MAGNETIC TRIGGER DEVICES

FIG. 1.

FIG. 2.

FIG. 3.

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The present invention relates to magnetic trigger devices. It is well known to employ a coil with a saturable magnetic core to produce output pulses in response to a driving wave which causes the core to be switched or triggered from one state of saturation to the opposite state. In order that the output pulses shall be of short duration, it is necessary that the rate of change of current of the driving wave over the switching range should be high, and to meet this requirement it may be necessary that the driving wave should have an inconveniently large amplitude.

The object of the invention is to shorten the output pulses without increasing the amplitude of the driving wave. This is accomplished according to the invention by connecting a second coil, linked with a saturable magnetic core, in series with the coil of the core to be triggered, the second coil being so designed that its core switches first. During the period of switching the second core, the current supplied by the driving wave first practically ceases to increase and then, when switching is complete, increases very sharply and triggers the other core so that it generates a very short output pulse.

The invention will be described with reference to the accompanying drawings in which:

FIG. 1 shows a schematic circuit diagram of an embodiment of the invention;

FIG. 2 shows graphical diagrams used to explain the operation of FIG. 1; and

FIG. 3 shows a schematic circuit diagram of another embodiment of the invention.

Referring to FIG. 1 there is shown a toroidal core 1 of saturable ferromagnetic material, such as a ferrite material, having wound thereon a triggering winding 2 and an output winding 3. A second similar core 4 has a triggering winding 5. The windings 2 and 5 are connected in series to a source 6 of a sine wave triggering voltage. This source should preferably have a low impedance so that the voltage is not much affected by the current supplied to the load. The number of turns of the winding 5 should be several times that of the winding 2; for example the numbers of turns of the windings 5 and 2 could be 20 and 5, respectively.

Graph A of FIG. 2 shows at 7 the sine wave output voltage of the source 6. It will be assumed that initially both cores are saturated in the negative direction so that a positive applied voltage is necessary to switch them. At some time t1, shortly after the voltage of the sine wave 7 has changed sign from negative to positive, core 4 begins to be switched, but since the winding 2 has a smaller number of turns than winding 5, the flux in the core 1 will not have increased sufficiently to reach the critical switching value at time t1. As soon as core 4 starts to be switched, the winding 5 presents a high impedance to the switching wave, and the switching current shown by the curve 8 in Graph B of FIG. 2 ceases to increase at time t2, and may remain practically constant, as indicated at 9 in Graph B. When the switching of core 4 is completed at a time t3, shortly after t2, the impedance of the winding 5 suddenly drops again and the switching current increases sharply as shown at 10 in Graph B. This causes the core 1 to be sharply switched substantially at time t2 and a very short output pulse shown at 11 in Graph C, FIG. 2, will be obtained from the output winding 3, FIG. 1. It will be evident that an output pulse of opposite sign will be obtained from the winding 3 shortly after the time t4 when the voltage of the sine wave 7 passes through zero in the negative direction, and so a series of regularly repeated alternately positive and negative short pulses will be obtained from the winding 3. All the pulses of the same sign may be eliminated, if not required, by conventional means, not shown. It will be evident also that any number of coils with cores and windings like 1, 2, 3 may be connected in cascade, and if the coils are differently biased so that they are triggered successively at different current levels along the portion 18 of the curve 8 (Graph B, FIG. 2), a train of short pulses produced by the successive triggering of the cores can be obtained from each positive-going (or negative-going) flank of the sine wave 7.

It will be clear also that the triggering wave from the source 6 (FIG. 1) need not be a sine wave; it could be a sawtooth wave, for example.

FIG. 3 shows an alternative method of ensuring that the core 4 switches before the core 1. The magnetic field produced in a toroidal core by a given current in a winding with a given number of turns is approximately inversely proportional to the mean circumference of the core.

In FIG. 3, the diameter of the core 1 is shown to be about four times that of the core 4, and the windings 2 and 5 have the same number of turns.

In accordance with the explanation just given, the magnetic field produced by the current in core 1 will be about one quarter of the field produced in core 4, so core 4 will reach the triggering point before core 1. The operation will be substantially the same as that of FIG. 1 described with reference to FIG. 2.

It will be noted that the common feature of the FIGS. 1 and 3 arrangements is that the ratio of the number of turns of the triggering winding to the mean circumferential flux path-length in the core is greater for core 4 than for core 1, and it will be clear that the core diameters and number of turns of the triggering windings can be selected in various ways to ensure that this condition is fulfilled.

It will be clear also that in the FIG. 3 arrangement, a number of cores such as 1 with different diameters, and suitably biased, may be connected in cascade in order to obtain a train of short pulses from each triggering flank of the sine wave, as explained with reference to FIG. 1.

One important application of the invention is to coders for pulse code modulation systems of communication. For example, in the case of the coder described in the specification of co-pending U.S. application Serial No. 708,186, filed January 10, 1958, now Patent No. 2,954,550, a group of similar magnetic cores is provided to define the quantizing levels. Each core has a triggering winding with the same number of turns, and a triggering wave is supplied to all the triggering windings in series. Only one of the cores is in a condition to be triggered, in which core there is substantially a balance between the bias flux and the flux due to the signal current. In that case a single additional core such as 4, FIG. 1, or 3 may be connected in series with the group of level-defining cores. Then, according to the invention, the output pulse generated by the level defining core which is triggered will be shortened. The additional core may be of smaller diameter than the other cores, or may have a triggering winding with a larger number of turns.

In other circumstances, where a group of magnetic cores is used for some purpose, it may be necessary
to supply an additional core such as 4 for each of the cores in the group.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What I claim is:

1. A magnetic trigger device comprising:
   a first core having a closed magnetic circuit of saturable magnetic material;
   a second core having a closed magnetic circuit of saturable magnetic material to control the time of reversal of the state of saturation of said first core;
   a trigger winding on each of said cores connected in a series circuit;
   the dimensions of said cores and the number of winding turns associated therewith being predetermined to assure that said second core starts to reverse its state of saturation before said first core;
   means coupled in series to said windings for supplying a trigger wave thereto, said trigger wave including a portion having the voltage increasing at a predetermined rate for a considerable time interval;
   said second core responding to said portion to complete the reversal of its state of saturation at a given time in said portion and simultaneously to sharply reverse the state of saturation of said first core to produce a narrow output pulse; and
   an output winding on said first core to remove said narrow output pulse.

2. A device according to claim 1 in which said cores are toroidal cores of a predetermined cross-section and in which the numbers of turns of the triggering windings and the diameters of the cores are so chosen that the ratio of the number of turns of the triggering winding of a core to the mean flux path-length in that core is different for each core, the said ratio being greatest for the said second core.

3. A device according to claim 2 in which the cores have the same mean diameter, and in which the triggering windings have respectively different numbers of turns.

4. A device according to claim 2 in which the triggering windings have the same number of turns, and the cores have respectively different mean diameters.

5. A device according to claim 1 in which the said saturable material is a ferrite material.

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