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(71) Applicant: **Beghelli S.p.A.**
40050 Monteveglio, Bologna (IT)

(72) Inventor: **Beghelli, Gian Pietro**
40050 Monteveglio (Bologna) (IT)

(74) Representative: **Coppo, Alessandro**
Ing. Barzanò & Zanardo Milano S.p.A.,
Via Borgonuovo, 10
20121 Milano (IT)

(54) Anti-intrusion detecting device

(57) An anti-intrusion detecting device (1), especially for doors and windows, to be applied on the outside of buildings, presenting a typically parallelepiped shape, where the larger side is placed horizontally over the opening (40) to be protected; the detector (1) incorporates two sensors (2,3) each of which functions in accordance with a different detection principle and each of which covers different volumes (44, 45) and areas (4, 5) of sensitivity.

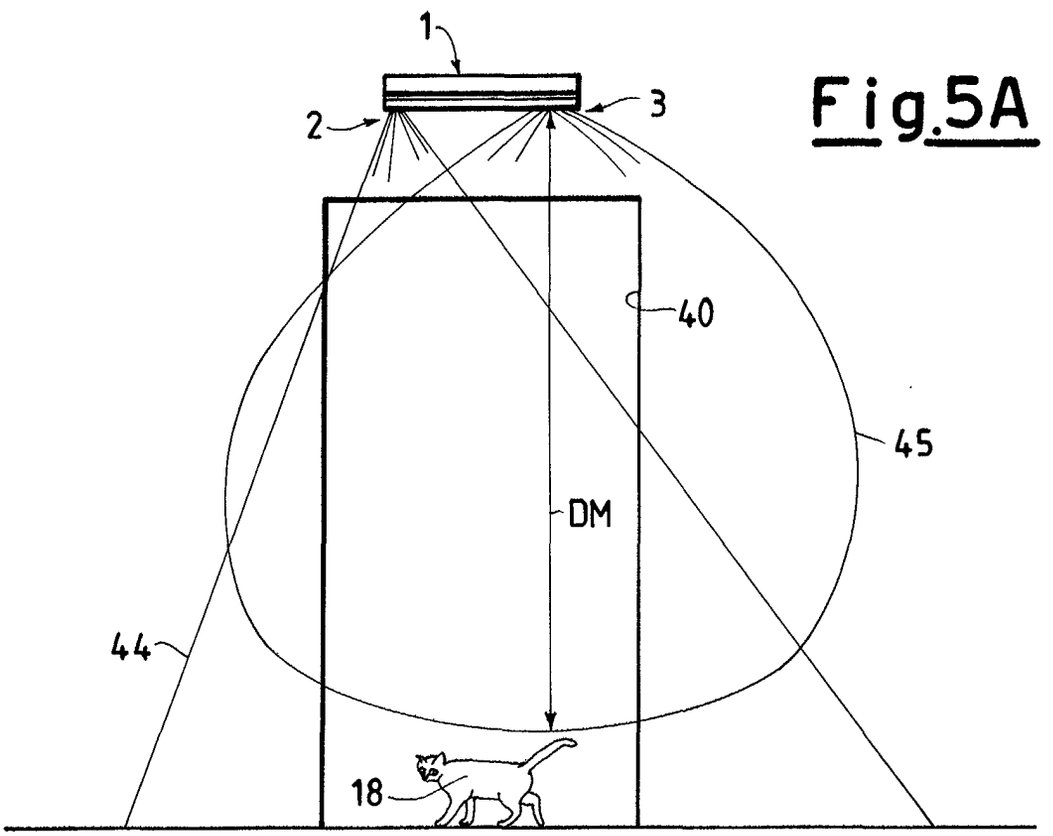

Fig.5A

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Description

[0001] This invention refers to an anti-intrusion detecting device, especially for doors and windows, to be applied on the outside of buildings.

[0002] The anti-intrusion systems of a traditional kind, installed on the outside of buildings, utilize a multiple number of detectors, capable of exploiting various physical principles to identify intruders, and to automatically actuate alarm systems to point out the danger to the building's occupants, and to discourage the ill-disposed.

[0003] However, the detectors placed inside the buildings identify the intruder at the time he has penetrated the building, after already damaging the passive protections present (doors and/or windows).

[0004] Likewise, external detectors are normally used which are placed outside the building, so as to reveal the presence of the intruder before he can damage the door and window frames, when he approaches the external perimeter; these detectors are designed to create invisible barriers, which trigger an alarm if crossed by the intruder.

[0005] However, the detecting devices of this type currently on the market generally exhibit a number of drawbacks, such as a complex installation, difficult calibrations and the need for long and complex wirings, poor esthetic effects due to the presence of long bars to be vertically applied to the sides of the opening to be protected, a sensitivity to false alarms caused by small mammals (dogs, cats) and birds, or by sudden changes in the environmental parameters (wind, rain, sunrise or others), or by the motion of persons or objects outside the controlled area.

[0006] The scope of the present invention is therefore that of obviating the drawbacks mentioned above, and in particular to point out an anti-intrusion detecting device, especially for doors and windows, to be applied on the outside of buildings, which allows it to be installed in a simple manner and at the same time to be esthetically agreeable.

[0007] Another scope of this invention is to produce an anti-intrusion detecting device to be extremely reliable and minimally sensitive or totally insensitive to false alarms caused by small animals, atmospheric agents or by the motion of persons or objects outside the controlled area.

[0008] A further scope of this invention is to produce an anti-intrusion detecting device, to be applied on the outside of buildings, in a simple and functional manner and at moderate costs, based on the advantages achieved.

[0009] These scopes are achieved by producing an anti-intrusion detecting device, especially for doors and windows, to be applied on the outside of buildings, according to claim 1, which is being referred to for brevity; further technical characteristics are contained in the subsequent claims.

[0010] In an advantageous manner, the detecting device according to the invention is especially designed for the protection of a single opening to the building (door or window or porch) and is applied on top, above the opening, for control and safety purposes.

[0011] Further characteristics and advantages of the anti-intrusion detecting device, as an object of this invention, will be better evident from the description and the attached drawings that follow, supplied for purely exemplifying and non-limiting purposes, in which:

- Figure 1 is a schematic view of an anti-intrusion detecting device according to this invention, installed above an opening door to a building;
- Figure 2 is a prospective view of a preferred form of embodiment of the anti-intrusion detecting device, according to this invention;
- Figure 3 represents a block diagram of the anti-intrusion detecting device according to this invention;
- Figure 4 is an electrical diagram of the processing circuits of the anti-intrusion detecting device according to this invention;
- Figures 4A and 4B represent the flow in time of a series of logical signals present in the processing circuit shown in Figure 4;
- Figure 5A is a front view of the detecting device according to this invention, applied above a door, in which the orthogonal projections of the areas of sensitivity are visible;
- Figure 5B is a lateral view of the detecting device according to this invention, applied above a door, in which the orthogonal projections of the areas of sensitivity are visible.

[0012] With particular reference to the Figures 1 and 2, in which a typical installation of the anti-intrusion detecting device according to this invention is visible above the door, the detecting device itself is generally indicated by 1 and assumes the typical and preferred, while simplified and non-limiting appearance of a kind of parallelepiped with a long side and two short sides; the long side runs horizontally above the opening 40, which must be protected.

[0013] The detecting device 1 incorporates two sensors 2, 3, each of which functions according to a different physical detection principle, and each of which has a different area of sensitivity.

[0014] In particular, the preferred use as a sensor 2 is a passive infrared sensor characterized by an area of sensitivity schematically indicated by the beams 4, while the preferred use as a sensor 3 is a "Doppler effect" microwave sensor, characterized by an area of sensitivity schematically indicated by the bubbles 5 in Figure 1.

[0015] Each beam 4 of the passive infrared sensor 2 schematically shows the axis of a focusing beam of a "Multiple Fresnel lens" of the built-in sensor 2 mentioned above, whose lens is facing downward; these beams create an invisible network sensitive to the heat of a human body, and their crossing on the part of a human

body induces the activation of the sensor 2.

[0016] On the other hand, the bubbles 5 of the "Doppler effect" microwave sensor 3 schematically show the virtual surfaces that must be crossed by an object in motion, having conductive or dielectric properties different from those of the air, for the purpose of inducing the activation of sensor 3.

[0017] The area of sensitivity of the infrared sensor 2 is separated in space from the area of sensitivity of the microwave sensor 3, as more evidently shown in the Figures 5A and 5B, which are schematically representing two orthogonal projections of the areas of sensitivity. The detecting device 1 also houses in its interior the processing circuits of the signals generated by the built-in sensors, a radio system with built-in antennas for transmitting the alarms, and a battery for supplying the whole.

[0018] Moreover, the detector 1 is equipped with a robust enclosure fitted with anti-opening switches, and provides a series of anti-removal switches, so as to sound an alarm in case the slightest attempt at tampering occurs.

[0019] Finally, the detecting device 1 may be fitted with appropriate protections against damage, such as for instance a vibration sensor, capable of generating an alarm in case of percussions applied in an attempt to damage it.

[0020] In some exemplifying and preferred yet not limiting forms of embodiment of this invention, the detecting device 1 may contain a lighting lamp, for instance of an incandescent or fluorescent type; in this case the circuits of the safety devices may be directly supplied by electrical energy from the network.

[0021] Figure 2 shows a possible esthetic embodiment of the detector 1, wherein the infrared sensor 2, assembled together with its own lens, is installed to the left of the device, while the microwave sensor 3 is to the right, protected and hidden inside the plastic enclosure 41 of the detector 1.

[0022] The advantages obtained by inserting a microwave detector 3 of a "Doppler" differential impulse effect type are those relating to the impulse technology and consist in achieving a low current consumption and a moderate sensitivity at close quarters, as well as in the possibilities of limiting the action radius of the sensor 3 with precision; in any case, such characteristics are in themselves not sufficient to achieve the requisites of immunity from false alarms.

[0023] In reality, such requisites can be achieved only by combining the mentioned technology with the detection technology based on measuring the infrared beams and the particular geometries used, according to this invention.

[0024] The operation of the anti-intrusion detecting device according to the invention is substantially as follows.

[0025] As clearly illustrated in Figure 3, the passive infrared sensor 2 supplies, if crossed by one of the sensitive beams, a signal 23 to the processing circuits 9, and the microwave sensor 3 likewise supplies, if crossed by the sensitive bubble, a signal 24 to the processing circuits 9.

[0026] The processing circuits 9 generate the signals 25, 26, 27 and 28, which are respectively supplied to an acoustic indicator 15, to a "dual band" radio transmitter 10, to the outlet circuits 11 and eventually to a lighting lamp 12 built into the enclosure 41 of the device 1.

[0027] The outlet circuits 11 comprise a relay of a bistable type to limit power consumption to a minimum, and their outlet may supply eventual external electrical devices. A non-rechargeable lithium battery 13 of 3.6 V, 5Ah supplies energy to the entire detector, by appropriate low consumption supply circuits 8 guaranteeing an autonomy of several years at normal operation.

[0028] As clearly visible in Figure 3, in which the dotted connecting lines indicate an electrical energy supply, the sole element not supplied by the lithium battery 13 is the eventual lighting lamp 12, which receives energy directly from the external 220 V electrical energy network, through the connection 29.

[0029] The lamp 12 is connected to the rest of the circuits only by the switching-on control, based on very low power, through an appropriate electronic switch and can eventually also be switched on in a permanent manner by an external control 35 connected to an appropriate switch.

[0030] Note that in a different version of the device the processing circuits of the signal 9 could likewise be shifted inside an alarm processing center; for this purpose, for example, it would be possible to produce a simpler and more economical version of the detecting device 1, in which both of the sensors 2 and 3 are simply connected to the radio transmitter 10 which, when appropriately coding the alarm data of the two sensors 2 and 3, reliably transmits them to the center, where said data may conveniently be processed.

[0031] As is evident from the picture in Figure 1, the crossing of the opening 40 of a door on the part of a person consequently determines the crossing of the bubbles 5 and of at least one of the beams 4; note that the functional blocks of the detector 1 are constituted in such a manner that the final alarm is sounded only after the activation in series of both the microwave sensor 3 and of the passive infrared sensor 2, respectively.

[0032] With particular reference to the Figures 3 and 4, note that the crossing of the bubbles 5 on the part of a person activates the signal 24, while the subsequent crossing of one or more of the beams 4 generates the signal 23; a mono-stable "re-triggerable" electronic device 39a extends the impulse 24 generated by the microwave sensor 3, generating at the outlet 32 an impulse which outlines the time frame within which the arrival of an impulse 23, generated by the passive infrared sensor 2 can trigger the alarm by using the signal 26.

[0033] Figure 4A represents the flow of the logic signals present in the electronic circuit of the detecting de-

vice 1 in the situation just described above.

[0034] The impulse-carrying signal 24 generated by the microwave sensor 3 activates the time frame T1; during said interval T1 the impulse 23 generated by the passive infrared sensor 2 arrives, and the combination of the two conditions allows generating the alarm impulse 26.

[0035] In the case of Figure 4B, this condition has not occurred and the impulse 23 generated by the infrared sensor 2 has failed to arrive in time, because the time frame T1 is already at the logical zero point; in this case the alarm 26 is not generated.

[0036] The duration of the time frame T1 is programmable within a pre-defined range of values, such as for instance between 200 ms and 1 s.

[0037] The described operating logic allows generating the alarm (signal 26) only when both sensors 2 and 3 have actually been activated in an alarm mode (for this purpose, provision is made for an AND gate 31, connected in series to the signals 23 and 24 at the outlet of the sensors 2 and 3, respectively). In fact, as shown in Figures 5A and 5B, the detecting device 1 is built so that the detecting areas of the two sensors 2, 3 are not overlapping (the intruder must abandon one before entering the other). In particular, the ill-intentioned must, when approaching the opening 40, first cross the volume 45 of the bubbles 5 emitted by the microwave sensor 3, and subsequently the maximum volume 44 covered by the beams 4 emitted by the passive infrared sensor 2; the intruder's only alternative is to laterally approach the door's opening 40 by simultaneously engaging both areas of sensitivity. In both cases, the described operating logic allows properly generating the alarm signal 26.

[0038] In the described cases, the alarm signal 26 at any rate activates the circuits of the "dual band" radio transmitter 10, which transmits a sequence of coded alarm signals capable of activating the alarm center and eventual acoustic and/or other actuators connected via radio to the detector 1. Ay every activation of the signal 24 generated by the microwave sensor 3, the mono-stable "re-triggerable" device 39b is further activated to supply an impulse 28 at its outlet, having a temporal duration T2 which can be regulated, for instance between 1 s and 30 s.

[0039] The signal 28 is utilized for the switching-on control of the eventual lighting lamp 12, which thereby lights up simultaneously with any activation of the microwave sensor 3, with an increasingly deterrent effect on the ill-intentioned.

[0040] The signal 27, which is utilized for activating the outlet circuits 11 (outlet relay), may be chosen, together with the deviator 33, between the alarm signal 26 and the signal 28, thus establishing the possibility of attributing to the outlet relay a significance either as an alarm or as a control for an external signaler with a deterrent purpose.

[0041] The signal 25, which pilots the acoustic signaler 15 ("buzzer") built into the detecting device 1, may similarly be chosen, along with the change-over switch 34, between the signal 32 relating to the mere activation of the microwave sensor 3 and the overall alarm signal 26.

[0042] The acoustic signaler 15, which can eventually be totally deactivated by using the change-over switch 34 in a central position, allows utilizing the detector 1 to warn the persons inside the building of the approach of a person to the opening 40 by a short sounding "beep".

[0043] With particular reference to Figure 5, the microwave sensor 3 exhibits a very precise sensitivity limit, as schematically shown in the figure by the total volume 45 of the bubbles 5; within a distance of about 20-30 cm this sensitivity falls to zero.

[0044] The detecting device 1, as an object of this invention, comprises a microwave sensor 3 which is built and calibrated at the factory, so that beyond a predetermined distance, shown by DM in Figure 5 and adjustable by the user at fixed intervals (for instance, at discrete intervals of 1.5, 2 or 2.5 meters), its sensitivity comes to be zero.

[0045] For this purpose, if for example the action range of the microwave sensor 3 is adjusted to 2 meters and the detecting device 1 is mounted above an opening 40, as shown in Figure 5, at a hypothetical height of 2.4 meters, a small animal, for instance the cat shown by 18 in the figure, is left out of the action range of this sensor 3, and therefore unable to activate it; in this case, for distances equal or less than 40 cm from the ground, the sensor 3 is in fact not sensitive. The same effect is obtained if the sensor is regulated for instance at 1.5 meters and mounted 20 cm above the upper side of a window, whose vertical opening length is 1.5 meters; in this case a small bird moving on the window sill is unable to activate the microwave sensor 3, because at least 20 cm of insensitive height are left over above said window sill.

[0046] In any case, thanks to the presence of the passive infrared sensor 2, which exhibits a beam detecting volume 4 indicated by 44 in the figures that is clearly separated from the volume 45 of the bubbles 5 generated by the microwave sensor 3, this system overcomes the limitation tied to a generalized hyper-sensitivity of the sensor 3; moreover, because the sensitivity volume 44 of the passive infrared sensor 2 is constituted by a very narrow band, which perfectly laps the wall by leaning against the same, this system further avoids false alarms, because the probability of a bird flight grazing the wall is extremely low.

[0047] Finally, it can experimentally be verified that, even if a bird crossed both of the volumes 44, 45 controlled by the two sensors 2 and 3, the fact that the areas of sensitivity are not overlapping, the speed of flight and the animal's small mass make it extremely unlikely that both sensors 2, 3 are activated in such a manner as to generate an overall alarm.

[0048] At any rate, this condition could eventually only occur if the bird crossed a left-open door or window in

his flight.

[0049] Another important characteristic of this invention is the fact that the two sensors 2, 3 are mounted at the two extremities of the detecting device 1; this determines that the detecting volumes 44, 45 are as far as possible removed from the immediate vicinity of the detector 1 itself, where the sensors 2, 3 exhibit a maximum sensitivity even with respect to small flying objects, such as small birds or leaves carried by the wind.

[0050] This further guarantees an excellent immunity against false alarms because an object such as a small bird or leaf carried by the wind has a very low probability of crossing the volumes 44, 45 in the manner needed to generate an alarm. This result could never have been secured by utilizing the sensors 2, 3 independently one from the other, because both are extremely sensitive to various environmental factors; for instance, the microwave sensors are very sensitive to rain and may generate an unjustified alarm if for instance big water drops cross the detecting volume (a rather highly likely event in case of installations made on perimeter walls unprotected by lean-tos').

[0051] The passive infrared sensor is, on the other hand, while not particularly sensitive to this environmental factor, extremely sensitive to sudden changes of heat, such as a sudden sunrise, or sudden sources of infrared radiation, such as an exposure to automotive halogen lights, while the microwave sensor is totally immune to these factors.

[0052] Thanks to its truly peculiar technical, characteristics, the detecting device 1 as an object of this invention can, as already mentioned, advantageously be employed for the external protection of door and window frames, for the purpose of not only preventively avoiding an undesired intrusion, but also of protecting the door and window frames themselves, which are in this case rendered unapproachable by potentially ill-intentioned persons.

[0053] It is moreover possible to implement a summertime perimeter protection of lived-in villas and apartments, under conditions where doors and windows are left open for aerating the premises.

[0054] The detecting device 1 is therefore capable of promptly signaling the intrusion, by actuating the acoustic alarm signal; this guarantees a very small probability of false alarms and leaves the occupants free to circulate within the protected premises, without risking false activations of the alarm.

[0055] The above description clarifies the characteristics of the anti-intrusion detecting device, especially for doors and windows to be installed on the outside of buildings, which is the object of this invention, just as it clarifies its advantages.

[0056] In particular, these are represented by:

- integration of two sensors having different detecting technologies;
- activation in a sequential or simultaneous manner of the two sensors for generating an alarm signal, in case a person approaches or crosses the protected opening;
- integration of the sensors within the detectors by using geometries such as to provide areas of sensitivity as far as possible not overlapping in space and separated a short distance from the detector, so as to minimize the probability that small flying objects may activate the alarm;
- a beam of a very flat sensitivity and of a vertical and squashed form of the infrared sensor,
- a microwave sensor of a controlled action radius, capable of allowing the calibration of the action radius, so that small animals may transit without activating the sensor;
- a very high immunity to false alarms generated by domestic animals, small animals, birds and environmental factors such as wind, the sudden switching on of lights, rain, hail or other;
- a supply by very low consumption batteries;
- a simplicity of positioning and installation;
- an absence of wirings for connecting to other portions of the safety system that the detector could be a part of, thanks to the transmission of the generated information;
- a possibility of choosing a broad action radius of the microwave sensor, depending on the detector's installation height;
- a possibility of utilizing the detecting device even during the summer period, in order to alert whoever lives inside a building about the presence of an intruder approaching a door or window left open to aerate the building;
- a possibility of arranging for a relay outlet to pilot the switching on of a signaling device or lighting lamp for deterrent purposes;
- a possibility of integrating a lighting lamp which may be lighted permanently (under the control of an external switch) for the purpose of lighting the building from the outside, or be switched on automatically as a deterrent against ill-intentioned persons;

[0057] Finally, it is evident that numerous variants can be applied to the anti-intrusion detecting device according to the invention, without thereby abandoning the principles of novelty inherent in the inventive idea, just as it is clear that in the practical implementation of the invention, the materials, shapes and dimensions of the illustrated details may be of any kind depending on the requirements, and that the same may be substituted by others of a technically equivalent type.

Claims

1. An anti-intrusion detecting device (1), especially for doors and windows, applicable on the outside of buildings, on at least one opening (40) to be pro-

tected from a crossing, **characterized in that** it incorporates at least two different types of sensing devices (2, 3), each of which functions according to a determined physical principle of detection and each of which exhibits different volumes (44, 45) and different areas (4, 5) of sensitivity.

2. A detecting device (1) according to claim 1, **characterized in that** said sensing devices (2, 3) comprise at least one first sensor (2) of a passive infrared type, and at least one second sensor (3) of a microwave type.

3. A detecting device (1) according to claim 2, **characterized in that** said first sensor (2) of an infrared type exhibits an area of sensitivity separated in space from that of said second sensor (3) of a microwave type.

4. A detecting device (1) according to claim 1, **characterized in that** it provides for protection and safety devices against damage, such as, for instance, a vibration sensor, capable of generating an alarm in case percussions applied in an attempt of damaging it.

5. A detecting device (1) according to claim 2, **characterized in that** said first sensor (2) of a passive infrared type and said second sensor (3) of a microwave type supply, in case of a crossing of the sensitive area on the part of ill-intentioned persons, a multiple number of signals (23, 24) to processing circuits (9), so that the outlet signals (25, 26, 27, 28) from said processing circuits (9) are respectively sent to an acoustic signaler (15) , to a radio transmitter (10), to outlet circuits (11) and eventually to a lighting lamp (12) built into the enclosure (41) of said detector (1).

6. A detecting device (1) according to claim 5, **characterized in that** said outlet circuits (11) comprise a relay of a bi-stable type to limit the power consumption to the utmost, whose outlet may actuate external electric devices.

7. A detecting device (1) according to claim 5, **characterized in that** said lighting lamp (12) receives its energy directly from the external electric network (29) and is connected to the circuits of the detector (1) by a switching-on control (28) or by an external control. (35).

8. A detecting device (1) according to claim 5, **characterized in that** said signal processing devices (9) are installed within an alarm processing center and that said first sensor (2) and second sensor (3) are connected to said radio transmitter (10) which, after coding the alarm information of said sensors (2, 3), transmits them to said center, where said information is processed.

9. A detecting device (1) according to claim 4, **characterized in that** said alarm is generated based on the activation in sequence of both the microwave sensor (3) and passive infrared sensor (2), respectively.

10. A detecting device (1) according to claim 9, **characterized in that** the passage of a person inside the volume (45) controlled by said microwave sensor (3) activates a first impulse-bearing signal (24), while the subsequent crossing of said volume (44) controlled by the passive infrared sensor (2) generates a second impulse-bearing signal (23), where said first impulse-bearing signal (24) is extended by at least one first mono-stable "re-triggerable" electronic device (39a), so as to determine an impulse at the outlet (32) which limits the time span (T1), programmable by a user, within which the arrival of said second impulse-bearing signal (23) can trigger the alarm, by an alarm signal (26).

11. A detecting device (1) according to claim 10, **characterized in that**, at every activation of said first impulse-bearing signal (24), at least one second mono-stable "re-triggerable" device (39b) further activates itself, which supplies an outlet impulse (28) of a pre-established and adjustable duration (T2), where said impulse (28) is utilized to control the switching-on of said lighting lamp (12).

Fig.1

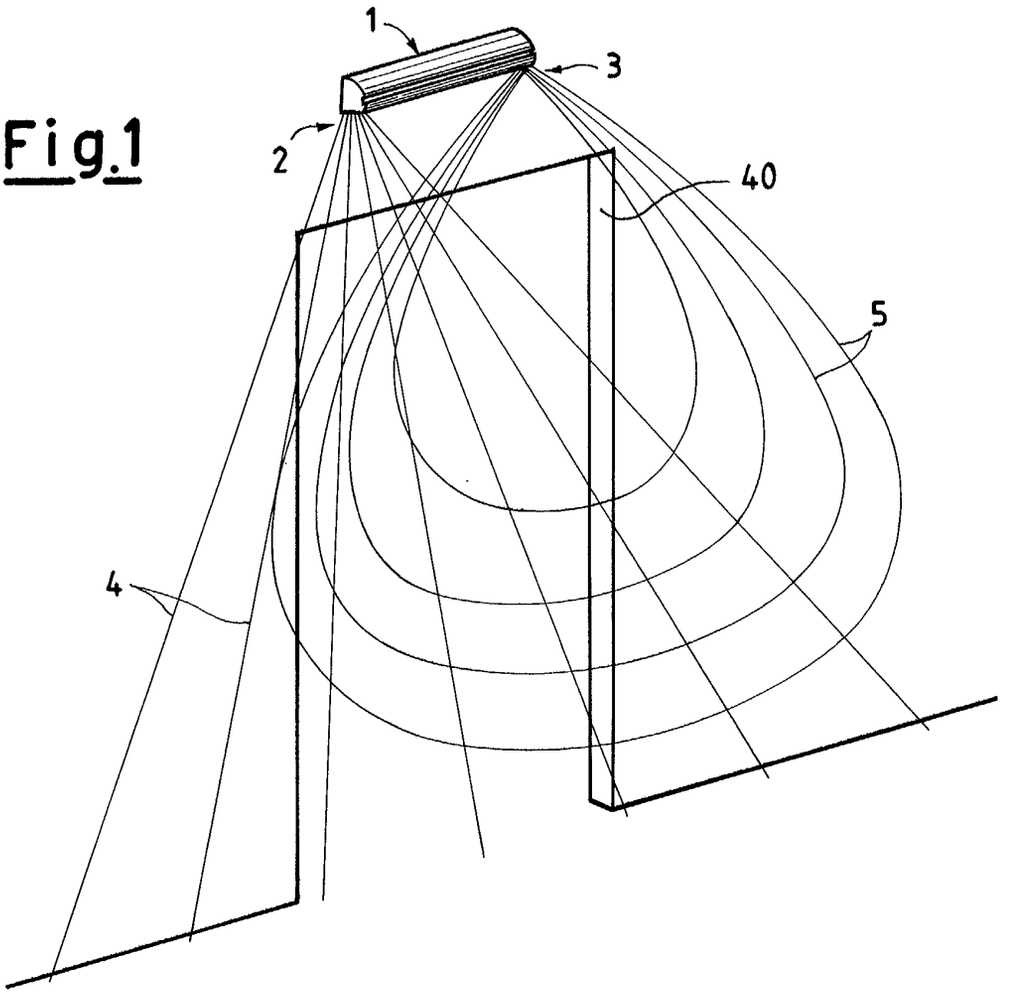


Fig.2

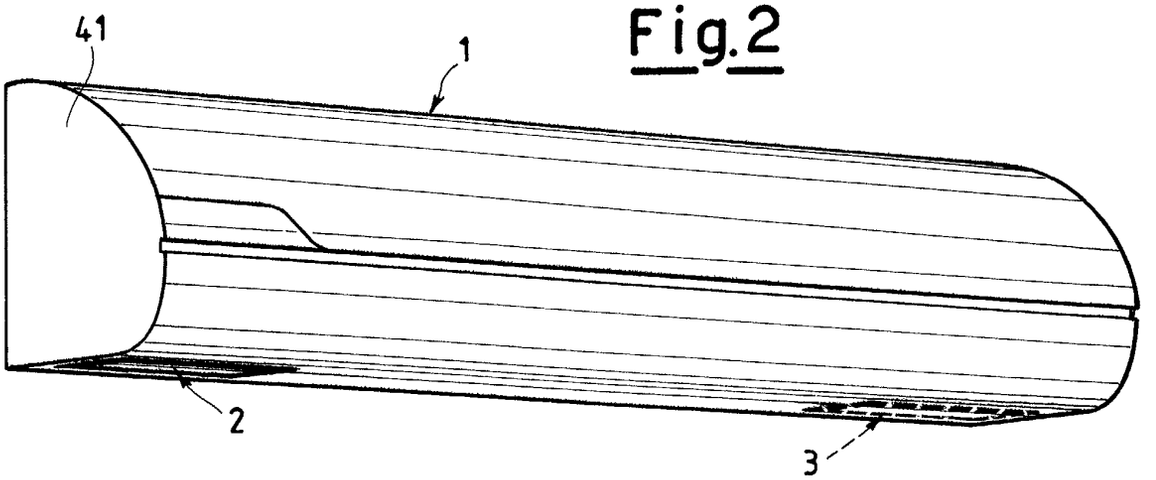


Fig.3

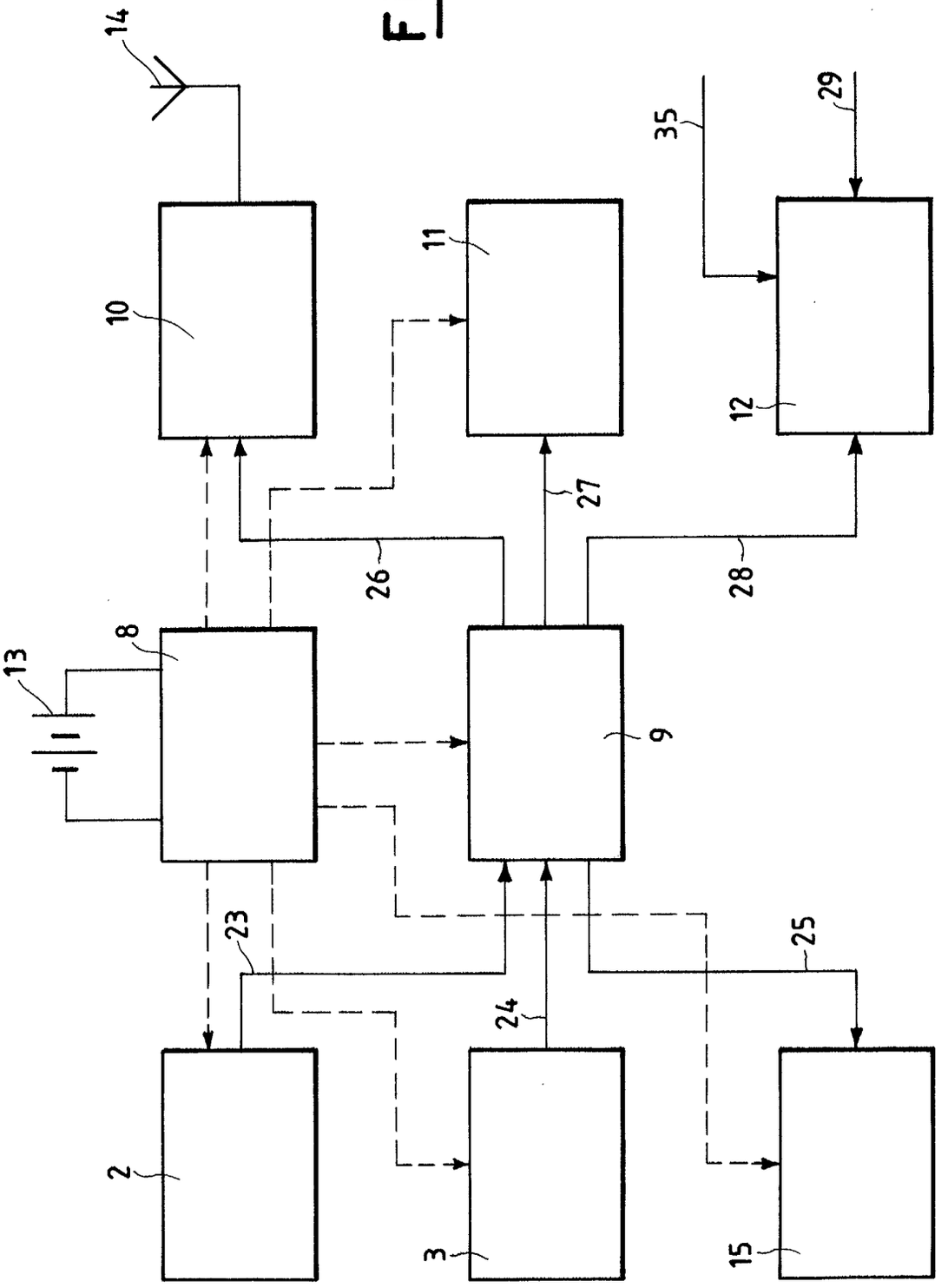
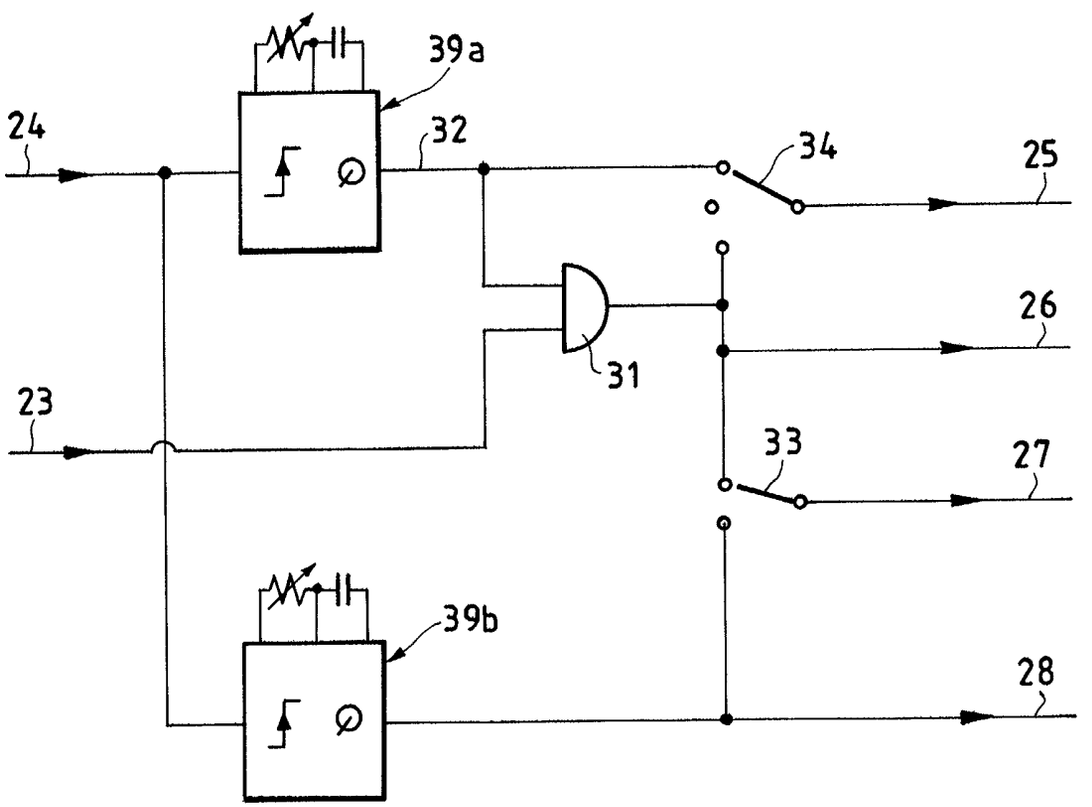


Fig.4



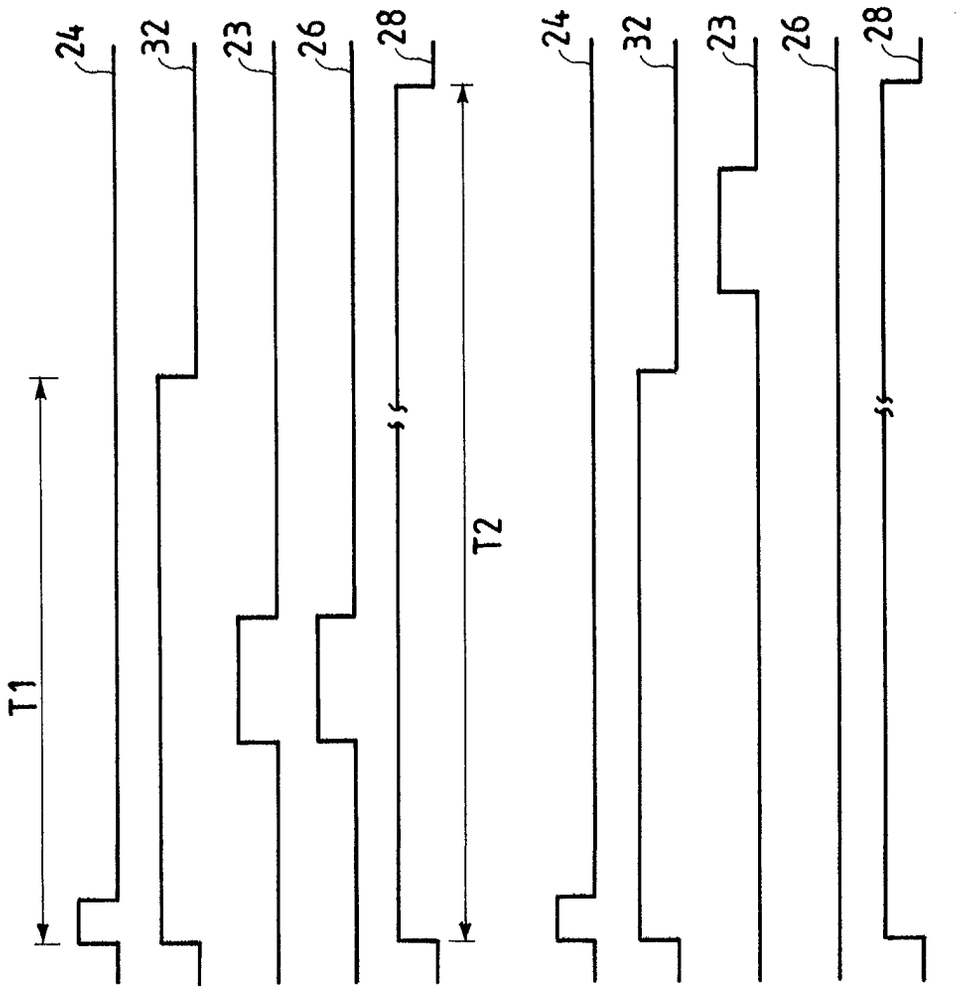


Fig.4A

Fig.4B

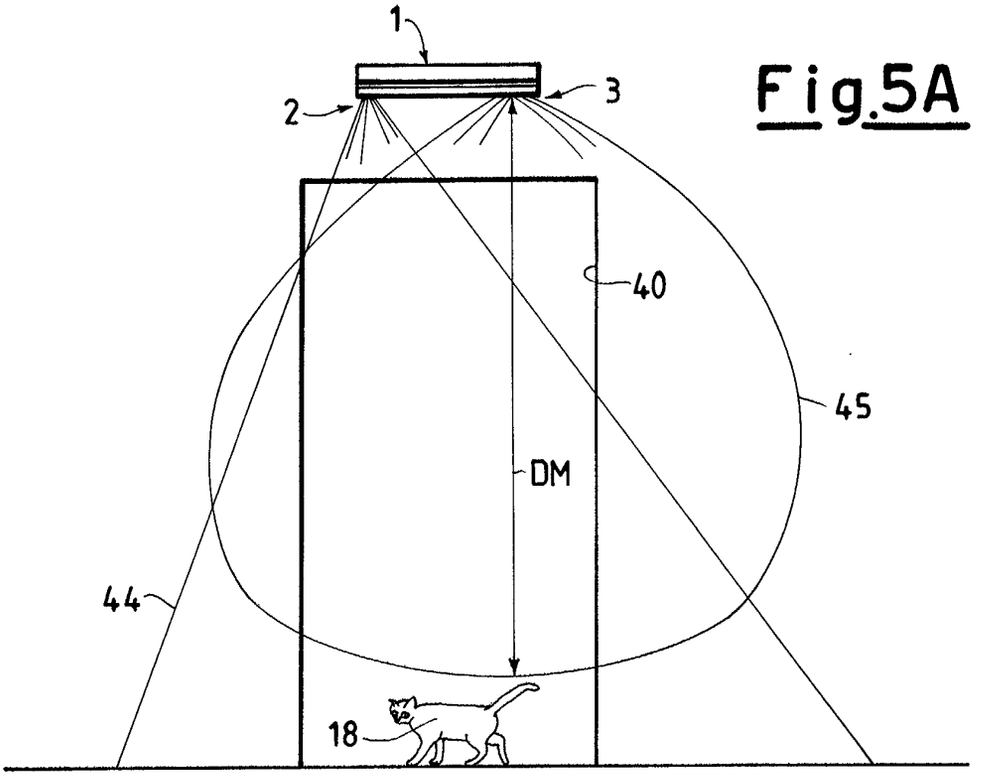


Fig.5A

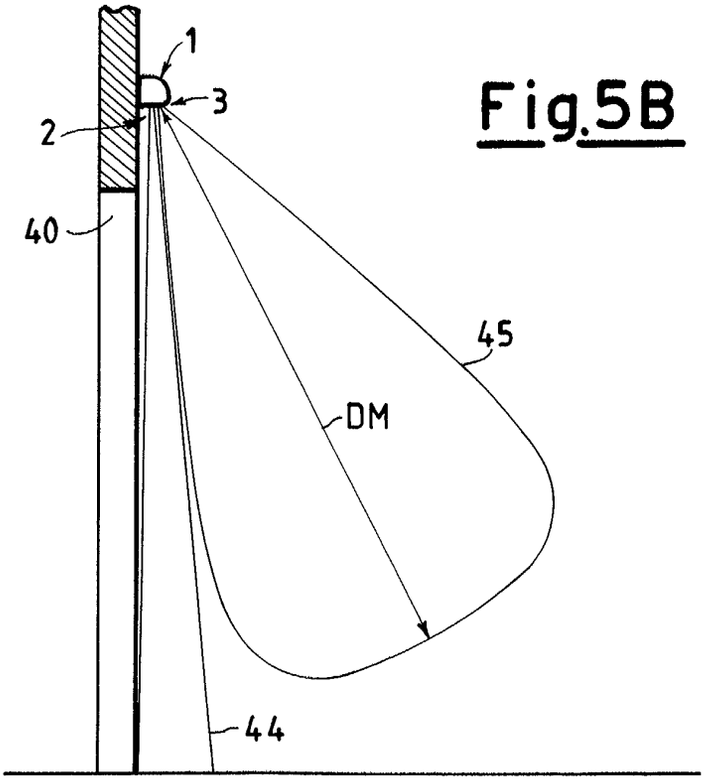


Fig.5B