The present invention relates generally to a relay actuating apparatus and more specifically to such a device consisting of a magnetic core circuit.

In present-day computer art, a considerable use is made of ferromagnetic cores as memory elements, and as logical building blocks in general in electronic systems. In such memory elements, it is often required that core circuit output signals be transferred to a bank of solenoids, relays and the like. For example, the peripheral equipment used in the computing system is often of an electromechanical nature in which solenoids are energized to actuate a cord punch, an electric typewriter or the like. In the past, the signal output of a magnetic core device has been used to trigger vacuum tubes which, in turn, served to energize such peripheral equipment by actuating a relay or solenoid. However, inherent in the use of vacuum tubes in the circuit are many disadvantages such as the relatively large size of the electronic packaging resulting when tubes are used, greater power requirements, and also the possibility of failure of the tube due to their limited life or breakage.

It is among the objects of the present invention to obviate or minimize the limitations mentioned above by eliminating the use of vacuum tubes. This is accomplished in the present invention by providing a single, saturable inductor functioning not only as a memory cell but also as a self-latching relay or solenoid actuator. Although the change in flux caused by switching a core produces a sizable single voltage pulse across the windings on the core, the output signal is of very short duration. The short output pulse ceases before the relay is latched. The present invention utilizes a capacitance to serve as a delay or energy storage means between the core and the relay for maintaining the output signal over a longer time interval. The present invention also introduces a restore or non-restore feature whereby the signal induced as a result of the collapse of the magnetic field in the relay can be utilized for switching a magnetic core to restore the pre-existing magnetic state of the core.

It is, therefore, a principal object of this invention to provide a single, saturable reactor means for storing indicating signals and applying same to an output load.

A further object of the present invention is to provide a saturable reactor, operatively associated with the relay means, such that the relay means may serve to restore or not restore the pre-existing state of the magnetic core.

A further object of this invention is to provide an actuating circuit in which greater reliability is obtained through the employment of saturable core reactors in place of conventional tube-type circuitry.

A still further object of this invention is to provide a means whereby the short output pulse caused in a winding by the switching of a core is delayed by use of passive storage elements for a sufficient duration of time to cause a conventional relay to latch.

These and other more detailed and specific objectives will be disclosed in the course of the following specifications.
mechanically coupled to each other. Contact 52 may be termed the holding contact whereas contact 53 is used to control the energization of some external circuit. Conductor 56 connects terminal 54 of switch 52 with the terminal of the normally closed push-button switch 62. The other terminal 60 of the push-button switch is connected by conductor 69 to voltage source 64. Relay contact 51 is electrically connected through conductor 50 and current limiting resistor 48 to terminal 34 of the relay actuating coil 38.

Although FIGURE 2 shows that two pulse generators are used to provide current to the windings 20 and 22, it is to be understood that the present invention is not limited to the illustrated embodiment. For example, a single pulse generator supplying bipolar pulses may be used and consequently one or the other of the signal or power windings may be eliminated. The signal pulse generator could be connected to winding 20 and a positive pulse excitation be made to switch the core in one direction and a negative pulse used to switch the core in the other direction. It may also be noted that voltage source 64 may be a source of negative voltage if diodes 26 and 44 were polar opposite to the manner shown.

It is obvious to one skilled in the art that a pulse generator may take many forms, such as, a monostable or bistable multivibrator circuit or a circuit employing magnetic cores. In the latter case, for example, the switching of a magnetic core in a shift register or similar device could be utilized to induce a signal in a winding on the core, and thus induced signal could, in turn, serve as a pulse for affecting a magnetic core, such as the one employed in the embodiment illustrated by FIGURE 2.

The operation of the circuit of FIGURE 2 will now be described. Assume that the initial state of core 18 is established at \(-B_n\), a state of negative remanent magnetization. Inasmuch as the signal or input coil 20 is poled oppositely to the power or readout winding 22, a pulse of current flowing in the input winding 20, which may arbitrarily be said to represent a binary "1," causes the magnetic state of the core to change from \(-B_n\) to \(+B_n\), and a subsequent pulse of current of the same polarity energizing the power winding 22 reverts the state of the core from \(+B_n\) to \(-B_n\). When an input pulse sets the magnetization of the core in the \(+B_n\) or its arbitrarily defined "1" state, a substantial change in flux is produced and an E.M.F. is induced in the output winding 24. However, the current resulting from this induced E.M.F. in the output winding is blocked by the diode 28 when the diode is polar as illustrated, and hence no energy is supplied to the capacitor 30 or relay 38. The core remains in the \(+B_n\) or "1" state until a pulse is applied to the core winding 22, at which time the core repeats the "0" state. The E.M.F. then induced in the output winding 24 is of a proper polarity to cause current to flow in the forward direction of the diode 28 to charge the capacitor 30 very rapidly. For example, in one embodiment this current pulse was several hundred milliamperes in amplitude, and lasted for only about 100 microseconds.

The circuit is now traced as being from source 64 through conductor 68, the normally closed pushbutton switch 62, the conductor 56, the armature 52 of relay means 39, and the current limiting resistor 48 to terminal 34, which is connected to relay actuating coil 38 and thence to ground. The self-latching relay 39 will remain closed until the circuit is opened by opening switch 62. Since switch contact 53 is mechanically coupled to switch contact 52, it will close on contact 66 when the magnetic field induced by current flowing through relay coil 38 causes armature 52 to latch. As mentioned hereinbefore, the circuit completed by the latching of armature 53 may serve to provide a signal indication to a utilization device.

In one application, push-button switch 62 or its equivalent can be energized by command signals from the device 67. A command signal could serve to cause switch 62 to open, thus indicating that the information carried by the relay has been sensed by the utilization device.

The opening of switch 62 would cause relay 39 to open carrying it to assume a rest state for subsequent signals generated in the aforementioned manner by the switching of core 18.

Returning now to the construction of the circuit shown in FIGURE 2, it will be further seen that the diode 44 is serially associated with switch 42 is connected across the terminals 34 and 36 of the relay actuating coil 38. This particular switch-diode arrangement permits the magnetic state of the core, existing prior to actuation of the relay, to be restored if desired. With switch 42 closed, the energy stored in the magnetic field of the relay, which is released in the form of current when the relay is unlatched by opening switch 62, is dissipated in a circuit including the diode 44, and very little energy reaches the output winding 24 of the core. With switch 42 opened, however, the current resulting from the collapse of the magnetic field of the relay actuating coil 38 now flows through the conductor 46, winding 24, and through line 32 to terminal 34 of the relay coil 38. This current is initially of sufficient amplitude and flows in the output winding 24 in a direction to cause the core to reswitch, thus restoring it to its pre-existing state.

In the sense then, that energy initially supplied by the switching of the core is used to restore the core to its pre-existing state, it may be said that the readout is nondestructive.

It is understood that suitable modifications may be made in the structure as disclosed provided such modifications come within the spirit and scope of the appended claims. Having now, therefore, fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. In a relay actuating circuit, the combination comprising: a magnetic core having substantially rectangular hysteresis loop characteristics, and having at least two windings coupled thereto; a source of bipolar pulses connected to a first of said windings for initially setting said core in a first remanent magnetic state, and for subsequently driving said core to its opposite magnetic state to induce substantial signals in a second of said windings; relay coil means having first and second terminals and at least one set of contacts associated therewith; energy storage means connected across the first and second terminals for storing said signals in a first interval of time, and for supplying energy to said relay means for a second interval of time greater than said first interval; a voltage source connected to one of said set of contacts; means connecting the other of said set of contacts to said energy storage means initially causing said contacts and said voltage source maintains said contacts in a closed condition; means to effect an opening of said contacts; means connecting said terminals in series circuit with said second winding for allowing the signal induced by the collapse...
of the magnetic field in the relay to re-establish the pre-existing remanent state of said core.

2. The device of claim 1 wherein means are provided across said first and second terminals for preventing a signal induced by the collapse of the magnetic field in the relay from re-establishing the pre-existing magnetic state of said core.

3. The device of claim 2 wherein said means is a switch.

4. The device of claim 2 wherein said means is a switch electrically connected in series with a diode.

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