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(54) Concealable proximity detector.

(57) A concealable proximity detector for detecting the approach of matter towards a target (1) (e.g. a room or doorway) and especially useful in intruder detection systems. The detector employs a capacitor which uses as its first electrode (51) a coat (2) of electrically conductive paint applied to the target which is concealed beneath or as part of the decoration of the target. The capacitor uses as its second electrode a (preferably earthed) surface (4) which is part of the surroundings of the first electrode (e.g. a floor or pavement) and which is therefore also inconspicuous. The capacitor and switching means serve as part of a proximity switch operable in response to the change in dielectric between the capacitor electrodes which occurs when an intruder in contact with the second electrode surface approaches the painted surface.

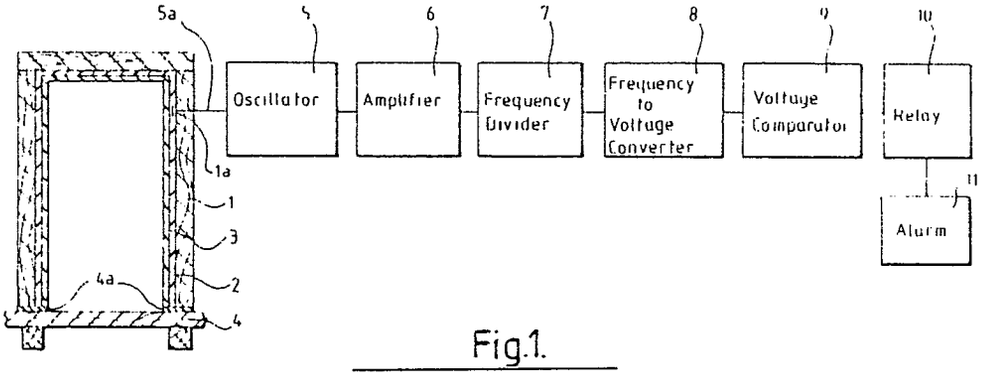

Fig.1.

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CONCEALABLE PROXIMITY DETECTOR

This invention relates to concealable proximity detector for use in detecting the approach of matter towards a target especially an architectural target such as a room or doorway. The dectector is therefore especially suitable for use in an intruder detection system.

Intruder detection systems have been proposed which rely on for example the interruption of a beam of light or a radio wave, on the sensing of infra red heat or on the change in the capacity associated with a radio antenna. Such systems have required the installation of fairly conspicuous equipment. An object of this invention is to provide a proximity detector which can be concealed overtly or covertly by means of the decoration of a target.

Accordingly this invention provides a proximity detector which provides an output signal indicative of the approach of matter towards a target comprising a capacitor arranged in an electrical circuit and having a first (or target) electrode and a (preferably earthed) second electrode so disposed relatively to each other that the approach of matter towards the target causes a change in capacitance of the capacitor thereby providing the output signal and wherein the first electrode comprises a layer of electrically conductive paint on the target. It has been discovered that the layer of electrically conductive paint can respond sensitively enough to the change in dielectric caused by the approach of a human intruder towards the target for the change to be detectable for example as a change in the frequency of oscillation of an oscillator of which the capacitor forms part. Therefore more particularly the proximity detector may comprise

a) a capacitor arranged in an electrical circuit and having a first (or target) electrode which is part of the target (for example a wall, ceiling, door or doorpost) and a (preferably earthed) second electrode which is usually a surface forming part of the surroundings of the first electrode (for example a door, doorstep or pavement) which is separated from the target electrode by electrical insulation (preferably insulation having a resistance of at least 0.5 Mohm) whereby the first electrode and the second electrode can be at different electrical potentials,

b) a switching means arranged in the same electrical circuit as the capacitor whereby the switching means and capacitor can serve as an oscillator whose frequency of oscillation depends on the dielectric between the electrodes of the capacitor and

c) response means which can detect a change in the frequency of oscillation of the oscillator

wherein the first electrode is a layer of electrically conductive paint. "Mohm" denotes mega-ohm.

The layer of electrically conductive paint may be concealed either overtly by appearing itself as part of the decoration of the target or covertly by being an undercoat for a (preferably decorative) covering, especially a coat of decorative paint. The layer of conductive paint when dried should preferably have a resistivity of from 1ohm to 250kohm/square (i.e. kilo-ohms per square of area). The total resistance of the first (target) electrode should generally be less than 12 Mohm, is preferably less than 8 Mohm and in practice it is usually below 3 Mohm. The paint may comprise any conventional binder, for example acrylic, alkyd or cellulosic resins and it is usually rendered conductive by the presence of conductive solids. Suitable conductive solids include particles (including fibres) of metals, semiconductive solids including (carbon black or solids coated with conductive solid material. Suitable metals include nickel, aluminium, silver and ferreous metals. Carbon blacks may be for example lamp blacks, furnace blacks or acetylene blacks. Other semi-conductive solids include zinc oxides and indium/tin oxides. The conductive solids preferably occupy from 15 to 40 vol% of the dried coating of paint.

Preferably the capacitor and switching means should combine to form an oscillator having a frequency of from 1 to 150 kHz. It has also been discovered that sensitivity is greatly increased by the selection of a unijunction transistor as the swithcing means. Unijunction transistors are described on pages 54 to 57 of the book "Semiconductor Projects for the Home Constructor" by R M Marston published in 1969 by Iliffe of London, the contents of these pages are herein incorporated by reference. Sensitivities have been achieved which allow a human intruder to be detected at a distance of up to 1m from the layer of conductive paint.

The change in output frequency is conveniently detected by response means which first convert the frequency to a voltage and then compare the voltage with reference voltages to detect whether a change has occurred. If necessary, the frequency may be reduced by a selected factor (for example by a factor of 5 to 20) to enable it to be accommodated by a frequency to voltage converter. The change in frequency detected as a change in voltage is then used to activate a relay which in turn may be used to actuate (for example switch on) an alarm.

The system can be worked successfully off a 12 volt dc power supply and its installation can be simple requiring little more than the application of a coating of the conductive paint (for example, during a conventional decoration of the target) followed by the connection of the coating to the remainder of the

detector. Paints for use in the invention are illustrated by the following examples.

EXAMPLE 1

An aqueous emulsion paint suitable for use as a conductive paint was made up to have the following formulation:

Wt %	Ingredient
33.70	Tapwater
25.93	Latex: The latex was a dispersion of 52 wt % (based on the total weight of the latex) of solid a film-forming copolymer in water. The copolymer was a copolymer of methyl methacrylate (50.5 wt.%), 2-ethyl acrylate (48.5 wt.%) and acrylic acid (1 wt.%) and had a glass transition temperature of -7°C.
39.37	"Monolite" Black XBE HD which is a paste of about 40 wt % lampblack particles (number average particle size 27µm) and about 60 wt % water. "Monolite" EHD is supplied by Imperial Chemical Industries PLC (Organics Division).

0.50	"Blanose" 7HC cellulosic thickener supplied by Hercules France SA.
0.20	"Tilcom" AT33 titanium chelate structuring agent described in the brochure ""Tilcoms" for structure in Latex Paints" published in 1975 by Titanium Intermediates Limited of London, the contents of which are herein incorporated by reference.
0.20	"Foamaster" NDW antifoaming agent supplied by Henkel Nopco Ltd.
0.10	Aqueous ammonia of specific gravity 0.88

The paint was made by first stirring the "Blanose" and "Foamaster" into the tapwater for 40 to 50 minutes. Next the "Monolite" paste was stirred in slowly followed by the latex also stirred in slowly and then followed by further stirring for 20 minutes. Finally the "Tilcom" and ammonia were added with stirring. A pigment volume concentration of 40 % and an organic solids content of 30 wt % were obtained in the final liquid paint.

The paint produced was painted onto glass plates which served as a non-conductive substrate. Sufficient paint was applied to a glass plate to produce a coating which when fully dry had a thickness of 15µm and to another glass plate to produce a coating which when fully dry had a thickness of 25µm. The resistivities of the coatings were found to be 3.5kohm/square for the 15µm coating and 2.2kohm/square for the 25µm coating.

EXAMPLE 2

This Example illustrates the manufacture of an organic solvent-based alkyd paint suitable for use as a conductive paint.

Firstly a black millbase was made having the following formulation expressed as parts by weight

Parts by weight	Ingredient
40	White spirit
12	Long oil soya bean alkyd, 75 wt % solids in white spirit, acid value 5 to 10.
2	Solution of a commercially available calcium drier containing 10wt% of calcium.
15	Carbon black (which was "Corax" L powder).
8	White spirit added during mixing.
77	1mm diameter glass beads.

The above ingredients were mixed together for 2 hours using a high speed stirrer rotating at 2300 rpm to produce a paint having an average maximum particle size of 10μm. The extra white spirit was added after 30 min of mixing.

A paint was then made by thoroughly stirring together the following ingredients using a stirrer rotating at 2300rpm:

Wt %	Ingredient
76.5	Black millbase as made above.
20	Long oil soya bean alkyd, 52 wt % solids in white spirit, acid value 10 to 17.
2	Dipentene antiskinning agent.
1	Solution of a commercial zirconium drier in white spirit and containing 18 wt % (on the solution) of zirconium.
0.4	Solution of a commercial cobalt drier in white spirit and containing 10 wt % (on the solution) of cobalt.
0.1	Silicone oil in white spirit to promote slip.

The liquid paint obtained from the above ingredients had a pigment volume concentration of 30 wt % and an organic solids content of 35 wt % (based on the weight of the paint).

The paint was painted onto glass plates to produce dry coatings as in Example 1 except that the second coating was 15 to 25μm thick. The resistivity of the coating was found to be 4.4kohm/square.

The invention is further illustrated by the following preferred embodiment which is described with reference to the drawings of which

Figure 1 is a section of a target shown together with a proximity detector in an intruder detection system represented as a block diagram,

Figure 2 is a detail on a larger scale taken from Figure 1 and shows the contact strip,

Figure 3 is a circuit diagram for the system shown in Figure 1 and

Figure 4 is a circuit diagram for a simpler conversion of frequency to voltage.

Figure 1 shows a target wooden doorframe 1 painted with a dried undercoat 2 of an electrically conductive paint (such as that made according to Examples 1 or 2) which serves as a first or target electrode. The target electrode is concealed by a dried top coat 3 of a decorative paint. Frame 1 stands on earthed floor 4 from which it is separated by 0.5 Mohm insulation 4a. Coating 2 and floor 4 constitute the first (target) and second (counter) electrodes of a capacitor which forms part of an electrical circuit in an oscillator indicated broadly by block 5. The oscillator is chosen to oscillate at a normal frequency of 100kH. When an intruder walking on floor 4 approaches painted surface 2, the dielectric between coating 2 and floor 4 increases causing a corresponding increase in the capacitance of the capacitor and thereby a reduction in the output frequency of the oscillator.

The connection between conductive undercoat 2 and wire 5a which connects the undercoat 2 into the oscillator circuit is shown more clearly in Figure 2. The connection is made to an aluminium contact strip 1a adhesively bonded to frame 1 and painted over by undercoat 2.

The output frequency imposed by oscillator 5 is fed as a signal via a conventional amplifier 6 to a frequency divider 7 where the frequency is reduced to one tenth of its original value. The reduced frequency signal is then fed to a convertor 8 where its frequency is converted to a voltage. The voltage is

fed to a conventional comparator 9 where it is compared with an adjustable reference voltage so that a reduction in the output frequency of oscillator 5 can be easily detected as a reduction in voltage. Accordingly convertor 8 and comparator 9 together constitute a response means which enables a change in the frequency to be detected.

A reduction in voltage detected by comparator 9 is used to actuate a conventional relay 10 which in turn may be used to switch on an alarm 11.

Figure 3 shows in detail the circuitry used in the embodiment to which Figure 1 refers. Block 5 broadly indicates a unijunction relaxation oscillator comprising a switching means which is unijunction transistor 51 and a capacitor consisting of undercoat 2 and floor 4, the counter electrode. The oscillator circuit also contains inductances 52 and resistor 53. It should be noted that undercoat 2 (the target electrode) is connected via a 10 Mohm resistance 55 (not shown in Figure 1) to earth as is one pole of the 12v power supply so as to comply with the safety requirements of British Standard BS 6800 : 1986.

Divider 7 contains a presettable "divide-by-N" counter chip 71 of the type HEF 4018B described on pages 189 to 194 of the "Mullard Technical Handbook", Book 4 part 4 published in London by Mullard Limited in July 1983. The contents of pages 189 to 194 are herein incorporated by reference. Convertor 8 contains a precision frequency to voltage converter 81 of the type LM331 described on pages 8-251 to 8-257 of the "Linear Databook" published in 1982 by National Semiconductor Corporation of Santa Clara, California see especially page 8-257. The contents of these pages are herein incorporated by reference. Voltage comparator 9 which contains chip 91 of the type LM741 described on pages 3-2 to 3-259 of the "Linear Databook" ibid. Again, the content of these pages is herein incorporated by reference.

Other components in the circuit are as follows:

Resistors:		Capacitors: "Wkg" denotes "working"	
53	270ohm	61	10 µfd at 35v wkg
54	47kohm	66	22 µfd at 35v wkg
55	10 Mohm		
56	47ohm	82	470 pfd polystyrene
57	50 kohm (Variable)	87	1 µfd polycarbonate
62	330kohm	89	0.01 µfd polycarbonate
65	5.6kohm		
		95	47 µfd at 25v wkg
72	10kohm		
80	6.8kohm	Transistors:	
83	10kohm		
84	47kohm	63	BC109µpn
		96	Diode IN 4001
85	5kohm (Variable)	97	2N 3906 pnp
86	68kohm		
88	100kohm	Inductances:	
92	10kohm (Variable)	52	1000 µH each
93	1.2kohm		
94	1.2kohm	Relay	
		98	12v DC dual pole change over

Figure 4 indicates a form of diode pump which could be used as a simple means for converting frequency to voltage instead of the combination of divider 7 and converter 8.

This invention also provides an intruder 30 detection system which comprises a proximity detector according to the invention, an alarm and a relay of enabling the switch to actuate the alarm.

Claims

1. A proximity detector which provides an output signal indicative of the approach of matter towards a target (1) comprising a capacitor having a first electrode (2) and a second electrode (4) so disposed relatively to each other that the approach of matter towards the target causes a change in capacitance of the capacitor thereby providing the output signal wherein the first electrode comprises a layer of electrically conductive paint on the target.

2. A detector according to Claim 1 wherein the capacitor forms part of an oscillator (5) whose output frequency varies with the change in capacitance caused by the approach of matter towards the target.

3. A detector according to Claim 2 comprising

a) a capacitor arranged in an electrical circuit and having a first electrode (2) which is part of the target and a second electrode (4) which is separated from the target plate by electrical insulation (4a) whereby the first electrode and the second electrode can be at different electrical potentials,

b) a switching means arranged in the same electrical circuit as the capacitor whereby the switching means and capacitor can serve as an oscillator whose frequency of oscillation depends on the dielectric between the electrodes of the capacitor and

c) response means which can detect a change in the frequency of oscillation of the oscillator

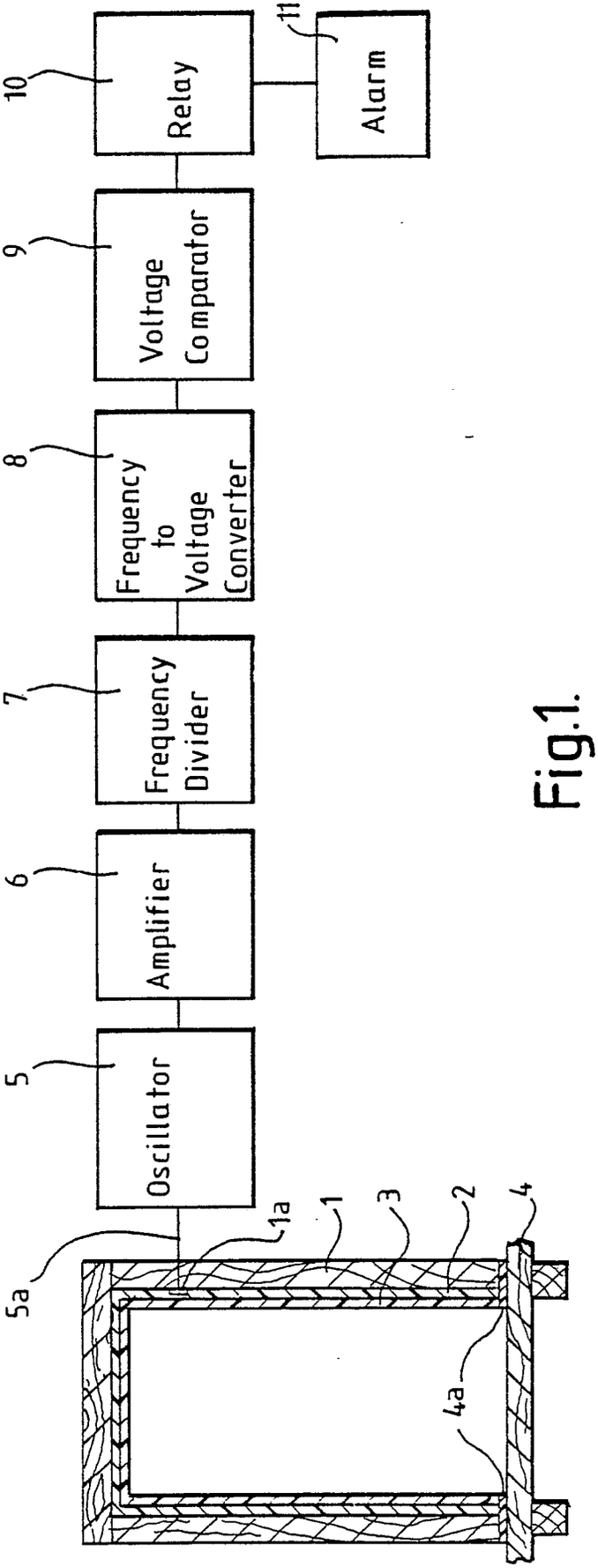
wherein the first electrode is a layer of electrically conductive paint.

4. A detector according to anyone of the preceding claims wherein the oscillator comprises a switching means which is a unijunction transistor (51).

5. A detector according to any one of the proceeding claims wherein the output frequency of the oscillator is converted to a voltage by a frequency to voltage converter (8) and this voltage constitutes the output signal of the detector.

6. A detector according to Claim 4 wherein the output frequency is reduced by a pre-determined factor before its conversion to a voltage.

7. An intruder detection system which comprises a proximity detector as claimed in any one of Claims 1 to 6, an alarm and a relay for enabling the detector to actuate the alarm.


Oscillator
Amplifier
Frequency Divider
Frequency to Voltage Converter
Voltage Comparator
Relay
Alarm
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7
8
9
10
11
5a
1a
1
3
2
4
4a

Fig.1.

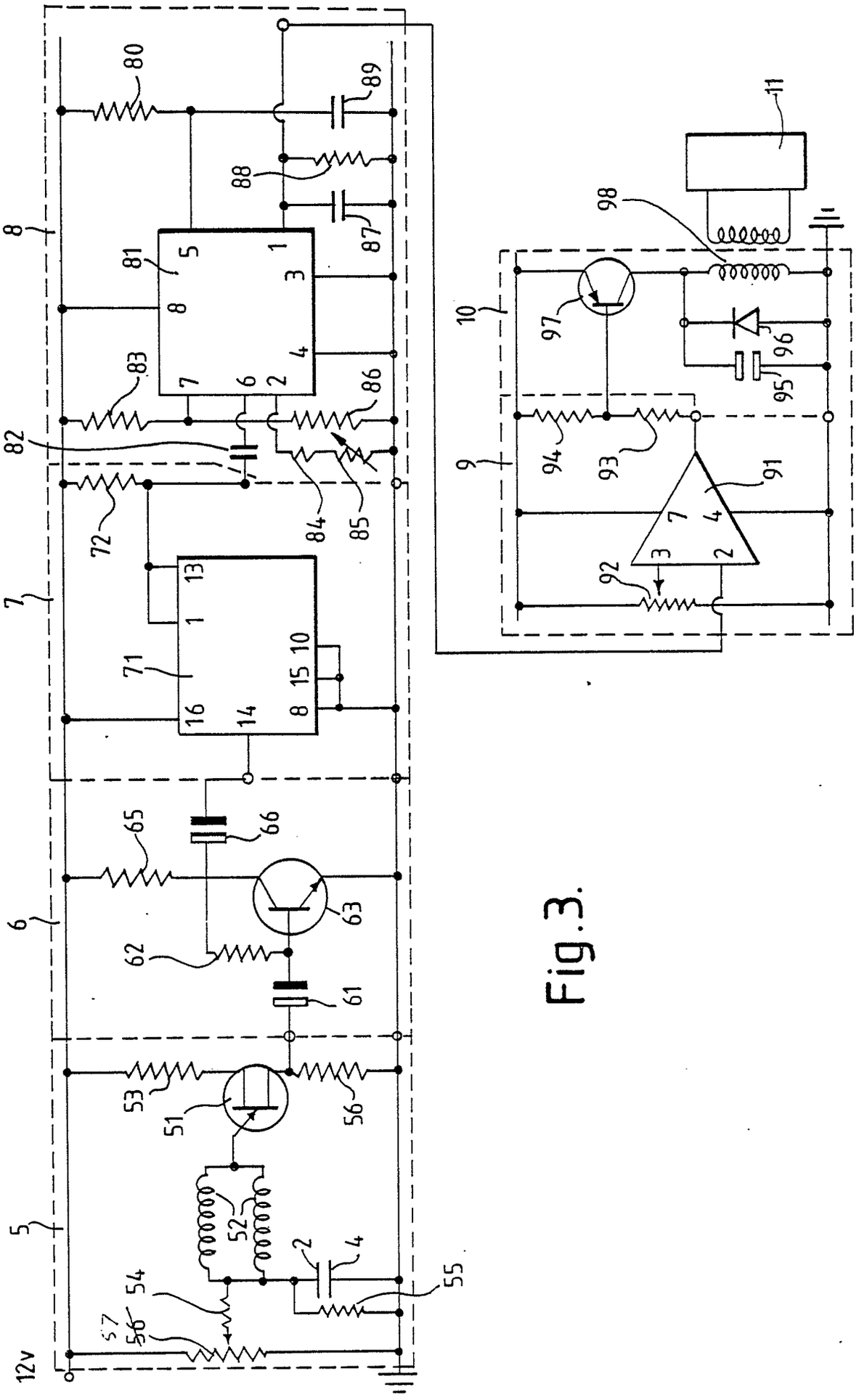
12v
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Fig.3.

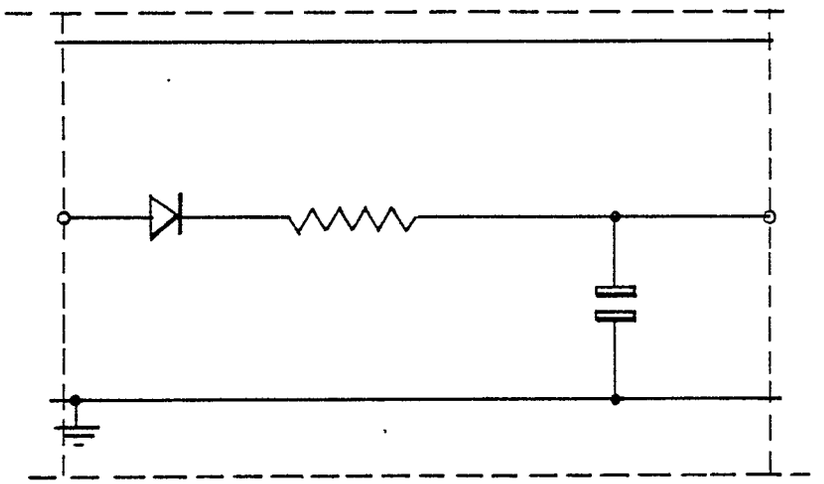

Fig.4.

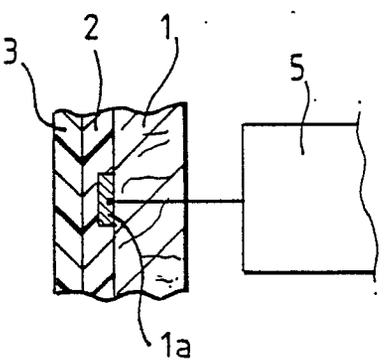

Fig.2.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 2494

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.4)
	NO RELEVANT DOCUMENTS HAVE BEEN DISCLOSED ----		G 08 B 13/26

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
G 08 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30-06-1989	REEKMANS M.V.

CATEGORY OF CITED DOCUMENTS

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