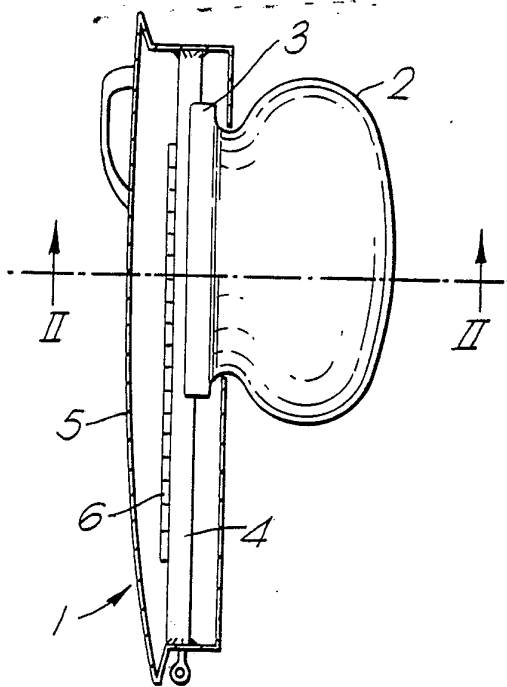




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<p>(21) International Application Number: PCT/SE89/00708 (22) International Filing Date: 4 December 1989 (04.12.89) (30) Priority data: 8828360.1 5 December 1988 (05.12.88) GB (71) Applicant (for all designated States except US): AUTOLIV DEVELOPMENT AB [SE/SE]; Box 104, S-447 00 Vårgårda (SE). (72) Inventors; and (75) Inventors/Applicants (for US only) : OLSSON, Jan [SE/SE]; Åsvägen 13 B, S-433 63 Partille (SE). SKÖTTE, Lars-Gunnar [SE/SE]; Vidblicksgatan 13, S-412 57 Göteborg (SE). JAKOBSSON, Peter [SE/SE]; Gräbergsvägen 18 C, S-441 41 Alingsås (SE). (74) Agent: MEULLER, Erik; Autoliv Development AB, Patentavdelningen, Box 104, S-447 00 Vårgårda (SE).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US. Published <i>With international search report.</i></p>

(54) Title: A TRIGGER CIRCUIT ARRANGEMENT



(57) Abstract

A safety device in a motor vehicle comprises an air-bag (2) which is triggered in response to a side impact. The triggering arrangement (6) comprises sensors (12-19; S_{1n} , S_{2n}) which respond to deformation of the skin (5) forming the side of the motor vehicle. The sensors are divided into two groups (12-15, 16-19; S_{1n} , S_{2n}) and at least one sensor in each group must be activated for the air-bag (2) to be inflated. Each sensor may comprise a switch (12-19) which is formed from a printed circuit board (7) carrying adjacent signal tracks (20, 21; 25, 26) with inter-digitated fingers (22, 23) which can be pressed against a contact pad (11).

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"A trigger circuit arrangement"

THE PRESENT INVENTION relates to a trigger circuit arrangement and more particularly relates to a trigger circuit arrangement suitable for use in connection with a safety device mounted on a vehicle intended to be responsive to side impacts. Such a device may be an inflatable bag, such as a so-called "air-bag" although the bag in question may be of a relatively low cubic capacity and may thus be termed an "inflatable side padding".

In connection with safety devices mounted on vehicles it has been proposed before to utilise triggering devices which are responsive to severe deceleration, such as encountered by the vehicle during a front impact, to trigger the safety device. The safety device may be, in such prior art proposals, either an air-bag, which is inflated to provide a cushion to protect a person travelling in the vehicle, or a device such as safety belt pre-tensioner which applies a tension to a safety belt in order to restrain a person firmly in his or her seat within the motor vehicle.

When a motor vehicle is subjected to a front impact, the vehicle decelerates over a period of time, as the crumple-zone which is normally built into the front of the vehicle, deforms. This provides a period of time during which safety devices of the type discussed above can be activated to provide the best prac-

licable protection for a person travelling in the motor vehicle.

However, when a motor vehicle is subjected to a side impact, for example when another vehicle fails to stop at a cross-roads or other road junction and impacts into the side of the vehicle with a substantial velocity, there is only a very brief period of time available to activate any safety devices if they are to be of any value.

Since the side of a motor vehicle is, generally speaking, not very strong, when a vehicle is subjected to a side impact, there is only a very brief period of time between the commencement of the accident and the time at which the side of the motor vehicle is so severely deformed that the driver or passenger of the motor vehicle is injured.

It is not practicable to utilise conventional inertia devices to detect a side impact if the response to the side impact is going to be sufficiently swift to be of value. By the time a conventional inertia device has responded to a side impact of any severity, the driver or passenger within the vehicle will probably have suffered severe injuries.

The present invention thus seeks to provide a trigger circuit which will provide a very swift response to a side impact.

According to this invention there is provided a triggering arrangement for activating a safety device in a vehicle and adapted to respond to a side impact of the vehicle, said triggering arrangement comprising a plurality of sensors divided into two groups of sensors, each group comprising one or more sensors, the trigger-

ing arrangement adapted to respond when at least one sensor from each group is activated, each sensor being adapted to be activated in response to a side impact on the motor vehicle.

Conveniently each sensor is adapted to respond to deformation of the skin forming the side of the vehicle.

Preferably the triggering arrangement is adapted to trigger an inflatable air-bag or inflatable padding which is mounted on a vehicle door.

Advantageously the or each sensor is mounted on a reinforcement bar mounted in a motor vehicle door.

Preferably the or each sensor is in the form of an electric switch.

Preferably each sensor is a piezo-electric sensor.

Preferably the switch comprises a laminate structure comprising means supporting a conductive surface and, spaced therefrom, a flexible or deformable printed circuit element carrying adjacent conductive areas forming parts of discrete signal tracks, such that on deformation of the printed circuit board the areas of track are both brought into contact with said conductive region.

Conveniently one group of sensors is connected between an igniter for an air-bag or the like and the chassis of a vehicle and the other group of sensors is connected between the air-bag and the battery of the vehicle.

The invention also relates to a triggering arrangement according to any one of the proceeding Claims in combination with an air-bag or inflatable padding.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which

FIGURE 1 is a horizontal sectional view of a car door incorporating a trigger circuit in accordance with the invention,

FIGURE 2 is a vertical sectional view of the door of Figure 1,

FIGURE 3 is a view of a printed circuit board forming part of the triggering circuit of Figures 1 and 2,

FIGURE 4 is an enlarged view of part of the circuit board of Figure 3,

FIGURE 5 is a cross-sectional view through the circuit board and an associated circuit board arrangement forming part of the triggering circuit,

FIGURE 6 is an elevational view of the parts of the triggering circuit as shown in Figure 5 other than the printed circuit board of Figure 4,

FIGURE 7 is an equivalent circuit diagram of the arrangement of Figures 1 to 6, and

FIGURE 8 is an alternative circuit diagram.

Referring initially to Figures 1 and 2 of the drawings, a door 1 of a motor vehicle such as a motor car is illustrated. Contained within the door, under ordinary circumstances, is an inflatable air-bag or inflatable padding 2, but in the accompanying drawings the air-bag or padding is shown in the inflated condition. Associated with the inflatable air-bag or padding is a gas generator 3. The gas generator contains a charge which is ignited electrically to produce, in a very brief period of time, a significant volume of gas which serves to inflate the bag to have the condition illustrated in Figures 1 and 2.

Contained within the door 1 is a horizontally extending re-inforcing bar 4 and mounted on the side of the re-inforcing bar 4 which faces the outer skin 5 of the door is a triggering switch arrangement 6 which will be described with reference to Figures 3 to 6.

The triggering arrangement 6 incorporates a laminate structure comprising an outer flexible printed circuit board 7, which is illustrated in Figures 3 and 4, a central insulating panel 8 provided with a plurality of apertures 9 therein and a rear board 10 provided with selected areas of electrically conductive coating 11 thereon. The electrically conductive areas 11 are of rectangular form and are substantially aligned with the apertures 9.

Returning to Figures 3 and 4 the elongate printed circuit board 7 carries thereon a metalised pattern which defines a first series of switch elements 12,13,14,15 and a second series of switch elements 16,17,18,19. The switch element 13 is shown on an enlarged scale in Figure 4.

The switch element 13 effectively comprises

two conductive paths or tracks 20,21 formed on the printed circuit board, these paths or tracks within the operative area of the switch defining a plurality of inter-digitated fingers 22,23. The fingers 22 all form part of the track 20 and the fingers 23 all form part of the track 21. The area of the track in which the inter-digitated fingers are present is aligned with the aperture 9 formed in the insulating panel of the laminated structure and as can be seen from Figure 5 the region of the inter-digitated fingers is thus opposed to the conductive area 11 (which is an isolated area and which is not in contact with any other conductive element) but is spaced therefrom by an air gap 24. It will thus be appreciated that if the region of the printed circuit board 7 which carries the inter-digitated fingers 22 and 23 is deformed so that those fingers are brought into contact with the region of metalisation 11 exposed through the aperture 9, then an electrical contact will be created between the signal tracks 20 and 21.

It can be seen that the region of the printed circuit board 7 which comprises the switching element 13 also includes two further signal tracks 25 and 26. As can be seen from Figure 3 these signals tracks extend past the switching element 13 and extend to another switching element 17 which is of identical construction.

The printed circuit board of Figure 7 thus presents two signals tracks 20,21 which are associated with four switching elements 12,13,14 and 15 and also carries two signal tracks 25,26 which are associated with four switching elements 16,17,18 and 19. If any one of the switching elements 12,13,14 or 15 is activated a short circuit will exist between the signal tracks 20 and 21 and similarly if any one of the switching elements 16,17,18 and 19 is activated a short cir-

cuit will exist between the switching elements 25 and 26.

It will be appreciated that whilst the printed circuit board 7 has been shown as carrying eight switching elements, the circuit board 11 could be made longer and could incorporate a greater number of switching elements.

It is envisaged that the switching elements illustrated in Figure 3 will be connected electrically to a squib 27, which acts an igniter to the charge present in the gas generator 3 in the manner illustrated in Figure 7. Thus one signal track 20 is connected to the battery 28 of the motor vehicle, whereas the other track 21 is connected to the igniter 27. The tracks 20 and 21 are effectively inter-connected by the switching elements 12,13 etc., which can act in the manner of independently operating switches. Similarly the signal track 25 is connected to the body or chassis of the motor vehicle, whereas the signal track 26 is connected to the squib or igniter 27. Again the signal tracks 25 and 26 are inter-connected by means of the switching elements 16,17 etc. which can again act as independently operating switches.

It will be observed, from Figure 7, that the igniter 27 will be ignited when one of the switches 12,13 etc. is closed and when simultaneously one of the switches 16,17 etc. is closed. However, under normal circumstances the igniter 27 is totally electrically isolated. Thus in normal circumstances the igniter is not electrically connected to the chassis of the vehicle, and is not electrically connected to the battery of the vehicle. Thus the risk of the igniter being inadvertently activated is minimised.

In the event of a side impact arising the outer skin 5 of the door will be deformed inwardly. When the skin has been deformed inwardly by a sufficient extent to touch the triggering circuit 6 mounted on the re-inforcing bar 4, with sufficient force to deform the flexible printed circuit board 7 in the region of two separate switching elements, one of the switching elements belonging to the series of switching elements 12,13,14,15 and the other switching element belonging to the series 16,17,18 and 19, then the air-bag or inflatable side padding 2 is rapidly inflated.

It is to be appreciated that since two switching elements must be actuated there is only a minimal chance of the air-bag being inflated accidentally or inadvertently.

Whilst the invention has been described with reference to one embodiment it is to be appreciated that modifications may be effected without departing from the scope of the invention. It is to be appreciated that a plurality of sensors may be provided, comprising a first group of sensors designated as sensors S_{11} , S_{12}, S_{1N} , and also a second group of sensors designated as S_{21} , S_{22}, S_{2N} . The sensors of the first group of switches may be connected to an OR-gate 28 as shown in Figure 8 and the sensors of the second set may be connected to an OR-gate 29 as shown in Figure 8. Thus if any one of the sensors of the first group provides a signal the OR-gate 28 will pass a logic "1" whereas if any one of the second group of sensors provides a signal the OR-gate 29 will pass a logic "1". The sensors may comprise switches, or other devices such as piezo-electric sensors which generate a voltage when compressed.

The outputs of the logic gates 28 and 29 are

connected to an AND-gate 30 which will only pass a logic "1" when both the inputs to the AND-gate each simultaneously carry a logic "1". The output of the AND-gate 30 is connected to a switch such as a transistor switch 31 which is connected in series with the squib or igniter 27 between the battery 28 and the chassis of the motor vehicle. Thus, in such an embodiment if two sensors are both activated simultaneously, the sensors being selected from different groups of sensors, then the squib is triggered and the air-bag becomes inflated.

Whilst this embodiment of the invention has been described with reference to an electronic logic arrangement it is to be appreciated that in an alternative embodiment of the invention the sensors and the logic may, for example, be fluidic, providing an output which is capable of triggering the squib 27.

CLAIMS:

1. A triggering arrangement for activating a safety device in a vehicle and adapted to respond to a side impact of the vehicle, said triggering arrangement comprising a plurality of sensors divided into two groups of sensors, each group comprising one or more sensors, the triggering arrangement adapted to respond when at least one sensor from each group is activated, each sensor being adapted to be activated in response to a side impact on the motor vehicle.

2. A triggering arrangement according to Claim 1 wherein each sensor is adapted to respond to deformation of the skin forming the side of the vehicle.

3. A triggering arrangement according to any one of the preceding Claims wherein the triggering arrangement is adapted to trigger an inflatable air-bag or inflatable padding which is mounted on a vehicle door.

4. A triggering arrangement according to any one of the preceding Claims wherein the or each sensor is mounted on a reinforcement bar mounted in a motor vehicle door.

5. A triggering arrangement according to any one of the preceding Claims wherein the or each sensor is in the form of an electric switch.

6. A triggering arrangement according to any one of Claims 1 to 4 wherein each sensor is a piezo-electric sensor.

7. A triggering arrangement according to Claim 5

wherein the switch comprises a laminate structure comprising means supporting a conductive surface and, spaced therefrom, a flexible or deformable printed circuit element carrying adjacent conductive areas forming parts of discrete signal tracks, such that on deformation of the printed circuit board the areas of track are both brought into contact with said conductive region.

8. A triggering arrangement according to Claim 5 or 7 wherein one group of sensors is connected between an igniter for an air-bag or the like and the chassis of a vehicle and the other group of sensors is connected between the air-bag and the battery of the vehicle.

9. A triggering arrangement according to any one of the preceding Claims in combination with an air-bag or inflatable padding.

Fig. 1.

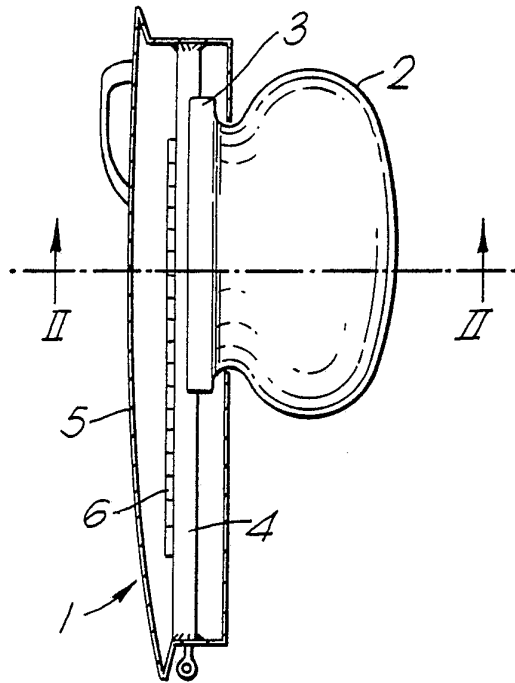


Fig. 2.

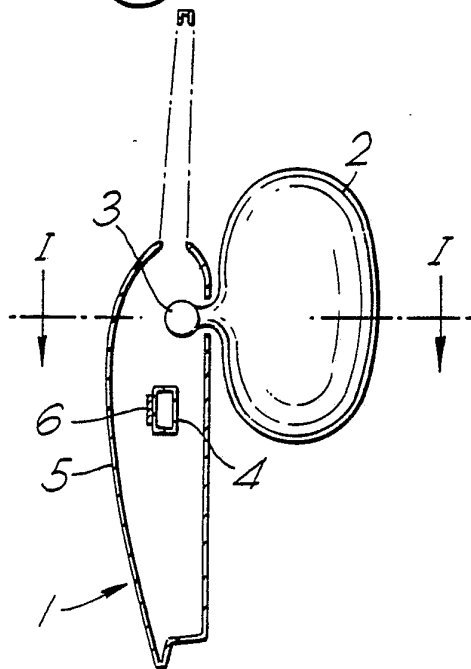
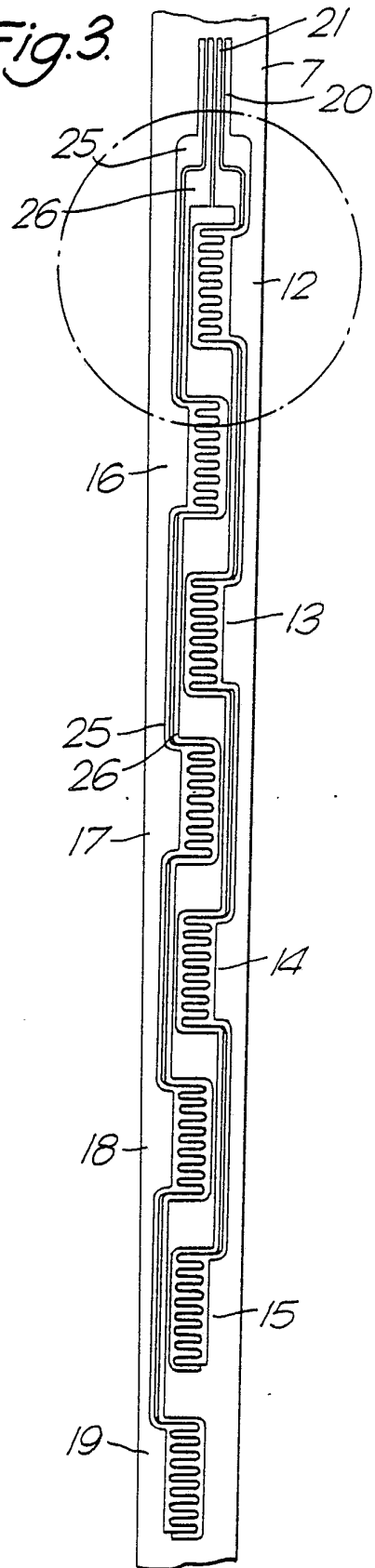


Fig. 3.



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Fig. 4.

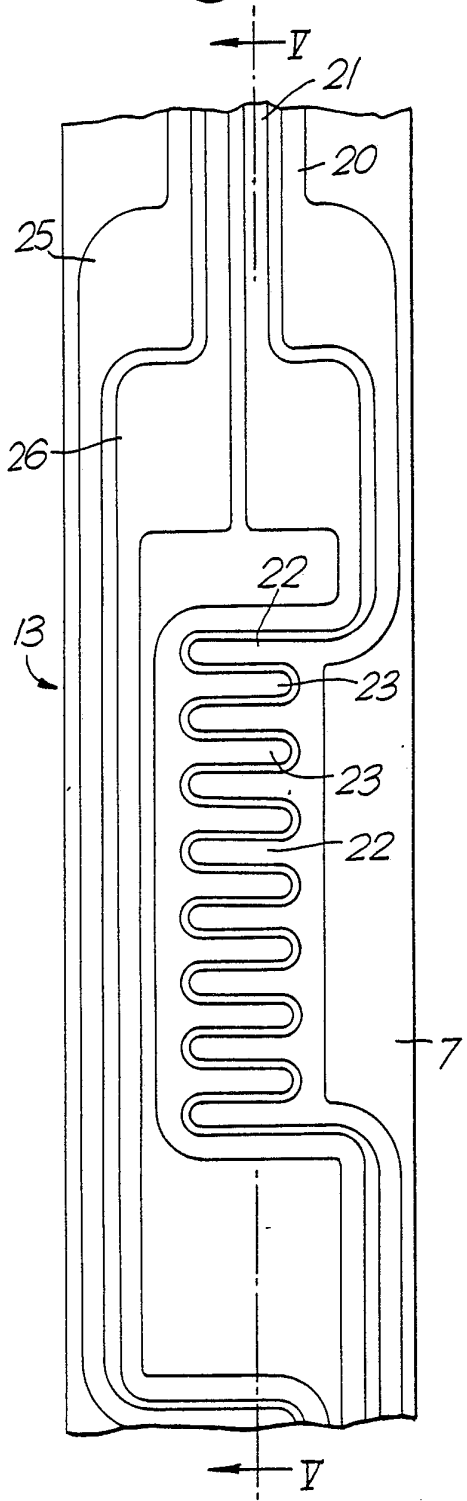


Fig. 5.

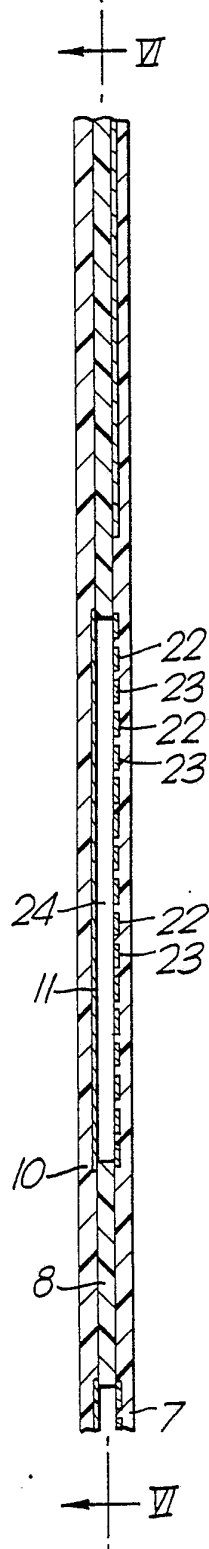


Fig. 6.

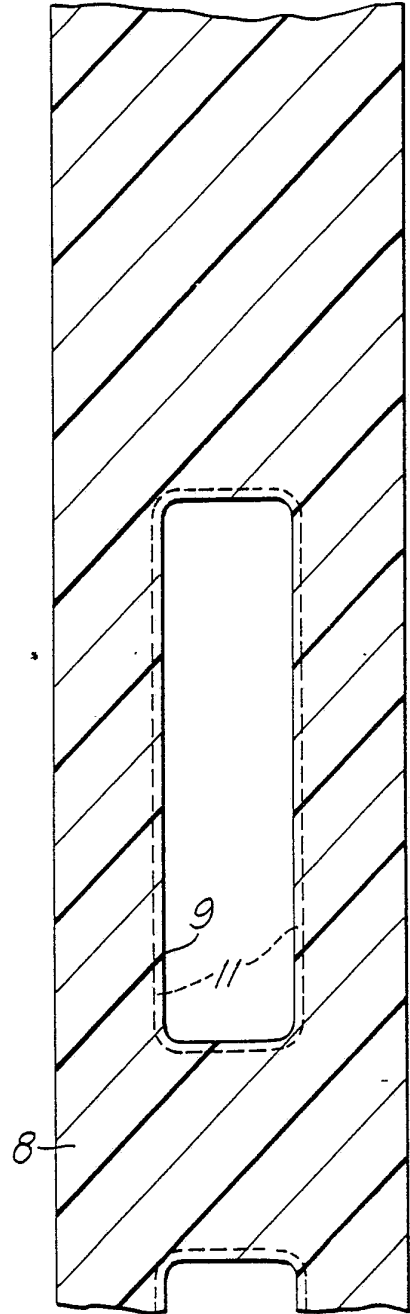
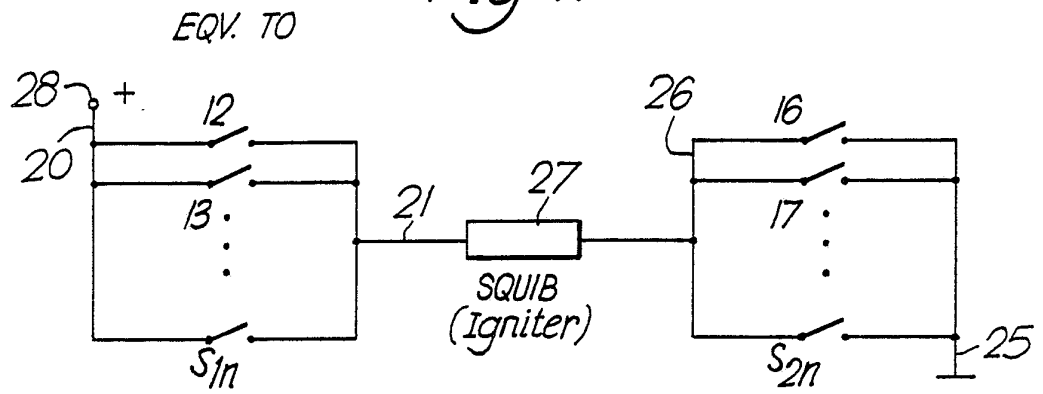
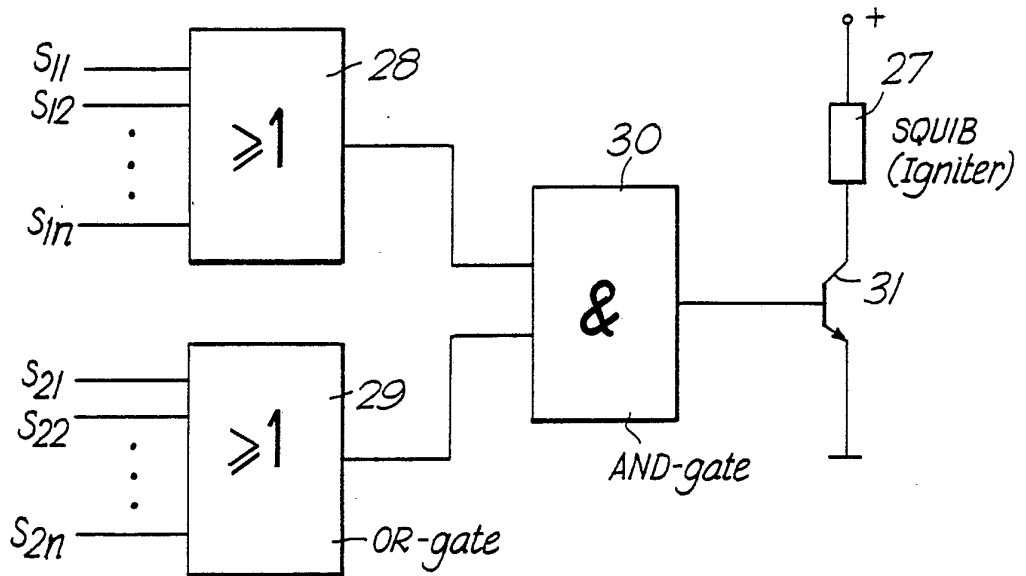


Fig. 7.



MULTIPLE SENSORS

Fig. 8.



INTERNATIONAL SEARCH REPORT

International Application No **PCT/SE 89/00708**

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC5: B 60 R 21/32		
II. FIELDS SEARCHED		
Minimum Documentation Searched		
Classification System	Classification Symbols	
IPC5	B 60 R; H01 H	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
SE,DK,FI,NO classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	DE, A1, 3716168 (BAYERISCHE MOTOREN WERKE AG) 24 November 1988, see the whole document --	1-6,8,9
X	SE, B, 362835 (NISSAN MOTOR CO., LTD) 27 December 1973, see the whole document	1-5,8,9
Y	--	7
X	DE, A, 2212190 (VOLKSWAGENWERK AG) 27 September 1973, see the whole document	1-5,8,9
Y	--	7
Y	SE, B, 452925 (FRANKLIN NEAL EVENTOFF) 21 December 1987, see the whole document --	7
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
8th February 1990		1990 -02- 15
International Searching Authority		Signature of Authorized Officer
SWEDISH PATENT OFFICE		Hans Nordström

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
P	DE, A1, 3729021 (MESSERSCHMITT-BÖLKOW-BLOMH GMBH) 16 March 1989, see the whole document --	
A	DE, A1, 3704331 (VOLKSWAGEN AG) 10 September 1987, see the whole document -- -----	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 89/00708**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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SE-B- 362835	27/12/73	GB-A- 1356178 CA-A- 941931 DE-A-B,C 2149158	12/06/74 12/02/74 06/04/72
DE-A- 2212190	27/09/73	NONE	
SE-B- 452925	21/12/87	GB-A-B- 2064873 FR-A-B- 2470435 US-A- 4268815 NL-A- 8006409 DE-A- 3044384 AU-D- 64679/80 SE-A- 8008205 CA-A- 1153801 CA-A- 1153577 CA-A- 1153802 CA-A- 1153803 CA-A- 1161921 GB-A-B- 2134320 GB-A-B- 2134321 GB-A-B- 2134322 AU-A- 544234 US-A- 4276538 JP-A- 1125871 US-A- 4301337 US-A- 4315238 CA-A- 1143030 US-A- 4314228	17/06/81 29/05/81 19/05/81 16/06/81 27/08/81 04/06/81 27/05/81 13/09/83 13/09/83 13/09/83 13/09/83 07/02/84 08/08/84 08/08/84 08/08/84 23/05/85 30/06/81 18/05/89 17/11/81 09/02/82 15/03/83 02/02/82
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