(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 655 879 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **94308716.3**

(22) Date of filing : **25.11.94**

(51) Int. Cl.^{6} : **H05B 37/02,** G08C 23/04

(30) Priority : **26.11.93 GB 9324381**

(43) Date of publication of application :
31.05.95 Bulletin 95/22

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB IE IT LI LU NL PT SE

(71) Applicant : **Mason, Colin Eric**
'Hewell',
Tunnel Lane,
Orleton
Nr. Ludlow, Shropshire SY8 4HY (GB)

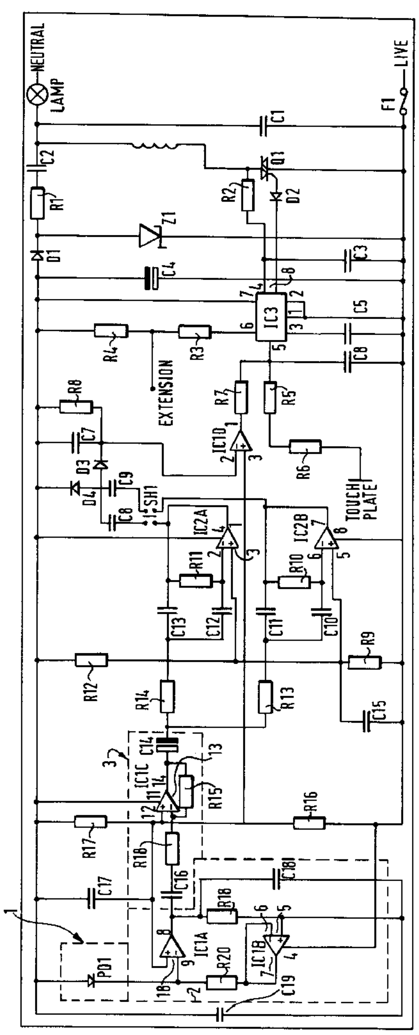
(72) Inventor : **Mason, Colin Eric**
Hewell,
Tunnel Lane
Orleton, Nr. Ludlow, Shropshire SZ8 4 HY (GB)
Inventor : **Day, Alan Brian**
142 The Hobbins
Bridgnorth, Shropshire WV15 5HH (GB)

(74) Representative : **Topley, Paul**
G.F. Redfern & Co.
Redfern House
149/151 Tarring Road
Worthing West Sussex BN11 4HE (GB)

(54) **Electrical lighting control.**

(57) There is described a remote control system for electrical appliances, comprising a control transmitter capable of emitting a plurality of differing control signals, and a number of control receivers wherein each control receiver can discriminate between the control signals and responds only to one of the control signals. In a preferred control receiver, a sensing device (1) provides a first output signal dependant on a control signal incident on the sensing device, the first output signal is fed to a plurality of band-pass filters (4,5) each of which is arranged to provide a second output signal when the first output signal has a signal parameter within a respective predetermined range, the second output signal from one of the band-pass filters (4,5) is selected in a selector device (6) and the selected second output signal is compared with a reference signal in a comparator device (8), and a third output signal generated by the comparator device (8) in dependance on the relative values of the second output signal and the reference signal is applied to an integrated circuit current control element (9,11).

Fig.2.



EP 0 655 879 A1

Jouve, 18, rue Saint-Denis, 75001 PARIS

The present invention relates to electrical installations, and is particularly concerned with remotely-controlled switching of electrical loads.

Dimmer switches for domestic lighting installations are well known, and are conventionally controlled either by potentiometers or by touch plate sensors wherein an integrated circuit controls the current supplied to the lighting apparatus in response to input signals from a capacitive touch plate. It is also known, for example from UK Patent 2,230,367, to control electrical loads by means of remote control transmitters using radio, infra-red, ultrasonic or microwave transmission methods.

A disadvantage of some conventional infra-red controlled lighting switches is that the usual wiring installation available at the switch location does not include a separate neutral line, and thus a conventional digital encoding device may not be used due to the difficulty in providing a suitably strong and stable power supply from the available wiring. Proprietary encoding devices generally include preamplifiers which require substantial current, and the signal to noise ratio is such as to render the coded signals indecipherable.

The present invention seeks to provide an infra-red control system for incandescent lighting or other electrical appliances having low power resistive loads, particularly in a domestic environment, wherein the control transmitter will emit a plurality of differing control signals, and wherein each control receiver can discriminate between such control signals and can respond only to a particular one of the control signals.

It is also an object of the present invention to provide an infra-red lighting switch of compact size which may be installed in a conventionally-wired lighting switch location without the need for the provision of additional wiring, particularly avoiding the need for a separate neutral line.

A further object of the present invention is to provide a control circuit for an infra-red lighting control switch which avoids the use of metallic screening in the receiving circuitry, thus reducing cost in materials and manufacture. A further objective of the present invention is to provide a controller for interior or exterior lighting, or for any other electrical load, which operates using a limited power supply having high noise content and avoids cross-talk between channels without the use of expensive screening.

According to a first aspect of the present invention, there is provided an infra-red remote control system for electrical appliances, comprising a control transmitter capable of emitting a plurality of differing control signals, and a number of control receivers wherein each control receiver can discriminate between the control signals and responds only to one of the control signals.

According to a second aspect of the present invention, there is provided a control receiver for an infra-red remote control system wherein a sensing device provides a first output signal dependant on the control signal falling on the sensing device, the first output signal is fed to a plurality of band-pass filters each of which is arranged to provide a second output signal when the first output signal has a signal parameter within a respective predetermined range, the second output signal from one of the band-pass filters is selected in a selector device and the selected second output signal is compared with a reference signal in a comparator device, and a third output signal generated by the comparator device in dependance on the relative values of the second output signal and the reference signal is applied to an integrated circuit current control element.

Preferably, the current supply for the control receiver is taken in parallel with the main current control element, via a series combination of a capacitor, a resistor and a diode.

An embodiment of the present invention will now be described in detail, with reference to the accompanying drawings, in which:

Figure 1 is a schematic block diagram of the infra-red receiver and touch plate controller for a lighting installation;

Figure 2 is a detailed circuit diagram of the receiver and touch plate controller shown in Figure 1;

Figure 3 is a circuit diagram of the controlling transmitter; and

Figure 4 is a circuit diagram of additional circuitry used in combination with the circuit of Figure 2 to provide an additional touch plate and infra-red control for a remotely located switch.

Referring now to Figures 1 and 2, the receiving circuit comprises a detector 1, which in this case is an infra-red photodiode. The detector 1 emits a signal to a pre-amplifier 2, which in turn boosts the signal and applies it to a second amplification stage 3.

The output of the second amplification stage 3 is fed to the inputs of two band-pass filters 4 and 5, whose outputs are fed to a channel selector 6. The channel selector 6 is set to transmit the signal from one of the band-pass filters to a comparator 8 via an integrator 7.

In the comparator 8, if the output voltage of the integrator 7 for the selected band-pass filter is greater when compared with the reference voltage taken at the junction between resistors R16 and R17, then an inverted output is made to the digital phase controller 9, the output being applied so as to simulate the operation of a touch plate 10 which is conventionally connected to such a digital phase controller. The digital phase controller in turn operates a switching element 11, preferably a triac, which controls the current flowing in the lighting circuit.

As can be seen in Figure 2, the detector 1 is an infra-red photodiode and the amplification circuits 2 and 3 provide inputs to the resistors R14 and R13 of two band-pass filter arrangements. By adjusting the values of the capacitors C13, C12, C11, C10 and resistors R11, R10, respectively of the band-pass filter arrangements, the signal frequencies passed by these filters are adjusted.

As can be seen from Figure 2, the output of one of the band-pass filters is selected by manually setting the switch SW1 prior to installation of the controller. Clearly, the switch SW1 may have more than two positions to allow selection of one channel from a plurality of possible channels, each of which will have its associated band-pass filter whose frequency has been preselected. As an alternative to a selector switch, the output of one of the band-pass filters may be selected by providing a plurality of selector input contacts each connected to a band-pass filter, and a selector output contact connected to an input of the comparator, selection of a band-pass filter being made by connecting the output contact to one of the input contacts by a permanent or temporary connection.

The output of the selected band-pass filter is then fed to an integrator 7, which is a rectification and smoothing stage composed of diodes D3, D4, capacitor C7 and resistor R8. This then feeds the signal to the input side of the comparator formed by integrated circuit IC1D and resistor R7. The other input to the comparator is taken from the second stage amplifier 3.

The digital phase controller IC3 is an integrated circuit (LS7232 or 7237 or 7338) which is specifically designed for brightness control or on/off control of incandescent lamps on an AC supply.

The output controls the brightness of a lamp by controlling the firing angle of a triac 11 connected in series with the lamp. All internal timings are synchronised with the line frequency by means of a built-in phase locked loop circuit. The output occurs once every half cycle of the line frequency. Within the half cycle, the output can be positioned anywhere between 159° phase angle for maximum brightness and 41° phase angle for minimum brightness in relation to the line frequency. The positioning of the output is controlled by applying a low level at the sensor input.

The integrated circuit IC3 is a conventional arrangement, which is usually operated by connecting a touch plate such as is shown at 10 in the Figures to its sense input terminal E. If an integrated circuit of the 7232 type is used, the conventional operation of the controller, by means of a touch plate, is such that if the touch plate is momentarily touched by an operator for a period of between 50ms to 400ms, the integrated circuit IC3 controls the triac 11 so as to 'toggle' the power supplied to the lamp. In other words, if the lamp is on and the touch plate is touched, then the lamp is turned off. If the lamp is off, touching the touch plate for a short time will turn the lamp on, the brightness of the lamp being that which was previously obtained before the lamp was last turned off.

If the sensor plate is touched, or the infra-red control is activated, for a prolonged time, typically more than 400ms, the integrated circuit IC3 controls the phase angle at which the triac is fired so as to change the light intensity emanating from the lamp. The phase angle is continually changed as long as contact with the touch plate is maintained, and whenever a maximum or minimum brightness is achieved the direction of change reverses.

If the integrated circuit IC3 is a 7237 type, then repeated operations of the IR control or repeated touches of the touch plate will result in the output being varied cyclically between a plurality of preset output levels as the firing angle of the triac is set to succeeding ones of a series of preset angles. Typically, five preset levels are provided by the 7237 integrated circuit if pin B of IC3 is unconnected, but this number of presets may be reduced to two to provide a simple on/off action, by connecting pin B of IC3 to the positive rail P1.

If the integrated circuit IC3 is a 7338 type, then repeated operations of the IR control or touches of the touch plate will result in the output being varied cyclically between a three preset output states; in the first, the triac is not triggered and the lamp is 'off'. In the second, the triac is triggered at a phase angle of 159°, and the lamp is 'on'. A further touch on the touch plate shifts the output to the third state, causing an immediate change of the triac firing angle to 107°, with a perceptible reduction of approximately 30% in lamp brightness, and subsequently the firing angle of the triac is reduced to 41° over a fixed period of approximately 250 seconds and is then turned off, so that the lamp dims gradually and finally extinguishes.

To rationalise production of the various circuits described above, the integrated circuit IC3 is preferably mounted to the circuit board by means of a DIL socket, rather than being directly soldered to the board. This allows the boards to be assembled without the integrated circuit IC3, and the appropriate chip for each individual device can be inserted in the DIL socket.

The transmitter seen in Figure 3 comprises a pair of light emitting diodes LD1 and LD2, the current supply to which is controlled by a transistor Q1 which in turn is operated by an integrated circuit IC1. The arrangement of the transmitter circuit is such that when one of the transmit switches TS1 or TS2 is operated, the integrated circuit IC1 controls the transistor Q1 to provide an intermittent current to the infra-red light emitting diodes LD1 and LD2, thus producing a pulsed radiation therefrom. The arrangement of the capacitors C2 and C3 and the resistors R3, R4 in the circuitry will determine the frequency of the pulsed radiation, the arrangement being such that operation of switch TS1 gives rise to radiation with a first pulse frequency and operation of switch TS2 gives rise to radiation of a second frequency. These frequencies are arranged to be within the frequency ranges of respective ones of the band-pass filters in the receiving circuitry.

It will readily be understood that, while the transmitter is capable of transmitting infra-red pulses at two specific frequencies, each of the receiving circuits illustrated in Figure 2 will be responsive only to radiation of one frequency, due to the selection using switch SW1 of a particular band-pass filter arrangement, either that constituted by resistors R11 and R14, capacitors C13 and C12, and integrated circuit IC2A, or that constituted by resistors R10 and R13, capacitors C11, C10, and integrated circuit IC2B shown in Figure 2. It will therefore be possible to control two such dimming circuits independently, even if their receivers are placed in such proximity that radiation from the transmitter will fall on both the receivers simultaneously.

In an alternative embodiment, it has been found that if two or more band-pass filters are linked to respective lighting control chips, then a single infra-red detecting circuit can control a plurality of lights independently of each other.

Referring again to the transmitter circuit, in the preferred embodiment shown in Figure 3, the transmitter comprises a timer IC1 configured as an astable multivibrator, the mark space ratio of which is approximately 1:11 set via resistor network R3 and R4 such that when in operation the output at pin 3 is low for 8% of the time. This output is used to drive PNP transistor Q1 which provides high current pulses to the infra-red emitter diodes LD1 and LD2.

The switching frequency (pulse rate) is determined by capacitors C2 and/or C3 which are connected in common to pins 2 and 6 of IC1 and are brought into circuit by channel control button TS1 via blocking diode D1 or channel control button TS2. Further channels can be provided by extending the number and value of capacitors brought into circuit by the utilisation of additional switches and blocking diodes. In addition these capacitors may be paralleled by a further capacitor brought into circuit by a switch, for example a mercury switch operated by the orientation of the transmitter module, thus increasing the number of available channels by a factor of two. When a channel control button is pressed IC1 oscillates at the predetermined frequency for that channel, and switches Q1 on and off developing high current pulses across LD1 and LD2. The off time of the IR diodes is shorter by a factor of 11 than the on time and thus battery consumption is kept low, typically 27 mA average, and power dissipation with a low duty cycle is good.

In the embodiment shown in Figure 2, the receiver comprises a photodiode detector 1, which is preferably a high speed PIN photodiode with high photosensitivity housed in a black infra-red transmissive moulding which reduces ambient white light interference.

This is connected to a pre-amplifier 2, constituted by IC1A and IC1C. When photodiode 1 receives infra-red pulses they are amplified by IC1A. The operating point for the photodiode is stabilised by offset IC1B to compensate for changes in ambient light levels which would present themselves as a DC component of the IR photodiode current. The output of IC1A is fed to IC1C via capacitor C16 which controls the frequency response between the two stages, the value being selected to produce a low frequency cut off. This in conjunction with C8 and C9 on the output side of the band-pass filers 4, 5, ensures that no low frequency interference in the 50/100Hz ranges gets through to the rectification stage.

The output of second stage pre-amplifier IC1C is fed via C14, R13, R14 to band-pass filters 4 and 5, constituted by IC2A and IC2B. These are set to specific individual frequencies, with each band-pass filter corresponding to the unique frequency rate of a specific channel. The output of one of the band-pass filters 4, 5 is selected by the position of switch SW1 and is fed through capacitors C8 or C9 respectively to remove harmonics of the specific frequencies and thence is applied to the rectification and smoothing stage, constituted by diodes D4, D3, and capacitors C7, R8.

The output of this circuitry is fed to a comparator 8, constituted by IC1D which inverts and ensures full rail voltage swing on its output. If the voltage on PIN 2 of IC1D exceeds that at the junction of R16 and R17 then the output of IC1D switches negative, thus via the resistor R7 the negative voltage is applied to pin E of IC3, the digital phase controller. Alternatively, if the output side of R7 is fed to capacitor C20 and a resistor R4 links pin E of IC3 to the positive rail P1, then a pulse input is fed to pin E of IC3 when the output of IC1D switches negative. The time constant for this pulse input is set by the values of capacitor C20 and resistor R4.

In conventional digital phase controllers of the type used in IC3, a timer circuit may be connected to PIN 2 of the integrated circuit chip, which will then enable the controller IC3 to fade down the current flowing through the lamp circuit at a predetermined rate until a zero lamp current is reached. This feature is useful as a night-light for children, since it can be set gradually to darken a child's bedroom at a predetermined rate as the child falls asleep. Clearly such a timer circuit could be incorporated in the controller shown in Figure 2, to enable this function to be incorporated in the remote controlled dimmer switch.

In Figure 4 the additional circuitry to provide a second touch plate (2) with infra-red control is seen. A first switch having the circuit of Figure 2 is provided, and a second switch which can also control the digital phase controller of the first switch has similar circuitry with the addition of the circuit of Figure 4. In the second switch, capacitor C8 is connected between output pin 1 of IC2A and the junction of diodes D5 and D7, and the 'EXTN OUT' is led to the 'EXTENSION IN' position of the circuit of the first switch. P2 is connected to the positive supply of the first switch. Either infra-red or touch sensing at the second switch then produces an input at pin F (the 'slave' input) of IC3 of the first switch, and the lamp is thus controllable from two locations.

The use of the circuitry of the present invention allows the sensitivity of a capacitive touch plate in an infra-red controllable circuit to be increased far beyond that which is possible using the conventional techniques. Thus, rather than having actually to touch the metallic capacitance plate, it is possible to provide a dielectric between the metallic touch plate and the user but still enable the capacitive touch plate to operate. This facility has led to the possibility of applying a transparent plastics cover to the touch plate, beneath which cover may be positioned a decorative panel to enhance the appearance of the switch and reduce its intrusion into the room decor. Clearly, an opening in the decorative panel must be left for the transmission of infra-red light to the sensor. Alternatively the metallic plate may be left visible through a transparent cover. The structure of such a cover may provide concealment for fixing screws fastening the control unit to a wall box, with the cover snap-fitted to the control unit after its mounting to the wall.

Claims

1. An infra-red remote control system for electrical appliances, comprising a control transmitter capable of emitting a plurality of differing control signals, and a number of control receivers wherein each control receiver can discriminate between the control signals and responds only to one of the control signals.

2. A control receiver for an infra-red remote control system wherein an infra-red sensing device provides a first output signal dependant on a control signal incident on the sensing device, the first output signal is fed to a plurality of band-pass filters each of which is arranged to provide a second output signal when the first output signal has a signal parameter within a respective predetermined range, the second output signal from one of the band-pass filters is selected in a selector device and the selected second output signal is compared with a reference voltage in a comparator device, and a third output signal generated by the comparator device in dependance on the relative values of the second output signal voltage and the reference voltage is applied to an integrated circuit current control element.

3. A control receiver for an infra-red remote control system according to claim 2, wherein the control signal is a series of pulses of infra-red radiation of a predetermined frequency, and the sensing device is an infra-red photodiode, and wherein the signal parameter to which the band-pass filters are sensitive is the pulse frequency.

4. A control receiver for an infra-red remote control system according to claim 3, wherein the output signal from the band-pass filter is rectified and smoothed through an integrator before it is fed to the comparator device.

5. A control receiver for an infra-red remote control system according to claim 4, wherein the selector device has a respective input contact connected to each band-pass filter, and an output contact connected to an input of the comparator, selection of a band-pass filter being made by connecting the output contact to one of the input contacts.

6. A control receiver for an infra-red remote control system according to claim 4, wherein each band-pass filter is directly connected via a respective integrator to a respective comparator.

7. A control receiver for an infra-red remote control system according to claim 6, wherein the output of the integrator of one of the band-pass filters is fed via a switching transistor to an integrated circuit current control element at a remote location.

8. A control receiver for an infra-red remote control system according to any preceding claim, wherein the receiver is housed in a conventional switch housing and has a metallic touch plate on an accessible surface, the metallic touch plate being covered by a transparent plastics cover.

9. A control receiver according to claim 8, wherein a decorative sheet is placed between the metallic touch plate and the transparent plastics cover, the decorative sheet having an opening located in alignment with the infra-red sensing device.

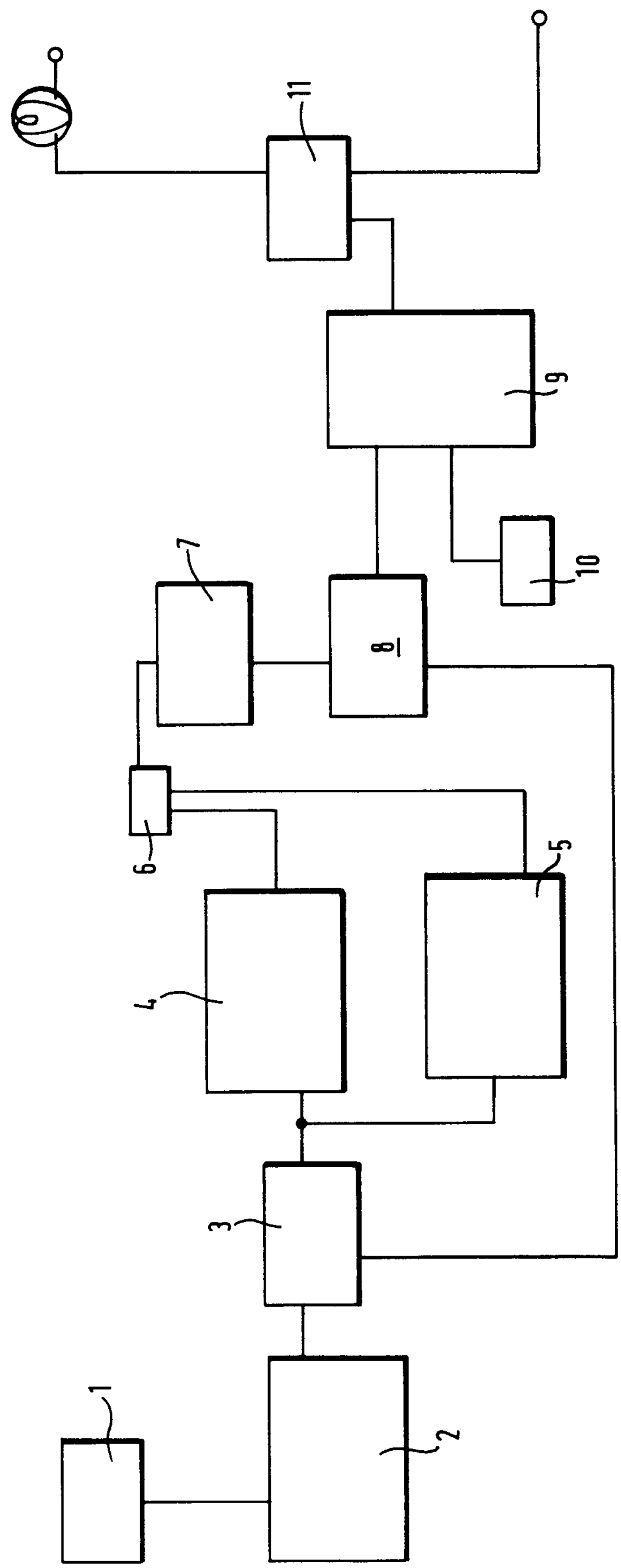


Fig.1.

Fig.2.

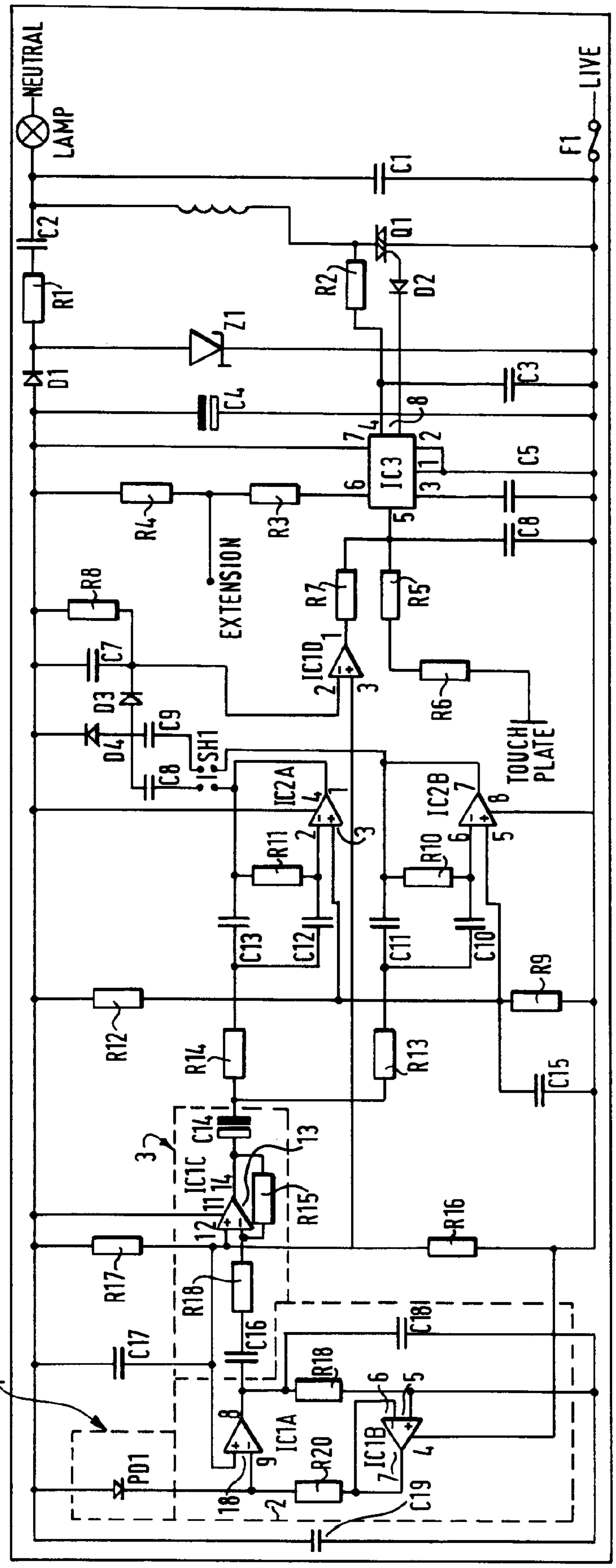
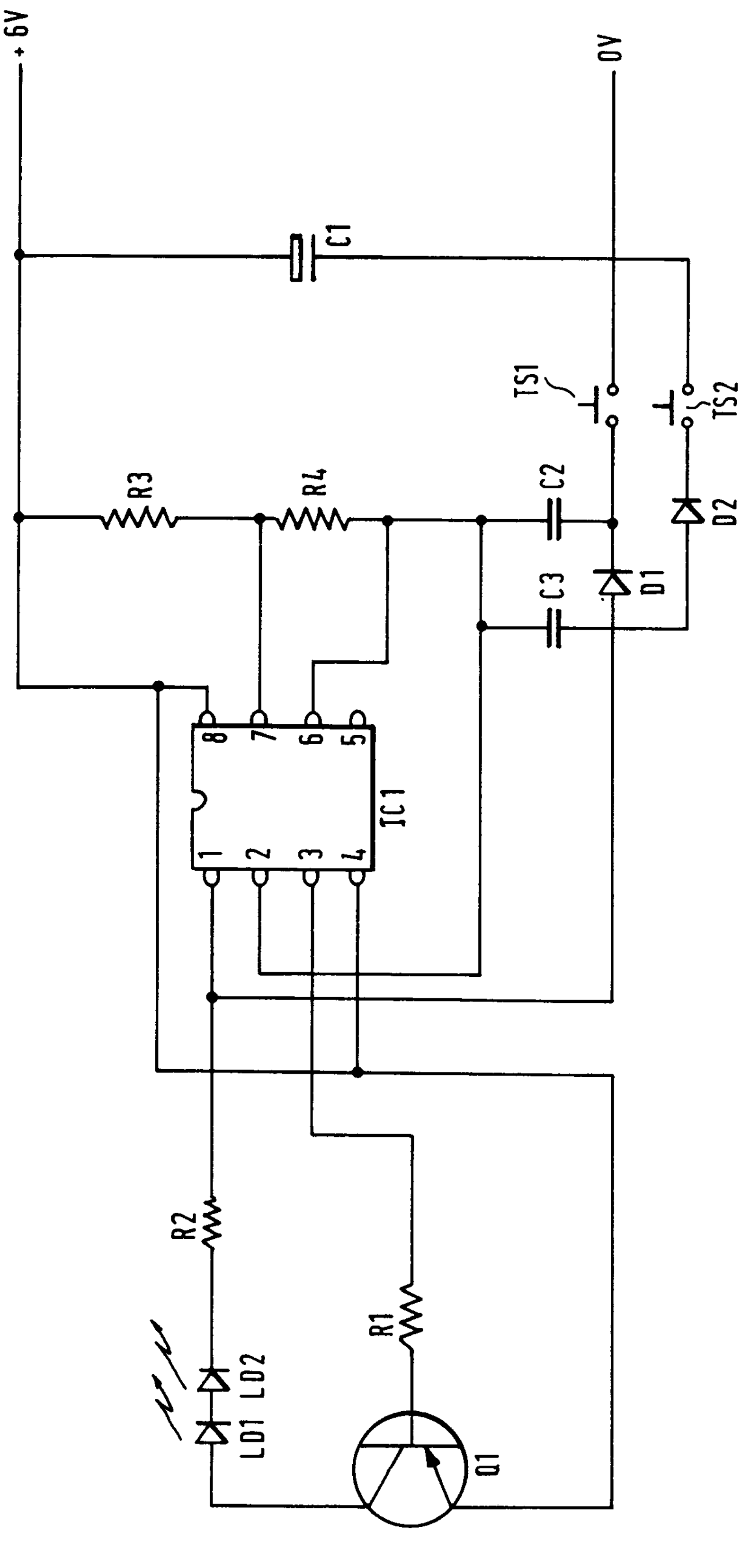

NEUTRAL
LAMP
LIVE
F1
C1
C2
Q1
R1
R2
D2
Z1
D1
C3
C4
IC3
C5
R4
R3
C8
EXTENSION
R8
C7
D3
D4
C9
SH1
R7
R5
IC1D
R6
TOUCH PLATE
IC2A
IC2B
R11
R10
C13
C12
C11
C10
R12
R9
R14
R13
C15
C14
IC1C
R15
R16
R17
R18
C16
C17
C18
IC1A
IC1B
R20
PD1
C19

Fig. 3.



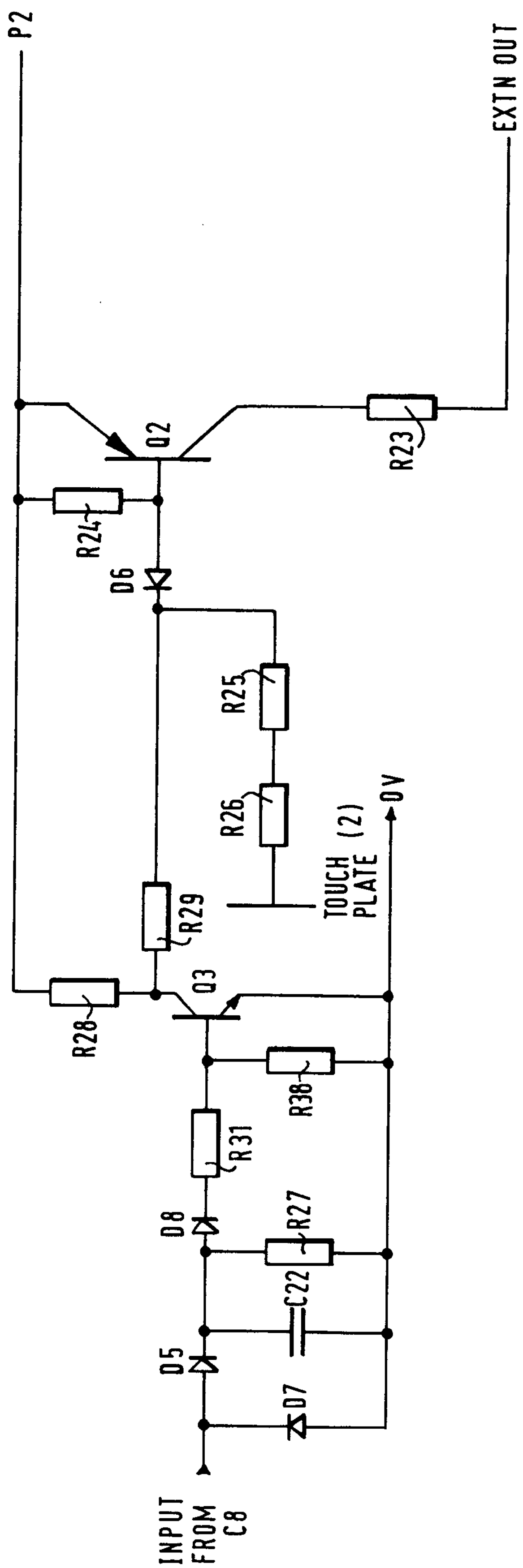

P2
EXTN OUT
Q2
R23
R24
D6
R25
R26
TOUCH (2)
PLATE
0V
R29
Q3
R28
R38
R31
D8
R27
C22
D5
D7
INPUT
FROM
C8

Fig.4.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 8716

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	EP-A-0 031 874 (VOLL) * abstract; figures 1-5 *	1 2-4	H05B37/02 G08C23/04
X A	DE-A-40 09 363 (SCHÄLE) * column 1, line 60 - column 2, line 7; figures 1,2 *	1 2,3	
X A	US-A-3 924 120 (COX) * abstract; figures 1,3 *	1 2,3	
X	GB-A-2 149 947 (STEPHENSON) * page 2, line 3 - page 2, line 98; figures 1,2 *	1	
A	WO-A-92 01968 (LEON) * abstract; figures 1,3 *	8,9	
A	EP-A-0 493 986 (GOLDSTAR) * figure 4 *	2-5	
A	ELECTRONIQUE RADIO PLANS, no.541, December 1992, PARIS FR pages 23 - 30 DUCOURET 'Système domotique télécommandé avec sonorisation' * figure 6 *	2-6	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H05B G08C H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 February 1995	Speiser, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document