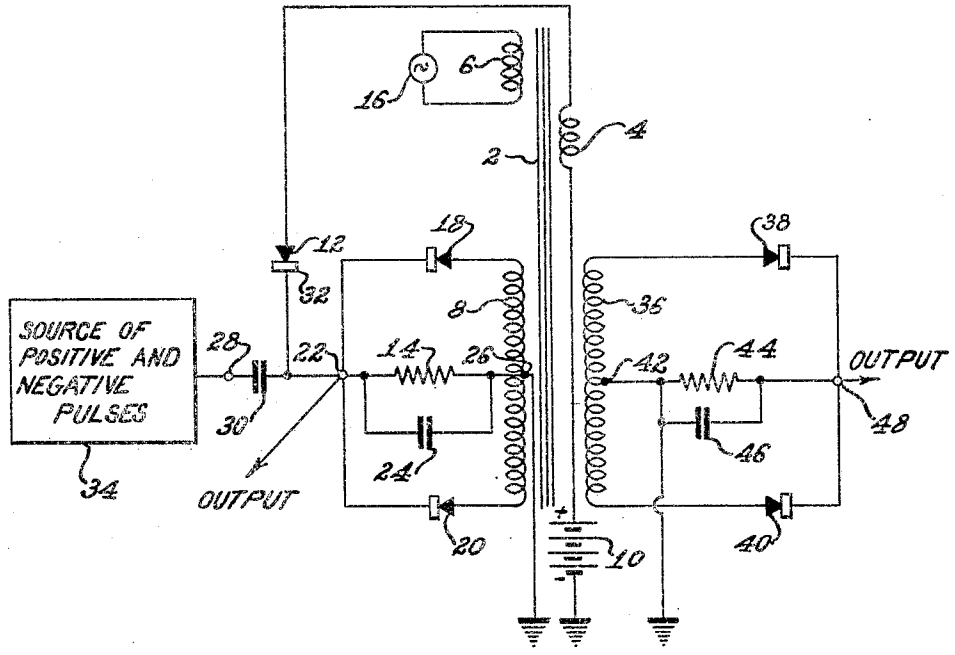
May 24, 1955 R. PRESSMAN 2,709,225

SIGNAL RESPONSIVE DEVICE

Filed Sept. 27, 1952



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United States Patent Office 2,709,225 Patented May 24, 1955

2,709,225

SIGNAL RESPONSIVE DEVICE

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Application September 27, 1952, Serial No. 311,842

17 Claims. (Cl. 307—88)

This invention relates to a signal responsive device of the type known as a trigger or switching circuit in which the usual electron discharge tubes are replaced by a saturable core reactor.

In modern information handling apparatus such as digital computers, considerable utility is made of electronic switching and trigger circuits which are used to perform various control and storage functions. A basic form of such circuits is the Eccles-Jordan or flip-flop circuit which responds to input signals to produce two different levels of output potential. The two outputs are produced by two different states of the circuit, which may be characterized by one of the tubes of the circuit being either conductive or non-conductive. Generally, in the Eccles-Jordan type of circuit, two tubes are used; the tubes being cross-coupled so that a change in a tube to one state produces a change to the opposite state in the other tube. Thus, the circuit has an essential binary character and mode of operation.

Due to the limited reliable life of an electron discharge tube leading to problems of tube replacement, circuitry has been developed, in the art, which performs essentially the same function as electronic trigger circuits but which dispenses with the electron tube as the basic circuit element. One such circuit is described in the Thompson Patent No. 2,519,513. See also the Wood Patent No. 2,524,154. These circuits make use of a pair of saturable core reactors (magnetic cores each with alternating and direct current coils wound thereon) which are cross-coupled in a manner analogous to the archetype Eccles-Jordan circuit. These saturable core reactor circuits also have a binary character or mode of operation. Two different levels of output potential are produced by two different states of the circuit which may be characterized by one of the magnetic cores being either saturated or unsaturated. As indicated in the above cited patents, trigger circuits using saturable core reactors may replace electron tube circuits in many applications.

The saturable core reactor trigger circuits of the prior art depend on one reactor being in a saturated state to maintain the other reactor in an unsaturated state. Similarly, a change in the state of saturation in one reactor is used to produce the opposite in the other reactor. Replacement of one of the two saturable reactors by a simple electric circuit so as to produce substantially the same result would apparently be an economical simplification.

Accordingly, it is an object of this invention to provide a new signal responsive device in which a saturable core reactor is used as a basic circuit element.

Another object of this invention is to provide a signal responsive device having a binary mode of operation utilizing but a single saturable core reactor as a basic circuit element.

Still another object of this invention is to provide an economical signal responsive device utilizing a single saturable core reactor.

A feature of this invention is that a variation in permeability in a reactor core produces a variation in the inductive coupling between two coils to produce a voltage for controlling core permeability.

These and other objects of this invention are achieved by utilizing a single saturable core reactor having a magnetic core and a biasing coil energized from a unidirectional current source for varying the permeability of the core between saturated and unsaturated conditions. A control network is provided which includes the saturable core reactor and at least one inductance element. The network is energized by alternating current, and its inductive characteristics vary with variations in core permeability. An output terminal of the control network is coupled to the biasing coil through a rectifier, known hereafter as the biasing coil rectifier. With changes in core permeability, output voltages are produced at the output terminal which permit or oppose flow of current in the biasing coil, and thus, control the permeability of the core. In the embodiment disclosed in detail below, the control network comprises a primary coil on the magnetic core connected to a source of alternating voltage, and a secondary coil on the core inductively coupled to the primary coil through the magnetic core and connected through a rectifying circuit to the output terminal.

Changes in core permeability may be initiated by input signals applied to an input terminal coupled to the biasing coil rectifier. An input signal voltage opposes the source voltage applied to the biasing coil and thus blocks flow of current in the biasing coil. The permeability of the core increases when the biasing current is removed, and the inductive coupling between the coils of the control network increases. As a result, there is an increase in voltage induced in the secondary coil of the network. This voltage is rectified and applied to the biasing coil rectifier to continue the blocking of current in the biasing coil. The core remains in this state until another input signal of opposite polarity is received. This signal reduces the voltage at the biasing coil rectifier and permits current flow in the biasing coil to saturate the core. Saturation of the core reduces the coupling of the coils in the network. Thus there is no voltage induced in the secondary coil to oppose current flow in the biasing coil, and the core remains in a saturated state.

The organization and method of operation of the invention may be best understood from the following description and the accompanying drawing in which there is shown a schematic circuit diagram of an embodiment of the invention.

Referring now to the drawing, there is shown a single saturable core reactor comprising a magnetic core **2** having three coils **4**, **6**, **8** thereon. One of the coils is a saturating or biasing coil **4**, and it is energized from the positive side of a source **10** of unidirectional voltage; the energizing circuit being completed through a rectifier **12** and a load resistor **14** to ground. Another coil **6** is connected to a source of oscillating voltage **16** and functions as the primary coil of a transformer network which controls current flow in the biasing coil **4**. The third coil **8**, the secondary of the control network, is inductively coupled to the primary coil **6** through the magnetic core **2**, and has its ends connected through a pair of rectifiers **18**, **20** to an output terminal **22**. The load resistor **14** and a peaking condenser **24** are connected between the output terminal **22** and a center tap **26** on the secondary coil **8**. The center tap of the secondary coil is connected to ground potential. An input terminal **28** is coupled through a condenser **30** to the cathode **32** of the biasing coil rectifier **12**, and it receives input signals from any appropriate source **34** of positive and negative pulses. The output terminal **22** is also connected to the cathode **32** of the biasing coil rectifier **12**.

The unidirectional current flowing through the biasing

coil 4 is of sufficient magnitude to saturate the magnetic core 2. When current is blocked in the biasing coil 4, the permeability of the magnetic core 2 increases and the core is essentially in an unsaturated condition. When the core is unsaturated, its permeability is high and, therefore, the inductive coupling through the core between the coils 6, 8 of the control network is large. At that time, the oscillating flux produced by the current in the primary coil 6 induces a voltage in the secondary 8. When the core is saturated, the inductive coupling through the core between the coils 6, 8 is reduced substantially, and any voltage induced in the secondary coil 8 is insignificant.

Considering the condition when a unidirectional current is flowing in the biasing coil 4, the magnetic core is saturated and voltage is not induced in the secondary coil 8. The potential at the output terminal 22 is above ground potential by the drop across the load resistor 14 caused by biasing coil current flowing therethrough. If a positive signal pulse is applied to the input terminal 28, the peaking condenser 24 charges and the voltage at the cathode 32 of the biasing coil rectifier 12 rises to oppose the voltage applied to the biasing coil 4. The voltage rise at the rectifier cathode 32 is sufficient to cut off current flow in the biasing coil. With the blocking of the saturating current, the coupling between the coils 6, 8 of the control network increases and a voltage is induced in the secondary coil.

The resulting current flow in the secondary coil circuit is rectified, and the voltage drop across the load resistor 14 maintains a high voltage at the output terminal 22. This control voltage is applied to the cathode 32 of the biasing coil rectifier, and has a magnitude sufficient to maintain or stabilize the blocking of current in the biasing coil. The period of the oscillating voltage is small relative to the time constant of the blocking circuit formed by the peaking condenser 24 and the load resistor 14. As a result, rectification can build up a blocking voltage before the peaking condenser voltage decays below the value necessary to block flow of saturating current.

The circuit remains in this stable condition of the biasing current blocked and the core saturated until a negative signal pulse is applied to the input terminal 28. This pulse reduces the potential at the cathode 32 of the biasing coil rectifier 12 and initiates current flow in the biasing coil 4. The core is again saturated and the coupling between the coils 6, 8 of the impedance network is substantially reduced. Thus, the voltage at the output terminal 22 continues to be low, and current flow is maintained in the biasing coil until the next positive input pulse is received.

The output terminal 22 of the control network may be used as the output terminal of the entire circuit. Two stable levels of potential are provided at the output terminal as in the usual trigger circuit. When the core is saturated, the potential at the output terminal is above ground due to the voltage drop produced in the load resistor 14 by the biasing coil current. When the core is unsaturated the terminal is much more above ground potential due to the rectified current from the secondary coil being larger than the biasing coil current.

These output potentials may be used for switching or gating purposes in the usual manner. Where the device to be controlled by the output voltages draws a significant amount of current, the voltage at the output terminal may be reduced below the level required for blocking current in the biasing coil. Under such circumstances, an auxiliary output circuit may be provided.

The auxiliary output circuit is identical to the secondary coil circuit previously described and comprises an additional coil 36 on the core inductively coupled to the primary coil 6, a pair of rectifiers 38, 40 connected to the ends of the coil 36, a center tap connected to ground, and a load resistor 44 and peaking condenser 46 connected between the center tap 42 and the cathodes of the rectifiers 38, 40. An output terminal 48 is provided at the cathodes of rectifiers 38, 40 in the same manner as previously described. This output terminal 48 presents two levels of output potential, and small currents drawn from this circuit do not materially affect the operation of the circuit.

The schematic circuit diagram is intended for explanatory purposes and not to show actual construction of the core and windings since suitable arrangements are well known in the art. For example, a three-legged magnetic core may be used, with the primary coil wound on the outer legs and the biasing coil on the center leg to prevent induction of oscillating voltages in the biasing coil.

It is, therefore, evident from the above description that a simple signal responsive device is provided utilizing but a single saturable core reactor which is economical in the components required.

What is claimed is:

1. A signal responsive device comprising a control network including (1) a saturable magnetic core, (2) a first coil on said core, and (3) means for applying an oscillating voltage to said network, a biasing coil on said core, means for applying a unidirectional voltage to said biasing coil, input means whereby a variation in core permeability may be produced and thereby a variation in an electrical characteristic of said control network, and circuit means connecting said control network to said biasing coil for affecting current flow in said biasing coil in accordance with a variation in an electrical characteristic of said control network whereby variations in core permeability are controlled.

2. A signal responsive device as recited in claim 1 wherein said control network has an output terminal, variations in core permeability producing variations in voltage at said output terminal, and said circuit means connects said output terminal to said biasing coil.

3. A signal responsive device as recited in claim 2 wherein said control network includes a secondary coil on said core inductively coupled thereby to said first coil, and rectifier means coupling said secondary coil to said output terminal, variations in core permeability producing variations in the inductive coupling between the first and secondary coils of said network.

4. A signal responsive device as recited in claim 2 wherein said circuit means includes a rectifier connected between said output terminal and said biasing coil whereby current flow in said biasing coil depends on the voltage at said output terminal.

5. A signal responsive device comprising a single saturable magnetic core, a coil on said core, means for applying an oscillating voltage to said coil, a biasing coil on said core, means for applying a unidirectional voltage to said biasing coil, input means whereby variations in the permeability of said core may be produced, and circuit means coupled to said oscillating voltage coil and to said biasing coil for producing a unidirectional voltage having a direction opposite to that of the voltage applied to said biasing coil responsive to a variation in the permeability of said core.

6. A signal responsive device comprising a single saturable magnetic core, a first circuit including (1) a coil on said core, and (2) means for applying an oscillating voltage to said coil, a biasing circuit for varying the permeability of said core including (1) a second coil on said core, and (2) means for applying a unidirectional voltage to said second coil, input means whereby a variation in core permeability may be produced, and circuit means coupling said first circuit to said biasing circuit for reflecting a variation in core permeability to said biasing circuit whereby a variation in core permeability is stabilized.

7. A signal responsive device comprising a single saturable magnetic core, a first circuit including (1) a coil on said core, and (2) means for applying an oscillating voltage to said coil, a biasing circuit for varying the permeability of said core including (1) a biasing coil on said core, and (2) means for applying a unidirectional voltage to said biasing coil, an input terminal for receiving input signals, circuit means coupling said input terminal to said biasing circuit whereby current flow in said biasing coil is changed upon reception of an input signal, and circuit means coupling said oscillating voltage circuit to said biasing circuit for reflecting a variation in core permeability to said biasing circuit whereby variations in core permeability are controlled.

8. A signal responsive device comprising a saturable magnetic core, a coil on said core, means for applying a source of oscillating voltage to said coil, a biasing circuit including a biasing coil on said core for receiving a unidirectional current of saturation magnitude, an input terminal for receiving an input signal, means coupling said input terminal to said biasing circuit for applying an input signal to said circuit to block flow of current in said biasing coil, and circuit means coupled to said oscillating voltage coil and effective upon current flow being blocked in said biasing coil to apply a signal to said biasing circuit to maintain the blocking of said current flow.

9. A signal responsive device comprising a saturable magnetic core, a first coil on said core, means for applying a unidirectional current to said coil to change the permeability of said core, an input terminal for receiving input signals, means coupled to said input terminal and to said first coil for blocking flow of said unidirectional current upon application of a signal to said input terminal whereby the permeability of said core is changed, and means including a second coil on said core for maintaining the blocking of said unidirectional current responsive to a change in the permeability of said core.

10. A signal responsive device comprising a control network including a magnetic core and an output terminal, a first coil on said core, means for applying a unidirectional current to said coil, input means whereby the permeability of said core may be varied, and a rectifier having a first and a second electrode, said first rectifier electrode being connected to said first coil, said network output terminal being connected to said second rectifier electrode, said control network including a second coil on said core and being responsive to an increase in the permeability of said core for producing a voltage at said output terminal to oppose flow of current in said first coil and responsive to a decrease in the permeability of said core for producing a voltage at said output terminal to permit flow of current in said first coil.

11. A signal responsive device comprising a saturable magnetic core, a primary coil on said core, means for applying an oscillating voltage to said primary coil, a secondary coil on said core inductively coupled to said primary coil, means for determining the permeability of said core and thereby determining the inductive coupling between said primary and secondary coils, and means coupling said secondary coil to said permeability determining means for stabilizing the determined permeability of said core.

12. A signal responsive device comprising a saturable magnetic core, a first winding, means to apply an exciting current to said first winding, a second winding coupled to said first winding through said core, means to saturate said core whereby the coupling between said first and second winding is rendered ineffectual, means to apply an inactivating signal to said core saturating means, and means coupling said second winding to said core saturating means to maintain said core saturating means inactivated following the application of said inactivating signal.

13. A signal responsive device comprising a control network including (1) a saturable magnetic core, (2) a primary coil on said core, (3) means for applying an oscillating voltage to said primary coil, (4) a secondary coil on said core inductively coupled thereby to said primary coil, (5) an output terminary, and (6) rectifier means coupling said secondary coil to said output terminal, a biasing coil on said core, means for applying a unidirectional voltage to said biasing coil to produce biasing current flow therein, input means whereby the permeability of said core is varied, and a biasing coil rectifier element coupling said output terminal to said biasing coil whereby a variation in core permeability produces a variation in voltage at said output terminal and thereby at said rectifier element to control current flow in said biasing coil.

14. A signal responsive device as recited in claim 13 wherein said input means includes an input terminal coupled to said biasing coil rectifier element whereby an input signal may be applied to said input terminal to vary the voltage at said rectifier element.

15. A signal responsive device as recited in claim 14 wherein said rectifier means includes a second and third rectifier element each having a pair of electrodes, one electrode of each of said second and third rectifier elements being connected to different ends of said secondary coil, and a resistor and a capacitor connected in parallel between the others of said rectifier electrodes and a central point on said secondary coil, said output terminal being connected to the others of said rectifier electrodes, and said biasing coil rectifier includes a pair of electrodes, one of said biasing coil rectifier electrodes being connected to one end of said biasing coil, and the other of said biasing coil rectifier electrodes being coupled to said input and output terminals.

16. A signal responsive device comprising a saturable magnetic core, a primary coil on said core, means for applying an oscillating voltage to said first coil, two secondary coils on said core each inductively coupled to said primary coil, two output terminals, separate rectifier means coupling each of said secondary coils to a different one of said output terminals, a biasing coil on said core, means for applying a unidirectional voltage to said biasing coil, an input terminal, and a rectifier element coupling said input terminal and one of said output terminals to said biasing coil.

17. A signal responsive circuit having two stable states comprising a single magnetic core, a biasing circuit including a biasing coil on said core for receiving a unidirectional current of predetermined magnitude, said core having one and another permeability respectively when said unidirectional current is flowing and not flowing in said biasing coil, and circuit means responsive to the state of permeability of said core for controlling the flow of said unidirectional current, whereby said signal responsive circuit is in one or the other of said stable states accordingly as said unidirectional current is flowing or not flowing.

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Publication, "Progress Report (2) on the Edvac," vol. II, published June 30, 1946, Moore School of Electrical Engineering, U. of Pa., Philadelphia, Pa., especially paragraph 4.2.12, etc., and Figs. 17*a, b,* and *c.*