

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G08B 1/08, 7/06	A1	(11) International Publication Number: WO 96/02902 (43) International Publication Date: 1 February 1996 (01.02.96)
(21) International Application Number: PCT/GB95/01660 (22) International Filing Date: 13 July 1995 (13.07.95) (30) Priority Data: 9414367.4 14 July 1994 (14.07.94) GB (71)(72) Applicant and Inventor: MARVELLY, John, Dunstan [NZ/GB]; 2 Brynlllys Uchaf, Henlllys, Manafon, Welshpool SY21 8BJ (GB). (74) Agents: NEWELL, William, Joseph et al.; Wynne-Jones, Laine & James, 22 Rodney Road, Cheltenham, Gloucestershire GL50 1JJ (GB).		(81) Designated States: GB, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>
(54) Title: EMERGENCY CONTROL APPARATUS (57) Abstract A smoke alarm activated switch discriminates the characteristic high pitched pulsed sound of a smoke alarm and switches or controls mains power accordingly. The switch is powered from the mains and may be incorporated in a wide range of equipment such as conventional switches, sockets, timers, dimmers, etc. The switch may discriminate on the basis of one or more of frequency, pulse repetition rate, pulse duration, and the mark/space ratio of the sound from a smoke alarm.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

Emergency Control Apparatus

This invention relates to emergency control apparatus and in particular, but not exclusively, to such apparatus for use in conjunction with smoke and fire alarms which emit
5 an audible alarm.

Many households and other premises are fitted with smoke alarms which include ionisation or photosensitive detectors which trigger an audible alarm when smoke is detected. These alarms may include escape or warning lights
10 integral with the alarm but these are battery-operated and do not generate a large amount of light. Further the light they do project is local to the smoke alarm. Moreover, the smoke alarms with integral lights are larger and visually more obtrusive than smoke alarms without such lights, partly
15 because of the window and light reflector. Smoke alarms may also be interlinked by wires to form a network of two or more alarms, in which a smoke alarm detecting smoke triggers the other alarms in the network too.

I have identified a need for a system in which slave
20 units respond discriminatively to the characteristic sound of a smoke alarm to switch or otherwise control other equipment, such as the mains lighting, so that a relatively inexpensive smoke alarm can act as a master unit which controls slave units by an acoustic signal.

25 Accordingly, in one aspect, this invention provides control apparatus responsive to the characteristic sound emitted by a smoke alarm or the like to switch a power supply or otherwise control a further item of equipment.

The term "sound" is to be construed broadly as including acoustic and vibrational energy. The sound may be any distinctive sound emitted by such alarms, such as the high-pitched regularly spaced pulsed "beeps" emitted by a piezo electric sounder. Here the frequency emitted (i.e. the resonant frequency of the sounder) and the duration and repetition of the pulses, are all well defined. However, it will be appreciated that the characteristic sound may emanate from different types of sounder, or be continuous and possibly of varying frequency.

In a preferred aspect, the control apparatus includes transducer means for detecting the sound emitted by a smoke alarm and providing a transducer signal, and control means responsive to said transducer signal to switch or otherwise control said further item of equipment.

The transducer means may be a microphone or other acoustic or vibrational pick-up.

The control means preferably responds to at least one of the frequency, the pulse repetition rate, the pulse duration, and the mark/space ratio of the transducer signal. The control means preferably sets upper and lower limits for the pulse repetition rate of the transducer signal to define an envelope outside which said control means does not respond.

In one arrangement, the control means includes phase locked loop means which receives the transducer signal and outputs a signal when the transducer signal is within a preset frequency band thus discriminating against acoustic

sources outside the correct capture frequency range.

In this one arrangement the control means preferably includes duty cycle discrimination means operable to reject the low duty cycle pulse train signal from the phase locked
5 loop means which occurs before the phase locked loop means has locked properly onto the transducer signal.

The control means preferably includes means responsive to a "true" signal from the discriminator means to accumulate a charge or increment value in a store, the
10 control means being caused to be activated to switch or otherwise control the further item of equipment when said stored charge or value exceeds a pre-set level. Preferably, said store includes means allowing decay of said charge or decrementing of said value with time, so that activation of
15 said control means occurs only when the detector sound source has a pulse repetition rate greater than a preset minimum. Further, the phase locked loop means is preferably selected such that it does not lock on to a sound within the capture frequency range if the pulse repetition rate is
20 higher than a maximum rate.

The control means preferably includes a monostable circuit which is triggered when the charge or value in said store exceeds said preset level and remains set for a preset time. The output from said monostable circuit preferably
25 controls a switch means, such as a triac, for switching said further item of equipment, although any other suitable form of switch or control may be used.

The control means is preferably additionally

activatable by an input logic signal, supplied for example from a further control apparatus.

This input logic signal may conveniently be supplied to said monostable circuit via a circuit implementation
5 providing an "OR" logical function.

To allow generation of such a logic signal for output to other similar control apparatus, the control apparatus preferably includes a switch means or other signalling means responsive to the state of said control apparatus to
10 generate a logic signal.

In another arrangement, the control means includes pulse shaping means responsive to the output of the transducer to output a pulse train of the same "frequency" as the transducer signal. The control means preferably also
15 includes first accumulator means for increasing or incrementing a charge or value in a store in accordance with the number of pulses, the store including decay or decrementing means for decreasing a decrementing the stored value, and accumulator output means for emitting a true
20 signal when the pulse repetition rate (and thus the frequency of the transducer signal) is above a preset minimum.

The output from the first accumulator means is preferably supplied to a second accumulator means which
25 increases or decrements a charge or value in a store when the output from the first accumulator means changes state. The second accumulator means also includes decay or decrementing means for decreasing or decrementing the stored

value and output means for emitting a true signal when the stored value exceeds a preset level, thereby representing a pulse rate above a preset minimum.

The output from the second accumulator means is preferably supplied to a monostable circuit and associated circuit elements as previously described in connection with the first arrangement.

Whilst the invention has been described above, it extends to any invention combination of the features set out above or in the following description.

Two embodiments of the invention will now be described by way of example only, reference being made to the accompanying drawings, in which:

Figure 1 is a block diagram illustrating a first embodiment of control apparatus in accordance with this invention,

Figure 2 is a block diagram illustrating a second embodiment of control apparatus in accordance with this invention, and

Figure 3 is a side view of a mains switch incorporating a control apparatus in accordance with the invention.

The embodiments of this invention each comprise a smoke alarm activated switch which is intended to switch on a mains lighting circuit (consisting of one or more lamps) when the characteristic high pitched pulsed sound of a smoke alarm is detected.

Referring initially to Figure 1, in the first embodiment the output of an acoustic transducer 10 is

amplified in a high gain amplifier stage 12 to give good sensitivity. The amplifier output is processed by a phase locked loop 14 which discriminates against acoustic sources which are not within the correct capture frequency range and
5 against acoustic sources of irregular frequency. The output of the phase locked loop is a digital signal and is passed to a duty cycle discriminator 16, which rejects the low duty cycle pulse train from the phase locked loop 14 which occurs before it has locked on to the incoming signal properly.
10 The duty cycle discriminator 16 generates a true logic level when a signal of fixed frequency, within the allowed range 16, has been detected. The output from the duty cycle discriminator 16 is passed to a charge pump 18 which generates a fixed measure of charge each time the phase
15 locked loop 14 has locked and the output of the duty cycle discriminator is therefore true. These measures are integrated capacitively as a voltage until the upper threshold level of a buffer 20 is reached. In this way a pulsating sound source is required in order for a true
20 signal to propagate to the output of the buffer.

The integration of charge has set decay time constant. The pulsation sound source must therefore have repetition rate greater than a minimum level in order for a true signal to be produced. Equally, the response time of the phase
25 locked loop is set so that repetition rate which is higher than the maximum allowed level will not produce a true signal.

These upper and lower designed limits on sound source

repetition rate together with the designed frequency capture range specify an envelope of sound within which the smoke alarm activated switch will respond. The envelope is tailored to be compatible with generally available smoke
5 alarms in the market place and to comply with standards for the audible warning devices used in smoke alarms, as the standards emerge.

The monostable 22 is triggered by a true signal from the buffer 20 via an OR circuit 24. The period of the
10 monostable 22 determines the time for which the lighting load is switched on. It is chosen so that sufficient time is available for inhabitants of the building to take necessary action. However it is not of sufficient period to cause major inconvenience in the event of false operation.

15 The monostable 22 may be triggered either internally or via the network line 26 from another unit. The network line 26 is buffered at 28 to give a high input impedance so that a large number of units can be networked.

The monostable 22 drives a high side switch 30, which
20 sources current into the network line 26 to trigger other units when a smoke alarm warning has been detected. The monostable also drives an AC switch 32, here a triac, which enables the unit to switch typical lighting loads which are connected to the mains supply.

25 Referring now to Figure 2, in the second embodiment, the output of an acoustic transducer 40 is amplified in a high gain amplifier stage 42 to give good sensitivity. The frequency response of the amplifier 42 is tailored to

attenuate frequencies which are outside the allowed range. The output of the amplifier 42 is processed by a circuit stage which produces a pulse train in sympathy with the acoustic source. This stage produces a waveform suitable
5 for driving a charge pump as well as rejecting small signal components which may be superimposed upon the fundamental tone of the smoke alarm. A suitable circuit stage is a Schmidt trigger 44 which produces a pulse train in sympathy with the acoustic source, when the output voltage of the
10 amplifier is alternating through its hysteresis band. Other suitable circuits are logic gates and high gain linear amplifiers. The pulse train from the Schmidt trigger is passed to a first charge pump 46, which generates a fixed measure of charge with each output pulse from the Schmidt
15 trigger. These measures are integrated capacitively as voltage in a buffer 48. The integration response time is balanced against a set decay time constant so that a minimum number of cycles, at a frequency above the allowed minimum frequency, is required in order for the output of the buffer
20 48 to be true.

The decay time constant also ensures that the pulse train must be interrupted for at least a minimum period in order for the output of the buffer 48 to be false again. The first charge pump 46 therefore demodulates the
25 pulsations in the smoke alarm audible warning from its fundamental tone up to a maximum repetition rate set by the decay time constant and the logical threshold of buffer 48.

The demodulated signal is processed by a second charge

pump 50, which generates a fixed measure of charge each time the buffered output of charge pump 46 is true. These measures are integrated capacitively as a voltage in the buffer 52. The integration of charge has a set decay time
5 constant. The pulsating sound source must therefore have a repetition rate greater than a minimum level in order for the output of the buffer 52 to be true.

These upper and lower designed limits on sound source repetition rate together with the frequency response
10 characteristics of the input amplifier 42 specify an envelope of sound within which the control apparatus will respond. The envelope is tailored to be compatible with generally available smoke alarms in the market place and to comply with standards for the audible warning devices used
15 in smoke alarms, as the standards emerge.

The operation of the remaining circuitry is as for the first embodiment, and similar items are given similar reference numerals.

Both embodiments include a fuse 8, for breaking the
20 mains live line in the event of an overload or failure, to prevent over-dissipation in the control apparatus and possible fire, which could occur at a current level below that at which the mains circuit breaker or switchboard fuse would operate. The fuse may be either a fitted or printed
25 component. Both embodiments derive a DC voltage from the mains supply from a shunt voltage regulator 54.

The AC switch 32 is capable of switching lighting loads, either incandescent or fluorescent. The switch is

also capable of switching DC loads and may be either a semiconductor or electromechanical device.

Referring to Figure 3, a wall switch 56 of this invention comprises the usual wall plate 58, toggle 60, 5 conventional switch gear 62 and connected in parallel between the terminals 64 thereof a smoke alarm activated switch 6. The wall switch operates conventionally via the toggle to switch the mains supply, but in the event of a smoke alarm sounding within the audible range of the smoke 10 alarm activated 6, the latter switches the mains on.

In all the embodiments, it will be noted that the coupling between the smoke alarm and the smoke alarm activated switch is acoustic, and there is no electrical connection. Signal processing within the smoke alarm 15 activated switch enables it to discriminate against most extraneous ambient sounds which are not within an allowed frequency band or pulsating at an allowed repetition rate, such as may be encountered in domestic and commercial environments. This ability avoids false operation. The 20 ability of the switch to respond to an activated smoke alarm is highest at night when the lighting is most required, because the level of ambient sounds is considerably lower.

The smoke alarm activated switch derives its power from the mains electricity which it switches and does not require 25 additional power sources such as batteries.

The smoke alarm activated switch may be connected to other such switches to form a network of units. A single low current, extra wire in addition to the mains wiring is

required to network two or more units. This connection to each unit is bi-directional in that a unit is able to switch its lighting load in response to a smoke alarm warning which has been detected by another unit, and is also able to
5 instruct other units to which it is connected to switch their lighting loads in the same way.

Once a smoke alarm warning has been detected, the lighting load is switched on for a set minimum period of time, sufficient for the inhabitants of the building to take
10 the necessary action.

The sensitivity of the smoke alarm activated switch is high enough to enable it to be enclosed, e.g within a light switch wall cavity, and still detect the smoke alarm (when in reasonable range). In installations where this is not
15 possible, the acoustic transducer may be mounted in an aperture but will be protected and visually shielded by a membrane or gauze which offers minimal impedance to acoustic propagation.

The smoke alarm activated switch may be incorporated in
20 many different types of electrical equipment as well as being a stand alone unit. Thus it could be incorporated in a dimmer switch to operate in parallel with the dimming circuit. Likewise it could operate in parallel with a timer, or be incorporated in a ceiling rose or a
25 freestanding lamp, or an electrical socket. If required, in a house, apartment, hotel etc., a series of smoke alarm activated switches may be installed from the sleeping area to a safe exit door so that the user can design a "path" of

lights which will be switched on when the smoke alarm is triggered, with individual units either responding directly to the sound, or being slaved together.

CLAIMS

1. Control apparatus responsive in use to the sound emitted by a smoke alarm or the like to switch a power supply or otherwise control a further item of equipment.

5 2. Control apparatus according to Claim 1, including transducer means for detecting the sound emitted by said smoke alarm and providing a transducer signal, and control means responsive to said transducer signal to switch or otherwise control said further item of equipment.

10 3. Control apparatus according to Claim 2, wherein said transducer comprises a microphone or other acoustic or vibrational pick-up.

4. Control apparatus according to Claim 2 or 3, wherein said control means responds to at least one of the
15 frequency, the pulse repetition (if any) rate, the pulse duration, and the mark/space ratio of the transducer signal.

5. Control apparatus according to Claim 4, for use with a smoke alarm which emits a series of sound pulses, wherein said control means includes means for setting upper
20 and lower limits for the pulse repetition rate of the transducer and responds only to a transducer signal having a pulse repetition rate between said limits.

6. Control apparatus according to Claim 4 or 5, wherein said control means incorporates frequency sensitive
25 means to determine whether said transducer signal lies within a preset frequency band.

7. Control apparatus according to Claim 6, wherein

said frequency sensitive means comprises a phase locked loop means.

8. Control apparatus according to Claim 7, wherein said control means includes discriminator means for determining each time the phase locked loop locks to said transducer signal.

9. Control apparatus according to Claim 8, wherein said control means includes means for integrating or accumulating the output of said discriminator means, and is operable to switch or otherwise control said further item of equipment when the integrated or accumulated output exceeds a pre-set threshold, whereby said apparatus is activated after a preset number of pulses.

10. Control apparatus according to claim 9, wherein said integrating or accumulating means include means for decrementing said integrated or accumulated output or allowing it to decay, whereby said control apparatus is activated above a pre-set pulse repetition rate.

11. Control apparatus according to any of Claim 7 to 10, wherein the response time of the phase locked loop is set whereby phase locking will not occur with a transducer signal having a repetition rate higher than a corresponding pre-set maximum.

12. Control apparatus according to any preceding Claim, including monostable circuit means for being triggered for a preset time when said control means detects the sound emitted by said smoke alarm.

13. Control apparatus according to any preceding

Claim, wherein said control means is operable to produce a control signal for a further control apparatus on detecting the sound emitted by said smoke alarm.

14. Control apparatus according to any preceding
5 Claim, wherein said control means is responsive also to a control signal from a further control apparatus according to Claim 13.

15. Control apparatus according to any preceding
Claim, wherein said control apparatus includes pulse shaping
10 means for producing a pulse train of frequency corresponding to that of the transducer signal, and first accumulator means for accumulating or incrementing an accumulated value, and decay or decrementing means associated with said
15 accumulator means for decreasing or periodically decrementing said accumulator value, whereby said first accumulator means outputs a "true" signal when the frequency of said transducer signal is above a pre-set value.

16. Control apparatus according to Claim 15, where
the output from said first accumulator means is supplied
20 a second accumulator means which outputs a "true" signal if the repetition rate of the transducer signal exceeds a pre-set value, and said control apparatus switches or otherwise controls further item in response to a "true" signal from said second accumulator.

25 17. A smoke alarm activated control apparatus for switching or otherwise controlling a further item of equipment includes a vibration transducer means and means responsive to the output of said transducer means

selectively to discriminate the characteristic, pulsed sound emitted by a smoke alarm on the basis of at least one of:-

- (i) the frequency of said characteristic sound,
- (ii) the pulse repetition rate,
- 5 (iii) the pulse duration, and
- (iv) the mark/space ratio

18 Control apparatus according to any preceding Claim, for switching a live mains supply, and including means for deriving power for operation of said apparatus
10 from said mains supply.

19. Control apparatus according to Claim 18, including at least one further switch or power regulator means, operable to control said mains supply in parallel with said control means.

15 20. Control apparatus according to Claim 19, wherein said apparatus includes means for mounting said apparatus in a pattress or wall box.

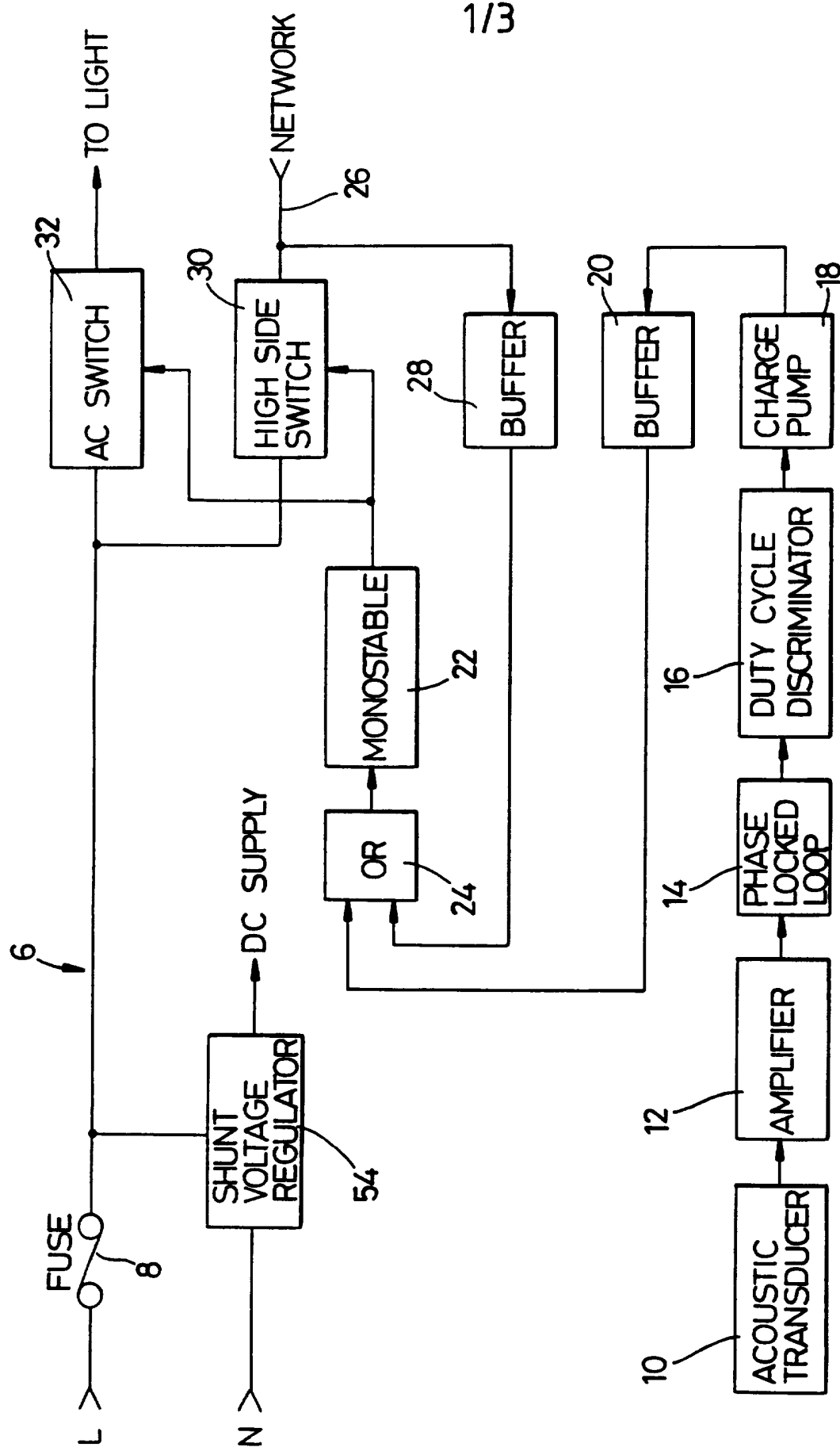


Fig. 1

2/3

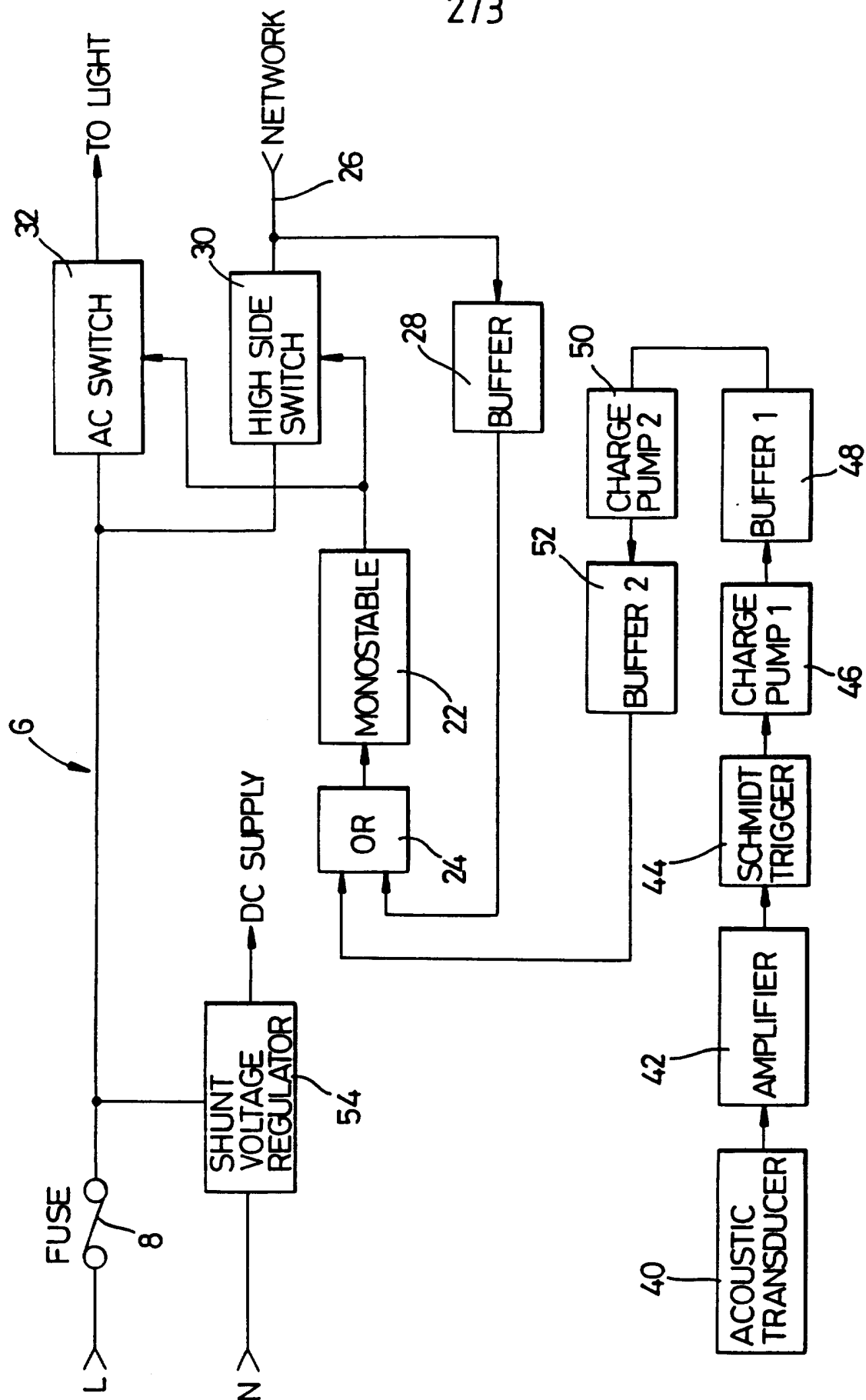


Fig. 2

3/3

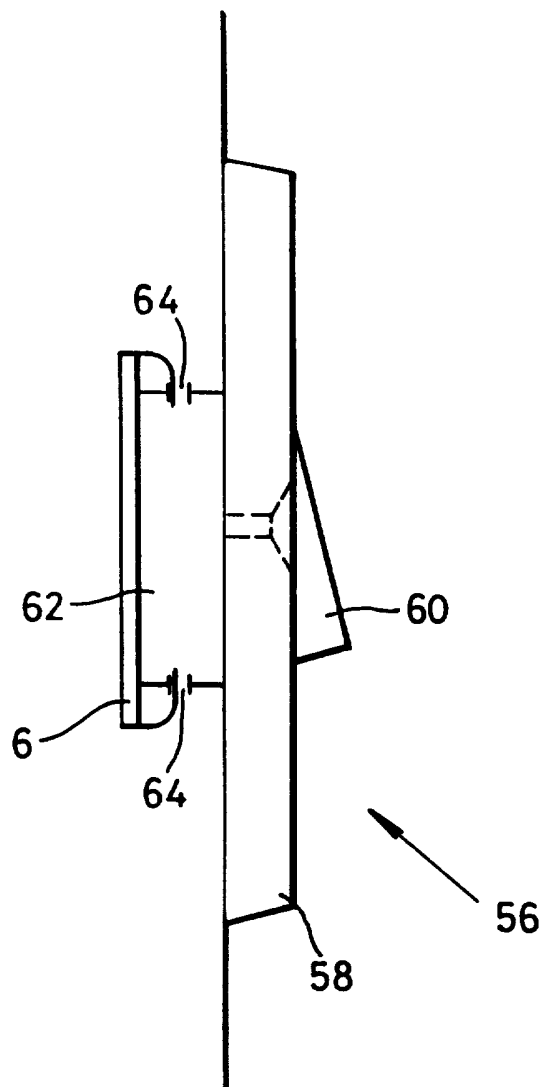


Fig. 3

INTERNATIONAL SEARCH REPORT

In: International Application No
PCT/GB 95/01660

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08B1/08 G08B7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,5 012 223 (C. GRIEBELL) 30 April 1991 see the whole document ---	1-20
X	GB,A,2 268 300 (W. CHITTLEBURGH) 5 January 1994 see abstract ---	1-4 13,14
A	EP,A,0 403 245 (THORN EMI) 19 December 1990 see abstract -----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- * "A" document defining the general state of the art which is not considered to be of particular relevance
- * "E" earlier document but published on or after the international filing date
- * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- * "O" document referring to an oral disclosure, use, exhibition or other means
- * "P" document published prior to the international filing date but later than the priority date claimed

- * "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- * "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- * "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * "&" document member of the same patent family

Date of the actual completion of the international search

26 October 1995

Date of mailing of the international search report

16. 11. 95

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+ 31-70) 340-3016

Authorized officer

Sgura, S

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/GB 95/01660

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-5012223	30-04-91	NONE	
GB-A-2268300	05-01-94	NONE	
EP-A-403245	19-12-90	NONE	