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KEY CONTROL SENDER

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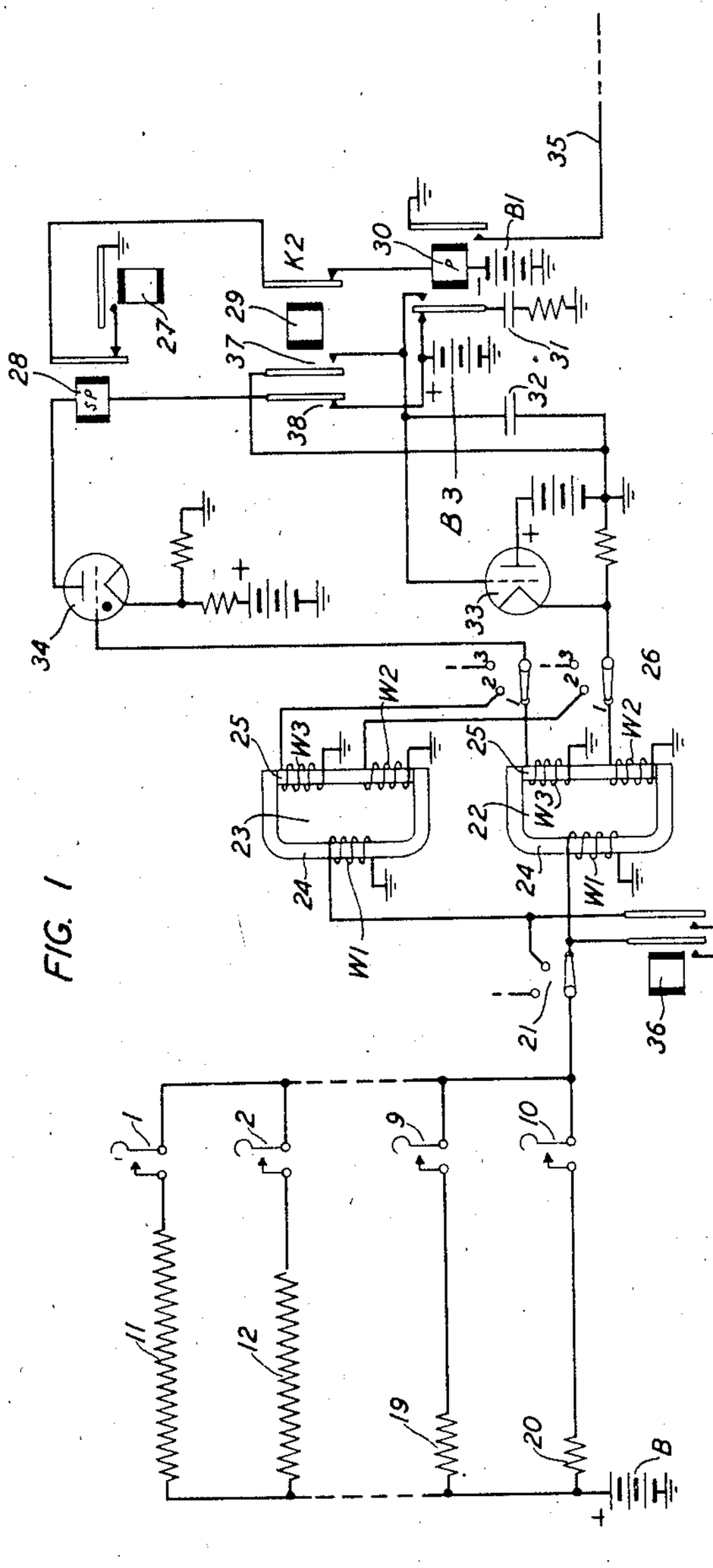

FIG. 1

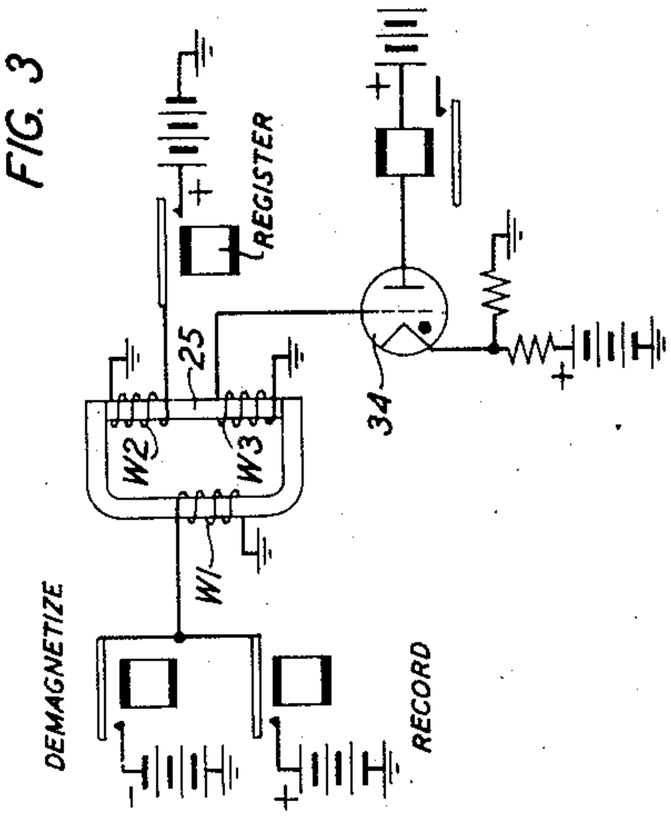

FIG. 3

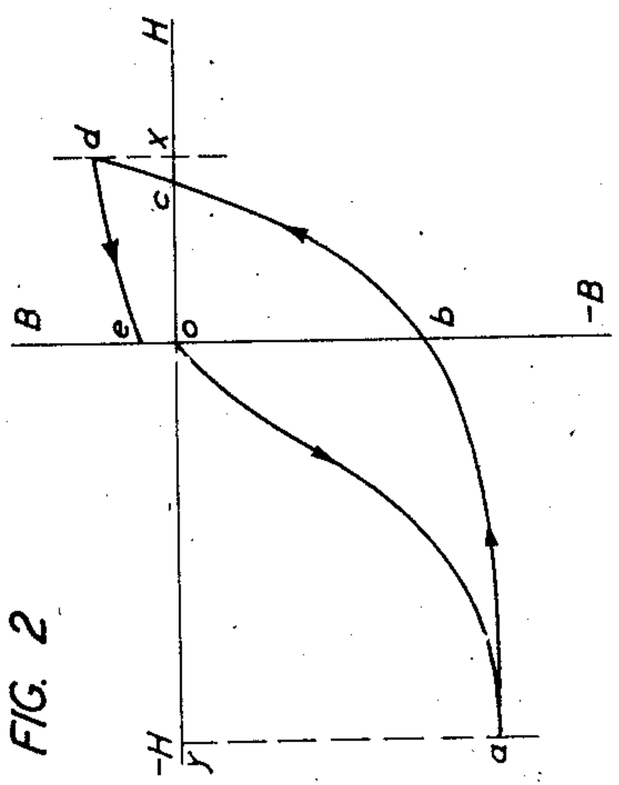

FIG. 2

INVENTOR
T. L. DIMOND
BY A. J. Krugman
ATTORNEY

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KEY CONTROL SENDER

Thomas L. Dimond, Rutherford, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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This invention relates, broadly, to systems for storing and subsequently reproducing information, represented by electrical current of characteristic value.

One embodiment of the invention resides in a system for storing what may be termed "on-off" information as to the occurrence or non-occurrence of a predetermined effect, a simple example being the closure of a door, momentary overload of an electric power circuit, and countless others, and subsequently determining and indicating the stored information.

Another embodiment resides in electrical systems, such as computing arrangements, machine switching telephone systems, and the like, in which information, such as numerical digits in the form of electrical current of characteristic value, is initially stored and later translated to effect any desired control. For example, machine switching telephone systems having so-called senders, are known in which the digits representing a called subscriber's number are stored in condensers in which each digit is represented by the amount of charge built up therein as fully described in United States Patent 2,002,219.

An object of the invention is to simplify and improve arrangements for storing information of the foregoing character.

A feature of the invention resides in employing magnetic means for storing information represented by electrical current of characteristic value, said means comprising an electro-magnetic core having a pair of series section, one of a material readily magnetizable and demagnetizable and of high permanent magnet qualities, and another of high permeability and saturable at low flux densities, means for magnetizing the first or permanent magnet section in accordance with the value of the electrical current representing the information to be stored and to a degree sufficient to more than saturate the second section, and in employing means for applying another magnetizing force to the second section in opposition to the magnetic field created by the magnetic condition of the first section to reduce and reverse the magnetic field therein, and further in employing means to indicate the occurrence of such a reversal.

Another and more specific feature resides in an arrangement employing the magnetic means before described for storing digital information in which the digital (current) value of a depressed key of a key-set is impressed on the section of the magnetic core having high permanent magnet properties and readily magnetizable and demagnetizable, which core section is serially connected with the second core section which is highly permeable and saturable at low flux densities. In this arrangement the stored information in the form of a magnetic condition of the core is determined and translated to control an automatic switch or other selective mechanism by applying current, which increases at successive intervals in uniform predetermined steps, to a winding on the second or highly permeable section of the core in such a direction as to decrease to zero, in equal steps, the magnetic field therein caused by magnetization of the first core section and in causing the immediately ensuing sharp flux reversal therein to interrupt said applied current. The number of current steps applied to the winding on the second core section to cause a flux reversal therein determines the numerical value of the digit stored which steps can be counted to effect control of desired mechanism.

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The invention will be understood from the following description when read in connection with the accompanying drawings:

Fig. 1 of which shows in schematic form a portion of an operator's key-set for recording digits of a wanted subscriber's line number and means according to the present invention for storing and later translating the stored information into electrical impulses to control any desired selective mechanism;

Fig. 2 is a typical B-H curve of the magnetic storing means and,

Fig. 3 shows an arrangement of the invention for storing and subsequently reproducing so-called "on-off" information.

Referring to the drawing, Fig. 1, keys 1 to 10 have digital values 1 to 0, respectively, according to conventional practice, which keys are connected in series with individual resistances 11 to 20, respectively, between a source of direct current, i. e., battery B and a "steering-in" switch 21.

Resistances 11—20 are of different values, resistance 11 having the greatest value thereby restricting the current therethrough to the lowest value and resistance 20 is of the least value thereby passing current of a predetermined maximum value.

The contact terminals of steering-in switch 21 are connected to windings W1 of individual magnetic structures 22, 23, etc. there being one such structure for each digit to be stored. For example, in an exchange where a seven digit code is employed, seven such magnetic structures would be required.

Structures 22, 23, etc. comprise a composite core

of magnetic material, one portion 24 of which is of material having high permanent magnet properties and capable of being readily magnetized and demagnetized, and another portion 25 in series with the first portion being composed of a material which has high permeability and saturates sharply at a low flux density.

The high permeability sections 25 of structures 22, 23, etc., each have two windings W2 and W3. The W2 winding of structure 22 being connected to the first terminal of one bank of a steering-out switch 26 and the W2 winding of structure 23 being connected to the corresponding No. 1 terminal of a second bank of the switch. Other structures similar to 22 and 23 for storing other digits of the code would have the W1 winding connected to other terminals of switch 21 and their W2 and W3 windings to succeeding terminals of switch 26.

The contact arms of switch 26 are connected to means, hereinafter described, for electrically determining and translating the code stored in the magnetic means 22, 23, etc.

Referring to Fig. 1, the operation of the system according to the invention will now be described:

Before the system is placed in service the core portions 24 are first given an initial magnetization in a direction opposite to the direction caused by operation of one of the digit keys 1–10. This may be done by causing relay 36 to momentarily operate to apply a negative force y (Fig. 2) to the cores 24 which is sufficient to magnetize cores 25 to a point a beyond saturation (see curve O to a). When relay 36 releases the flux density does not decrease to zero but returns to a point b which becomes the starting point for the first magnetization of the core by operation of a digit key which we may assume applies a positive force x to extend the curve through c to d. When the key is released the curve descends to e which is the effective value of the stored digit. It will be assumed for purposes of description that the first two digits of the code required to establish the desired connection with a called subscriber is 29 and therefore an operator desiring to transmit this code will first depress key 2 whereupon current which is a function of the value of resistance 12 is applied by steering-in switch 21, in its first position, to the winding W1 of the magnetic structure 22 thereby magnetizing its core section 24 to a degree determined by the value of resistance 12, whereupon the core section 25 in series therewith will immediately become saturated.

When key 2 is released the steering-in switch 21 will advance, under control of means not shown to its second position. Operation of key 9 following operation and release of key 2 now applies current, which is a function of resistance 19, to the W1 winding of magnetic structure 23 over switch 21 now standing in the second position, whereupon the magnetic core 24 of structure 23 will be magnetized to a degree determined by the current passing through resistance 19 which will be considerably greater than that of the magnetization of core section 24 of structure 22 established by operation of key 2. Core section 25 of structure 23 now also becomes saturated due to the magnetization of its companion core section 24.

In case the called number code comprises further digits, additional magnetic structure similar to 22 and 23 are necessary and are connected in a like manner between switches 21 and 26 and magnetized in accordance with successive operations of the keys 1 to 10.

When the desired digits are stored, 2 and 9 in the present example, means (not shown) causes relay 27 to periodically connect ground impulses over back contacts of relays 28 and 29 to relay 30 thus causing that relay to alternately operate and release. During the released period of relay 30, condenser 31 is charged in an obvious circuit from battery B3 and when relay 30 operates the charge on condenser 31 is transferred to condenser 32 thereby establishing a definite potential on the grid of vacuum tube 33 and causing plate current due to this grid potential, to flow in winding W2 on the saturated core section 25 of storage device 22 in a direction to create a magnetic field therein which is in opposition to the field due to the degree of magnetization stored in the corresponding core section 24. When relay 30 releases condenser 31 is disconnected from condenser 32 and reconnected to the charging source B3. The charge on condenser 32 however maintains the grid of tube 33 positive and the plate circuit continues to pass current through the winding of W2 during the interval relay 30 is released.

On the next operation of relay 30 the renewed charge on condenser 31 is transferred to condenser 32 thereby increasing its potential and that of the grid of tube 33 to cause an increase in the opposing flux in core section 25 of the storage device 22, which it is assumed is now sufficient to reduce the magnetic field therein, due to the magnetized section 24, to zero and to cause a sharp flux reversal to occur therein which is sufficient to induce a surge of current in the W3 winding which is applied to the control electrode of the gas-filled discharge device 34 to cause it to fire and operate relay 28 which now opens, at its back contacts, the circuit for relay 30 and stop its periodic operation.

It will be noted that two cycles of operation and release of relay 30 were required to cause a flux reversal in core section 25 of the storage device 22 and operation of relay 28, and consequently by means of the left-hand contacts of relay 30, two ground pulses were transmitted over conductor 35 to a counting or pulsing circuit. As soon as the information (digit 2) stored in magnetic structure 22 and translated into two ground pulses over conductor 35, means (not shown) advances steering-out switch 26 to its second position and momentarily operates relay 29 thus opening its right-hand contacts to insure against false operation of relay 30, closes its contacts 37, to completely discharge condenser 32 and opens its contacts 38 to restore tube 34 and release relay 28. When relay 29 releases and 27 again operates, the pulse operation of relay 30 and the step-by-step neutralization of the stored field in core 25 of magnetic structure 23 starts. Due to the fact that the core section 24 of this structure was magnetized to a greater degree than the corresponding section of structure 22 due to the lower values of resistance 19, nine successive operations of relay 30 are required to reduce and reverse the field in this section and therefore nine ground pulses are transmitted to the counting circuit over conductor 35.

The foregoing operational sequence continues until the entire stored code or number has been translated into ground pulses over conductor 35 whereupon the steering switches will be restored to their first position by means (not shown) and relay 36 will be momentarily operated to demagnetize all of the storage devices in readiness for further use. See joint b in Fig. 2.

The means for recording and reproducing "on-off" information shown in Fig. 3 is merely a simplified arrangement of the foregoing described system for recording digital information shown in Fig. 1. Due to the fact however that the "on" information to be stored may be represented by current of a single predetermined value it is only necessary to apply a reversing current to the winding W2 of such a value as to reduce and reverse the flux in the core section 25 to fire the gas-filled device 34 to give any desired indication of the recorded effect.

In case there has been no occurrence ("on" information) recorded at the time the register winding W2 is energized there will be no flux reversal to fire the device 34 and hence no indication of an occurrence of the effect will be given.

What is claimed is:

1. In a system for storing and subsequently reproducing information represented by electrical current of characteristic value, a composite magnetic core comprising serially joined sections one being of high permanent magnet properties and another highly permeable and saturable at low flux densities, means for causing said information current to magnetize said core, magnetizing means for causing a flux reversal in the permeable material section, and means for measuring the value of the magnetizing force required to effect said reversal as an indication of the information stored.

2. Information storage and reproducing system comprising a composite magnetic core, serially including a section having high permanent magnetic properties and readily magnetizable and demagnetizable, and another section of highly permeable material capable of saturating at low flux density, means for characteristically magnetizing the first section in accordance with the information to be stored and to a greater degree than that necessary to cause magnetic saturation of the second section, other magnetizing means for reducing and reversing the magnetic condition of the second section and means for indicating the magnetic force required to effect said reversal as a measure of the information stored.

3. In a system for storing and subsequently reproducing information represented by electrical current of characteristic value, means for storing said information comprising a composite magnetic core having serially joined sections one of readily magnetizable and demagnetizable material of highly permanent magnet properties and another of highly permeable properties and saturable at low flux densities, means for magnetizing the highly permanent section of said core, in accordance with the value of the current representing the information to be stored, to magnetize the highly permeable section beyond saturation, means for applying a magnetizing force, which increases in value in successive steps of equal value, to the highly permeable section in opposition to the direction of the flux therein caused by the magnetized condition of the permanent magnet section and means responsive to a flux reversal in the permeable section to discontinue application thereto of said magnetizing force and to cause an indication of the number of steps required to cause said flux reversal.

4. In an information storing and reproducing system, storing means comprising a composite magnetic core having a section of high permanent magnet properties, readily magnetizable

and demagnetizable, in series with a highly permeable section saturable at low flux densities, means for magnetizing the first section to a degree characteristic of the information to be stored and sufficient to more than cause saturation of the second section, and means for translating and indicating the stored information comprising means for magnetizing the second section in an opposite direction to the flux therein, to a degree sufficient to cause a reversal of said flux, and means for measuring the magnetizing force applied to said second section to cause said reversal as an indication of the characteristic degree of magnetization of the first section.

5. In a system for storing and subsequently reproducing identifying information consisting of electrical impulses of characteristic strength, a transformer having a composite magnetic core serially including material having high permanent magnetic properties and readily magnetizable and demagnetizable and highly permeable material which saturates at low flux density, means for applying said information impulse to magnetize the high permanent magnet portion of said core, means for applying electrical current in periodically increasing steps to create a magnetic condition in the permeable material portion of the core in opposition to the condition caused therein by magnetization of the permanent magnet portion, and means responsive to a reversal of flux in said permeable portion to discontinue application of said successively increasing current and to register the number of current steps required to cause said flux reversal as an indication of the stored information.

6. In a sender for controlling the setting of a selector switch, a transformer having a core serially including magnetic material section of different characteristics, one being readily magnetizable and demagnetizable and having high permanent magnet properties and another saturable at low flux density and of high permeability, means for selectively magnetizing said first core section to an intensity which is a function of the desired switch setting to cause a magnetizing force to be applied to the second section which is greater than that required to cause saturation therein, step-by-step means for causing a flux reversal in the second section, means responsive to said flux reversal to stop said step-by-step means and means for controlling said selector switch in accordance with the number of steps required to cause said flux reversal.

7. In a sender for controlling the setting of a selector switch, a plurality of keys each corresponding to a different setting of said switch, a transformer serving as a register and comprising a core serially including a first section of magnetic material having high permanent magnet properties and readily magnetizable and demagnetizable, and a second section of highly permeable material which saturates at low flux densities, windings on each of said sections, means responsive to operation of any one of said keys for energizing a winding on the first section of the core to magnetize said section to a degree which is a function of the key operated and more than sufficient to saturate said second core section, means for applying a periodically increasing electric potential, in uniform step-by-step increments, to a first winding on the second core section in such a direction as to create an increasing magnetization effect therein in opposition to the effect therein due to the magnetization of the

first core section to cause a flux reversal in the second core section, means including a second one of the windings on said second section responsive to a reversal of flux therein to discontinue application of said periodically increasing potential, and means for controlling the setting of said selector switch in accordance with the number of potential steps applied to the first winding on the second core section.

8. A system for storing and subsequently reproducing information represented by electric current whose value is a function of the information to be stored, characterized by an electromagnet having a composite core of serially joined sections of different magnetic properties one section being of material readily magnetizable and demagnetizable and of high permanent magnet properties and another of highly permeable material saturable at low flux densities, by means of applying said information current to said core for establishing a magnetic condition therein of a degree characteristic of said current, by means for causing a flux reversal in said core, and by means responsive to said reversal for indicating the current value of the stored information.

9. A system for storing and subsequently reproducing information represented by electric current whose value is a function of the information to be stored, characterized by an electromagnet having a composite core of serially joined sections of different magnetic properties, one section being of material readily magnetizable and demagnetizable and of high permanent magnet properties and another of highly permeable material saturable at low flux density, means for applying the information current to the first section to create a magnetic condition therein effective to cause a saturating condition in the second section, means for decreasing, step-by-step, the magnetic condition of the second section to cause a flux reversal therein, and means responsive to such flux reversal to stop and register said steps.

10. In a machine switching telephone system, a sender for controlling the setting of a selector switch, comprising means for storing information characteristic of the desired switch setting and means for subsequently reproducing and translating said stored information to control said switch, said storing means comprising an electromagnetic core having serially joined sections having different magnetic properties, one section being of a material readily magnetizable and demagnetizable and of high permanent magnet properties and another of highly permeable material saturable at low flux densities.

11. In an information storage and reproducing device, an electromagnet having a core serially comprising a section of material of high permanent magnet properties and readily magnetizable and demagnetizable and another section highly permeable and saturable at low flux densities, means for magnetizing the permanent magnet section to a degree representing the information to be stored, means for magnetizing the highly permeable section in opposition to the magnetic force due to the permanent magnet section, means responsive to a flux reversal in the highly permeable section, and means for evaluating the opposing force required to effect said reversal as a measure of the information stored.

12. In a device for storing and subsequently translating information represented by electrical currents characteristic of the information to be stored, a composite magnetic core comprising two serially joined sections one of high permanent magnet properties and readily magnetizable and demagnetizable and the other section highly permeable and saturable at low flux densities, means for causing said information current to magnetize the permanent magnet section to establish a saturated condition in the highly permeable section, means for applying a magnetizing force to the highly permeable section in opposition to the force due to the permanent magnet section to cause a flux reversal in the highly permeable section and means responsive to and controlled by said reversal of flux to evaluate the opposing force required to cause said reversal as a measure of the information stored.

THOMAS L. DIMOND.

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