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PEAK LOAD DISTRIBUTOR: U.S. PATENT 4,066,913
ELECTRONIC SWITCHING: U.S. PATENT 4,163,271

Manning Tronics, Inc.

April 17, 1995

95-0099 APR 21

Chairman Florida Public Service Commission
700 S. Adams St.
Tallahassee, Fla. 32304

Re: Request for Declaratory Ruling on Load Management Device

Dear Sir:

I request, the Florida P.S.C. to make an affirmative determination in compliance with Federal Laws 95-617, and 95-619, as to Standards for Load Management Techniques.

With an affirmative order from the Commission, declaring the Peak Load Distributor a load limiting device, meeting the standards of a load management technique, the product could be implemented on facilities meeting the requirements of utility rates designed for load management purposes.

Please consider the enclosed request.

Sincerely,

Michael Manning
Inventor

Enclosure

RECEIVED

APR 21 1995

Florida Public Service Comm.
Commissioner Clark

DOCUMENT NUMBER-DATE
04067 APR 24 95
FPSC-RECORDS/REPORTING

MANNING TRONICS, INC.
P.O. Box 6322 Athens, Georgia 30604 706-549-7038

REQUEST FOR DECLARATORY RULING

BEFORE THE Florida P.S.C.

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Now come Michael L. Manning, and Manning Tronics, Inc. and with leave of the Commission file this petition for a declaratory ruling.

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The petitioners requests an affirmative determination regarding a load management technique known as the Peak Load Distribution.

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The issue is a request of the Commission to make a finding pursuant to Federal Statutes, the National Energy Conservation Act P.L. 95-619, 42 U.S.C. 8211 (2) (11) (G) and 42 U.S.C. 8217 (b) (c) and the Public Utilities Regulatory Policy Act, P.L. 95-617, Sub. B, Standards for Electric Utilities.

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1. The Commission has jurisdiction over the parties and subject matter.

2. The Commission has a duty under the Federal Laws to make a determination of a load management technique when requested to do so.

3. The Peak Load Distributor presented by Michael Manning, and Manning Tronics, Inc. is a load limiting device that may be identified as a Load Management Technique [16 U.S.C. 2625 Sec. 115 (c) under the Federal definition.

EVIDENCE AND CONCLUSION FOR FINDING OF FACT NO. 1

Finding of Fact No. 1 is based on Federal Statutes [16 U.S.C. 2622, Sec. 112, Obigationss to Consider and Determine, and 16 U.S.C. 2621, Sec. 111].

EVIDENCE AND CONCLUSION FOR FINDING OF FACT NO. 2

This is statutory and is found in the above Federal Statutes. [16 U.S.C. 2621, Sec. 111 (d) (6)].

EVIDENCE AND CONCLUSION FOR FINDING OF FACT NO. 3

The main issue is whether of not the Peak Load Distributor is a load limiting device that will satisfy the Federal tests set out in 16 U.S.C. 2625, Sec. 115 (c). If so, then 16 U.S.C. 2621, Sec. 111 (d) (6) establishes the device as a " Load Management Technique" and the State regulatory authority (the Florida P.S.C.) will have complied with Federal Laws.

The evidence in support of the Commission finding that the load limiting device called, the Peak Load Distributor, issued under two U.S. Patents Nos. 4,066,913 and 4,163,271 (Exhibit A), is a load management technique seems unquestioned, as it has been found to be in compliance of a load limiting device under the Underwriters Laboratory test for residential load management as well as electrical industrial controls. Both classifications are tests for safety in performing the functions of electrical load limiting (Exhibit B).

In 16 U.S.C. 2602 the definition of a Load Management Technique states, " Any technique to reduce the maximum kilowatt demand on the electric utility, including .... load limiting devices."

The reliability of the Peak Load Distributor is recognized from the large number in the market place (excess of 5,000) for more than 15 years.

THEREFORE: The Florida P.S.C. based on the evidence in the record, should conclude that the Manning Tronic's Peak Load Distributor is a technique when used to limit electrical loads, and that it qualifies for the standard in 16 U.S.C. 2621, Section 111 (d) (6) and 16 U.S.C. 2625, Section 115 (c).

We request the Commission to order. The Florida P.S.C. finds the Peak Load Distributor by this order to be a "technique" when used in an electrical system wherein it limits demand and it will qualify under 16 U.S.C. 2621, Section 111 (d) (6), 16 U.S.C. 2625, Section 115 (c), 47 U.S.C. 8211 (2) (11) (G) AND 42 U.S.C. 8217 (b) (c) as a load management technique with all rights and priviledges therein.

United States Patent [19]
Manning et al.

Exhibit "A"

[11] 4,066,913
[45] Jan. 3, 1978

[54] ELECTRIC LOAD DISTRIBUTOR

[76] Inventors: Michael L. Manning, 155 Lakeforest Drive; Thurman L. Anglin, 31 N. Stratford Drive, both of Athens, Ga. 30601; Richard F. Grayson, Union Church Road, Watkinsville, Ga. 30677

[21] Appl. No.: 706,773

[22] Filed: July 19, 1976

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 611,526, Oct. 7, 1975, abandoned.

[51] Int. Cl.² H02J 3/00
[52] U.S. Cl. 307/38
[58] Field of Search 307/38, 39, 41, 31, 307/35

[56] References Cited

U.S. PATENT DOCUMENTS

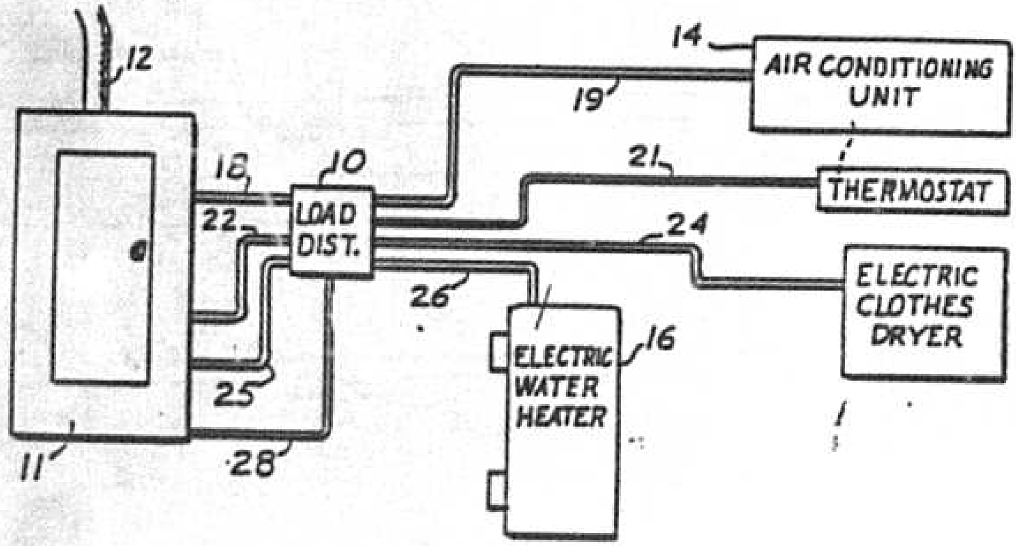
3,629,599	12/1971	Zuckerman	307/38
3,970,861	7/1976	McCollum	307/35

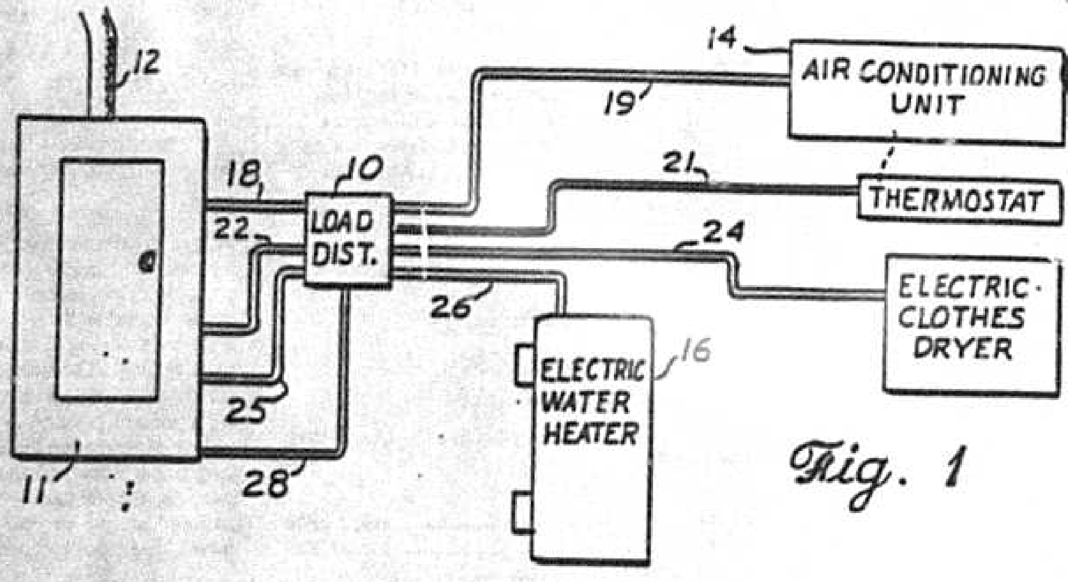
Primary Examiner—Herman J. Hohauser
Attorney, Agent, or Firm—James B. Middleton

[57] ABSTRACT

A load distributor for an electric power system having a plurality of loads, each of the loads having a priority level, the load distributor including a first disabling means operable by a first load having a first priority level for disabling at least one other load having a lower priority level. The load distributor may further include second disabling means operable by a second load having a second priority level for disabling another load having a lower priority level, the second load and other load being some of the aforementioned plurality of loads. A thermostat or other variable device may be included in one or more of the loads for selectively varying the priority level of the load.

10 Claims, 2 Drawing Figures

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AIR CONDITIONING UNIT
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THERMOSTAT
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LOAD DIST.
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ELECTRIC CLOTHES DRYER
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ELECTRIC WATER HEATER
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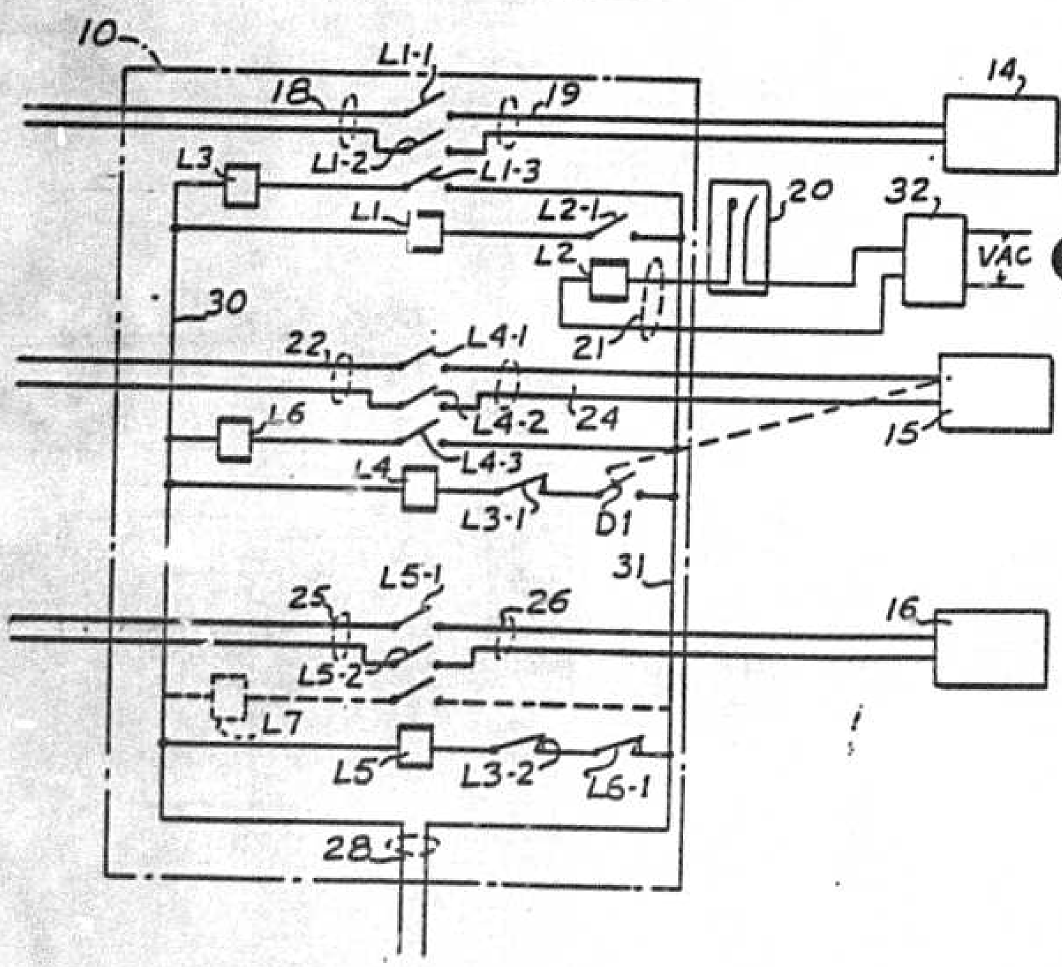
Fig. 1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L3-1
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L5-1
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L5-2
L7
L5
L3-2
L6-1
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Fig. 2

ELECTRIC LOAD DISTRIBUTOR

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of the co-pending application filed Oct. 7, 1975, under Ser. No. 611,526 by the same inventors, and entitled "Electrical Peak Load," now abandoned.

This invention relates generally to power distribution systems, and is more particularly concerned with power distributing means for an electric power user for minimizing the peak power demand.

For a considerable number of years, there has been a trend towards greater use of electrical power in residences. A significant portion of the electrical power used in present-day residences is used for major appliances and devices such as electric heating and cooling, electric water heaters and electric clothes dryers. Though a reasonably large amount of electric power is used in a normal residence for such things as lighting, radio, television and various sound systems, the total amount of power required for all these smaller items tends to be equal to the power required for only one or two of the major items. Thus, use of electrical power to operate a few major appliances or devices creates an extremely large demand for power when two or more are operated at the same time.

The presence of a large power demand by a residence leads to several large expenditures. First, it will be realized that the company supplying the electric power must have sufficient power available to meet the maximum expected demand; however, because of the nature of society, there tend to be periods of several hours in which there is relatively little demand, followed by relatively short periods in which there is exceptionally high demand. As a result, the power company's large capacity is virtually wasted for long periods of time and called into use for only short periods. In addition, it will be realized that if a residence is to have several major electrical appliances, the service drop bringing power to the house must be large enough to carry the maximum current required for all the appliances. Then, the main electrical panel must be similarly large with the attendent large expense. It will therefore be seen that there is an excessive capital expenditure on the part of both the power company and the residence owner in order to be able to supply peak demand for electrical power.

In the past, there have been some efforts to resolve the problem of the peak demand for electrical power. One rather obvious solution is to penalize a user by increasing the charge for electric power in accordance with the power demand. While such a system produces revenue with which the power company can provide the power the system does nothing to prevent the excessive expenditure by both power company and user. Other systems have been devised wherein one monitors the total power used and selectively disconnects certain electrical loads when the demand reaches a predetermined level. When demand decreases, various systems have been utilized for re-connecting loads in accordance with priority of the loads. All of these prior art systems, however, have taken the form of very complex systems, generally including some form of electronic data processing means for storing information, monitoring power use, and making decisions based on the stored information. Such systems are necessarily expensive and tend to be usable only in large groups of dwellings such as in a multiple-dwelling building, or in a community or the like. Also, since there is a central control over a plurality of dwellings, there is little or no opportunity for a person to change the priorities of loads to be in accordance with his own values.

The present invention overcomes the above mentioned and other difficulties with the prior art by providing load distributing means adapted to distribute the electrical load of a single power user. The distributing means of the present invention includes means by which operation of a first load having first priority disables other loads having lower priority. When the load of first priority is not in operation, one of the other loads can be operated and disable other, even lower priority, loads. Additionally, at least one of the loads includes means for altering the level of priority so that the apparatus of the present invention is subject to personal values as to load priorities.

Though the present invention is designed primarily for use by a single user of electrical power, it will be understood that a device made in accordance with the present invention will lower the peak demand of the single user. As a result, if all users of a given power company utilized such apparatus, the peak demand on the power company's facilities would be lowered. Thus, a single user could benefit from use of the present invention through a lower capital expenditure in electrical service to a residence. If the user is on a "demand rate" for his power, he could benefit through lower rates paid for the power. Power companies could benefit significantly from use of the present invention by lowering the investment they must make in power generating plants in that the excessive capacity to meet the peak demands would no longer be necessary.

These and other features and advantages of the present invention will become apparent from consideration of the following specification when taken in conjunction with the accompanying drawings in which:

FIG. 1 is an illustration showing the installation of an electrical load distributor made in accordance with the present invention; and,

FIG. 2 is a schematic diagram showing one embodiment of the electrical load distributor of the present invention.

Referring now more particularly to the drawings, and to that embodiment of the invention here chosen by way of illustration, it will be seen in FIG. 1 of the drawings that the load distributor 10 is connected by appropriate electrical cables to the main electrical panel 11, and the panel 11 is supplied with electrical power through the entrance cable 12.

It will be understood that the distributor 10 can be used to control almost any electrical load from very small appliances and lights to large heating and cooling systems, machinery and the like. By way of illustration, however, three very common major appliances are shown, each of the appliances requiring approximately 4 or 5 kilowatts for its operation. Thus, if all three appliances are used simultaneously, they will have a power demand of 12 to 15 KW, while if they are used one at a time, the demand drops to 4 to 5 KW. Further, for purposes of illustration, it is assumed that the highest priority of use is given to the air conditioning unit 14, with second priority given to the clothes dryer 15 and third priority given to the hot water heater 16. These priorities are given by way of example, but it will be understood by those skilled in the art that the appliances to be controlled and the priorities given to the appliances are variable in each installation and at least somewhat variable after installation.

The panel 11 as here shown is a conventional electrical panel, and includes a plurality of overload protection devices, one such device being installed on each of a plurality of separate circuits. Such a panel would therefore have a plurality of electrical cables extending therefrom for carrying electrical power to various parts of the building, at least one such cable being provided for each circuit. For clarity of illustration, however, most of the cables are omitted, and cables are shown for only the circuits to be described in detail in conjunction with the present invention.

There is a cable 18 extending from the panel 11 and leading to the distributor 10. As will be seen hereinafter, the cable 18 is connected internally of the distributor 10 to a cable 19 which leads to the air conditioning unit 14. Also, a thermostat 20 is here shown, the thermostat 20 having a line 21 that is connected into the distributor 10. As will be discussed in detail below, the distributor 10 is inserted into the circuit to the air conditioning unit 14 to control the circuit. Similarly, a cable 22 is connected through the distributor 10 to a cable 24 which provides power to the clothes dryer 10, and a cable 25 is connected through the distributor 10 to a cable 26 which provides power to the water heater 16. A line 28 is connected between the panel 11 and the distributor 10 for providing power to the electrical control means within the distributor 10.

Attention is now directed to FIG. 2 of the drawings for a detailed discussion of the load distributor 10. The load distributor 10 is indicated by the broken line in FIG. 2, and the various electrical cables 18–28 are shown schematically.

It will be remembered that the air conditioning unit has been assigned to the highest priority in this illustrative example, so the air conditioning unit can receive power any time conditions demand. To achieve this, it will be seen that there is a relay connecting the cable 18 from the panel 11 to the cable 19 supplying the air conditioner 14.

At this point it should be understood that the coil for operating a relay is assigned the letter L followed by a number, e.g., L1, L2, etc. Switches, or relay contacts, are then designated by the coil designation plus a hyphen and a number. Thus L1-1 designates a first switch operated by coil L1, L1-2 designates a second switch operated by coil L1, and so forth. Such designation is frequently used in the electrical arts and should be understood without further elaboration.

Returning to FIG. 2 of the drawings, it will be seen that there is a relay coil L1 having contacts L1-1 and L1-2 connecting the conductors of cable 18 to cable 19. The contacts are shown in their normal condition, so the contacts are normally open. It will therefore be seen that the relay L1 must be energized to close contacts L1-1 and L1-2 in order to operate the air conditioner 14.

The relay coil L1 is connected between two line wires 30 and 31 which comprise the cable 28. The wires 30 and 31 provide the power for operation of the components of the load distributor 10. Thus, the coil L1 is connected to the wire 30, and the other side of the coil L1 is connected to the wire 31 through a relay contact L2-1. The relay coil L2 controls the contact L2-1 so that the relay constitutes disabling means for the relay L1, hence for the air conditioner 14.

Because the air conditioner 14 has been assigned the highest priority, the disabling means operates only when it is determined that the air conditioner 14 does not need to operate. As is conventional, this decision is made by the thermostat 20. The arrangement with the distributor 10 is that the thermostat 20 acts as a control switch to connect the relay coil L2 to the secondary winding of the transformer 32. As is conventional, power would always be supplied to the primary winding so that any time the thermostat 20 closes, the coil L2 will be energized to close contact L2-1. Closing contact L2-1 will place coil L1 across the lines 30 and 31 to energize coil L1 which will in turn close contacts L1-1 and L1-2. As a result, the air conditioner 14 will be operated any time the ambient temperature causes the thermostat 20 to close its contacts.

The control for the air conditioner 14 as here shown is conventional for central air conditioning units. It should also be understood, however, that the other control arrangements could also be used, the important feature being means to operate the disabling means. In the case of other control arrangements, other means could be used to open a switch such as the contact L2-1 to achieve the same result.

Also, it will be noted that the relay L2 is used simply to energize the relay L1. In many practical installations such an arrangement will be necessary due to the power requirement of the relay L1 and the low power available from the transformer 32. Nevertheless, it should be understood that the use of the two relays is only an expedient to meet the exigencies of one common situation, and the omission of relay L2 is well within the scope of the present invention.

Since the air conditioner 14 is first priority, there must be some means for indicating that no other apparatus can use power while the air conditioner is using power. To provide such an indication, the relay L1 has a third contact L1-3 which connects the line 31 to a relay coil L3, the opposite side of L3 being connected to the line 30 so that, on closing of contact L1-3, coil L3 will be energized.

At this point it should be understood that each of the circuits being controlled by the distributor 10 is broken by a set of relay contacts, so that a relay coil must be energized in order to close the circuit and operate any particular appliance. Thus, it will be seen that the cable 22 is connected through a relay L4 to the cable 24, and the cable 25 is connected through a relay L5 to the cable 26.

The coil L4 is connected between the line wires 30 and 31; but, between the coil L4 and the wire 31, there is a pair of switches. One of the switches is designated L3-1, and is a normally closed contact of relay L3. Similarly, the coil L5 is connected between the line wires 30 and 31; but there is a pair of switches between the coil L5 and the line 31. One of these latter switches is designated L3-2, and is another normally closed contact of the relay L3. Since the contacts L3-1 and L3-2 must be closed, or in their normal condition, in order to energize the coils L4 and L5 respectively, it will be seen that energizing the coil L1 thereby closing contact L1-3 prevents operation of either relay L4 or relay L5. It will therefore be seen that disabling means are provided wherein operation of the air conditioner 14 prevents operation of either the dryer or the water heater 16. The only apparatus to stop operation of the air conditioner is the thermostat 20 which controls the relay L2, so the air conditioner 14 will operate in accordance with the ambient temperature.

When the air conditioner 14 is not operating, either of the other two appliances may be used. The dryer 15 is arranged to receive power through relay contacts L4-1 and L4-2 which must be closed by coil L4. To energize coil L4, the contact L3-1 must be closed, which means that relay L1 must be de-energized, and the switch D1 must be closed, the switch D1 being operated by the dryer 15.

Though no particular mechanical operation is here shown for operation of switch D1, it will be understood by those skilled in the art that the switch D1 may be physically located on the dryer 15, or the switch D1 may be a relay contact wherein the relay is energized by means at the dryer 15. Many forms of physical arrangement will suggest themselves to those skilled in the art.

Once the switch D1 is closed by appropriate manipulation at the dryer 15, assuming the contact L3-1 is closed, the coil L4 will be energized closing contacts L4-1 and L4-2 to operate the dryer 15, and contact L4-3 will be closed. The closing of contact L4-3 will place the control voltage across relay coil L6 because one side of L6 is connected to the wire 30, and the other side is connected through contact L4-3 to the wire 31. Energizing coil L6 will operate contact L6-1 which is adjacent to and in series with contact L3-2 and coil L5. Relay L6 therefore serves as the disabling means for relay L5 when the relay L4 is closed and the dryer 15 is operating.

Looking finally at the water heater 16, it will be seen that the circuit to the water heater 16 is broken through relay contacts L5-1 and L5-2, so the coil L5 must be energized to allow operation of the water heater 16. Before the coil L5 can be energized, however, the contact L3-2 must be closed which means relay L1 must be de-energized, and contact L6-1 must be closed which means relay L4 must be de-energized. Thus, the water heater 16 can be disabled by either of the other two appliances.

There is a third contact, L5-2, connected by wires shown in dashed lines to a relay L7 shown in dashed lines. Though the present illustrative embodiment of the invention includes controls for only three appliances, it should be understood that addition of the relay coil L7 as shown in dashed lines would allow the addition of control circuits similar to those here shown. Energizing relay coil L7 would open appropriate disabling contacts in the circuits of ... priority in the same manner as discussed above.

From the foregoing it will be understood that the distributor 10 will be connected into the circuits of each of the appliances or devices to be controlled. Since the air conditioner 14 is here shown as having the highest priority, the relay L1 will be energized any time the thermostat 20 detects a high temperature and closes the switch in the thermostat. Because of this, it will be readily seen that, if a person decide to have less cooling and more clothes drying and/or water heating, the setting on the thermostat can be changed so the demand will be less.

The dryer 15 is operated only when one takes steps to make it operate, such as by closing the switch D1 in whatever manner is chosen. Once the dryer 15 is set to operate, it will have second priority so that the water heater is disabled, but the air conditioner 14 can operate and simultaneously disable the dryer. However, when the air conditioner 14 ceases operation, the switch D1 will remain closed, so closing the contact L3-1 will automatically re-start the dryer 15.

The circuit to the water heater 16 is such that, any time one of the other two appliances is not operating, the circuit to the heater 16 is completed. Since the heater 16 contains its own thermostats, power is provided purely on a priority basis, and the self-contained thermostats control the operation within the allotted time.

It will of course be understood by those skilled in the art that the particular embodiment of the invention here shown is by way of illustration only, and is meant to be in no way restrictive; therefore, numerous changes and modifications may be made, and the full use of equivalents resorted to without departing from the spirit or scope of the invention as defined by the appended claims.

We claim:

1. In an electric distribution system including a panel having a plurality of circuits, a power supply to said panel, and a plurality of loads connected to said plurality of circuits, a first load of said plurality of loads being the only load on a first circuit of said plurality of circuits, and a second load of said plurality of loads being the only load on a second circuit of said plurality of circuits, the improvements comprising a load distributor connected into said first circuit and said second circuit, said load distributor including a first circuit interrupting means for interrupting said first circuit between sad panel and said load, and a second circuit interrupting means for interrupting said second circuit between said panel and said second load, and disabling means for causing said second circuit interrupting means to interrupt said second circuit while said first circuit is completed to said first load, said disabling means including detecting means for determining when said first circuit is completed to said first load, and switch means responsive to said detecting means for interrupting said second circuit.

2. In an electric distribution system as claimed in claim 1, a third load of said plurality of loads being the only load on a third circuit of said plurality of circuits, said improvement further including a third circuit interrupting means for interrupting said third circuit, said disabling means including second switch means responsive to said detecting means to cause said third circuit interrupting means to interrupt said third circuit while said first circuit is completed to said first load.

3. In an electric distribution system as claimed in claim 2, said improvement further including second disabling means, said second disabling means including second detecting means for determining when said second circuit is completed to said second load, and third switch means for causing said third circuit interrupting means to interrupt said third circuit while said second circuit is completed to said second load.

4. In an electric distribution system as claimed in claim 3, said first circuit interrupting means, said second circuit interrupting means, and said third circuit interrupting means comprising first, second and third relay means respectively, having associated switch means, said disabling means comprising fourth relay means having said switch means, said fourth relay means being operable by one of said associated switch means of said first relay means.

5. In an electric distribution system as claimed in claim 4, said second relay means and said third relay

means being connected in series with said associated switch means of said fourth relay means.

6. In an electric distribution system as claimed in claim 4, said second disabling means comprising a fifth relay means having associated switch means, said fifth relay means being operable by said associated switch means of said second relay means.

7. In an electric distribution system as claimed in claim 6, said associated switch means of said fifth relay means being connected in series with said third relay means.

8. In an electric distribution system as claimed in claim 7, said second load and said third load each including switch means for selectively connecting said load into its circuit, said switch means for selectively

connecting said load being between said load distributor and said load.

9. In an electric distribution system as claimed in claim 7, said first load including means for causing intermittent operation of said first load, said means for causing intermittent operation of said first load being operably connected to said first circuit interrupting means for operating said first circuit interrupting means to interrupt said first circuit.

10. In an electric distribution system as claimed in claim 9, said means for causing intermittent operation of said first load comprising a variable thermostat responsive to ambient temperature, relay means operable by said thermostat, said relay means being operably connectd to said first circuit interrupting means.

* * * * *

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Patent, Trademark and Copyright Causes

United States Patent [19]
Sturrock

[11] 4,163,271
[45] Jul. 31, 1979

[54] ELECTRONIC SWITCHING APPARATUS

[75] Inventor: James C. Sturrock, Atlanta, Ga.
[73] Assignee: Michael L. Manning, Athens, Ga.

[21] Appl. No.: 830,089
[22] Filed: Sep. 2, 1977
[51] Int. Cl.[2] H03K 17/00; H03K 17/72
[52] U.S. Cl. .... 361/93; 307/86; 307/252 N
[58] Field of Search .... 307/252 N, 252 J, 252 W, 307/86; 361/35, 93

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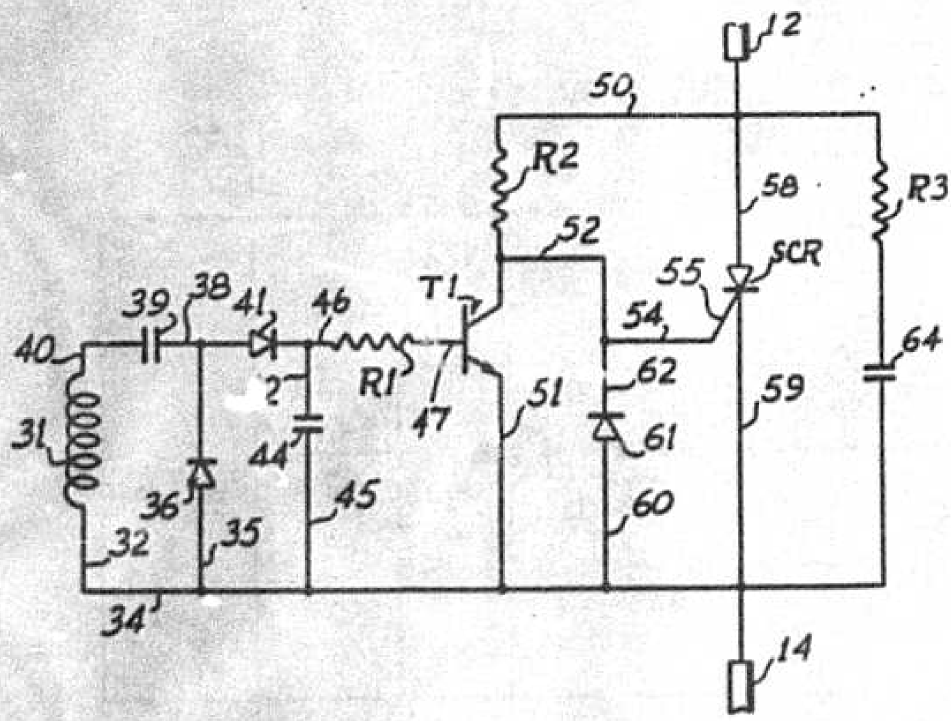
Primary Examiner—John Zazworsky
Attorney, Agent, or Firm—James B. Middleton

[57] ABSTRACT

An electronic switching apparatus comprising an elongate device having an opening in one end thereof for receipt of an electric conductor therethrough, a transformer winding surrounding the opening within the device such that a voltage will be induced in the transformer when a current passes through the conductor, means for detecting the induced voltage and providing a shunt in response to the induced voltage, a path through the device having a controlled rectifier therein, the rectifier having a gate, a circuit connecting the gate to the path for causing the rectifier to conduct, the shunt providing a shunt around the gate to prevent the rectifier from conducting.

3 Claims, 2 Drawing Figures



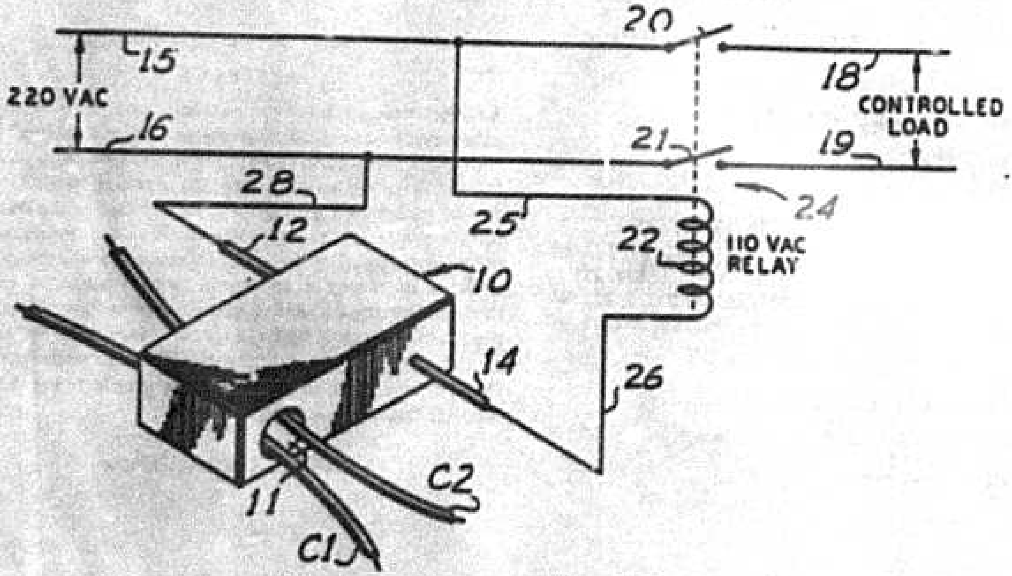

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Fig. 1

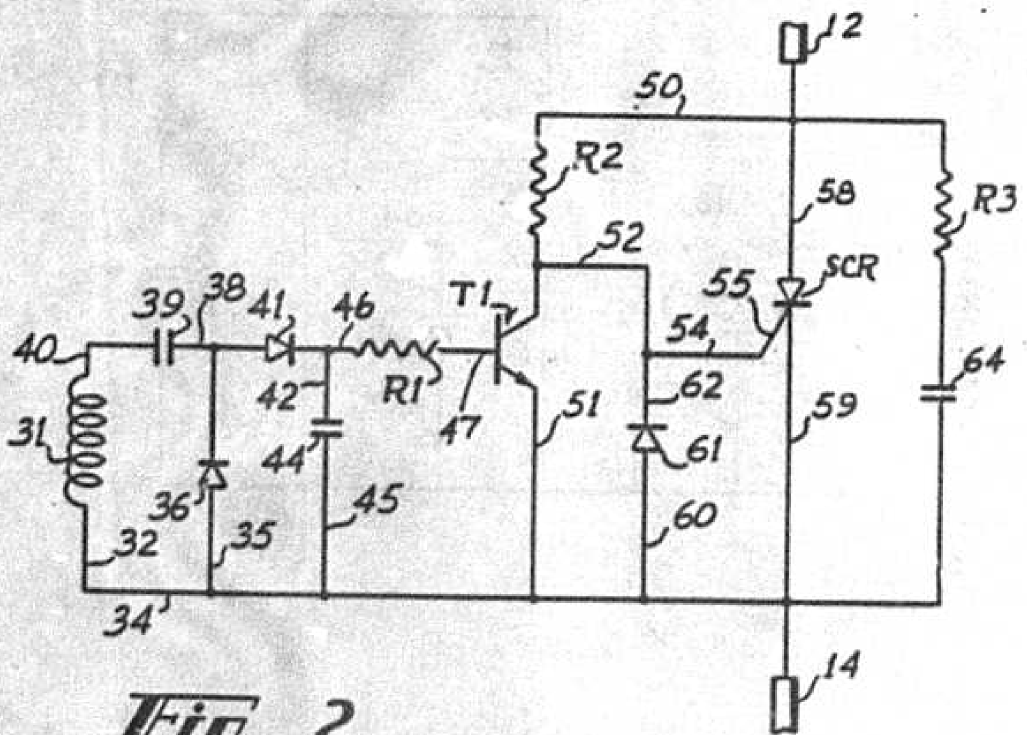
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Fig. 2

ELECTRONIC SWITCHING APPARATUS

This invention relates to electronic switching apparatus, and is more particularly concerned with a switching apparatus wherein the completion or interruption of a circuit is determined by the presence or absence of current in a separate circuit.

There are numerous instances in which one desires to control an electrical load automatically, that is, to supply power to the load or to remove power from the load based on certain conditions. In many instances it is desirable to control one load on the basis of whether or not one or more other loads are energized at the particular time.

In the past, the most frequently used form of sensing means has been a current transformer, which comprises a coil of wire having a large number of turns in the coil. Current passing through a wire, with the wire passing through the center of the coil, induces a voltage in the coil so that the voltage from the current transformer can be used in various ways. However, a current transformer tends to be very large and very heavy because of the great number of turns of wire that are necessary to have a voltage of any usable magnitude induced in the coil, especially when dealing with small currents. This makes the current transformer very unhandy, and difficult to use in many situations. Other forms of sensing devices include the very simple expedient of placing some device in parallel with the switch that operates a load, such that when the load is operating some other device is also operating. While this simple expedient may be effective, it generally requires a large amount of additional wiring since separate wires must be connected between the load to be controlled and the other apparatus that is connected in parallel with the load.

The present invention overcomes the above mentioned and other difficulties with the prior art by providing a switching means which comprises a current sensing means for determining when a current is present, and switch means operable by said current sensing means. The present invention further includes a switch means that is operable for only a half-cycle of an alternating current so that the effective voltage is cut approximately in half. As a result, if the voltage to be controlled is 220 volts A.C., the relay coil or other control means can be designed to operate on the lower voltage of approximately 110 volts without separate voltage sources, transformers or the like. The apparatus made in accordance with the present invention is quite simple and readily lends itself to construction with solid state components so that the entire device can be very small and light weight.

These and other features and advantages of the present invention will become apparent from consideration of the following specification when taken in conjunction with the accompanying drawing in which:

FIG. 1 is a partially pictorial and partially schematic view showing a switching apparatus made in accordance with the present invention and illustrating one form of electrical connection to control an electrical load; and,

FIG. 2 is a schematic circuit diagram showing one embodiment of switching apparatus of the present invention.

Referring now more particularly to the drawing, and to that embodiment of the invention here chosen by way of illustration, it will be seen in FIG. 1 that the device of the present invention is indicated generally by the numeral 10 and includes a generally circular opening 11 in one end thereof, and includes a pair of electrical leads 12 and 14 extending outwardly from the opposite end thereof. The switching device 10 is shown as being substantially rectangular in overall shape, and it should be understood that the device shown in FIG. 1 of the drawing is a housing, or module, which may be of any shape and size desired, or appropriate, to contain the circuitry and other portions of the present invention.

Referring further to FIG. 1 of the drawing it will be seen that a supply voltage is provided on a pair of wires 15 and 16; and, by way of example, the voltage between the wires 15 and 16 is indicated as 220 volts A.C. The wires 15 and 16 lead to the controlled load which is indicated as being connected between wires 18 and 19. It will be understood by those skilled in the art that any thing or device operated electrically could constitute the controlled load without regard to the precise function of the electrical power.

Connected between the wires 15 and 16 and the wires 18 and 19, there is indicated a pair of switches 20 and 21, the switch 20 being between the wires 15 and 18, and the switch 21 being between the wires 16 and 19. As indicated by the broken line, the switches 20 and 21 are ganged for simultaneous operation, and are operated by the coil 22 which is here labeled as a 110 volt A.C. relay coil. It will therefore be understood that the drawing indicates a substantially conventional relay generally designated at 24, the relay comprising the coil 22 with two normally open contacts 20 and 21.

One side of the coil 22 is connected, by means of a wire 25, to the wire 15, while the opposite side of the coil 22 is connected by means of a wire 26 to the wire 14 extending from the device 10. The wire 12 extending from the device 10 connects to a wire 28 which is then connected to the wire 16. As a result, it will be seen that the relay coil 22 is connected in parallel with the 220 volt source indicated by the wires 15 and 16, but the device 10 is interposed in one side of the circuit to act as a switch to control the energization of the coil 22. It will therefore be understood that, when the circuitry of the device 10 creates a conducting path between the wires 12 and 14, the relay coil 22 will be energized; and, when the circuitry of the device 10 does not provide a conducting path between the wires 12 and 14, the relay coil 22 will not be energized.

As will be discussed more fully hereinafter, it will be understood that the wires C1 and C2 indicate two separate circuits which are not shown here in detail; however, so long as no current is flowing in either of the circuits represented by the wires C1 and C2, the device 10 causes the path between the wires 12 and 14 to be an electrically conducting path so that the relay coil 22 is simply placed in parallel with the wires 15 and 16 to cause the coil 22 to be energized. While the relay coil 22 is indicated as being a 110 volt coil and the voltage source indicated by the wires 15 and 16 is indicated as being a 220 volt source, it will be shown hereinafter that the nature of the embodiment of the present invention here shown is such that the effective voltage will be appropriately reduced so that the 110 volt coil will operate properly.

When the relay coil 22 is energized, it will be understood that the switches 20 and 21 will be moved from their normal position as shown, to their transferred position which is closed, thereby placing the controlled load indicated by the wires 18 and 19 in a complete circuit from the wires 15 and 16.

When a current flows through either the wire C1 or the wire C2, the circuitry of the device 10 will detect the current and cause the path between the wires 12 and 14 to stop conducting. This effectively opens the circuits so that the relay coil 22 is no longer energized from the conductors 15 and 16 so that the relay 24 will be de-energized, allowing the switches 20 and 21 to return to their normal position as shown in the drawing, thereby to de-energize the controlled load by removing the voltage from the wires 18 and 19.

It will therefore be seen that the device of the present invention can be very quickly and easily connected into any given circuit to control a load in that circuit; and, one or more conductors, such as a conductor C1 and C2, can be simply passed through the opening 11 to effect the desired control on the controlled load.

Referring now to FIG. 2 of the drawing, it should first be understood that the schematically shown circuit in FIG. 2 of the drawing would be housed within the device 10 shown in FIG. 1 of the drawing; and, the coil 31 shown in FIG. 2 of the drawing would be so located within the device 10 that the conductors C1 and C2 would pass through the coil when they pass through the opening 11. Further, the wires 12 and 14 shown in FIG. 1 of the drawing are represented at 12 and 14 in FIG. 2 of the drawing. With these preliminaries in mind, a detailed description of the circuitry follows.

It should first be mentioned that, when a current flows through a wire or other conductor, a magnetic field is built up around the conductor, the magnetic field being proportional in intensity to the current flowing through the conductor. As a result, a coil of wire can be placed around a conductor; and, when a current flows through a conductor, the build-up of the magnetic field around the conductor will cause the magnetic lines of force to cut the conductors of the coil of wire, thereby inducing a voltage in the coil of wire. As a result, when the current flowing through the conductor is an alternating current, the magnetic field builds up and collapses as the current rises from zero to the maximum value then falls back to zero. With such a fluctuating magnetic field, a coil placed around a conductor carrying an alternating current will have an alternating voltage induced therein, the induced voltage being proportional to the intensity of the current flowing through the conductor and the number of turns of wire in the coil.

With the foregoing in mind, it will be seen that the coil 31 constitutes a means for providing a signal in response to current flowing through a conductor. As the magnetic field builds up around the conductor, a voltage in a first direction will be induced in the coil 31; and, as the magnetic field around the conductor collapses as the current moves towards zero, a voltage will be induced in the coil 31 in the opposite direction. The coil 31 will therefore have an alternating voltage induced therein. When the coil 31 has a first voltage induced therein which causes a current to tend to flow from the coil 31, through the wire 32 and to the bus 34, it will be seen that the current can flow through the wire 35 and through the diode 36 to the opposite bus 38. The bus 38 then has a capacitor 39 connected therein, the capacitor 39 being connected to the opposite side 40 of the coil 31. A complete circuit is therefore provided which will allow current to flow as long as the voltage is present or until the capacitor 39 is fully charged.

When current flows in the opposite direction due to the opposite voltage's being induced in the coil 31, current will flow first to the wire 40, through the capacitor 39 (which will cause discharge of the capacitor 39), then through the bus 38, and through the diode 41 which is connected in the bus 38. Current can then flow through the wire 42 which has a capacitor 44 connected therein, the capacitor 44 being connected by a wire 45 back to the bus 34. It will therefore be seen that, when the opposite voltage is induced in the coil 31, a complete circuit is provided from the wire 40, through the capacitor 39 and through the bus 38, through the diode 41 and through the wires 42 and 45 with their included capacitor 44, thence through the bus 34, the wire 32 and back to the coil 31. Current can flow in this circuit as long as the voltage is present, until the capacitor 44 is fully charged, and/or until the capacitor 39 is fully charged in the opposite direction.

From the foregoing discussion, it will be understood that when a voltage is induced in the coil 31, in either direction, a voltage is applied to the end 46 of the resistor R1.

Looking now at the tabs 12 and 14 where the device would be connected into a circuit as shown in FIG. 1 of the drawing, it will be understood that an alternating voltage is applied between the tabs 12 and 14. This will be understood by reference to FIG. 1 of the drawing where it will be seen that the voltage would be applied from the wire 15, through the wire 25 and the coil 22, then through the wire 26 to the wire, or tab, 14 while the wire 16 is connected through wire 28 directly to the wire, or tab, 12. There will therefore be a voltage across the wires 12 and 14, the voltage being reduced due to the voltage drop across the relay coil 22.

Returning now to FIG. 2 of the drawing, the voltage between the tabs 12 and 14 tends to cause a current to flow from the tab 12, through the wire 50, then through the resistor R2 and to the transistor T1, then from the transistor T1, through the wire 51 and to the bus 34 where the tab 14 is connected. It will be understood that current cannot flow through the circuit described unless the transistor T1 is in a state to be conducting, therefore, the transistor T1 will control the flow of current from the tab 12, through the wire 50 and resistor R2, through the transistor T1, the wire 51 to the bus 34, then to the tab 14.

So long as the transistor T1 is not conducting, it will be understood that the voltage will be applied from the wire 50, through the resistor R2, then through the branch wire 52 which is connected by a wire 54 to the gate 55 of a silicon controlled rectifier indicated at SCR.

Those skilled in the art will understand that, when the appropriate voltage is applied to the gate 55 of the SCR, the SCR will conduct, but in only one direction; therefore, so long as the voltage is applied to the gate 55 of the SCR, there will be a conducting path from the tab 12, through the wire 58, through the SCR then through the wire 59 and to the tab 14; however, there will not be a conducting path from the tab 14 through the SCR to the tab 12 since the SCR will not allow current to pass in the opposite direction.

Returning now to the coil 31, it will be understood that, when a current flows through a conductor so that a voltage is induced in the coil 31, this voltage will be detected by the circuits previously described to place a voltage on the resistor R1. The resistor R1 is connected to the base 47 of the transistor T1. When a voltage is placed on the base of the transistor T1, the emitter-collector circuit will conduct so that the circuit is completed from the wire 50, through the resistor R2 and through the emitter-collector circuit of the transistor T1, then through the wire 51 and to the bus 34. The completion of this circuit shunts the voltage around the gate 55 so that the gate 55 of the SCR has insufficient voltage to trigger the SCR. As a result, the SCR does not conduct and the circuit between the tabs 12 and 14 through the wires 58 and 59 is not completed.

With the foregoing in mind, it should now be understood that, with the device connected into a circuit as shown in FIG. 1 of the drawing, when no current is flowing in the conductor C1 or C2 so that the coil 41 has no voltage induced therein, there will be a zero voltage on the base 47 of the transistor T1 so that the emitter-collector circuit of the transistor T1 will not conduct. The voltage applied from the wire 16, through the tab 12 and through the wire 50, resistor R2 and branch wire 52 and wire 54 will place sufficient potential on the gate 55 of the SCR to cause the SCR to conduct. This results in a complete circuit from the tab 12 through the wire 58, through the SCR then through the wire 59 to the tab 14. It will be understood however that, since the SCR conducts in only one direction, the current through the circuit described will provide a half-wave rectified voltage through the relay coil 22. Those skilled in the art will realize that, when dealing with alternating currents, it is the "effective" voltage that is important in the operation of various devices rather than the maximum voltage, and an alternating voltage that is rectified so that only a half wave is provided yields an effective voltage of about half the effective voltage of either the original alternating voltage or of full-wave rectification. For this reason, the relay or other device can be rated at about half the voltage of the supply voltage indicated on the wires 15 and 16.

When the SCR is conducting, an alternate path is provided for the current flowing in the opposite direction. This alternate path is from the bus 34, through the line 60, through a diode 61, then through the wire 62 which connects to the wire 52, thence to the resistor R2, through the wire 50 and back to the tab 12. IT will therefore be seen that a first complete circuit is provided through the SCR for flow of current in the first direction, and a second circuit is provided through the diode 61 for current flowing in the opposite direction. The diode 61 is of course necessary to prevent the path through the wire 52, the wire 62 and the wire 60 from being a complete shunt around the transistor T1.

Those skilled in the art will further realize that the inherent nature of a silicon controlled rectifier such as that here indicated at SCR is such that when there is no voltage on the gate 55 of the SCR, as soon as the voltage is removed from the wire 58, the SCR will stop conducting. When a silicon controlled rectifier is used with a direct current, this inherent feature causes no problems; however, in the case of an alternating current it must be remembered that the voltage falls to zero twice for each cycle, and this falling to zero is sufficient to cut off the SCR. Also, since the apparatus of the present invention is intended to control all manner of loads, many of which will be highly inductive loads it will be understood that the SCR may inadvertently be turned off simply because of the falling to zero of the alternating voltage and the badly lagging alternating current. To prevent such an inadvertent cutting off of the SCR, there is a resistor R3 connected in series with a capacitor 64, this network being connected between the wires 50 and the bus 34. This network is sufficient to provide a voltage between the wire 50 and the bus 34 to maintain the SCR in its conducting state during the instantaneous removal of potentials.

From the foregoing discussion, it should be understood that the apparatus of the present invention provides a very simple switch means for controlling an electrical load. The switch means for the present invention includes the sensing means for sensing a current in one circuit, the sensing of current in the one circuit being used as the control signal to open the switch means of the device of the present invention so that one device is controlled in response to the operation of another. Since the simple passing of a wire or other conductor through the opening 11 in the device of the present invention is all that is required to connect the device of the invention to the circuit, it is very simple for one or more circuits to act as the master circuit from which another circuit will be controlled.

It will of course be understood by those skilled in the art that the particular embodiment of the invention here chosen is by way of illustration only, and is meant to be in no way restrictive; therefore, numerous changes and modifications may be made, and the full use of equivalents resorted to, without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. In a plurality of electrical circuits wherein a first circuit of said plurality of electrical circuits controls a second circuit of said plurality of electrical circuits, said second circuit having a supply voltage and a load, and switch means for selectively disconnecting said load from said second circuit, first relay means for operating said switch means for selectively disconnecting said load, and switching apparatus for operating said first relay means in response to a current in said first circuit, said switching apparatus being characterized by sensing means for sensing an electric current in said first circuit, said sensing means comprising a coil adjacent to said first circuit for having a voltage induced therein, detecting means for determining when said sensing means senses an electric current in said first circuit, first selective conducting means connected in series with said first relay means for selectively energizing said first relay means, said first selective conducting means including a gate for causing said first selective conducting means to conduct, circuit means connecting said gate to said supply voltage, and second selective conducting means for shunting said supply voltage around said gate in response to said detecting means, and further characterized in that said first relay means is constructed to operate on a voltage of approximately half said supply voltage.

2. Switching apparatus as claimed in claim 1, said first selective conducting means comprising a silicon controlled rectifier for allowing electric current to flow in a first direction therethrough while blocking current flow in a second direction therethrough, said current sensing means comprising a transformer having an opening therethrough for receiving a conductor of said first circuit.

3. Switching apparatus as claimed in claim 2, said opening through said transformer being of such size as to receive a plurality of conductors therethrough for sensing current in a plurality of circuits.

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