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(54) **A SWITCHING CIRCUIT.**

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Description

The invention relates generally to a switching circuit for making and breaking capacitive, inductive and resistive load in an electrical circuit, as disclosed in the introductory part of Claim 1, such a circuit being known from EP-A- 0 146 809.

Electrical switching devices are known in various embodiments, commonly known by the term "relay". Known electromagnetic relays have been available for several years, but they demand a lot of space, energy, and are besides generating electrical noise at making and breaking. Such devices also require a relatively high controlling power, and are thus precluded for a number of tasks, e.g. where the controlling is being done from a computer.

A different kind of electrical switching circuits are based only upon electronics, i.e. making and breaking is being effected without mechanical contacts; on the contrary, semiconductor technology is utilized. These so-called "SSR-relays" ("Solid State Relay") have great heat losses with high loads, especially with inductive loads. They thus need to be cooled, for which reason they are precluded for a number of tasks, in particular for use over a longer period of time.

US Patent specification 4,074,333 discloses a device in which these detrimental features by far are eliminated. Said device operates by means of first making the load using an electronical coupling means, a bidirectionally controlled, contact less switch, whereupon a mechanical relay connects and holds the load circuit. The order of making and breaking is controlled by a dedicated sequence controller. Means are provided for controlling the triac, responsive to signals from the sequence controller through a phase detector. The phase detector is provided to ensure making and breaking at the point in time where the phase angle in the load circuit equals zero (zero-voltage crossing). A signal is fed back from the triac-controller to the sequence controller, which, through the energizing means, provide closing of the electromagnetical relay.

An advantage of the device disclosed in US 4,074 333 compared to directly using an electromechanical relay, lies in the fact that arcs are avoided in making and breaking the load circuit, as said load circuit previous is made by the contactless switch. This implies utilizing the advantages from both kinds of switches, the "SSR"-technology provides a non-arc making, and the electromagnetical relay provides a permanent connection without substantial heat losses.

A disadvantage with the device disclosed in US 4,074,333 is that it comprises a relatively complex circuit including a plurality of relatively complex

circuit elements. If this circuit should be designed according to the description, using existing circuit elements, it would become unreasonably expensive. Furthermore, the device would require a relatively great amount of space, so that the device have to be large and expensive, and thus of less commercial interest.

It is therefore a main object for the present invention to provide switching means for making and breaking various kinds of loads to any AC-circuit, especially in cases where any creation of heat or high-frequency noise in making or breaking is undesired or unacceptable, or where risks exist for explosion. Importance is attached to providing switching means which is compact, simple, reliable and inexpensive in manufacturing. It is a more particular object to improve known switching means, in order to provide switching means being more simple, less expensive, and which require less space.

According to the invention, this can be accomplished with a circuit as stated in the characterizing part of Claim 1. Additional favorable features are disclosed in Claims 2 to 5.

Present invention is in some respect based upon similar principle as the device known from said US Patent specification 4,074,333. However, as opposed to this, the present invention is carried out using a minimum of, and simple elements, a fact which results in the circuit does require a minimum of space. Furthermore, the tolerances are not critical for the function of the circuit. All these factors contribute to a very low cost for the manufactured circuit.

In the following a best mode of using the invention will be described with reference to the accompanying drawing, showing a circuit diagram of a switching circuit according to present invention.

The function of this embodiment is that a control voltage 11 is applied, for controlling making and breaking of the circuit. If AC voltage is to be used, it should be rectified (not shown in the figure). In the presence of the control voltage 11 a current will flow through a diode 12, a resistor 13, and a light-emitting section 14a of an optical coupler. This will in its turn provide triggering of the light-sensitive section 14b. The optical coupler 14a, 14b is of the kind being used to control triacs, and is in addition delaying the making until the phase angle being zero. Optical coupler 14b is connected to the control input of a triac 21, which is capable of making a load 22. Said load can be inductive, capacitive or pure resistive. Provision of voltage to the triac, results in connection of the load.

Simultaneously with the control voltage 11 triggering the triac 21, the same voltage 11 starts generating an electric field in capacitor 18 through

a resistor 17. The capacitor 18 will, together with the resistor 17, form a time-delay circuit (RC-network), which will, in a period of time determined of the selected values of the resistor 17 and capacitor 18, generate a voltage between the base of a transistor 19 and ground, so that the transistor 19 will conduct current through the control coil of a mechanical relay 20a, which shuts a switch 20b of the relay, making the load 22. In utilizing a transistor 19 for amplifying the voltage level of the RC-network 17 and 18, the development of a high charge in the RC-network is rendered redundant, and the capacitor can consequently be of a considerably less capacity.

As the control voltage is triggering triac 21, and starts charging the capacitor 18, the same control voltage also starts charging capacitor 16 through the resistor 15. Resistor 15 and resistor 13 are, together with capacitor 16 forming a time delay circuit. This time delay circuit is utilized in breaking the load connection.

As the control voltage 11 is cut off, the RC-network formed of resistor 15, resistor 13, and capacitor 16, will provide current to optical coupler 14a, 14b in a period of time determined by said RC-network. On the other hand, the transistor 19 will immediately be turned off, opening the electromagnetic relay 20a, 20b. However, connection to the load will be maintained by means of the triac 21 until the control voltage entirely disappears when the capacitor 16 is sufficiently discharged. To have the triac 21 breaking the circuit in zero-voltage crossing, the time constant for the RC-network formed by 13, 15 and 16, should correspond to at least half a period of the load 22. Still, it could be larger, as it is the phase detecting optical coupler observing the breaking being exactly in zero-voltage crossing. This fact implies that a narrow tolerance of the components are not crucial, and it is possible to use inexpensive components to obtain the same result as with more accurate and expensive components.

By using the optical isolator 14a, 14b to make and break the triac 21, it is in addition obtained a galvanic separation between the control circuit 11 and the load 22.

Claims

1. A switching circuit for making and breaking an electrical load (22) by means of an electromagnetic relay (20a and 20b) and a parallel bidirectionally controlled contact less switch (21) to which is connected an optical coupler (14a, 14b), wherein
at making, the bidirectionally controlled contact less switch (21) first will connect the load (22), and after a certain period of time, the

electromagnetic relay (20a) will shut; and

at breaking, the electromagnetic relay (20a) will first open, whereupon the bidirectionally controlled contactless switch (21) will disconnect the load (22) in the first, or a subsequent zero-voltage crossing,

characterized in the optical coupler (14a, 14b) is a phase detecting optical coupler (14a, 14b), having an integrated zero crossing detector, wherein after activation of the light-emitting section (14a), the integrated zero-crossing detector will detect first subsequent zero crossing of the load, so that the light-sensitive section (14b) activates the bidirectionally controlled contactless switch (21) at said first zero-crossing of the load.

2. Circuit according to claim 1,
characterized in a RC-network (17, 18) being connected in parallel to the relay coil to delay energizing of said coil.
3. Circuit according to claim 2,
characterized in the primary coil of the relay (20a) being connected in series with a transistor (19), which amplifies the voltage level from said RC-network (17,18).
4. Circuit according to claim 1,
characterized in a RC-network (13, 15, 16) being connected to delay the de-energizing.
5. Circuit according to claim 4,
characterized by said RC-network (13, 15, 16) has a time constant greater than, or equal to half a period of the load circuit (22).

Patentansprüche

1. Schaltkreis zum Einschalten und Ausschalten einer elektrischen Last (22) mittels eines elektromagnetischen Relais (20a und 20b) und eines parallel geschalteten, bidirektional gesteuerten kontaktlosen Schalters (21), mit dem ein Optokoppler (14a, 14b) verbunden ist, in dem
beim Einschalten der bidirektional gesteuerte kontaktlose Schalter (21) zuerst die Last (22) einschaltet und, nach einer bestimmten Zeitperiode, sich das elektromagnetische Relais (20a) schließt; und
beim Ausschalten sich das elektromagnetische Relais (20a) zuerst öffnet, wonach der bidirektional gesteuerte kontaktlose Schalter (21) die Last (22) beim ersten oder in einem darauf folgenden Nulldurchgang der Spannung ausschaltet,
dadurch **gekennzeichnet**, daß der Optokoppler (14a, 14b) ein phasendetektierender

Optokoppler (14a, 14b) ist, der einen integrierten Nulldurchgangsdetektor aufweist, in dem nach dem Aktivieren des lichtemittierenden Teils (14a) der integrierte Nulldurchgangsdetektor den ersten folgenden Nulldurchgang der Last detektiert, so daß der lichtempfindliche Teil (14b) den bidirektional gesteuerten kontaktlosen Schalter (21) beim erwähnten ersten Nulldurchgang der Last aktiviert.

2. Schaltkreis nach Anspruch 1, **gekennzeichnet** durch ein RC-Glied (17, 18), das zu der Relaiswicklung parallel geschaltet ist zum Verzögern der Erregung der Relaiswicklung.
3. Schaltkreis nach Anspruch 2, dadurch **gekennzeichnet**, daß die Primärwicklung des Relais (20a) in Reihe mit einem Transistor (19) geschaltet ist, der das Spannungsniveau des erwähnten RC-Gliedes (17, 18) verstärkt.
4. Schaltkreis nach Anspruch 1, dadurch **gekennzeichnet**, daß ein RC-Glied (13, 15, 16) zugeschaltet ist zum Verzögern der Ent-Erregung.
5. Schaltkreis nach Anspruch 4, dadurch **gekennzeichnet**, daß das erwähnte RC-Glied (13, 15, 16) eine Zeitkonstante hat größer oder gleich der Hälfte einer Periode des Lastkreises (22).

Revendications

1. Circuit de commutation pour la mise en circuit et la mise hors circuit d'une charge électrique (22) au moyen d'un relais électromagnétique (20a et 20b) et d'un commutateur sans contact (21) commandé dans les deux sens, monté en parallèle, auquel est connecté un coupleur optique (14a, 14b), dans lequel
 - à la mise en circuit, le commutateur sans contact (21) commandé dans les deux sens connecte d'abord la charge (22) et, après une certaine période de temps, le relais électromagnétique (20a) se ferme; et
 - à la mise hors circuit, le relais électromagnétique (20a) s'ouvre d'abord, après quoi le commutateur sans contact (21) commandé dans les deux sens déconnecte la charge (22) au premier passage par zéro de la tension ou à un passage suivant,
 - caractérisé en ce que le coupleur optique (14a, 14b) est un coupleur optique à détection de phase (14a, 14b) comportant un détecteur de passage par zéro intégré, dans lequel,

après activation de la section émettrice de lumière (14a), le détecteur de passage par zéro intégré détecte le premier passage par zéro suivant de la charge, de sorte que la section photosensible (14b) active le commutateur sans contact (21) commandé dans les deux sens audit premier passage par zéro de la charge.

2. Circuit selon la revendication 1, caractérisé en ce qu'un circuit RC (17, 18) est monté en parallèle sur la bobine de relais pour retarder l'excitation de ladite bobine.
3. Circuit selon le revendication 2, caractérisé en ce que la bobine primaire du relais (20a) est montée en série avec un transistor (19) qui amplifie le niveau de tension dudit circuit RC (17, 18).
4. Circuit selon la revendication 1, caractérisé en ce qu'un circuit RC (13, 15, 16) est connecté pour retarder le désexcitation.
5. Circuit selon le revendication 4, caractérisé en ce que ledit circuit RC (13, 15, 16) a une constante de temps supérieure ou égale à la moitié d'une période du circuit de charge (22).

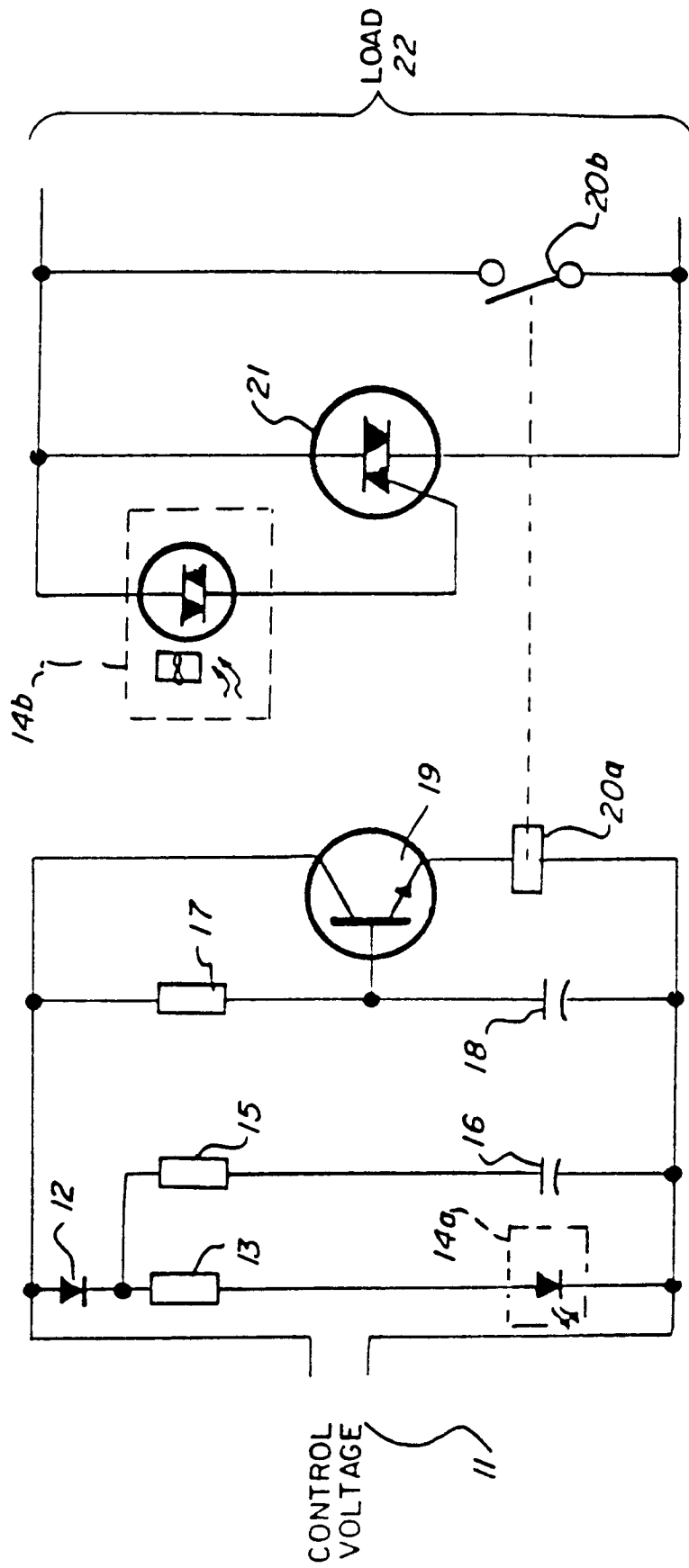


Fig. 1