Feb. 14, 1961 C. K. LEONARD 2,972,071

ELECTROMAGNETIC CONTROL OF CURRENT FLOW

Filed June 20, 1956

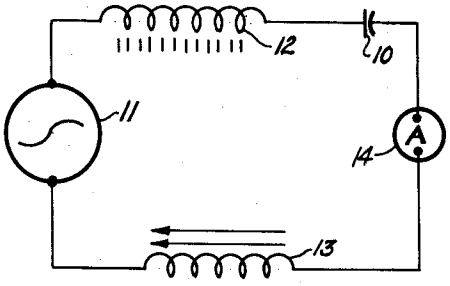


Fig. 1

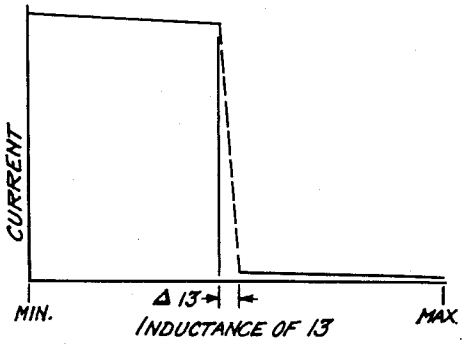


Fig. 2

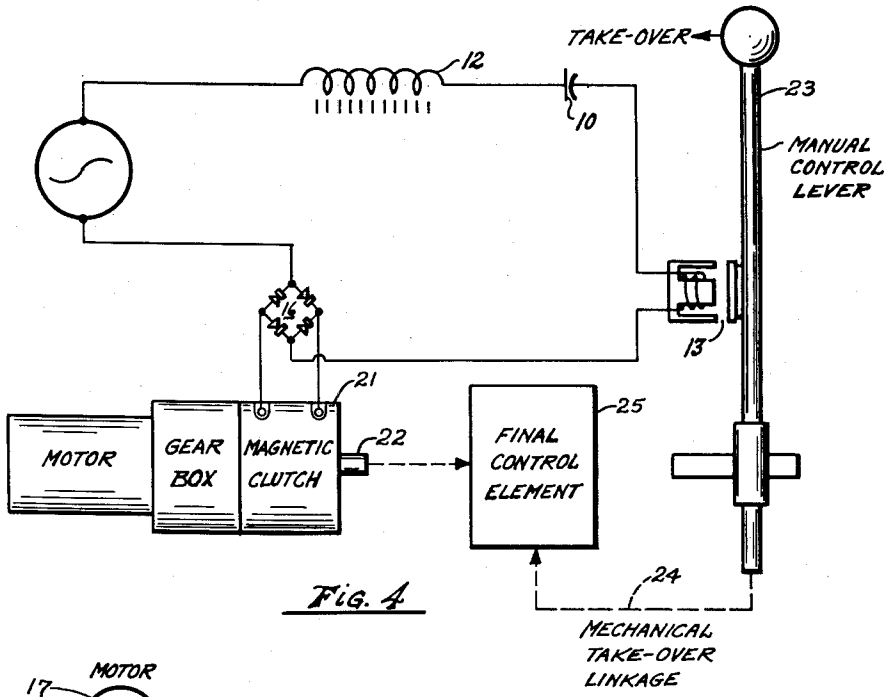


Fig. 4

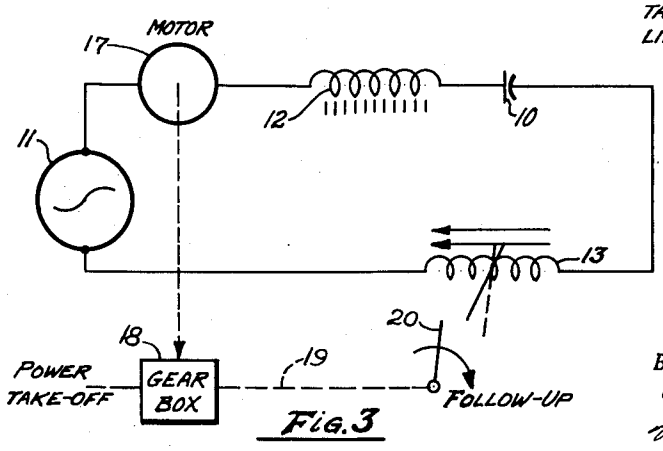


Fig. 3

INVENTOR.
CULLMAN K. LEONARD

BY Wade Koontz and Martin J. Finnegan
ATTORNEYS

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# ELECTROMAGNETIC CONTROL OF CURRENT FLOW

Cullman Kaye Leonard, Hamilton, Ohio, assignor to the United States of America as represented by the Secretary of the Air Force

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1 Claim. (Cl. 310—94)

This invention relates to the control of the flow of current in an electrical circuit, and particularly to controlling current flow by sudden changes in the impedance characteristics of such a circuit.

It is well known that the impedance characteristics of a circuit will vary in accordance with changes in the condition of a magnetic core of the saturable reactor type. The present invention utilizes this principle in a novel manner, and provides circuitry adapted for use as a means of controlling application of energizing power to an electric motor or equivalent electro-responsive device. Thus the circuit functions as a switch, but without requiring physical separation of switch contacts.

This type of circuit is not subject to the evils of arcing contacts which have a limited normal life and which often fail in operation due to welded contacts. The contactorless switch further is not a source of radio interference as is the conventional contactor type of switch.

In particular applications the methods disclosed in this invention could be utilized to result in an improvement over existing equipment employing relays having short life due to contact arcing. The invention also lends itself readily to application at reduced pressures where relay contact arcing is one of the particular problems.

An object of the invention is to provide a new and improved electrical control system.

Another object of the invention is to provide a new and improved electrical circuit which operates as a current flow interrupter without the use of contact surfaces.

A further object of the invention is to provide a method of preventing contact arcing in control devices and more particularly to prevent contact arcing aggravated by reduced pressure conditions.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiments in the accompanying drawings wherein:

Fig. 1 shows the basic sharp cut-off circuit;

Fig. 2 illustrates the sharp cut-off characteristic of the variable inductance;

Fig. 3 shows an application of the limit switch; and

Fig. 4 shows the limit switch applied in a mechanical take-over system.

The basic series circuit is used as a sharp cut-off circuit triggered by the increase of inductance of one of the circuit elements. In Fig. 1 the special saturable inductance **12** provides the on-off action of the circuit. The special saturable inductance **12** is composed of a single coil wound on a core of magnetic material which has a sharp break in its saturation curve, giving it a distinct knee. This inductance changes impedance from several hundred ohms to several hundred thousand ohms in going from the saturated to the unsaturated condition.



Also with reference to Fig. 1, a common mechanically variable inductance **13** is used as the actuator in the circuit. The value of capacitance **10** is chosen so that a near series resonant circuit condition exists when the variable inductance **13** is at some minimum value when the saturable inductance **12** is saturated. The basic series circuit shown in Fig. 1 includes an alternating current supply source **11** and an ammeter **14** as a means to measure the current flow through the circuit.

Fig. 2 shows the change in current as a function of the mechanically variable inductance **13**. As the variable inductance **13** is increased the resonant circuit is detuned slightly and the current decreases accordingly. This decrease in current causes an increase in the saturable inductance **12** and it approaches the knee of its saturation curve. A further minute increase in the variable inductance **13** causes the saturable inductance **12** to sharply come out of saturation and increase the series circuit impedance to such a magnitude that negligible current flows. Hence the flow of current has been virtually interrupted.

If this circuit is used in series with a control device such as an alternating current motor **17** and the mechanized output of the motor is used to change the variable inductance **13**, then the circuit becomes a limit switch for the mechanical output of the motor. Fig. 3 illustrates the circuit wherein the motor **17** is being controlled thereby. Mechanically connected to the motor **17** is a gear box **18** which includes a power take-off and also another shaft **19** for driving a follow-up system **20**. The core of the variable inductance **13** is adapted to cooperate with the follow-up system **20** so that the rotation of the motor **17** is, in effect, controlled and limited by the position of the core of the variable inductance **13** as determined by the motor **17** itself.

Fig. 4 shows the basic circuit as a switch in a portion of a mechanical take-over system from automatic control of some function, such as fuel flow of an aircraft gas turbine. A displacement of the manual control lever **23** to the left closes the air gap of the variable inductance **13** and causes an increase in inductance. Saturable inductance **12** comes out of saturation, the current goes to near zero and the magnetic clutch **21** is deenergized. The rectifier **16** is used as the current source for the magnetic clutch **21** which ordinarily acts to engage and disengage the drive shaft **22** during automatic operation of the function. If it is desired to manually control the function, the manual control lever **23** may be used with a mechanical take-over linkage **24** connected to the final control element **25**. Thus, when the control lever **23** is pushed inward to close the air gap the magnetic clutch **21** is deenergized and the drive shaft **22** stops rotating. The lever **23** may then act through the mechanical take-over linkage **24** to regulate the final control element **25** in the desired manner.

Although the invention has been described with reference to particular embodiments, it will be understood to those skilled in the art that various changes and modifications can be made therein without departing from the invention. I intend to be limited only by the true spirit and scope of the appended claim.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

In an electric system wherein a variable core inductance operates to control current flow, the combination with said variable core inductance of a magnetic drive control, means including a saturable core inductance in

series relation to said variable core inductance for controlling the energization of said drive control and coupling means for linking said magnetic drive control to said variable core inductance and operative to inhibit current flow in said system by the sudden desaturation of said serially connected saturable core inductance.

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