source 1 and the primary 25. A voltage developed across the resistor 31 may be applied in phase opposition to the secondary winding 27 by some means such as a winding 28 improving decoupling without substantially reducing the output pulse amplitude when the core 13 is unsaturated.

Figure 7 illustrates a circuit in which the time-modulated pulse generator, according to the invention, is applicable to a railway signalling system. 8,000 cycle and 30 cycle single phase sources couple energy to a pair of terminals 33, 35 between which are connected two stator windings 37, 38 which may be arranged as in a split-phase capacitor motor with capacitors 32 and 34 providing phase-splitting action. Connected in shunt with the windings 37, 38 is a transformer 29 wound about a core 14, as illustrated in Figure 6, disposed within the magnetic field of the stator. The transformer primary winding 25 is serially connected to a capacitor 39. The split-phase windings offer high impedance to 8,000 cycle energy and therefore the stator is excited only by the 30 cycle power. On the other hand the primary winding 25 is series tuned by the capacitor 39 to the 8,000 cycles and accepts only negligible 30 cycle energy. Thus the secondary winding 27 of the transformer delivers 8,000 cycle power to a pair of railway system tracks 41.

While it is possible to physically rotate a single-phase magnetic field about the core, or perhaps to rotate the core within a single-phase magnetic field, it is preferable, as set forth according to the instant invention, to set up a rotating polyphase magnetic field.

Thus according to the instant invention, there is disclosed an improved time-modulated pulse generator for generating pulse energy at selected time intervals. The generator is structurally simple, requires little maintenance, and is particularly suitable for outdoor use. The supply source for saturating the core may be any conveniently obtainable power frequency. Another advantage is that the presently disclosed generator provides satisfactory operation if only single-phase power is available.

What is claimed is:

1. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a magnetic core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a reactive winding coupled to said source connection means and disposed about said core, said winding having low impedance when said core is saturated and having relatively higher impedance when said rotating field flux is less than a predetermined value, and means coupled to said winding for deriving modulated pulses of said signal energy.

2. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a rotatable magnetic core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a reactive winding coupled to said source connection means and disposed about said core, said winding having low impedance when said core is saturated and having relatively higher impedance when said rotating field flux is less than a predetermined value, and means coupled to said winding for deriving modulated pulses of said signal energy.

3. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a rotatable magnetic core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a reactive winding coupled to said source connection means and disposed about said core said winding having low impedance when said core is saturated and having relatively higher impedance when said rotating field flux

is less than a predetermined value and a balanced transformer connected to said reactive winding providing substantially no output of said signal energy when said core is saturated, said transformer providing a desired output when said reactive winding is of high impedance.

4. A system as described in claim 2 including an inductor and a resistor for balancing said transformer when said core is saturated by said rotating field flux.

5. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a rotatable core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, and a transformer having primary and secondary windings disposed about said core, one of said transformer windings being coupled to said source connection means, said transformer providing desired output pulses of said signal energy substantially only when said core is unsaturated.

6. A system as described in claim 5 including a resistor for decoupling said primary and secondary windings when said core is saturated.

7. For use in a system for generating time-modulated pulse energy the improvement comprising means responsive to single-phase input power for generating a rotating polyphase magnetic field, a rotatable magnetic core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a transformer having primary and secondary windings disposed about said core, said primary winding being connected to said source connection means, a capacitor serially connected to said transformer primary winding for delivering desired output pulses to a load circuit, said transformer primary and secondary windings being substantially decoupled when said core is magnetically saturated, and said primary winding delivering desired time-modulated pulses of said signal energy to said secondary winding when said core is unsaturated.

8. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a rotatable core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a reactive winding coupled to said source connection means and disposed about said core having low impedance when said core is saturated and having relatively higher impedance when said rotating field flux is less than a predetermined value, a balanced transformer connected to said reactive winding providing substantially no output of said signal energy when said core is saturated, said transformer providing a desired output of said signal energy when said reactive winding is of high impedance, and means for balancing said transformer when said core is saturated by said rotating field flux.

9. For use in a system for generating time-modulated pulse energy the improvement comprising means for generating a rotating magnetic field, a rotatable core disposed within said rotating magnetic field the strength of said field being sufficient to saturate said core for a selected portion of the normal flux variation of said rotating field, connection means for a source of signal energy, a balanced transformer having primary and secondary windings disposed about said core with said primary winding coupled to said source connection means, said transformer providing desired output pulses of said signal energy from said secondary winding substantially only when said core is unsaturated, and means for decoupling said primary and secondary windings when said core is saturated by said rotating field flux.

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