PATENT SPECIFICATION (11) 1 591 757

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(21) Application No. 4986/78 (22) Filed 8 Feb. 1978 (19)
(31) Convention Application No. 786000 (32) Filed 11 Apr. 1977 in
(33) United States of America (US)
(44) Complete Specification Published 24 Jun. 1981
(51) INT. CL.[3] H02J 13/00
H03K 17/725
(52) Index at Acceptance
H2H 22G 25G SS

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(54) A REMOTELY ACTIVATED ELECTRICAL CONTROL CIRCUIT

(71) We, TEKTRONIX INC., of 14150 S.W. Karl Braun Drive, Tektronix Industrial Park, near Beaverton, Oregon 97077, United States of America; a corporation organized and existing under the laws of the State of Oregon, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

Prior art applications of controlling the energization of a load have included a triac or bilateral triode switch device which can be made to conduct on both alternations of an AC voltage. In such applications, trigger circuits are provided for the triac which must be triggered into conduction. As an example, in U.S. Patent 3,665,219, there is described an AC semiconductor switch for controlling the energization of a load from a relatively high voltage source which is controlled by signal pulses supplied to the semiconductor from a circuit connected to a relatively low voltage source. Such teachings, however, have the disadvantage that a separate DC voltage source must be provided to the signal producing circuit. This additional DC voltage source tends to degrade the power control due to the cost, reliability and weight associated therewith.

In addition to the above-described disadvantages of the prior art, circuits have been developed to control the energization of a load using techniques such as optical isolation of the trigger signal and the concept of zero-cross triggering to improve radiated noise and reduce surge current, for an example, as the circuit described in U.S. Patent 3,723,769. Here again, external DC sources have been utilized.

It is therefore an object of the present invention to provide an electrical control circuit which overcomes the disadvantages of the prior art.

According to the present invention there is provided a remotely activated electrical control circuit for applying power to a load, the circuit comprising: switch means connected to an alternating current power supply and in series with the load for switching power to the load; a transformer comprising a first, a second, and a third winding; and control means for controlling the conduction and non-conduction of said switch means, said first winding being coupled to said alternating current power supply and said second winding to said switch means, said control means controlling the voltage to said switch means via said second winding by means including a full-wave rectifier connected between the output terminals of said third winding for providing a d.c. voltage to activate said control means to control the load on the transformer.

The present invention will be described further, by way of example with reference to the accompanying single Figure which is a schematic diagram of an electrical switch in accordance with one preferred embodiment of the present invention.

Referring to the single Figure, it is seen that the switch according to the present invention includes a transformer 10, such transformer being utilized to provide operating power to a control source ordinarily requiring a separate source of power, as well as isolating such control source from a source of electrical energy applied to the switch via input terminals 12 and 14. This electrical energy is coupled to a first winding 16 of transformer 10 via a series connected resistor 18. Resistor 18 can, of course, be of such value to enable, for example, a conventional 115 volt, 60 Hertz waveform to be the source of electrical energy, or it may be of different value to enable a conventional 230 volt, 60 Hertz waveform to be the source of electrical energy. Disposed in parallel with first winding 16 and the limiting resistor 18 is a load 20 and series connected TRIAC 22. It is the load 20 that the electrical switch according to the present invention is remotely conditioned to control. This load may be, for example, a variety of electronic or electric equipment which requires energization from an AC voltage waveform of the power lines.

The TRIAC 22, which is a conventional three terminal switch that can be triggered with either positive or negative gate pulses when the anode potentials are positive or negative, respectively (see "Integrated Electronics: Analog and Digital Circuits and Systems" by J. Millman and C. Halkias, copyright 1972 by McGraw-Hill, Inc.), has its gate terminal coupled to a second winding 24 of transformer 10 via a plurality of diode pairs 26-28 and 30-32. It should be mentioned that the diodes 26, 28, 30 and 32 are utilized to insure the gate characteristics of the TRIAC are fully anticipated, and could be eliminated entirely or require additional ones depending upon the voltage turn on (activation) specification of the selected TRIAC.

Before continuing, it should be mentioned that transformer 10 is preferably a transformer having a second winding 24 with fewer turns than the first winding 16 to provide a current-step-up for driving the TRIAC gate. In addition, transformer 10 preferably provides the dielectric withstand as required by IEC and UL ratings for line isolation between primary and secondary.

A third winding 34 of transformer 10 is provided for delivering to the control source the energy transferred across the transformer. Such energy is firstly applied to a plurality of diodes 36, 38, 40 and 42. These diodes are conventionally connected so as to treat the energy transferred across the transformer to the advantages of full wave rectification. Coupled between the diodes 36, 40 and 38, 42 is a series connected circuit comprising a resistor 44, a resistor 52, the base-emitter junction of a first transistor 50 which is preferably of the NPN type, and a diode 56. The junctions formed by the connection of the resistors 44, 52 and the connection of the diode 56 to diodes 38, 42 respectively, are provided with terminals 54 and 58 with polarity as shown. These terminals are provided as logic compatible inputs for logical circuits such as TTL, RTL, DTL, MOS, CMOS, Reed Relays, switches, Optoisolators, etc. and will be discussed elsewhere in the description.

The circuit additionally consists of a second transistor 48 which is preferably of the PNP type, having its emitter-collector junction disposed between the diodes 36, 40 and the junction formed by the connection of the resistor 52 and the base of first transistor 50. The base of this second transistor 48 is directly coupled to the collector of first transistor 50 and also coupled to the diodes 36, 40 via a base-emitter resistor 46. Although not shown in the drawings, each transistor may have a capacitor disposed across its base-emitter for noise suppression purposes.

Before considering the operation of the switch, while applicants do not wish to be limited to any particular set of values, the following values for the components have proved useful in one embodiment of the described invention:

Resistor 18	10KΩ, 3 Watt @ 110V, 20KΩ 6 Watt @ 230V
Resistor 44	100KΩ, ½ Watt
Resistor 46	4.7KΩ, ½ Watt
Resistor 52	6.2KΩ, ½ Watt
TRIAC 22	General Electric SC141D
Diodes 26,28,30,32,56	1N4152
Diodes 36,38,40,42	1N4610
Transistor 48	2N3906
Transistor 50	2N3904
Transformer 10	Winding 16 - 3000 turns #42
	Winding 24 - 300 turns #33
	Winding 34 - 3000 turns #42
	Core - EI-25

Operation of the circuit will now be considered. Assuming that terminals 54 and 58 are as shown in the drawings and that an AC source of power is instantaneously applied between the pair of power terminals 12, 14, there will exist the beginning of a pulsating or half-sinusoid at the output of the bridge rectifier comprising the already mentioned diodes 36, 38, 40 and 42. This causes a current to flow via resistor 44, resistor 52, and the base-emitter junction of transistor 50 which is returned to the bridge via the diode 56. Transistor 50 is therefore biased into conduction which, in turn, turns on transistor 48. With transistors 48 and 50 both conducting, the voltage across winding 34 is clamped. Due to transformer action, the winding 24 is also clamped but the clamping level is not sufficient (voltage) to cause TRIAC 22 to conduct. Consequently, the load 20 is not energized.

In this mode of operation, auxiliary features of the present invention exist. As has been previously stated, the voltage across terminals 54, 58 is logic compatible with TTL, RTL, DTL, MOS, CMOS, Reed Relay, Switch, Optoisolators, and is available since the diode 56 is a level shifting diode to make the control voltage logic compatable. This diode could be eliminated for some logic types.

Continuing, assume now that some means were provided whereby the terminals 54 and 58 could be remotely controlled, say, by a simple mechanical switch coupled between the terminals and manually switched to short the terminals. Another example would be a computer or the like, so that terminals 54 and 58 become electrically connected together. This could not be a normally non-conductive transistor whose collector-emitter junctions were appropriately disposed between the subject terminals and where the base thereof was controlled by a control voltage obtained from a computer to render the transistor conductive for certain periods of time to thereby short the terminals together.

With the terminals 54 and 58 electrically connected together, the transistors 48 and 50 continue to conduct until the next zero crossing of the applied AC source of power. With such zero crossing, transistors 48 and 50 lose the necessary substaining current and switch to the non-conductive state. Instantly, the output of the transformer produces a normal-sinusoid voltage which is transferred via winding 24 to gate the control terminal of TRIAC 22 so that TRIAC 22 conducts thereby completing the series circuit. Consequently, the AC source of power applied across power terminal 12, 14 now energizes the load. As long as the terminal 54 and 58 remain electrically connected together, the SCR like switch is off and the load remains energized. In addition, the voltage at the output of the bridge rectifier could be utilized for power startup or sensing applications.

Therefore, the present invention provides an electrical switch for controlling the energization of load 20 which comprises a pair of power terminals 12, 14 which are connectable to the load for receiving an AC source of power, a switch 22 connected in series with the load with the switch having a control terminal which is selectively controlled to cause the load to be conditioned to either an ON or OFF state, and a control means which is isolatively coupled to the power terminal and to the TRIAC 22 which includes a means for activating the control means which, in turn, provides a control signal to control the energization of the load by controlling the conduction of the TRIAC 22.

While there has been shown and described the preferred embodiment of the present invention, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Therefore, the appended claims are intended to cover all such modifications that fall within the scope of the invention.

WHAT WE CLAIM IS:-

1. A remotely activated electrical control circuit for applying power to a load, the circuit comprising: switch means connected to an alternating current power supply and in series with the load for switching power to the load; a transformer comprising a first, a second, and a third winding; and control means for controlling the conduction and non-conduction of said switch means, said first winding being coupled to said alternating current power supply and said second winding to said switch means, said control means controlling the voltage to said switch means via said second winding by means including a full-wave rectifier connected between the output terminals of said third winding for providing a d.c. voltage to activate said control means to control the load on the transformer.

2. The electrical control circuit according to claim 1 wherein said control means includes: a first transistor having the emitter connected to one terminal of said full-wave rectifier; a second transistor of opposite conductivity to said first transistor having the collector, base, and emitter thereof connected to the base and collector of said first transistor and the other terminal of said full-wave rectifier, respectively; first and second resistors connected in series with each other between said one terminal of said full-wave rectifier and the collector of said first transistor; and external means for electrically connecting or disconnecting the junction point of said first and second resistors to said other

terminal of said full-wave rectifier, thus effectively shorting the output terminals of said third winding.

3. A remotely activated electrical control circuit substantially as herein described with reference to and as illustrated in the accompanying drawing.

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Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1981.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*